

Maximum Muscle

The Science of Intelligent Physique
Development

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Introduction

I started writing this back in 2006. In that span of three odd years I alternately wrote, got bored, got tired of writing, got sick of the fitness industry, then threw it out and started all over again. Three times. That totaled three manuscripts long enough to be books. You may not think it's a big deal, and in the scheme of things it's not. You may not even care, and I wouldn't blame you, but that's the price you pay for reading somebody's introduction. The point is, I don't want anyone to think this is some fly-by-night project I threw together on a whim.

In a lot of ways, I wrote this for myself as much as anyone else. I've got a lot of thoughts on the subject, and putting them on paper has always been the best way to organize them. It's interesting how concepts seem to crystallize when you have to state them in a way that others can understand and digest.

There's another purpose, so now let me bore you with a little of my life's story. Once upon a time I was the clueless newbie ambling around the gym, mindlessly following bodybuilding routines from the magazines. I was that guy we all see doing 10 kinds of curls, benching way too much weight, and squatting with the little dippy-doo knee-bends that seem to pass for squats. I didn't know any better; hell, I didn't even realize there was a problem, let alone that I needed to improve. All the big jacked guys I saw were doing about the same thing, near as I could tell, so the rational conclusion was that if I did the same thing, I'd get there sooner or later.

I started 'working out' when I was 18, towards the end of high school. Unlike a lot of the weight-training crowd, I never played any sports and I don't come from a terribly athletic background, which I realize makes me an outlier. I ended up taking a weight-training class during my last year of high school just to get out of an hour each day. For some odd reason I wasn't allowed to just go home, so I had to have a class. Being that I was barely coming to school as it was, I figured why not throw in another PE credit?

Funny thing, I found I enjoyed it. A lot. There was something fun and alluring about moving weights around. This may not seem a big deal to a lot of you, but you have to understand that at the time, anything remotely physical was completely antithetical to my world-view. I'd always been the nerd-guy, the slacker guy, and it had literally never occurred to me that I could go lift weights and actually do something productive with it. And boy did that ever show. I've got a small build even now; back then, I was lucky to clock in at 125 pounds. I'm around 5'8, maybe 5'9, just for reference, and haven't grown much taller since those days.

That was my first taste of Iron and the results it can bring. Now I'm not going to get all Henry Rollins poetic on you here; I'm just making the point that I came from humble beginnings.

Like all guys that age, I was in it to get jacked so I could get the babes. We can dress it up all day long, but narcissism is the main reason people exercise. At that point I was pretty much the poster-boy for the stereotypical clueless 18 year old guy at the gym, which meant you'd go to the gym as much as possible, follow some split routine from the magazines (which really meant bench press and 10 kinds of curls 5-6 days a week), and eat a very poor diet and while spending as much money as possible on supplements.

I guess I do get points for consistency, because I did stick to it religiously, and I did put on around 30 pounds in the first couple of months – right up to a whopping 155 pounds. Looking back, considering that I ate virtually nothing, I'm pretty well convinced that 150-160 is where my body wanted to be in the first place, so I don't consider that much of a victory. At that stage I was just making up the deficit.

In any event, I was fortunate enough to stumble on to powerlifting and other strength sports over on Jason Burnell's Deepsquatter site (which is still around over at www.deepsquatter.com). That was a different time on the Internet, when you could actually trust some of the information you found. When you're used to nothing but the muscle-group splits from the rags at the newsstand and what all the other kids at the gym are telling

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you, powerlifting routines are a whole new ballpark. I read up on the sport and started doing the routines. Next thing you know, I'm getting stronger and getting bigger to go along with it.

Fast forward ten years later. I've broken the 200 pound barrier (which was a hell of a milestone for little me, you must understand), gotten fairly strong by average-folk standards, and gotten myself hurt. Bodybuilding, powerlifting, rehab. The circle of life. Fortunately, this can be useful for you readers. While all that was going on, I've picked up quite a bit of information. I've trained some folks. I've talked shop with some of the best in the field, and I've even read a few research papers on the matter. And that's as far as I'm going with the self-aggrandizement.

I'm far from the only game in town (and certainly won't call myself the best, by any stretch), but I like to think I've got some experiences and a whole lot of Labcoat-theory to spread around. This book is especially targeted towards you clueless types, male and female alike, that want to start the process of 'getting in shape' but have no idea where to look.

I'm a perfectionist when it comes to things that have my name on them. I don't want to be associated with sub-par work, and that's a big part of why this project has been delayed so long. Collecting, reading, and processing research isn't easy or simple, and frankly the only reason this is out now is because I had to tell myself to stop and just release it. If I did things the way I wanted, you'd never see it because I'd still be digging through Pubmed for more data. Even now, after the draft is completed, I still see new studies pop up; it takes will power to ignore them and carry on.

While I'm on that subject, I do have to thank the whole group over on the Monkey Island for generously providing me with research when I needed it (you know who you are) and for the labcoat proving ground. A lot of the ideas presented here were fleshed out over there, by bouncing ideas off other like-minded folks in our lovingly named 'wanking threads', so they collectively deserve a lot of credit.

Regarding the book itself, I'm making a departure from the standard weight-training and exercise books. Generally those all follow the same template: lay out some science, then give you some pre-formatted workouts to do along with some pretty pictures showing how to do all the nifty exercises. These days, the market is pretty much saturated with these things, and even worse, the programs they give you aren't all that different from one another. Which isn't bad in itself, but it's a bit shady when said book is predicated on selling you that particular program (even going so far as to claim said program as proprietary information).

This isn't a step-by-step manual with nicely-formatted tables of workouts and pretty pictures of exercises. It's an analysis of *why*. My premise is not that solid information is hard to come by; my premise is that people aren't even thinking about the subject with the right mindset. I want to tear down all your preconceptions and start from sturdier ground.

There's four chapters in total, and the very first is where things start to deviate from the usual path. I'm going to touch on the concepts of logic and reasoning as they apply to the fitness industry. I want to examine where both research and anecdote fit into the picture, and why a lot of assumptions the general public tends to hold may not stand up to scrutiny. This may bore you, you might hate it, but in its own way critical thinking is necessary considering my thesis. Information isn't the problem and never has been. *How you look at information* is the piece of the equation that's so often missed, and worse, the Fitness Industry is complicit with this problem. That's going to be chapter one.

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Chapter two is going to be the in-depth look at the physiology that underlies exercise, with a lean towards the process of muscle growth. This is where I have the greatest chance of losing people, because there's only so much you can water things down without losing the meaning. I could have taken the mass-marketing approach and opted for the least-common-denominator style of science-writing, but I chose to uphold some standards. The good news is that chapter two, while not superfluous, isn't essential to understand the rest of the book, so you don't *have* to understand more than the basic concepts – and I do go out of my way to make those accessible. You won't be worse off for having read it, but if it just gets over your head, you can skip ahead and not be horribly lost.

Chapter three is still pretty sciency, but it's geared more towards the specifics of weight training and exercise, so it's much easier to put into digestible terms. If I lose you here, just give up. Seriously though, it's the same concept as chapter two: take the concepts that 'everyone knows' and then stand them on their collective heads. It's part myth-busting, part road-map.

Finally chapters four and five will take everything else and weave it together into some usable guidelines that you can take with you to the gym. The goal of these chapters will be to not just give you a list of rules or some cookie-cutter program that I slapped together, but to show how other programs put those rules into practice. I'm going to deconstruct the entire concept of the 'program' as you might understand it.

By the time it's over, I want you to not only have more facts in your head, but to look at those facts in a different way.

A lofty goal, you say? Without a doubt. But I don't feel anything is lost for making the attempt. Some people will love it, while some will hate it and feel that this whole thing is a waste of their time. All I can do is all I can do.

A note on reference citations: I've cited any claims that came directly from research. However in some sections, just due to the subject matter it was impossible to cite each and every claim as much of it fell under the category of general knowledge – such as the sections on basic physiology. I opted to list the source material in the reference list at the end of the book instead of cluttering the text with things that maybe five of you will care about in the first place. If I drew upon it to write this, it's in the citations list.

Even making it a point to draw on review papers whenever possible, the reference list is still well over 200 citations. If I'd gone full-bore this could potentially reach over a thousand – since this isn't an academic work targeted to an academic audience, I feel that my shortcuts can be excused. If you feel that I'm missing a reference or that something is incomplete, by all means let me know. I really doubt this is going to inconvenience anyone reading this, but I do want it to be known in any event.

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In other words, you're free to share away, if that's your desire, as long as you point it back at me. Just be aware that there are repercussions for trying to sell this material, even if you get creative and 'put it in your own

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words'. This isn't 4th grade, and you don't have any reason for copying my book report. If you've got an idea to make money on this material, send me an email and we'll work something out.

Why am I doing this, you ask? I mean, aren't I basically ruining my business? According to the fitness industry, I should be selling this to you as aggressively as possible, using all manner of sales tactics and marketing wizardry to get you to give me money. Part of that business model includes aggressive rights management; after all, the information is the product. Doing something insane like releasing a product under a non-proprietary license is lunacy.

Maybe, maybe not. I've got a few reasons that have led me to this decision.

We live in a world now where information can no longer be considered proprietary intellectual property. The free exchange of ideas has been one of the hallmarks of the Internet since its foundation, and I consider myself a strong advocate of that movement – from open source software to file-sharing technologies. Copyright reform falls squarely under that umbrella.

I had originally planned to release this under the standard copyright restrictions and in a hard-copy format, which doesn't prevent piracy, but makes it a lot less convenient. Obviously I've changed my mind. At the end of the day I couldn't have written this book without the free and open exchange of information. I wrote it with OpenOffice.org Writer, which is an open-source alternative to Microsoft Office; the two images herein were made with the GIMP. It would be not only hypocritical but strangely ironic for me to try and make this into intellectual “property”.

Ultimately I just can't reconcile my pro-sharing viewpoint with what is now expected in the fitness industry. It would be fundamentally dishonest on my part. While I am asking for donations, at the end of the day that's up to you. If you feel this has been worth something to you, drop me a few bucks.

The most compelling reason is simple: I'm trying to distance myself from a fitness industry that *sorely* needs a new way of doing business, not to mention a good class on ethics.

To be less vague: I'm really sick and tired of the misinformation and dishonesty I see from “fitness experts”, whether they're on the Internet or in the gym (there's little difference), and I don't want any part of it. I'm tired of the crappy ad-copy pages. I'm tired of cheats and liars. I'm tired of people presenting themselves as authorities and still spreading crappy information. Information should not be reduced to a money-making opportunity for incompetents and con-men.

This is my first and only foray into this arena. While I feel that I've presented something worthwhile here, I simply have no desire to deal with it on a regular basis. A big part of me wanted to just trash it and not bother; but I'm not doing anyone a service by hoarding the information and ideas contained herein. Quite the contrary; I'm involved in the fitness industry precisely because I want to help people out.

So I'm releasing this book, free of charge and with a very generous licensing scheme. If the ability to spread this information around can help with some of the lunacy, then so be it. If it sucks and nobody cares, then nothing's lost.

Enjoy.

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Chapter 1: The Logic Of Exercise

TO REACH UNDERSTANDING, YOU NEED A FOUNDATION.

Since you're actually reading this, I'm assuming a few things about you, the reader.

First, you're at least somewhat interested in muscle mass, or more specifically, how to increase the amount you carry. In other words, you want bigger muscles. You might not realize this is your goal, however. You might just want to get 'in shape', or lose some fat, or even just look better.

You've probably spent some time in the gym. Maybe you've gotten results, maybe you haven't. You could just be interested in knowing more about the hows and whys, or you might be after some new ideas to improve your own training.

You could be tired of all the myths that people spread without any kind of proof. Or maybe you've had enough of marketing hype and just want a frank discussion of the facts.

Whatever your reasons, on some level, you're concerned with 'bodybuilding'. Allow me to elaborate on that before you freak out and think you've wasted money. By bodybuilding, I don't mean you want to step on stage in your underwear while covered in oil and fake tan. When I use the term 'bodybuilder' in this book, I'm referring to anyone that's concerned with improving his/her appearance with the use of exercise and nutrition strategies.

Don't freak out because you're not getting ready to step on stage. The way I'm defining it, the vast majority of people that exercise are 'bodybuilders' even though they have no competitive goals. Most people are just after visible abs, or bigger biceps, or whatever the fad is these days.

If you're concerned with getting a bigger squat or a faster sprint, odds are you're not going to pick up much here. I don't want to discourage you, but this book is mainly oriented around getting bigger muscles with the end-goal of making your body look pretty. A lot of the traditional rules and suggestions that given for athletes with an anti-bodybuilding stance aren't going to apply here.

I'm narrowing it down even further because there's going to be very little in the way of nutrition info here. I thought long and hard about that (not really), but the conclusion I reached was that, although nutrition is *absolutely vital* for muscle growth and being pretty – at least as important as anything I discuss here, if not more so – it's just outside the scope of this particular book. To be blunt, it's just not my area of expertise. While I can discuss the topic, I'd simply be rehashing other (superior) sources, and I don't see any need for that.

Now muscle, on the other hand – that's where I can break it down and talk shop. In contrast to diet information, I'm not aware of any works out there that are doing what I'm attempting here, which is to really sit down, have an honest look at what people do in the gym, and relate that to the research.

In particular, I want to address a lot of the myths that people hang on to and how exercise relates to the results people get. Most books on lifting look at the process from the top down. They start with a conclusion, then work backwards to find data that supports it. I'm doing the exact opposite here, going about things deductively – by examining the situation and using that to reach conclusions. To do that, I'll be diving into a good amount of scientific research. At times it can get a little thick, but I've done my best to keep it as easy a read as possible. Just be aware that when given the choice between oversimplifying and being correct, I'm going to go for correct.

The core of this book is actually logical reasoning and critical thinking. You thought you were buying a book about lifting? Well, you did. I'm just approaching this from an entirely new direction.

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You see, anybody can write about 'science'. You see it all the time. One of the most common things you'll see in fitness publications is some author grazing over the abstracts of a few papers, jumping to some hasty conclusions, and then claiming that his or her thoughts are based on science.

That's not what I'm after here.

Anybody can write about strength training, or diet, or bodybuilding. While there is some science involved in many cases, a lot of it is based on anecdote and on guys that are simply working to 'prove' conclusions they've already assumed are true. That's not productive - that's just reinforcing old myths and creating new ones.

This isn't just about science, about relaying all those sound-bite factoids and slogans that the fitness industry seems to build itself on. Yes, I'll be quoting research; quite a bit of it. At the core, I want it to be more than that. I want to go over the hows and whys of my reasoning. If you don't understand my thought process, then we won't be on the same page. One thing I find myself saying repeatedly is that having opinions and drawing conclusions is as much about the journey as the destination. *What* you think is not necessarily more important than *how* you think.

There's something to be said for having a rational thought process and having the tools required to evaluate information. If you aren't able to filter information, then you can come into a situation where even the broken clock is right just by coincidence. Is it really 6:42pm, or did you just happen to glance at the clock at the right time?

You may have the right facts, but you have no way to objectively know if you're really correct. This leads to an unfortunate situation; without the ability to separate the ice cream from the manure, you can fall into the trap of assuming that every viewpoint is equal and worth attention.

As unpopular an idea as it seems to be these days, some viewpoints are objectively more correct than others. Just because someone believes something or holds an opinion does not mean that viewpoint is right. If there is an overall theme to this book, besides 'get jacked', that would be it. My goal here is not just to give you information. My goal is to make sure you understand why I draw my conclusions.

To do that and make sure we're all on the same page, I'm going to raise the bar a little. This isn't just a matter of copying abstracts off of Pubmed and cherry-picking data that supports my pet conclusions. That happens enough already. Instead, we need to look at the tools of critical thinking. Everybody talks about science, but nobody actually looks at the underlying thought process. I'm a firm believer in using logic and basic common sense to cut through the garbage out there. If you can do that, then you've got a leg up on most people.

Why You're Reading This

If you're like the average person in the modern Western world, you don't get a lot of activity. Chances are your job has you sitting down most of the day. You probably don't eat that well. It's very likely that you don't look the way you'd like to look.

If you picked this up in the first place, I'd put very high odds on that last statement.

Question is, what do you do about it? If you're really honest with yourself, do you even know where to start making changes? You may have an idea about needing to exercise and eat better, but really, where do you start? You don't know, do you?

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I'm sure that you've got your own beliefs, shaped by things you've heard over the years. Things you've picked up on the news, things you've heard from buddies that lift, things that you remember from playing sports in high school.

But have you ever asked yourself if these things are *true*? We live in a time where anybody can just make a claim or have an opinion – and it will be taken as authority, regardless of evidence or proof.

One of the drawbacks of a media culture is that there's just no critical thinking. There are no standards of evidence. Simply stating something is enough for most people to assume it's true.

Maybe you're not the average guy. Maybe you've got some gym-cred. You've spent some time in the trenches. Maybe you've had some results. Trained some clients. Even done a show or two. Certainly you know what you're doing, right?

Not so fast. Although it may sound crazy, your results are not a guarantee that you've got the holy grail. Don't believe me? Keep reading – I'll make you a believer.

Even a lot of experts are *too* results focused. Meaning, they only focus on their own results, without considering the larger body of evidence. This isn't bad – there's nothing wrong with ironing out a system that works. But that's not what I'm after here, and you need to realize this up front. This book isn't just going to lay out a program and an eight-week plan for you to follow. I'm not going to spout off a personal methodology and then tell you why it's better than what everybody else is doing.

I've always been a believer in teaching a man to fish. If you just want 'Matt's Eight Week Bulking Cycle', sorry. You're not going to find it here.

This book is going to look at what people do in the gym, what the research says, and then try to make some sense of the two. I'm not here to lay out a workout plan. I'm here to flesh out the core principles of bodybuilding – the rules that define all muscle-building workout routines.

The goal is a model of muscle hypertrophy – the process of muscular growth. I want to account for *What Works*. If you understand the bigger picture, all the other routines tend to crystallize out of it. It sounds like a lofty goal, for sure. And it hasn't been easy. But what you'll get is my best shot at it.

I can't promise it's 100% complete, and I can't promise that my reasoning is fool-proof. But with luck, you, the reader, will at least come away looking at things in a different light. At the end of the day, that's all I'm after. Once you start looking at weight training in the right way, a lot of the questions go away.

I want you to ask yourself a question, and be honest about it. Why are you exercising? What do you want to get out of it? For better or worse, most people are in the gym to chase some appearance-related goal.

I'm not going to sit here and argue over subjective aesthetics. What I like isn't what you like, and it's just that simple. But I do need to clarify what this book is going to discuss. When it comes to appearance, I've found that it always boils down to a few different mindsets.

'I don't want to get too big'

Also found in women as *'I just want to tone up a little'*. These people are under the impression that if they touch a weight, they'll wake up in a week or two looking like the shredded bodybuilder they saw in the magazine, complete with veins popping out all over the place.

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This usually leads to training with a vague goal of 'sculpting' or 'toning up'. For a variety of reasons, this usually ends up with said person getting little to nothing in the way of results.

'I need to add some muscle, but my abs go away'

This one is usually limited to younger, usually skinny guys that think they need to keep a visible eight-pack all year long. They're around 150 lbs, and while they realize they need to get bigger, they've convinced themselves that they can't gain weight - because as soon as they eat, their abs vanish.

Also applies to the ladies, as they tend to have a chronic fear of any weight gain, loss of definition, or the slightest sign of 'bulking up'. Nothing wrong with being lean, but if you're going around trying to stay small, you're going to limit your results in both size and in strength.

GFH

GFH guy is a complete 180 from abs guy. He's on a quest to get as big as possible, and to do this he'll eat, and eat, and eat. He's overcome the issues with eating, you see. GFH guy tends to have good results in terms of adding muscle, but the problem is he'll never see it because he carries too much fat.

Ladies, you don't seem to have an equivalent, since it's really not marketable to become a tank-ass power ogre if you're a girl. This may be for the best.

What does GFH mean? I'll give you three guesses.

The Competitor

The Competitor may be the best off out of the lot. He (or she) has done some shows, probably looks pretty damn good, and at first glance wouldn't need any kind of help.

As you'll see though, just being in that condition isn't a guarantee of being able to apply knowledge. And even the Competitor is looking for an edge. You never know when a new outlook can give you an advantage.

All of these groups can (probably) benefit from reading this, because all those approaches have some problems to overcome, and all hold their own sets of myths.

Tone-up girl and abs guy are probably the most challenged. They're operating on a lot of assumptions that just don't hold up to scrutiny.

GFH guy may have a better insight; additionally, he could be a strength athlete that's just not worried about getting fat. This isn't to be confused with an obese person, mind you. He's got muscle, he just has to get around the problem of holding lots of fat. If you're a would-be bodybuilder, though, you've got some issues to think about. Again, this isn't a diet book, but if you're like GFH guy, you can still benefit from the information.

The Competitor might just want a better understanding of the subject and some new ideas to think about.

Whatever category you fall into, you'll probably find something to make you think about what you're doing and why you're doing it.

As you might have gathered, this isn't just for men. Women will benefit just as much as (arguably more than) men will, simply because women are bombarded with so much, well, pure bullshit.

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The bad part is that women are more prone to buy into it because they tend to have a very specific body image in mind, and a lot of social pressure to keep smaller. For reasons beyond the scope of this, women as a group have become convinced that muscle just isn't attractive. At the same time, they're continually being sold on the idea that they can sculpt their bodies in all kinds of crazy ways. Sadly it doesn't work that way.

If that's what you feel you need, ladies, I'm not going to try to change your mind. Just be aware that the advice and information is *not* going to be geared towards you. There's no shaping, sculpting, or toning up – this book is geared towards building muscle and improving body composition, full stop. If you think you need that kind of thing, and manage to convince yourself that I'm full of shit, well, you'll find plenty of people willing to sell you that dream. If the skinny starlet look is your thing, you need to look to the things that will get you there: different parents, starvation, and heavy partying.

Now, I will take a look at why these myths came about, and what might be the real culprit behind them, so if you're interested in a new viewpoint to contrast your old outlook, you're in the right place.

If you bought this expecting just another Guru book on lifting, I'm very sorry to disappoint you. This isn't going to be just another re-packaged trip through the exact same science with the exact same conclusions, nor is it going to be a showcase for all the neat recycled programs and training methods that I'll claim I came up with in order to feed my ego.

I just can't write one of those books and still feel good about myself. If you just want a program, then there's plenty of resources out there, and a lot of them are free. This is written for those of you that are tired of program-hopping, tired of not getting actual results, and tired of getting scammed by marketing hype.

Don't worry about the whole logic/critical analysis stuff, either. I'm not going to turn this into a strict treatment of the subject; I just want to get into some basics that will hopefully help you to understand where I'm coming from.

From there, we can see what *Will Work*. As far as that goes, I like to look at it as an umbrella. At best we can draw out broad guidelines, general principles that tell us what tends to be effective on average. The problem we run into is in laying out specifics; once you get underneath the umbrella, it's very hard to say that one approach will work better than another.

That's a little secret that most would-be Fitness Experts don't want you to know. In marketing, it's all about creating a brand name for people to associate with. If you're coming out and admitting that your favorite program is just one combination of principles that happens to work - instead of being a magical program of magic - then you're losing that competitive edge in the market. This method of branding is a hallmark of Guru marketing; to set himself apart and 'create value', the expert will claim that his program is better than others. Or he'll use some gimmick to try and be flashy. The reality of it is that there is no legitimate way to say that any *effective* program is better than any other. By the time you're done with this, you'll understand why.

The Role Of Science

As I stated before, research is going to be the cornerstone of this little project.

It has to be, really. Scientific research tells us how the body works. The fields of anatomy and physiology tell us how the body is constructed and how it operates, respectively. Subsets of these fields, namely biomechanics, kinesiology, and exercise physiology, give us specific data on how the body moves and how it responds to

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physical activity. Without that information, we'd be stuck with a process of guesswork, and that's not good for anybody.

It helps to understand what science actually is. I don't mean the pop-culture treatments of science; unless you've actually gone through some kind of post-secondary education, you may be convinced that science is what you see in TV shows. I can go ahead and tell you that it's not based on mad scientists working in hidden lairs; it's not rogue misunderstood geniuses making strides that the rest of the orthodoxy rejects. It's certainly not a 'belief system' that just happens to be opposed to emotion and faith.

At its core, science is a process of observation and description. You see something happen, then figure out why it happened. That's all science is once you boil it down to the basics. You watch something happen, describe it in as much detail as you can, and then figure out why it happened.

As you might imagine, this process can get quite in-depth, and most experiments will often raise more questions than they answer. Despite claims to the contrary, this is the greatest strength of science. It can update itself and constantly opens up new avenues to explore. We're always refining our knowledge and understanding. It's not a matter of having unchallenged absolute truth. It's a matter of constant learning.

We've formalized this process into a series of steps called the *scientific method*. In broad terms, the researcher will come up with a hypothesis, design a way to test that hypothesis, then gather the data from that test to figure out what actually went on.

A hypothesis is simply an idea or concept that can be tested: the sky is blue, grass is yellow. In reality, a hypothesis is usually very specific, some statement that can be tested in detail. When the average person says 'I have a theory...' and then goes off to talk about whatever he thinks about some subject, he's actually talking about a hypothesis, not a theory. In science, 'theory' has a different and specific meaning. The hypothesis is a question that needs to be tested, and thus either proved or disproved.

The test of a scientist's hypothesis is the experiment. Experimentation has to be tightly controlled to ensure that there's nothing to confound the results. For example, if you're doing a study to figure out whether or not darkness helps you sleep, it won't do you much good to do it in a loud room. You'd have no way of knowing what was affecting sleep - is it darkness, or is it the fact that the room is loud and keeping your subjects awake?

In this example, the loud noise is called a *confounding variable*, which makes it impossible to know if the thing you're studying is actually responsible for the effect. If you can't establish a cause-and-effect relationship, then it's impossible to say that X causes Y. This is why controlled research is important, to narrow down the exact cause of the effect we're watching. A big chunk of experimental design is about removing or minimizing confounding variables. If we don't do this, we can never be certain that there's a cause-and-effect relationship - we can't know if what we think is the cause is really the cause.

When we have a hypothesis that stands up to repeated experiments, *then* it's formalized into a theory. Now as I mentioned, laymen tend to use theory and hypothesis interchangeably, implicitly meaning 'an idea I have about something or other'. In the science world, a theory is a hypothesis that has been tested and tested and tested again; through all that testing, it's remained true. A scientific theory has a proven track record, so we can assume that it holds true in all the circumstances we can test; certainly there's no reason to call it into question. Obvious examples of this would be things like gravity and germ theory. They've been tested so thoroughly that we just take for granted that they're true, though once upon a time they were just somebody's working hypothesis.

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That leads to another thing I need to touch on. Scientific theories are explicitly designed to be falsified; they need to be tested and challenged. That doesn't mean we want them to be wrong; it means that we want them to be as accurate as possible, and this means they must be open to new data if they are wrong. A theory that has withstood scrutiny is a theory that's reliable. On the other side of the coin, a theory that's called into question by a new observation is a theory that will need to be updated – because it might be wrong. It's a process of constant refinement and learning. The ability to challenge and refine knowledge is the difference between a scientific theory and dogma.

I can't emphasize this point enough. Science isn't about always being absolutely right - it's about being as right as possible with what we know.

Case in point. Everyone's heard of the theory of gravity. Isaac Newton first formalized this back in the 18th century when he had a legendary run-in with an apple, or so the story holds. To this very day, Newton's ideas on gravity are considered fundamental to physics. Gravity is quite possibly the easiest of all theories to test, and I don't think anyone outside of Wile E. Coyote has ever come across an exception.

Now, what would you say if I told you that Newton's theory of gravity is wrong? Popycock? Balderdash?

Not so fast. Back in the 1930s, one Albert Einstein came along with his theories of general and special relativity that stood Newton on his ear. Relativity is a complex mish-mash of concepts that are quite beyond this book, but the gist of it is that *Newton was wrong* - but only in circumstances that don't tend to arise on Earth (astronauts can notice the difference down to billionths of a second due to the difference in gravity in orbit, but that's about it). As far as anyone on our planet is concerned from day to day, Newton is absolutely correct. Yet he was still wrong.

So what happened?

Well, modern physics is still using Newton's concepts of gravitation because they're still accurate. We only invoke Einstein under those conditions where relativity fits better - when things are moving *very* fast, or when things are very *very* heavy. The classical theory of gravity, as Newton's work is known, wasn't thrown out; it was improved. Newton wasn't wrong, he was just *incomplete*. He simply didn't have any way to test things in the way Einstein did, and since it was completely irrelevant to the world of humans, it didn't matter. It was only when we reached out for further understanding that we discovered the greater detail.

That's the role of a theory in science: it will stand as long no new information contradicts it. When we're talking about a well-tested and well-understood theory, the odds of it being thrown out completely are next to zero. Gravity isn't going anywhere, as one example. If something comes along to expand on the theory of relativity, you can guarantee that we'll still rely on Einstein's work. The new theory will only define new phenomena – it won't contradict anything we already know or anything we've already observed.

Theories are refined and improved, but very rarely are they contradicted.

This is unfortunate in an age where we have a sensationalist media that thrives on controversy, because they'll make it seem like any minor flaw or issue is suddenly a 'great controversy'. I don't care what the news or some web article tells you, science just doesn't operate like that. The reality is that we understand a great deal of how the final picture will look; missing a few pieces doesn't change that.

Mass-media science reporting would have you believe that a puzzle, obviously creating a picture of a mountain, was really showing you a cat – just because you were missing the piece that contained the mountain peak.

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It's never about absolutes, really (you see what I did there?). The point is not to think as right/wrong, but 'most likely correct' or 'probably not possible' based on the current body of evidence. When a scientist says something will 'never' happen, the implied meaning is 'so unlikely based on what we know that for all purposes it will never happen'. This is alien to a society so used to thinking in simple polarized terms like good vs. evil, but that's how things are.

Which brings me to the field of exercise science. Unlike physics, chemistry, or even biology, exercise science isn't a fundamental subject. It's a subset of physiology that looks at how the body responds to physical activity. What this means is that in practice, it's not a very specific or well-understood field in comparison to others. Exercise science is comparatively vague, leaving open a lot of room for interpretation.

There's as much creativity, and dare I say art, involved in the field of physical conditioning as there is genuine research.

Aha! Science can't tell us anything!

Not quite - the whole discussion on the scientific method throws that reasoning out the window. Just because we haven't finished the puzzle doesn't mean we can't tell what the final picture is going to look like. Exercise science still has quite a bit to tell us. The trick here is parsing it into useful terms, not just throwing it all out because it's not 100% complete.

A lot of people seem to think that science has to give you a specific workout program, and never ever be wrong, in order to be useful. A lot of people will put science on the back burner, giving more credence to their own experiences. In both cases (and plenty of others) this boils down to people just not understanding the role that science plays - and not understanding how to apply the information that it gives us.

Like any field, you'll start out with a broad understanding. With time and research, the knowledge will gradually filter down to greater detail; and that's the real power here. By narrowing things down, research establishes boundaries. It doesn't necessarily give us specific details and protocols, and you wouldn't expect it to do this. But it does give us general starting points. Most important of all, it tells us what doesn't work.

You may wonder why that's important. Why should you care what you can't do? You want to lift weights, and you need a program to do that, right?

It's important so that you can see through misinformation. Further, knowing what *not* to do is how we establish starting points. You'll always rely on trial and error to some degree, but you can make that process much easier by ruling out things that won't be productive.

All that said, we have to be careful. Research does have very real limitations and we have to acknowledge those. Too many people treat research like an almighty gospel, as if presenting an abstract or two can justify any claim. It doesn't work that way either.

When you look at a research paper, you'll find some common themes. First and most notable is the abstract, which is a brief summary of the research and the results of the experiment. This is useful because it lets you get the key details with a quick glance. A well-written abstract will cover all the bases and give you the idea of what the paper is describing.

However, there are nuances and subtleties that an abstract just can't convey, and when we're interpreting a paper to figure out how useful it is, you have to look at the whole thing to make sure it's applicable. Research

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papers are written with certain common content. They'll all go into details on their initial hypothesis, or what they're wanting to test out; they give details regarding the actual experiment, including who or what was the subject, how the experiment was performed, how data was collected and so on; they'll detail the results of the experiment and any data collected; and finally the authors will usually discuss the results, how they relate to existing research, and what can be taken away from the paper.

This is all done for good reason. Research is all about transparency. If you go into detail with regards to everything you did, then other researchers can duplicate your results and confirm your results. If you make an unusual choice in your experimental design, people can see that and note it. If your results don't fit with the rest of the data, you can explain why: maybe it was something to do with your actual test, or maybe it had to do with how you collected your data.

In short, you have to consider a lot of variables when you're interpreting a study. In exercise-related research, there's a few recurring issues we have to look at in particular.

Most research into exercise deals with either aerobic exercise or with rehabilitation. As you might gather, this isn't terribly useful for generalizing into strength-training concepts, let alone something specialized like bodybuilding. Although the West is starting to catch up, a lot of what you read about is actually taken from older Soviet-era information, which, while not bad necessarily, can be hard to corroborate.

Once we start to look at the Western research into actual strength exercise, we start to see a common theme: 'untrained subjects'. Now, in some ways this is good because at least it's done in humans. However we run into some potentially major issues because we've seen it demonstrated repeatedly that an untrained person just doesn't respond the same way as someone with years of experience. Lots of strength-training studies will demonstrate amazing results in untrained subjects, but comparatively few of them account for this so-called 'newbie effect'. Beginners can get away with lots of things; often they will still improve in spite of what they do, not because of it. When we're trying to establish a cause-and-effect relationship, this can throw a huge wrench into things.

It gets worse. The bulk of the research into the actual biochemistry and physiology is done in rats. While there's a lot of similarities in humans and rats, there's a lot of differences too. There's plenty of examples where things that happened in rats didn't pan out in humans; that's a big weakness.

This is a favorite tactic of the supplement industry, actually. They love taking some rat research or weakly-applicable research in humans and then claiming it supports their new magic product. They conveniently ignore the fact that not only is that data not applicable, but they also have exactly nothing showing their claimed results in humans. Besides the claims of the product users, of course - but that's not placebo effect or anything. See also my earlier point about controlling for variables; when you don't perform research in controlled conditions, you can't be sure that your attributed cause is creating the effect. Since giving out free supplements to bodybuilders is almost the definition of 'bias' and 'placebo effect', these testimonials have to be considered highly suspect.

And of course all of these objections can apply just as easily to any workout routine, or any study that looks at strength training.

The good news is that recent years have given us a good number of studies that have started looking at these factors in humans. It's still not perfect, but the picture is shaping up to be much clearer than it ever has been.

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Finally, there's a limit to the resolution of research as it applies to any single individual. It simply can't apply to every last person in a literal sense. There's always going to be some deviation from this norm. This is where the creativity and trial-and-error aspects come into it. We can establish general starting points and guidelines, but these are derived from statistical analysis. Your mileage may vary, and in fact it's highly likely to deviate from the general rules by at least some degree.

I say this because one of the big objections I see is that science 'doesn't apply'. I have a hard time seeing how that can be the case; by definition, science just watches and describes. To say that science 'doesn't apply' would be suggesting that somehow your body just happens to differ from everyone else's body. Last I checked, humans all had the same basic physiology. Your body will have specific responses within the boundaries that research describes, but you won't ever do something that's just completely out of left field.

There are ways to account for your individual needs, though, and the fortunate thing is that nobody will deviate that much from the baseline. You need to adjust things to the individual, yes, but that doesn't give you permission to go do anything you feel like just because 'everybody's different'. You still have to obey the guidelines, even if you have flexibility within those guidelines.

Why We Can't Ignore Anecdote

An anecdote is a personal experience. Bodybuilding as a culture likes to use the hell out of anecdotal evidence - or as some of us affectionately refer to it, 'Bro-science'. Bro-science is when a claim is correct because it works for the person making the claim. Or because he's seen it work in like 10,000 clients that he's trained in the 50 years he's been doing this.

Bro-science is of course named after all the good Bros that know what's really going on: that you have to do 50 sets to make your biceps grow, that women have to do high reps to tone, and you can't eat dairy foods on a contest diet because it makes you smooth. You know - Bro-science.

This is justified because the Bro in question will look good himself, and will often train other people that will look just as good. Obviously this flies right in the face of both the scientific method and any semblance of logic, but that's the state of the industry: looks mean more than real knowledge. In the minds of most people, looks equal knowledge. Our Bro is an expert because he looks good and because (some of) his clients look good.

Well, hang on a second. Why is that a bad argument? If a guy has gotten to a high level, obviously he's doing something right. And a guy that's training a lot of clients can certainly be relied on, right? I mean, he gets results. What's the problem with anecdotes, anyway?

The big problem is that anecdotes aren't tested rigorously. Unless some steps are taken to minimize interference, you'll be dealing with all kinds of confounding variables that will skew cause and effect. What you believe to be the cause may not be - you could be giving credit to the wrong thing.

For example, research tells us that you can't spot-reduce fat - you can't drop fat from a body part by just working that part. This means you can't just go in and do 1000 crunches every day to get that six-pack. In actuality, the body uses up fat in a way that's pre-programmed, and you really can't affect that. You lose fat from where your body wants to lose fat.

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Now a Bro comes along and says that you have to really work your midsection while contest dieting in order to lose fat around the waist. He knows this because he's competed for something like 20 years, and always comes in with shredded abs. He has all his clients do this, and they always come in looking great.

Who's right?

Unless our Bro has explicitly controlled all variables and kept meticulous records, then he can't say for sure that working his abs is what caused the fat loss around his waist. Think of all the things that might impact that result.

On a contest diet, bodybuilders tend to diet very harshly to get very lean. Even if the midsection is a stubborn area, that fat might well come off under those extreme conditions. Has he tried a contest diet without a lot of ab work to see if it makes a difference?

The extra attention to the muscles might make them stand out more. A muscle that's getting attention is going to grow and stay tighter while at rest. This will be even more noticeable if you don't really pay the abs any attention in the off-season. Has he accounted for that?

How is he determining any of this in the first place? Has he taken strict waist measurements and skin folds and then compared that to what happens when he doesn't work his abs, or does he just go by the mirror?

For that matter, how can he even be sure that he didn't just luck out on the fat storage genes, so that he can lose abdominal fat without much work?

What about his clients? Does it really work for all of them without fail? What if you really look around and find that he can only point to a handful that actually have amazing abs, while the rest don't really seem to make any progress? Remember that the exceptions to the rule are just that.

Are you still so sure that this approach works?

Without knowing any of this or taking any steps to control for these issues, saying 'you have to work the abs during a contest diet to take the fat off' is a complete guess. There's absolutely nothing concrete to support it. The only evidence is the fact that this guy worked his abs while he got lean at the same time. From there, he just assumed that the ab work created the leanness.

Are you starting to see the problem here? There's much more involved than just looking at a few success stories. Sadly, this kind of reasoning goes on all the time in bodybuilding and fitness circles. It's not even about the actual end results - it's about the path you want to take to get those results. When you give credit to the wrong thing and rely on BS explanations, you tend to do the wrong things. Just because a broken clock is right twice a day doesn't mean it's really 6:45 all day long.

This is the difference between *correlation* and *causation*. The original Bro got results while doing a lot of ab training, but that's not what caused his results, no matter what he thinks. Just because X happens at the same time as Y doesn't mean that X causes Y. If you follow the Bro's advice and don't do any of the things that did cause his results, guess what happens to you? You keep your chunky midsection.

Consider the ramifications of this example. If you tell people that you have to work their abs to get the fat off, guess what they'll do? They'll go to the gym and work the hell out of their abs every single day. Now what happens when they don't get a six-pack from it? Do they consider that maybe they're doing the wrong thing? Of course not. They assume they aren't working hard enough, and do even more ab training.

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Why is this? It's because there's no context. It's normal to assume that you've gotten the right answer, so you just assume it's a matter of the effort you put in. How many people would stop and ask if they're even doing the right thing to begin with?

That's the mindset you need. Not to think in terms of the end results, but in terms of the *process*. What is your goal, and what series of actions will bring you towards it? Are the things you're doing actually moving you towards that goal, or do you just think they are?

Now, if you're a 'results based' person, you may not care - as long as your program or diet is working, you might care less about what's actually making it work. Hey, that's fair enough. Not everybody's really going to give half a damn about the why. However, there's a caveat there. If you're going to be putting yourself out there as an expert, then you should have a handle on the hows and whys. It's not just good manners, it's a matter of being competent.

Worse yet, these same guys will try to argue the actual science behind their ideas. I don't care how long you've been training people - if you read research wrong, you read research wrong. Last I checked, 20 years of training clients isn't equal to experience with research methodology.

If it's wrong, then why aren't these people called on it? Same answer as before: these experts will often have very well-built clients. Or they can point to someone, possibly themselves, who is big and ripped, and trains that way. The fitness industry is the only field where 'Hey, look at me!' can be taken seriously as an argument.

What happens is that the big ripped hulks and the super-lean fitness models tend to get results regardless of what they do. I don't mean that they don't work hard, just that they're the type that will get the best results for putting work in. This could be caused by psychological factors - the most successful are the ones that tend to work the hardest, to the point of becoming almost OCD about lifting weights and dieting.

There's certainly a physical component too. A guy that's 5'6 with a small bone structure will never be able to get as large as a guy that's a 6'6 giant, no matter how hard he works. Besides overall build, we also notice that there are genetic tendencies to both build muscle mass and stay lean. Given that, even guys with identical frames can end up looking very different, even with all else being equal. Same applies for women; girls that seem to have that perfect mix of frame, muscle, and low body fat ('hot chicks') are often in that condition for reasons that have little to do with their choice of workout and diet.

And then we have the drug factor. I listed this one last because, paradoxically, it's not that important, but at the same time it's the most important thing here. Bodybuilders use drugs, and the bigger and more ripped they are, the more likely that they're on something. Drugs do not make the athlete, and they certainly don't remove the need for hard work in the gym no matter what you've heard, but they do raise the bar on what's possible. Steroids are no guarantee that you'll reach the top of the mountain, but they do make for a more productive climb.

So that's where we stand right now. If you're a big hulk or a stunning figure girl, then chances are you've got a lot of these factors going for you. If you're a little guy trying to become a big hulk, or an overweight woman trying to get sexy, it's equally likely that some or all of those factors are missing. That's where the disparity comes from. Following the big guy's training doesn't mean you'll end up looking like the big guy. Doing what the sexy starlet does won't make you look like the sexy starlet. You can copy the program and the diet, but you can't copy the other factors that go into their success.

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For us mortals, we have to look at the averages, the things we know will cause positive changes if you do them, if we want to get results.

If that's not enough to sway you, then think about this. For all the big guys in the gym doing the muscle-group split routines for 100 sets of 8-12 reps, how many little guys are doing the exact same thing and not growing from it? How many girls are spending hours on the treadmill and doing 'high reps to tone up' and getting results from it? How many do that and never see a change? In every commercial gym I've ever gone to, it breaks down to something like 1-5 really big impressive guys, maybe 2-3 times that number are 'respectable', and the rest barely look like they work out. I'd imagine you've had similar experiences. So if the 'what everybody knows' style of training is what gets you huge, why isn't everyone doing it huge and jacked, or slim and sexy? Bear in mind this line of reasoning is not immune to being picked apart; I'm simply stating this to point out why you can't completely rely on anecdote and gym-evidence to make your case.

That said, I'm not willing to completely rule out anecdote for several reasons. In places where research is incomplete, we can use anecdote to fill in the gaps and draw reasonable conclusions. We can also use anecdote to frame the conclusions of research; the actual 'operational protocol', or what you do in the gym, will boil down to as much creativity as it will science. That's where anecdote can come in handy.

I'm of the opinion that a *protocol* coming from anecdote can be very viable. However, an interpretation of *science* based on anecdote is likely not useful. What's the difference here?

When I say protocol, think of a recipe. You take the ingredients, follow the instructions to put them together, and you get a finished product. In this sense, I'm talking about a training program, diet, or some combination. That's your protocol, and it can be effective even if the explanations for it are total garbage. It doesn't matter if you think fairies in the oven are making the bread rise; as long as you get a loaf of bread, the protocol/recipe is effective.

A lot of the results that 'experience minded' people get are due to this, even if they don't realize it. They may not have any realistic basis for a program, other than 'it works', but for a lot of people that's sufficient. Provided it actually does work, of course.

If they follow a style of training that disagrees with science, and they get awesome results, then why isn't the science wrong? I refer you to the previous discussion: we can't claim that it works without actually crunching the numbers. The more likely situation is that the science itself isn't wrong – it's being interpreted wrong.

The problem arises when the Bros bite off more than they can chew and start trying to bring science into it. It's one thing to come up with an effective system, but it's another thing entirely to start making scientific claims or interpreting research so that it supports your claim. This is also known as 'making things up'. In the worst cases, it's a complete appeal to authority - if you don't have a science background, then it doesn't matter what you look like. Your abs and 20" arms and bodybuilding trophies do not give you the authority to speak on science. Doesn't mean you can't get results – just means you're not qualified to speak about how science fits in.

Worse than a pure Bro is when you get a guy that wants to play both science and Bro-science at the same time. This chameleon will always bring out science first, quoting a handful of studies and usually interpreting them very poorly. But watch what happens! When someone with a better handle on the research comes along and points out the errors, the chameleon will change colors. Now the science doesn't matter, because he's done the things he claims, and further, he's seen it happen in like 500 clients. Most of these clients will have been in the Olympics.

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It's not impossible to put controls even on anecdotal evidence. This becomes a kind of 'gym-science', where a scientific approach is used even though you're not in the lab. This is especially possible for coaches and trainers that have a large client base to work with.

I do have to stress, though, that this is not infallible: I've seen plenty of Bro trainers that use a pseudo-scientific approach, cherry-picking results to back up their own beliefs. Anything of this nature must be taken with a grain of salt.

Bro-labs tend to keep methods and results a secret, and frankly I don't trust anybody in this industry unless I can see hard information. Even then it can be a crapshoot. It's a sad state of affairs, but the reality of it is people can be incorrect, and people will lie. Even in the best-case scenarios, anecdote is going to have only weak validity. Bonus points if the guy actually admits that, though.

With published research, there's transparency. You can see how the experiment was done and you can see all the data that came from it. That's the main reason that research will always take precedence; research is transparent and can be independently verified. It may be flawed, but if it is those flaws will be exposed.

Sometimes people will just do things because that's how it's done. It's completely circular logic, and you have to watch out for this. Sometimes guys will stumble on effective things; sometimes they're just doing it because they don't know any different. It's one thing to base your reasons on results. It's another thing entirely to do it just cause that's how you do it.

One trend you may notice among the popular Bro-trainers is that they only push their successes; but pay attention to the failure rate. If you've got a popular trainer that's coached a couple of big names into shows and won a few trophies, that's awesome - but competence as a trainer isn't measured by your best results. If he's got a 98% wash-out rate because his particular style only works for the 2% that can handle it, then he's not effective - doesn't matter how good he looks. That's called the 'meatgrinder'. You feed in as much beef as you can get and hope that you get a few successes out of it. If he's not able to adapt his thinking to get results in the majority of people, then the handful that have gotten on stage aren't representative of his competence.

It's all shades of gray, though. While I don't assign anecdote the same level of importance as science, I still don't throw it out, either. You have to note it for what it is, and use it accordingly. My rule of thumb is that if I can frame it inside the greater body of evidence, and if I can directly link it to results, then I'll consider it. If not, then it's probably just how it's done cause that's how it's done: Bro-science.

Like it or not, bodybuilding gym-lore has stumbled on some interesting ideas, and without research to give a yea or nay, we can't discount some of these things. Indeed, if you look at some of the gym-lore in the right context, it definitely fits in the larger scheme of things. This is where being able to parse things intelligently comes into play.

When anecdote disagrees with science, there's a few steps we can take. The first thing is to just look at it rationally. Does the science *really* disagree, or does it just seem to disagree with a quick glance? Sometimes there can appear to be a conflict when in reality it's just a misunderstanding. Look back at the spot-reduction argument from earlier to see this in effect; if you don't control your experiments properly, then you can't be sure that what you think is what's really having the effect. What you've taken for granted as a cause might not be the actual cause.

If the anecdote still seems like crap, then see if you can parse the information in more meaningful terms. If someone tells you to 'tone up your lower body region', do you go pick up a 'toning routine' and start doing 20

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reps? I wouldn't if I were you. What you can do however is concentrate on losing fat to lean out the trouble spot. You have to be able to translate Bro-speak into realistic, practical terms. Look for the meaning, not so much what was said.

And of course sometimes garbage is just garbage; if you look at a claim and it still doesn't pass the muster, then by this point you can just throw it out.

Knowledge: The Importance Of Critical Thinking

More than research or anecdote, critical thinking is the most important piece of the puzzle. Critical thinking isn't just where information comes from, it's how you analyze that information to determine whether or not it's useful.

We have to be able to put claims to the test and determine if there's any truth to them, and this goes for scientific research just as much as anecdote. That's what critical thinking is: the ability to scrutinize a claim and figure out if it's worthwhile. With the fitness industry being what it is, a multi-million dollar marketing engine with no professional standards, information is the least of your concerns.

This is easily the biggest problem I see on a daily basis. It's not that people aren't asking questions and learning – it's that people don't even know what questions to ask. People don't know how to tell the difference between the good and the bad. They lack context.

At heart, we're trying to determine a cause and effect relationship. Something happens, then something else happens as a result. Being able to think critically is key when you're trying to figure that out. Although they're usually wrapped up together, science is not necessarily the same as critical thinking. It should be, but it isn't always. The problem is usually not the scientists and researchers, though - the issues usually come from people that are trying to apply research to a situation.

This is where people trip up, by not understanding the distinction between the two. People consider professionals infallible. They see 'research study' and assume that it can't be wrong. But these things can fall prey to shoddy logic. A professional in a field can be wrong. A research study can be flawed, or not applicable to the situation.

How many times have you heard someone say, 'well so and so is a doctor, so he must be right'? How many times have you seen someone quote a research study without ever justifying it? Gurus will try to use all kinds of research to support their claims, or exclude things that disagree with them; you'd probably be surprised if you knew how often they were misrepresenting the research or simply cherry-picking to make themselves look right.

Doctors are very well-trained. They've got extensive education in dealing with the body and its problems. By extension a doctor will certainly have the background to understand exercise-related concepts. Here's the catch though: his existing training may not be sufficient to make him an expert in exercise or nutrition. If you accept the doctor's opinion as gospel *just because* he's a doctor, you're committing what's called an appeal to authority. The doctor may or may not be knowledgeable on exercise, but in this case you can't simply look at his status and position to say he's correct. Being an MD does not automatically make one an authority on exercise science. The doctor may well be correct, but you can't say that *simply* based on his degree. The same applies to a scientist in any field that's not specifically related to exercise science.

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What about examining research? Often, people without a lot of exposure to research methods will just pick out one or two papers and consider them to be reliable. Without considering the entire body of data, this is pretty pointless (unless that single paper is the entire body of data). You have to consider the information as a whole. Data will sometimes conflict; you need to know when this happens and why. If possible, you need to be able to explain why the conflict might exist. This is the problem of applicability that I discussed before. Just because data exists does not mean it is relevant.

Additionally, you can't just pick a few lines out of the abstract and conclude you've got the whole story. The full paper will detail the research in mind-numbing terms, so you can see what drawbacks the experiment might have had. Sometimes this isn't obvious from the abstract.

Then we have cherry-picking, where they just go pick out the stuff that supports their conclusion and ignore the stuff that disagrees. And boy do the Gurus love this tactic - they start by assuming that they're right, and just pick out all the stuff that makes them look good. Conveniently, any data that calls their belief into question is left out, or 'not important'. This is also where the chameleon tactic becomes important – if data disagrees with you, then just reject science in general. Hell with it, you've got 50,000 clients and you know what you've seen. Just because research was supposedly supporting your point 10 minutes ago is hardly relevant.

You can see how that's a blatantly dishonest tactic, but that doesn't really seem to stop anybody. Most people aren't equipped to challenge that kind of argument in the first place. Again, you have to look at *all* the relevant information, not just the stuff you like.

Sometimes it's not actually dishonest in the sense of somebody intentionally trying to lie to you, but it's still intellectual dishonesty. There's plenty of cases where the person in question just doesn't understand how to pull data from research and apply it correctly. You really do have to look at things in detail, consider all the options. Who was in the study? How many subjects? How was the experiment done? Was it long enough? Are the results meaningful? Who can this data apply to? And so on. It's a multi-faceted process, not as clear-cut as just looking at the abstract, pulling a few lines out, and calling it a day.

These are all examples of logical fallacies, or mistakes of reasoning. See, when you make a claim, what you're actually doing is drawing a conclusion from other statements, called premises. In logic, this is called a formal argument. It might look like this:

- A. Dogs like to bark.
- B. Dave is a dog.
- C. Therefore, Dave likes to bark.

That's one of the simplest kinds of logical argument: $A = B$, $B = C$, therefore $A = C$. A and B are premises, while C is the conclusion. This is both a sound and valid argument: the premises support the conclusion, and the conclusion is correct. This is how you'd want your argument to be made, in other words.

Realistically, the fitness industry is full of more fallacious thinking than the Moon has craters.

What I need to stress is that both science and anecdote can fall prey to poor reasoning. You can mis-use science just as easily as anecdotal evidence. The goal should be reasoning things out properly, not just sticking to our guns. This goes for those looking at research just as much as those relying on experience.

Applying science data is mostly a matter of thinking it through. You have to consider the context and the implications of what you read. If you can filter anecdote properly, then there can be some gems there too. As

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always, you have to frame things the right way. If someone gives you a training tip, run it through the filter. Does it sound right? Can you re-state it in a different context, so that it makes sense? Remember, science defines your context - if you can fit information into that model, then it's probably right.

Of course, sometimes information is just crap.

These are just a few examples; there's plenty more out there. When you're debating or arguing with someone, knowing just a few of the most common logical fallacies is absolutely invaluable. They'll allow you to see through BS like nothing else can.

I'm willing to give most people the benefit of the doubt in this area. Without an exposure to any sort of logical thinking, a lot of people will just not know any better. The problem you'll run into is the loud-mouth know-it-alls that aren't even able to understand why they're wrong. If you ever run into one of these, just realize that screaming doesn't equate to being right.

The worst of all though are the ones that should know better and still operate by standing on top of a pile of fallacies. Usually you find this in people that have something to sell you, or are just driven by ego to be 'right'. This is common among Gurus that are trying to sell you information products, supplements, or whatever else.

The point here is that it's not always a matter of 'different viewpoints'. In most any situation dealing with science, there will inevitably one viewpoint that is more correct than another. When you simply look at two viewpoints as 'equal but different', you're committing what's called a fallacy of the Golden Mean. While it can be tempting to just assume two opposing viewpoints are equal and worthy of consideration, in many cases that's not true - one position is objectively more correct than another. Be aware of this. Simply because someone has an opinion and chooses to voice it does not make it valid. The correctness of a viewpoint is based on the facts that support it. While you're certainly welcome to your own opinions, you can't choose your facts.

You have to look at each side objectively. A well-considered position based on facts and demonstrable evidence is always going to be better than an argument based on 'I feel...' or 'I believe...' You can look at the first case, examine its claims, and verify the evidence presented. In the second case, the argument is a guess. You can dress it up however you like, but it's a complete guess. There's just no comparison in quality, and trying to boil that back down to two 'competing viewpoints' is missing the point.

The best part is that you don't have to be a scientific genius or have a master's degree in logic to exercise some scrutiny. That can help of course, but evaluating information is just a matter of questioning. I'd suggest operating from a stance of optimistic skepticism. Be open to new ideas and be willing to consider other viewpoints. At the same time, be skeptical. Don't hesitate to ask for evidence. Don't take claims at face value, and don't take anyone's word alone as evidence.

Finally, keep in mind the old adage: if something sounds too good to be true, it probably is.

How To Kill A Myth With Occam's Razor

I want to give a special mention here to a tool that's extremely valuable in cutting through garbage. In science, you'll sometimes hear discussion of Occam's razor. This is a metaphor for the concept of *parsimony*: the notion that a theory should be as simple as possible, but no simpler.

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Occam's razor was designed to remove 'fluff' and unnecessary terms from formal theories. For example, say you're dealing with a person that claims invisible pink elephants are hiding in his room. The elephants are invisible, completely quiet, and apparently you can walk right through them. The question is, even if the elephants are really there, do they matter? What effect happens with these elephants that would not otherwise happen?

If they aren't touching anything, make no sound, don't smell, then what are they affecting? What use is there to put invisible pink elephants in our world-view when they don't do anything and we can't even tell they exist? That's what parsimony and Occam's razor are designed to take care of. The razor cuts the invisible elephants right out of the equation. We don't need them; they're pointless fluff.

Boy do people ever get this one wrong, too. I've actually had people tell me that Occam's razor is the simplest possible explanation. End of story. That's not what the razor is all about. If you start excluding *known* data, then you're not using Occam's razor: you're just wrong. The qualifier is there for a reason. A theory must account for all known data. If you start ignoring data, you're cherry-picking, and that's ignorant at best. At worst, it's blatant dishonesty. Occam's razor implies the simplest possible explanation that still accounts for known data.

You can probably understand how this would be a powerful tool. Occam's razor comes in especially handy when dealing with a Guru claiming he's got *The Magic*. Consider my earlier statement about the difference between different protocols, or packaged-up programs. Realistically, without well-controlled trials, you just can't say that Program A is better than Program B.

All we can say is that Programs A & B both use sound principles; your actual mileage may vary.

However a lot of Bro and Guru marketing is based on the notion that *this particular program* is the bomb-shizzle. They aren't just saying 'this is a solid program based on solid principles'. They're saying '*this program* is the best ever!'

Is it really that the protocol is just that awesome? Or is it that the program simply meets the required conditions to see awesomeness happen? To phrase it another way, what's really important: the program, or the fact that the program forces you to do the things that are effective? Think about that one for a minute. If you invoke Occam's razor, the likely explanation is that a program is just a particular collection of rules that happen to make you do effective things. The Guru idea that Program A is the source of all your success requires a leap of faith; Occam's razor lets us cut the 'program magic' right out of the equation.

Even a broken clock is right twice a day. Correlation is not causation. Sometimes, a person can spout off a line of garbage, and it will still be effective advice by pure chance. Occam's razor is a powerful tool to keep perspective. If a claim is needlessly complex, then cut out the crap. The simplest theory that still accounts for all the data is probably the correct one.

The Labcoat Mindset: Towards A Model Of Hypertrophy

Now I want to move back towards the topic. I'm sure you were eating up my discussion on the need for applied logic, but seriously, having at least a handle on the basics will go a long way. The goal now is simple enough. The tools of analysis, and how I intend to use them, have been presented. What I want to do in this book is straightforward. I want to set out a working model that can tell us what it is that makes a muscle bigger and stronger.

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Duh, lifting weights!

Well, yes, but I'm thinking a little more in-depth. The more specifics that I can lay out, the less room there is for error - and at the end of the day, that's what it's all about, making sure people are doing the things they need to be doing and not wasting time on the chaff.

This model will have to account for the science, and it will have to account for observed real-world results. At the very least, it will need the ability to explain those results. I'm going to start out with a look at the science, including some long-standing myths, and also practical matters, the common questions and assumptions that I've seen over and over again. I'm not going to hold anything sacred - everything is going to be put under the microscope.

One on-going theme of this book is that individual programs aren't that important in the scheme of things. A program is a construct that reflects sound underlying principles. To that end, I'm not even going to give you a program per se, but rather explain why effective programs work. The idea is to look at the common themes and then flesh out some rules that can explain the results.

You'll get some idea of what's optimal and ideal, and what may not be such a good idea. By the time the dust settles, I want to have a model that establishes both boundaries - that is, what you probably shouldn't be doing - and practical guidelines to get you started. The science will form the foundation, with anecdote and a dose of common sense filling in the gaps when it's needed. I'm not just going to spell out 'lift weights, get big'; this model will account for why different workouts can all be effective; why different people respond in different ways; and most importantly, it's going to outline the issues that are really important (and the ones that aren't).

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IT'S JUST NO FUN WITHOUT A LAB COAT.

This is where the fun begins.

I'm going to keep this as non-technical and easy to read as I can, but I can only do so much without completely watering it down. That said, it's not necessary to have a science background in order to understand this chapter, so if you're science-shy, don't freak out.

I realize I'm coming in here and totally nerding up the whole idea of pumping iron for all you folks that just like to hit the weights, but covering the material really is necessary. Some of this information will undoubtedly be redundant if you've read other books on the subject, but I can't come in with the assumption that you know the basics, so I have to at least touch on it.

What Is Muscle?

I'm going to assume you know what a muscle is. That might be a dangerous assumption, but I don't think it's unreasonable. Assume Captain Obvious mode for just a moment, though, so everybody can be on the same page.

What I'm discussing here is properly known as *skeletal muscle*, to distinguish it from the other kinds of muscle in your body. As you might guess from the name, skeletal muscles are attached to your skeleton; they create movement by pulling on the levers formed by your bones and joints. This is the muscle tissue that everybody can see, the kind that's responsible for movement.

If you're a bodybuilder, any sort of physique competitor, or even if you're just some average dude that wants to look better, you're concerned with the condition of your muscles. Ladies, don't zone out here. You're concerned with muscles too, whether you realize it or not - even if your goal is just to 'tone up'. Muscles don't just make you big and strong. Muscles give your body shape, even when your concern is losing body fat or being lean and sexy. This has to do with body composition - which is how much of your body weight is lean mass as compared to fat mass. You can improve body composition, and thus your appearance, by adding muscle mass or by reducing fat mass. Despite pop-culture belief, having muscles isn't a bad thing, and lifting weights won't turn you into a hulking bodybuilder unless you really, really (really) want it to.

If you want to look 'good', whether that means big and hulking or lean and toned, then you need to do some kind of resistance exercise to train your muscles. The devil tends to be in the details, though, which is why I'm going to discuss this in greater depth as we go on.

Skeletal muscle is a very interesting tissue. At the smallest level, you can think of muscle tissue as a sort of machine built out of protein. Two specific proteins, called myosin and actin, are arranged into tiny strands that lie next to each other, creating a unit called a sarcomere. This is considered the basic unit of movement; you can think of it as the motor that makes muscle contract. These protein-motors are stacked end to end, arranged into long filaments called myofibrils.

Myofibrils in turn are long chains that run the length of a muscle fiber. When they receive the signal to contract, the sarcomere 'motors' pull themselves together, end to end, which shortens the entire myofibril. This shortens the entire muscle fiber. Every muscle in your body is made up of numerous individual muscle fibers, each containing myofibrils. Your muscles are really little more than bundles of protein-motors.

When the muscle contracts, it also tightens up. The easiest analogy to use is stretching a rubber band. If you've got one handy, stretch it out. Feel how it gets tighter? Now do the same thing with a muscle - flex it and feel

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how it tightens up. This is a result of *mechanical tension* being created in the muscle. The tension created in the muscle depends on how hard it has to contract. The greater the resistance you have to overcome, the higher the tension created. Remember this; it'll be important later.

As far as muscle's function, think of your car's engine. The harder you run it, the more strain you put on it. An engine that's revved up a lot, maybe because it has to sit through stop and go city traffic, is going to have a lot more wear and tear than the engine that gets a lot of highway miles. The muscle is similar in that regard too, except for a key difference: it can actually change itself in response to those different situations. This process of change is called *adaptation*.

We can extend the car analogy. A car used to travel long distances will look differently and act differently from cars that have to sit through a lot of regular wear and tear. Muscles operate on a similar principle. Muscles that are placed under specific conditions will gradually adapt to those conditions.

If you do a lot of endurance activity, pushing your muscles to keep up activity for long periods of time, the muscles will adapt to reflect that. Likewise, if you do a lot of 'stop and go' type activity, the muscles will change to reflect that. In both instances, your body is trying to optimize itself to its function. By doing so, it prevents stress and saves itself a lot of trouble.

It just happens that a bigger muscle is more effective under the inefficient 'stop and go' conditions. You're not after endurance. You need to rev up the engine and then come to a full stop.

Of course I'm just making an analogy here to get the point across, but this is actually the gist of it. As you'd expect, this is a matter that's important to those of you looking to get bigger muscles. The body's goal is efficiency under specific conditions, which is in some ways counter to the goal of getting big. Your goal is to keep pushing your body so that it is forced to keep changing.

One thing we do know is that, broadly, skeletal muscle is skeletal muscle. There are of course going to be slight variations from person to person, and there are some gender-linked differences as well - but the gist of it is that the way one person reacts will be the same as anyone else. I call this the 'you are not a unique snowflake' clause. The *magnitude* of response may be different between individuals, but the response itself will be the same.

To phrase that in easier words, different people will see greater or lesser results, but the basic things that cause those results will not change no matter who you are.

Neurological Stuff

When we're talking about muscle activity, we can't forget the nervous system. The brain, spinal cord, and the nerves that connect them to your muscles are critical to your ability to move. In fact, the relationship is so close that we'd be doing better to speak in terms of the *neuromuscular system*, rather than just talking about muscle tissue alone. Muscle is not just a dead piece of meat following blind instructions from the brain. It's an active tissue, returning both neurological and chemical information to the body.

The easiest way to imagine it is like an electrical switchboard. The nervous system would be circuits that connect to the muscles and 'wire them up' to the brain.

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Collectively, the spinal cord and the brain form the central nervous system (CNS). The CNS is ultimately responsible for all movements and pretty much anything else that happens in your body. It's fairly important. A type of nerve called a motor neuron links to the muscle from the spinal cord, connecting to numerous muscle fibers. The spinal cord in turn links to the brain, which coordinates movement.

Again, the details aren't terribly important for you to know. Just understand that the brain talks to the spinal cord, and the spinal cord talks to the muscles. This process works in reverse, too. The muscles aren't just dead slabs of meat. They send signals back to the CNS, and this helps you to fine-tune movement.

Getting back to the point, when a motor neuron fires, all the muscle fibers connected to it get the signal to contract. This neuron and all the fibers it connects to are called *motor units* (MUs). The motor unit forms the basis of your control over a muscle.

When we talk about the strength that a muscle can produce, we're talking about two different things:

- 1) The force that the muscle itself can produce, and
- 2) Coordination between several muscles to create force against external resistance

The first point is related to *intramuscular coordination* – this is how and when the individual motor units inside a muscle are activated. The proper term for this is *motor unit recruitment*. The analogy I use here is the electrical circuit in a light switch. You flip the switch and the bulb comes on. When a motor unit fires, the muscle fiber contracts in response.

In most situations, all available motor units in a muscle are going to be recruited once the tension is past a certain threshold. While this point varies from muscle to muscle, the ballpark number thrown out for most major muscles is 80-85% of the muscle's maximum strength.

Once you're past this point of maximum recruitment, further strength gains are a result of firing frequency. Imagine our hypothetical light bulb, and now imagine that you flip the switch on and off very quickly. Now imagine that each flip of the switch makes the light brighter. If you flip the switch fast enough, you'll never see the light go out – and the room will get brighter.

Motor recruitment works the same way. Each contraction of a fiber adds together, creating higher forces over a time period too short for us to notice. The more often each motor unit fires, the greater the force that the muscle can produce.

The firing frequency is directly related to how much 'oomph' your CNS can deliver, called *neural drive*. Further, neural drive seems to be connected to our concentration. The more you focus and 'push', the greater the frequency of nerve impulses. This link between the mind and the muscle is going to be very important, as you'll see later on.

The coordination between different muscles is important in the sense that each movement we perform is a 'skill' from a neurological standpoint. Even something like a squat or a bench press is still a movement skill, and we can become efficient at those movements. This, too, will have some implications for both bodybuilding and strength training.

I'm going to get a bit sciency for a minute here. The rest of this section actually has to do with the different kinds of muscle fibers found in our bodies. If you want to skip ahead, feel free; this segment is here mainly to dispute some of the myths going around about muscle fibers.

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You might know that there are different types of muscle fibers. Usually some Guru or another will make your fiber types a *Big Deal*, trying to emphasize how important it is to be fast-twitch or have a lot of Type IIB fibers or some such. Well, let's talk about that.

First and foremost, muscle fiber types aren't really the important matter here. The motor units are actually more important, since they're how the CNS controls the muscle. So that's where we have to start.

Motor units are classified as either fast-twitch (type II) or slow-twitch (type I) depending on how they behave. A slow-twitch MU contracts slowly and relaxes slowly, whereas a fast-twitch MU does the opposite. This contraction time, or twitch, is what determines the fast/slow classification.

This is most likely what is meant when somebody's talking about 'fiber types'. It's not the fibers at all, but the motor units, which determine this. It's the difference between a light switch and all the light bulbs it turns on.

But there's a bit more to it. As mentioned, when a muscle fiber contracts and relaxes several times in a row, the effects add up and produce greater peak force. This happens over a very short period of time, so you don't really notice it. Some motor units are better at this than others, so we rate them by their ability to contract really quickly in order to create peak force (Enoka 2001).

Here's the thing, though: The peak force from human motor units doesn't depend on the contraction time, which some people seem to think. The usual thinking is that displays of strength and power in sports are a result of fast-twitch fibers – but in humans, fast-twitch fibers can create low forces, and vice-versa (Enoka 2001). Regardless of whether a motor unit is fast or slow, what is important is its ability to create force.

Then we have resistance to fatigue, which is the ability to keep producing force over time. A fatigue-resistant MU will be able to keep contracting for long periods of time, where a fast-fatiguing MU will tire out quickly. Fatigue-resistant MUs tend to have low force potential, while the fast-fatiguing variety tend to be the heavy hitters.

Human motor units are actually classified by the differences in peak force and by fatigue resistance, not contraction speed. Because of that, it's wrong to say that low-force contractions are sustained by slow-twitch muscle fibers (Enoka 2001). This may hold true in other mammals, but not for us.

While human muscles do contain actual fast- and slow-twitch motor units, there's no real association between that and their ability to create force. Whether it's fast-twitch or not isn't important. This is important to remember, mostly when debating Internet masters going on about how important your 'fiber types' are. The classification in humans is a bit different than animal models, but it's the animal models which are usually trotted out.

Now, there are different kinds of actual muscle fibers, too. What seems to happen a lot of time is that people confuse the concept of motor units with muscle fibers. The motor unit is the light switch, where the fibers are the bulbs.

When we look at the different fiber types, all we're doing is looking for the factors that make them behave that way. The *behavior* of the fiber – determined by the nervous system – is what determines the *characteristics* of the fiber. In other words, *form follows function* – the types of fibers you have and their behaviors will be entirely determined by your nervous system.

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This is where my light bulb analogy breaks down. When you flip on a light, you'll usually see the normal white-ish light. You can also have different colored lights, like red or green or blue. But the color of the light has to do with the bulb, not the switch. If we were comparing this to muscle and motor units, the color of the light would be determined by how often you cut the switch on and how long you left it turned on.

The three main classifications of actual muscle fibers are contraction speed, metabolic activity (how the fiber fuels itself), and the particular flavor of myosin found in the fiber (which is related to both). To make it even more confusing, a lot of fibers are hybrids, a mish-mash of several different qualities. This tends to come up in trained individuals, meaning that it's probably a side-effect of exercise.

Confused yet? Don't worry, even researchers aren't entirely clear on what's what – there's no universally accepted classification so far.

Yet, there's people out there that would have you believe you can train these individual fiber types. If you've ever heard somebody tell you that you can work your slow-twitch fibers instead of your fast-twitch fibers – and we all have – well, no, you can't. Not in any practical way.

The activation and training of motor units is far more complex than that, and even researchers haven't come to solid conclusions about what's going on – so beware when Jimmy the Personal Trainer is telling you to watch out for working your slow-twitch fibers.

It's been thought that the dominance of one 'fiber type' is one factor that influences the sports someone is good at. Naturally gifted strength/power athletes, ranging from powerlifters to throwers and sprinters, have traditionally been thought to be more fast-twitch dominant. People that tend to be good at endurance are thought to be more slow-twitch.

I've already explained how this is a bit simplistic when you consider how human muscle works, but it seems that neural wiring could be a significant contributor here even so. In any case it's not the fibers that are the issue – it's the wiring, the motor units, that are the issue. Genetic tendencies to have more fatigue-resistant or force-producing fibers would still be there, even if the fast/slow-twitch category isn't that important.

Individual muscle fibers tend to change themselves to reflect how they're trained. For example, we see in some endurance athletes that there's a shift from type II towards type I behavior. The individual fibers will change themselves according to how they're being used. In this case, the endurance athlete is bringing in his type II fibers during long bouts of activity, which they're not suited for; so they're adapting themselves to act more like type I fibers.

This shift doesn't seem to really affect the ability to produce peak force. So you're left with a population of fibers that can produce higher forces but also have a higher fatigue resistance. Now a marathon runner isn't going to have big, strong muscles simply because he's not training those fibers in a way that will make them big and strong. But the shift in fiber type hasn't really affected the marathon runner's ability to get big and strong, either.

Surgical experiments that have taken the neuron from one motor unit and transplanted it to different fibers have shown that those fibers will change to reflect the signals of that neuron. The fibers are built how they're built at least in part because of what they do.

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Or, better stated, *form follows function*. Remember that. Your training needs to focus on the goal at hand. It doesn't matter if the goal is more strength, more speed, or more size – when you perform any activity, your muscles will respond accordingly. This is the principle of specificity, and it will play a very important role in how we exercise.

In reality, you're not going to do a lot to affect any of this. Your tendency towards any given type of motor units will be genetically built-in. My old rule of thumb on this is to train for your goals, not for your muscle fibers.

When it comes to actual program design, this is a non-issue. I really have to laugh whenever I hear somebody saying that you'll train your slow-twitch fibers by doing sets of 15 reps. No realistic rep range, even talking 25-40 reps, is going to sufficiently challenge your slow-twitch endurance-type fibers. They tend to have fatigue times measured in minutes. Nothing you do in a weight workout is going to affect that.

Train for what you want to train, and the fibers will take care of themselves. If everything else in this section blurs out, remember one thing: you won't be changing your muscle fibers, not without re-wiring your nervous system under the knife. *You need to train for the goals at hand, not for any particular muscle fibers.*

Getting A Muscle Bigger

The size of a muscle is determined by the total size of all the muscle fibers that make it up. A muscle fiber is basically just a tiny tube; if you look at it end-on, you're going to see a circle, or cross-section. When the fiber grows, that cross-section gets bigger - increase the size of all the fibers, and the whole muscle gets bigger. The fancy term for this is *cross-sectional area* (CSA). Having more 'stuff' in the muscle fibers makes them expand; this increases the cross-section and thus the size of the whole muscle. This is the physical basis of *muscle hypertrophy*, or the growth of muscle tissue.

It doesn't particularly matter what that 'stuff' is, although we know that myofibrils make up something like 80% of the volume of a muscle fiber. The rest is made up of non-contractile mass, better known as sarcoplasm. This is the life-giving jelly that is mostly water and the assorted chemistry that makes life possible. A muscle fiber is a living cell just like any other in your body, and it requires the same cellular machinery in order to function.

As a rule, the total cross-sectional area of the muscle will be proportional to the strength potential of that muscle. The number and density of myofibrils in a muscle fiber is directly related to its force-creating potential. Stated simply, a bigger muscle is more likely to be a stronger muscle. This is important to keep in mind, as it will be a recurring theme.

Sarcoplasm is necessary for the muscle to survive, as it holds all the life-sustaining bits and pieces you'd find in any other cell. This includes everything from nuclei and ribosomes that direct the activity of the cell; capillaries, metabolic enzymes and mitochondria that provide energy; and other miscellaneous things that are present in all cells. Although it makes up a relatively small portion of the muscle fibers, it's thought that it can 'grow' too, adding to the overall size of the muscle.

In fact, you'll see people arguing over whether we actually see myofibrillar hypertrophy (increase in myofibrils) or sarcoplasmic hypertrophy (increases in water, enzymes, etc) in the muscle. I'm not really sure that these functions have ever been actively separated in any realistic setting; the difference seems to be one of those 'looks good on paper' things. To my knowledge, there's never been any research that shows one happening without the other. In practice, any training you do that increases one is going to increase the other at least to some degree, although there might be some difference in proportion depending on how you train.

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Anecdotally, you'll hear people talking about how bodybuilders tend to look more 'full and rounded', while strength-based lifters have a more 'dense and hard' look. This is usually chalked up to the differences in training, with bodybuilders sticking to higher-rep 'pump' type training, and strength athletes lifting heavy weights. I'm not sure how accurate that claim would be if you put it under the microscope, but this does open up the idea of attacking the problem from different directions - if some exercise favors one over the other, it might make sense to use complementary methods in order to maximize total growth.

There is some potential information to back this idea, in principle anyway. In *Supertraining* (2003), Siff describes the idea of *irrational adaptation*. The gist of it is that if you increase the amount of myofibrils too quickly, you can overwhelm the fiber's ability to support those new proteins. The muscle fiber literally grows too fast for its own good. It's speculated that this happens when you attempt very rapid progress in strength – you stimulate the muscle to add new proteins, but the resulting changes limit the supply of energy available to the fiber. As a result, the fibers tend to limit their own size to something more manageable. In contrast, a moderate rate of strength-gain would create a *rational adaptation*, where the fiber has time to adjust to the new condition.

There is a real physiological basis for the idea. It's well known that the size of a living cell will be limited by the ratio of its surface area to its volume. When the cell grows, the surface area will increase as a square, while volume increases as a cube. A muscle fiber that doubles its size will have eight times the volume, but only four times the surface area. The surface area is important because that's how nutrients enter and exit the cell; beyond a certain point, the cell won't have enough surface area to support all the stuff inside it. It's not that out-there to assume that a muscle fiber would have similar limitations, especially if it's increasing in size quickly. We also know that muscle fibers are very responsive to changes in energy levels; the mitochondria and other energy-producing stuff will tend to transform itself in ways that will accommodate a smaller energy supply (Novotova et al 2006).

Unfortunately, besides Siff's reference in *Supertraining*, I've found nothing else to support this concept. Even *Supertraining* only listed one reference to a Russian paper dating to 1990; given the sometimes dubious nature of Russian research in the Soviet era, I'm hesitant to take this at face value. It's a reasonable enough idea, and it does seem to agree with other observations, but in practice I'm not sure we can accept this idea without more evidence. If this is true, it would be a convincing argument for the need to increase the energy-producing substance, not just the myofibril content of the fiber, if we want it to continue grow. It would also suggest focusing on gradual, steady increases in strength rather than short-term bursts of strength gains. There are more convincing arguments to be made in relation to this point, which I'll get into later.

For our purposes right now, though, we'll just consider that the more protein you pack into a muscle, the bigger it's going to get.

When we're talking about the actual process of the muscle growing, the key point to remember is that your muscles are almost entirely made up of contractile proteins (the myofibrils) that are designed to make the muscle shorten and create force. The amount of protein in your muscles, and the amount that your muscles can keep there, are the two main determinants of how large those muscles can get. If the sarcoplasmic tissue does contribute, it's going to be secondary to this.

This has some implications for a lot of people with poorly-defined goals. Based on this information alone, you can start to rule out some of the common sayings. You have those people that want to 'tone up', or even worse, the nonsensical idea that you can make your muscles 'long and lean'. Toning up at least has some basis

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in reality, even though it has nothing to do with what people mean when they say it; it has more to do with overall aesthetics than anything having to do with training your muscles. The idea of lengthening a muscle is pure voodoo; ask yourself if your bones are meant to get longer too. I don't see people coming out of Yoga class taller.

So we're left with this basic idea: a muscle is either getting bigger or it isn't. I'd also make an exception for simply maintaining size and strength as well; this is what plenty of people are actually doing when they're 'toning up'. If you have a goal that relies on some other magical transformation of the muscle, you should probably be re-evaluating your goals at this point.

PROTEIN METABOLISM

At heart, the size of your muscles is a function of your body's ability to metabolize protein.

Metabolism, as you may or may not know, is your body's ability to build up or break down the materials involved in life processes. Respectively, we call these *anabolic* (building up) and *catabolic* (breaking down) processes. The list of materials includes proteins, fats, carbohydrates, and countless other substances that form the structure of your body.

Every tissue in your body is in a constant state of flux. The anabolic and catabolic processes are constantly working to tear things down and re-build them. As you might imagine, all this turnover of material is quite expensive in terms of energy and nutrients. However it does give the body a very useful means of repair and adaptation; it's easy to make changes when the environment is constantly shifting. In the muscle, this total flux of amino acids – the building blocks of protein – is called *protein turnover* (Tipton and Ferrando 2008).

Usually protein turnover balances out. There's no net positive or negative, so the muscle stays the same size; you never see this going on because there's no obvious changes at the level you'd notice. This is called *homeostasis*, the state of equilibrium. Your body likes homeostasis, and it's always going to try and move towards that balanced state.

As I mentioned, your muscle is mostly made up of contractile proteins. Indeed, skeletal muscle is considered the body's largest reserve of amino acids. These proteins are built from individual amino acids, taken up from the blood stream and then synthesized into proteins inside the cell. This is *muscle protein synthesis* (MPS), the anabolic process inside a muscle fiber. To see a positive balance, MPS has to be higher than protein breakdown (MPB). If we want a bigger muscle, we have to overcome the trend towards homeostasis and encourage a state of positive protein balance - where the rate of anabolism has to be higher than the rate of catabolism (Tipton and Ferrando 2008).

Making the muscle grow is 'just' a matter of increasing the amount of total protein in the muscle.

Think about your bank account. At any given time, money is coming in from your job and going out to pay your bills. This is the total turnover of money in your account, the total amounts that flowed in and out. The muscle works the same way, only with amino acids instead of cash. Hypertrophy is a result of making the bank account bigger. You want to encourage the muscle to hang on to as much protein as possible. It's the same idea as living within your means and saving money, or spending more than you earn. The former is going to result in the bank account getting bigger, while the latter is going to make it shrink.

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There's two primary factors responsible for increasing the rate of MPS and creating a positive protein balance: ingestion of amino acids and resistance exercise. In layman-talk, this means that eating protein and lifting weights are the two most anabolic things you can do. Further, when you combine the two, the effects are synergistic. Lifting weights elevates MPS, but lifting weights with amino acids in the blood (i.e., after eating a meal) elevates it even more than either one alone.

What we find is that both of these factors manipulate your body's physiology – right down to the genetic level, in fact – to create that favorable anabolic response.

We know that training with external resistance (i.e., lifting weights) causes the greatest change in protein balance, shifting it towards the positive. Starting 2-3 hours after the workout, muscle protein synthesis will start to increase up to a peak, which usually happens around 24 hours after the fact. It stays elevated for as long as 48 hours, after which it will begin to return to normal. By 72 hours after the workout, it will usually have returned to normal levels.

Nutrition is arguably just as critical. Having an adequate supply of amino acids, aka protein in the diet, is just as necessary to support muscle growth. Certain amino acids, namely leucine, have shown the ability to trigger protein synthesis on their own. When provided along with a resistance training workout, the effects of both are increased. It's been shown that resistance workouts without adequate nutrient intake can't provide a positive protein balance, although the workout will help to reduce the amount of muscle proteins lost – this is important to remember while dieting (Tipton and Ferrando 2008).

Ironically enough, this is one area where bodybuilders were ahead of the curve. Bodybuilders have always suggested eating high-protein diets, while the researchers were only studying the effects of fat and carbohydrates. More recent analysis is starting to come around to the same idea: physically active people require, or at the very least will benefit from, higher protein intakes than the RDA.

Insulin, which is stimulated mainly by eating carbohydrates, also plays a role in net protein balance by reducing the levels of protein catabolism that result from a workout session. While not absolutely necessary, contrary to many claims, this can be helpful when you're trying to build or maintain muscle. Reducing total breakdown will affect the net balance just as easily as increasing protein synthesis.

The critical factors are still very clear: lift weights and get your protein.

What we see actually happen in response to a resistance workout is that both MPS *and* MPB become elevated. It's important to note that this means catabolism also increases around a workout. Protein breakdown is greatest during and immediately after a weight-training workout, in response to both energy shortages and the damaging effects that resistance training has on muscle fibers.

However, the increased catabolism also seems to be a response to the increased level of protein synthesis. It's thought that this increase in catabolism increases overall protein turnover and helps conserve the total amount of available amino acids, in order to make sure that your muscles aren't hogging up all the aminos that could be needed elsewhere. This isn't a bad thing, though. Protein synthesis tends to have a slight edge, and stays high longer, so that the *net balance* will still be positive in response to a workout. If the muscle is in a positive protein balance, then it's growing - even if catabolic factors are increased as well. Both of these are good things. Keep this in mind any time a good Bro is trying to tell you how bad it is to be catabolic.

Anabolic steroids will strongly influence this process. Their activity tends to keep MPS 'switched on' even in the absence of a stimulus from exercise or amino acids in the blood. Steroids are also thought to increase the re-

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uptake of amino acids – that is, when protein is broken down under normal conditions, usually the bulk of it returns to the bloodstream. When using steroids, a greater amount of this broken-down protein is taken back into the muscle. The combination of these factors results in a very large accumulation of protein and a rapid increase in muscle size. Even natural levels of testosterone and related anabolic hormones can create this effect to an extent.

Ultimately, you grow both because of the increased protein synthesis levels after a workout and because of the decreased levels of protein loss between workouts. Each workout and meal will result in a small increase in the total amount of protein in the muscles. Over time, this will add up to visibly bigger muscles.

This may sound like simple common-sense stuff, but I don't imagine a great many people think of it in these terms. Importantly, this gives us the basis of a muscle-building regime: you have to lift weights, and you have to eat your protein, with the goal of creating a net positive protein balance.

THE ENERGETICS HYPOTHESIS

One of the original models of hypertrophy attempted to explain things as a balance of energy inside the muscle fiber.

As noted above, you're after a positive protein balance, where the rate of protein synthesis exceeds the rate of protein breakdown. This positive balance requires energy - quite a bit of it, in fact. Even under normal resting conditions when MPS and MPB are balanced, MPS is still eating up a lot of energy just to maintain existing amounts of protein. In the currency of cellular energy, keeping a positive protein balance is expensive.

A living cell will only have so much energy available to it at any given time. There's limits to both the total amount of energy that can be stored in a muscle, and to how fast energy can be produced. This creates a limited pool of energy for all functions of that muscle fiber.

The idea behind the *Energetics Hypothesis* is that a muscle contraction dips into that pool of energy - and when it does so, protein synthesis suffers, allowing protein breakdown to dominate. The result is a negative protein balance while the muscle is contracting. This model states that this temporary increase in protein breakdown is what stimulates later growth.

This has been expanded on in research - we know that there are regulating mechanisms inside a cell that monitor energy balance. Specifically, research has identified a regulatory molecule called AMPK that does just that. If energy drops too much, this 'energy thermostat' activates and starts turning off all the metabolically-costly processes – the things that are wasting energy from the cell's standpoint. As far as your body is concerned, survival is more important than big muscles – it will sacrifice protein synthesis in favor of energy-sparing actions that will keep the cell alive. It's not ideal for those of you looking for the biggest muscles you can get, but it's there and you have to deal with it.

The Energetics Hypothesis does explain some observations if you look at it as a black box model, meaning the actual inner workings aren't important. However, more recent research has caused us to give the actual mechanism a second thought. What we're finding is that the process of growth is a bit more intricate and involved than a simple change in energy balance. While an energy shortage and AMPK's action may well be a part of the overall process, what we're finding is that there are specific signals inside the cell which directly regulate protein synthesis – and the strongest of these signals aren't really linked to energy balance at all.

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We can loosely divide muscle growth into a short-term immediate phase, which happens right after the workout, and a long-term chronic phase, which starts a few hours after the session and can last for a couple of days after the fact.

The immediate phase can be thought of as the trigger for growth. This begins in your workout, where you actually stimulate the growth process, and continues for a few hours after the fact. Starting around 3-6 hours in, you get to the long-term phase which can be called *adaptive remodeling*. That's just a fancy way of saying that the muscle fibers change themselves in response to exercise. The remodeling process is when the highest MPS rates will be observed, along with inflammation and structural changes to the fibers; this usually peaks around 24-48 hours after a workout, and is more or less back to normal by the 72 hour mark.

The Short-Term: Mechanical Signaling And Protein Synthesis

All living cells are governed by a cellular nucleus, which is where your genes are located. You can think of your genes as a sort of biological memory, containing the instructions on how your body is built and how it operates.

It just happens that genes are a dynamic thing. They switch on and off in response to chemical signals, doing their best to keep a cell healthy and happy in response to its environment – that homeostasis thing again. You can think of a living cell as a network of chemical activity. A very, very complex network of chemical activity. The body is always seeking homeostasis, and to this end there are innumerable feedback loops regulating all the processes required for life. From that outlook, it's not surprising at all to find that muscle growth is regulated by these same chemical signals.

The processes that control genetic expression are extremely complex, creating a self-regulating network that we don't fully understand just yet. We do understand the process in general terms, though. Once a gene is turned on by a chemical signal, it undergoes the process of *translation* which converts the information of the gene into messenger RNA (mRNA), a compound which transmits the instructions of the gene. The mRNA then travels outside of the nucleus to structures called ribosomes.

Protein synthesis can be thought of as a kind of cellular industry. Amino acids are taken in from the blood and then built into the specific proteins required by the cell. This is done in tiny factories called *ribosomes*, which take their instructions from the cell's nucleus. When they receive mRNA from an activated gene, they begin the process of transcription, building a specific protein step by step based on the instructions in mRNA. This is how protein synthesis occurs. Since protein transcription requires raw amino acids, you can see why having adequate amounts is critical.

This activity is what governs the entire state of a cell.

It just happens that muscle protein synthesis is at least in part signaled by direct action on the genes that govern muscle size. This was first pointed out back in the 1970s in research done by two guys named Goldspink (Goldspink and Howells 1974, Goldspink et al. 1975), where it was shown that muscle growth was dependent on work-induced changes in the muscle. Researchers have since discovered a signal chain, Akt-mTOR, that is directly 'upstream' of the factors that activate these genes (Glass 2005, Frost and Lang 2007).

The mTOR molecule itself is directly receptive to both resistance exercise and amino acid intake - which gives us the link between exercise, diet, and protein synthesis. Eating protein and lifting weights both work to directly switch on the genes that make your muscles grow (Goldspink and Yang, 2001, Goldspink 2002, 2003).

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As I mentioned, there's a whole all-you-can-eat buffet of chemistry at work here. While researchers have identified four major factors involved in mTOR activation, they all boil down to 'lifting weights' and 'eating enough food' (Wackerhage and Ratkevicius 2008).

The biggest and most consistently observed trigger is the mechanical stretch and deformation of the muscle fiber. Muscle contractions that happen during strength training place a large mechanical stress on the muscle tissue, just like stretching out a rubber band. Turns out that when a fiber is placed under stress like that, it sets off a whole lot of chemistry that will eventually activate Akt-mTOR and protein synthesis.

Scientists have given this process a name: *mechanotransduction*. Literally, this is the conversion of mechanical stress into chemical signals. When the muscle fiber is stretched or strained while under tension, mechanotransduction converts that into chemical signals. So far as we can tell, mechanical stress is the factor that has the greatest impact on Akt-mTOR. In short, mechanical stress created by muscular tension and stretching is pretty much *the* essential requirement for growth.

To be a little more specific, we can classify 'stress' in several ways. One is simple 'deformation' of the fiber. This happens when the muscle is stretched; and that's exactly what it sounds like. It's no different than taking a rubber band and pulling it apart. What happens when you do that? The band gets tighter, right? This is the same process that occurs in the muscle when it lengthens.

In exercise science, we call this lengthening movement the eccentric portion of the exercise. You might have heard it called the negative, which is an older bodybuilding term. When you lower a weight under control, you're effectively stretching out the muscle while it's under tension. Note the key part here: under control. Dropping the weight with sloppy form doesn't count.

The eccentric phase of the lift does interesting things, compared to the concentric (or lifting) phase. This is where most of the damage to the muscle fibers happens, and there's several theories as to why. Some research indicates that it's a change in the way fibers are recruited, with preferential activation of the big high-threshold motor units. This would place the stress on those fibers, thus working them by increasing the tension in each individual fiber. However, other research has called this into question, so it may not be accurate.

Another hypothesis suggests that there's a difference in the way your myofibril cross-bridges are formed. This is somewhat reinforced by a few studies showing differences in gene expression between eccentric movements and other types of movement. Regardless of the cause, the eccentric phase of the lift creates more mechanical stress and seems to do more actual damage. One way or another this is linked to deformation and stretching of the fibers that occurs.

Arguably the most interesting effect of stretching and deforming fiber has to do with the growth factor Insulin-like Growth Factor 1 (IGF-1). IGF-1 is actually found in multiple forms: a circulating form that has effects throughout the body, and a locally-produced muscle-specific form. This muscle-specific form is identified as Mechano-Growth Factor (MGF) to distinguish it from the circulating form. MGF is synthesized in response to mechanical stress, hence the name, and it's thought to be a critical link between mechanical stress and protein synthesis. MGF does a lot of neat things in the muscle as far as anabolic processes go, but the biggest contribution is the effect on satellite cells, which I'll discuss in the next section. Needless to say, it's a critical step in the growth process (Adams 1998, Goldspink 1999, Adams 2002, Laviola et al. 2007, Philippou et al. 2007, Quinn et al. 2007).

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This is one reason that anabolic steroids work so well to increase muscle mass. Testosterone causes the satellite cells to be fruitful and multiply, while working with MGF to improve the process of nuclear donation. Of course, MGF also acts to trigger protein synthesis directly, as well as blunting atrophy mechanisms. It's an all-around useful compound, and quite necessary for the growth process to happen.

In the last decade or so, researchers have isolated a number of signaling pathways that regulate both anabolic and catabolic processes.

These signals are responsible for taking the outside stimulus, like lifting a weight, and translating it into a biological function.

Most of those signals are largely irrelevant to you. They're minutiae that isn't necessary to understand the bigger picture, mostly because they all end up working on the Akt-mTOR axis anyway. Even MGF exerts its effects through that signal.

Truth is I'm not even sure I should have mentioned Akt-mTOR, because it's only going to score me a ton of e-mail from OCD detail-freaks asking if they need to do barbell curlz or dumbbell curlz to turn on their mTORs. It's enough to know what happens in general terms; I'm only mentioning the molecules for the sake of completeness. While there are other signals that can activate protein synthesis, muscular tension is squarely at the top of the list.

This makes sense from a logical standpoint; the body doesn't just randomly start making your muscles bigger. The body is always after homeostasis - you have to disrupt that status quo in order to stimulate changes. There are other conditions that can enhance or modulate MPS signaling, but heavy resistance training is the one that has to be present. Mechanical stress is a necessary condition for growth to occur.

Aside from just triggering protein synthesis, mechanical stress and stretch also tends to create an overall responsive environment for anabolic processes to happen. The number of ribosomes will increase, as will the number of receptors for the anabolic hormones and growth factors. Not only does tension actively increase protein synthesis, but it creates a favorable environment for growth.

This signaling response works both ways, though - the more a muscle fiber is exposed to that stress, the less responsive it becomes. The process of adaptation works to protect the body from damage, so any amount of stretch or deformation will create a progressively weaker signal with repeated exposures.

This has been experimentally verified by several sources (Goldspink 1975, Martineau and Gardiner 2001, 2002). The amount of tension created in the muscle fiber is what determines the greatest increases in protein synthesis. Tension in the muscle is what equates to mechanical stress and deformation.

These stretch-sensitive signals don't seem to be very picky about the source of the stretch, either. Even something as seemingly innocent as pulling water into the muscle fibers can trigger anabolism to some degree. More water equates to more volume inside the cell, which causes a stretch of its own. This is one reason why eating more carbohydrates after a low-carb diet can help trigger muscle growth – each molecule of glycogen that is stored in the muscle brings water along with it. Creatine supplementation would have similar effects. This is just one more reason that being fat and bloated is good.

It just happens that the easiest and most direct way to create the stimulus is progressive resistance exercise - lifting weights, and working to keep increase strength levels so that you overcome the adaptation.

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Cellular energy balance plays a role in signaling too, giving a nod back to the Energetics Hypothesis. I mentioned how the molecule AMPK will work to switch off protein synthesis when energy supplies are low. As explained, it requires energy to contract a muscle fiber. But it also requires energy to keep a muscle cell alive. When a muscle contracts, it has to dip into this energy reservoir. If the contraction is severe enough and lasts long enough, the cell will end up with a shortage of energy.

If this happens, muscle breakdown will be exaggerated; protein synthesis is expensive business, and it only makes sense to shut down expensive things when you're running out of energy.

Fortunately, this state doesn't tend to last long. Once the contraction stops, the muscle begins to refuel itself. If there are nutrients available in the blood, the muscle will refuel very quickly - one major reason you need to be fed before a workout and make sure to eat afterwards.

However, this energy shortage does help to exaggerate the amount of stress placed on the muscle fibers. Without available energy, the muscle fiber will actually stiffen, a condition called *ischemia*, and become much more vulnerable to mechanical damage. The cross-bridges literally don't have the ability to separate, making the fiber rigid. Now, here's a thought experiment. When something that's usually flexible becomes very stiff, and you try to stretch it, what happens? Usually it breaks, right? It's been suggested that this is one further mechanism in the hypertrophy response — the muscle fibers, now rigid due to lack of energy, are very susceptible to damage on any further eccentric actions. When you continue moving, the fibers get damaged (Fry 2004).

In light of the above information on the need for muscular tension and stretch, this is not entirely out of the question. If anything, it simply completes the circle: tension and stretch create their effects in part due to what happens after the muscle fibers become exhausted. Regardless of the actual mechanism, several papers show that energy expenditure (or work done) can affect the degree of hypertrophy experienced (Wernbom et al. 2007). This would indicate that while tension is necessary for growth, it's not sufficient to maximize growth; you have to do enough work with your heavy weight to see the best results.

In my mind, there's a continuum at work. You don't have to fatigue or exhaust a muscle fiber for it to grow. As long as it's placed under heavy-enough tension, it'll get some degree of training effect. Training the fiber to exhaustion may simply be one way to maximize the effect. I should also note that exhausting fibers in this context is not the same thing as training to muscular failure.

To recap, a muscle contraction directly signals growth processes by stretching and deforming the muscle fibers. Contraction also reduces the amount of available energy in a cell, which in turn reduces the energy available for MPS, increases the rate of MPB, and makes the muscle more susceptible to damage during exercise. All of these factors are going to play a role in signaling the growth response.

This brings us right back to resistance exercise, in that strong muscle contractions are necessary to create these conditions. Endurance exercise doesn't have the same effect on protein synthesis levels or the anabolic growth chemistry, even though it activates AMPK and all of its metabolic friends. Just exhausting the muscle on its own isn't enough; the muscles need to get tired while you're moving some heavy iron. If you exhaust the muscles while running 30 miles, that's not going to cut it. Exhaust them under heavy weights and you've got the recipe. Muscle growth is primarily a product of the tension created, not the work done.

The Long-Term: Adaptive Remodeling

The short-term 'trigger' phase is straightforward enough. The muscle is mechanically and metabolically overloaded during a workout session; in response it begins a process of adaptation - which in this case means growing.

The really interesting stuff starts to happen in the long-term phase. We see protein synthesis rates increase up to a peak rate a day or two after the workout session. It's critical that you keep a source of amino acids in your diet while this is going on, in order to 'feed' that process. Besides this, we see some other neat things happen, and they bear mentioning.

Growing your muscles is not just a matter of building them up one time, since your body is constantly recycling proteins. Not only do you have to create growth in the first place, you have to support it after the fact. Any given nucleus can only support so much protein because of these limits. The amount of protein that can be synthesized and maintained is directly limited by the number of ribosomes and nuclei. There's only so much protein synthesis that can go on with a given number of resources.

Think of it as a maintenance cost on a car you already paid for. When you're driving around the old Chevy that you didn't pay a lot for in the first place, your maintenance costs are going to be relatively low. Oil changes, tires, even more expensive repairs and maintenance won't be all that expensive in relative terms.

Say you get a little raise at work and decide to go buy the newest BMW. Not only do you have to pay a lot more up front just to drive off the lot, but suddenly repairs and mundane upkeep are costing you more out of pocket too. It's got a bigger engine than the old Chevy so you've got to pay more for gas too.

That's about what goes on here. A larger muscle requires a higher investment up front, but it also has a higher on-going maintenance cost. In order to add any further amount of muscle proteins, you'd have to find a way to add more nuclei and ribosomes. If that raise at work was big enough, those upkeep and fuel costs for the new BMW will be affordable.

Fortunately, our muscles are equipped to do just that. Unlike most cells in our body, muscle fibers are multi-nucleated – that is, they can have more than one nucleus. This leads to an odd quirk in how human muscles grow and adapt - muscle fibers rely on the process of adding nuclei in order to grow.

These nuclei have to come from somewhere, of course. Your muscles are surrounded by immature, undeveloped cells commonly known as satellite cells or the nerd-term *myoblast*. You can think of satellite cells as a kind of stem cell, coming from the same 'line' of undeveloped cell that becomes all the other cells in your body. In adults, these particular stem cells will usually only become muscle or fat.

Under the right conditions, satellite cells can be signaled to increase in number and grow larger. These processes are called proliferation, differentiation, and activation, respectively - the cells increase in number, become more 'muscle-like', and then become 'switched on' to do their thing.

Once the satellite cells are large enough, they can fuse with the existing muscle fibers. This donates all of their nuclei and ribosomes in the process: all of the things that are required for protein synthesis. As you might gather, this is very important to long-term changes in muscle size. In fact, if it doesn't happen, the muscle can't grow beyond a point. The number of nuclei and amount of ribosomes are what directly determine how much protein a muscle fiber can hang on to (Allen et al. 1999, Kawano et al. 2006).

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You might notice that this isn't terribly dissimilar from the irrational adaptation I mentioned before. This concept has more backing, since it's not dependent on energy levels but rather protein synthesis, and we've seen time and again that satellite cell activity does have a significant impact on muscle growth. Nevertheless, it's not unreasonable to assume that more than one factor could contribute. No matter what, we do see that there is a fundamental rate-limiting step that will put a cap on muscle growth in any given time frame.

The good news is that most of the same variables that signal increased protein synthesis also have some effect on satellite cell behavior. Satellite cells seem responsive to heavy weights and resistance exercise in general, so it's not really something you have to worry about in isolation.

However there are some potentially interesting implications. In a study a few years ago, it was discovered that giving a maximum over-the-counter dose of aspirin had negative effects on protein synthesis after a workout (Trappe et al. 2002). The authors of that study found that aspirin and other NSAIDs were affecting COX-2, which is a molecule involved with inflammation. Besides regulating elements of inflammation, COX-2 also governs the synthesis of compounds called prostaglandins. One of the prostaglandins, PGE2, is involved in both protein synthesis rates and in the activity of satellite cells (Rodemann and Goldberg 1982, Vanenburgh et al. 1990, 1995, Bondesen et al. 2004, 2006). What they found was that blocking COX-2's action also reduced the levels of PGE2 - and this worked to reduce protein synthesis.

I'm not telling you this as a scare tactic to avoid your ibuprofen after a session, as other research using lower doses hasn't shown the same effect (Krentz et al. 2008). This is important because it demonstrates that prostaglandins, specifically PGE2, are responsible for at least some of the long-term responses to a workout, and that at least part of this long-term response is related to the satellite cells (Adams 2006, Veliça and Bruce 2008).

Further, it appears that some degree of inflammation response is at least useful in triggering this activity (Tidball 2005, Arnold et al. 2007, Chazaud et al. 2009). It seems that not only do the prostaglandins have an effect, but some of the cells involved in the repair process actually encourage satellite cell activity (Smith et al. 2008).

This has some interesting and compelling implications – namely, you actually need some degree of inflammation in order to see optimal gains.

In fact, I have a semi-plausible hypothesis about inflammation and satellite cells that might explain some observations about advanced bodybuilders.

The more advanced you get, the more important it becomes to ensure that the muscle fibers can actually support further growth. Earlier I mentioned the irrational adaptation idea, and how it's plausible even though it does have poor support in the research. However, satellite cells represent a much better documented bottleneck, and unlike the irrational adaptation based on energy limitations, it's been confirmed that satellite cell fusion is a requirement for growth.

In my thinking, working to trigger satellite cell activity starts to become more important than 'just' triggering elevated MPS as your muscles get larger. The bigger a muscle is, the more protein it will have to maintain. We know that any given fiber will eventually reach a point where sustaining the new protein is more important than just increasing MPS rates - if the fiber can't hang on to the new protein, then synthesizing it doesn't mean much. It'll just break back down and head back into the bloodstream.

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It's my thinking that the bigger and more 'mature' a fiber becomes, the more important satellite cell fusion becomes. The greater the cross-sectional area, the more internal volume and total protein that the fiber will have to sustain. Eventually you'll hit a limit, some point where further growth becomes all but impossible - so slow and tedious that it might as well be impossible. When you hit that point, you'll have to constantly work to stimulate satellite cell fusion if you want to create any growth.

Satellite cell activity is closely tied to two factors: androgen levels and inflammation. A natural bodybuilder is going to have a limit to his androgen level in the form of circulating free testosterone. There's also a contribution from MGF as well, which would also be determined by naturally-available levels. The easy answer, and the one that's usually taken, is just to increase the circulating levels of androgens - to take steroids, in other words. The use of anabolic steroids has been shown over and over to increase the ceiling of both total muscle mass and the rate of muscle mass gains.

The other avenue is to stimulate satellite cells with inflammation - which means that there just might be a place for those very heavy, very hard workouts that 'blast' a muscle group. This represents a greater overall stimulus to the muscle tissue, with the unfortunate side-effect of creating a lot of collateral damage - damage that will have to be recovered from. This may explain at least in part why a more advanced bodybuilder can benefit from training in this way, while a relative newbie won't really see the best results.

This would suggest to me that the training needs of people at different levels of development would be different. A relative beginner could get by with 'just' triggering elevated MPS rates, lifting as often as possible to take advantage of that. Someone highly advanced would have to create a much larger acute stress - a heavier, more difficult workout, in other words - in order to trigger a greater response from the satellite cells, with the trade-off of longer recovery times and less frequent sessions.

However, I do want to caution that this is just one possibility. We also know that muscle becomes more and more resistant to growth with training experience. The fiber membranes and the surrounding connective tissues reinforce themselves as the muscle grows, and as a consequence they become less sensitive to the mechanical signals that are required to trigger growth. This fact by itself could be the culprit; as it stands, we just don't have enough data to say for sure. The idea that satellite cell fusion becomes more important with progress is not completely unfounded, but I'd like to see something more concrete before I'm willing to

What we do know is that more advanced lifters have different needs than beginners, regardless of the mechanism behind it. The advanced guy wouldn't necessarily lift with super-hard workouts because it's optimal, but because he has no choice if he wants to grow. He has to accept the compromises, even though it may not be the most efficient from the standpoint of protein metabolism. There's no way to say for sure when you'll reach this point. It's going to vary for everyone, as it's based largely on hormonal conditions, local growth factors, and other things that aren't easy to measure just yet. This is at least one avenue to explain why some people get bigger than others, and why some people find it easy to grow while others struggle.

Regardless, satellite cells and the process of nuclear donation are known to be crucial steps in the larger process of muscular growth, so it's important to recognize this step.

Metabolic Variables

Although considered a weaker overall stimulus for anabolism, metabolic action is still important in itself as the muscle needs energy to function and to grow.

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Metabolic or endurance training tends to cause increases in stored energy reserves (molecules like glycogen and its associated enzymes), mitochondria (the source of cellular energy), and in the amount of capillaries in the muscle, which are important to deliver nutrients and remove waste products. All of these things can add to the CSA of a muscle. There are caveats, though.

In comparison to the contractile proteins, the metabolic stuff makes up a small portion of the muscle. The number I usually see is 20% or thereabouts. However, if you're after size for the sake of size, then muscle volume is muscle volume. Over the long term, I've got a feeling that the metabolic stuff can end up being important to maximize growth, provided you don't go overboard with it.

Our friend AMPK does more than just regulate energy levels. It also acts as a control switch for endurance-type adaptations. The body is stingy when it comes to energy, as energy from nutrients can become scarce. At least they could when our bodies evolved, and there's not been much change since we were living on the prairie or wherever the hell our ancestors lived.

From an evolutionary standpoint, AMPK is a savior. Under conditions of energy shortage, it cuts off expensive processes and cuts on energy-conserving measures. It's like an accountant to make sure you don't spend money you don't have.

Unfortunately for us it just happens that muscle protein synthesis is one of those costly processes, and AMPK will directly work to blunt it. At the same time, it can along work with muscle atrophy processes to increase catabolism and net protein loss. In fact, AMPK is one of the culprits responsible for increased catabolic activity during and right after a workout – it directly works against Akt-mTOR.

Now, if you're eating enough food, this isn't an issue after a weight session. AMPK will cut on briefly during the session, but once you're back at rest and well-fed it goes on its merry way and protein synthesis kicks on as it should.

If you're training for endurance sports, the story changes. With a ton of endurance-type training, AMPK is going to start making more extensive changes to the muscle fibers. The net outcome is that they'll become more oxidative (using oxygen to burn fat) and otherwise smaller and more efficient.

This isn't good for building big muscles, even though efficiency sounds good on paper. My car analogy is apt here. AMPK will eventually make your muscles into sub-compact hybrids. A big muscle is an inefficient gas-guzzler - you want a good old American SUV, which means you actually need a degree of inefficiency.

This isn't to say you can't or shouldn't do any kind of endurance work, just that you need to keep it in its place. If you want the big muscles, there's little to no need for any kind of true endurance work. Note that this does not include basic conditioning to stay in shape, but I consider that to be a different matter. Staying in shape is going for a half-hour walk or playing around with kettlebells. Endurance training is running 10 miles.

This is mainly due to the relative contribution of energy. Long-distance stuff is aerobic in nature, whereas shorter, harder activity is dominantly anaerobic. Anaerobic activity doesn't tend to create all the problems of excessive aerobic work. With that in mind, I can see a rationale for keeping that kind of work in the mix.

One potentially interesting idea is the contribution of capillaries to feed the muscle tissue. I remember reading Fred Hatfield's book *Hardcore Bodybuilding: A Scientific Approach* years ago, and he spoke of the need for very high reps, 40 or more, in order to encourage the development of new capillaries and energy-producing structures.

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At the time I took it for granted, and over the years I basically forgot about it with the 'heavy weights' orthodoxy, but there's a growing body of research that's starting to make me think there's something to it.

This wouldn't necessarily have anything to do with actual aerobic-endurance training. Most of the adaptations relevant here would be anaerobic in nature, which probably explains why they're not breaking down tissue.

Where endurance adaptations tend to be mutually-exclusive with strength and muscle-building changes in the muscles (Docherty et al. 2000, Nader 2006), anaerobic endurance doesn't necessarily have that problem. In fact, it seems to create a compromise by improving the energy metabolism of the cell in some ways without going out for the whole hog like aerobic training would.

The KAATSU research coming out of Japan is doing a lot to push forward this idea. The KAATSU idea is based around vascular occlusion – that is, blocking blood flow in and out of a working muscle. To do this, they just put a pressure cuff around an arm or leg and tighten it up.

Some of the results have been quite interesting – even though very light weights are used, on the order of 20-40% of the 1RM, the occlusion research shows sometimes significant gains in both muscle mass and neurological adaptation. This is counterintuitive; you wouldn't expect that kind of thing to build muscle, yet it seems to be the case.

Originally I'd thought we could write this off as limited to beginners, as most of the research was in our beloved untrained subjects. However repeated studies have demonstrated changes in both neurological activity and in the response of the muscle tissue (Takarada et al. 2000, Goto et al. 2004, Teramoto et al. , Fujita et al. 2007), and it's not limited to just beginners (Takarada et al. 2002). Besides the Japanese team, others have validated the idea (Burogmaster et al. 2003, Moore et al. 2005, Wernbom et al. 2008).

Like it or not, this is a consistent data-point. The good news is that it's not incongruent with the existing evidence, even though it might seem out of place.

The fact that the loads are so light rules out tension overload, which we'd normally need. However, there is a feasible mechanism to explain this without resorting to voodoo. Instead of looking at pure tension, we have to look at *the effects tension creates*. Specifically, remember what I said about muscle fibers becoming fatigued then turning stiff and 'snapping'.

If you deplete the muscle fiber of energy by cutting off its blood flow, then you're basically cutting out the middle man. The fibers are being fatigued and then subjected to damage with any further contractions. This seems the most likely option, considering that there's changes in neurological activity as well.

Regardless of the actual mechanism, we observe that occlusion and the resulting lack of oxygen trigger increased protein synthesis (Fujita et al. 2007). In addition, it would seem that there's some positive effects on anaerobic metabolism and even capillary formation in response to this kind of training.

This may seem like a bit of a conundrum considering what we know about the effects of concurrently training aerobic and anaerobic qualities - they tend to cancel each other out - yet it appears that on some level, this is a real effect that can contribute to muscle cross-sectional area.

However, when you figure that this is still strength/resistance training and that the effects are dominantly anaerobic, it's really not that big of a stretch. Basically all you're doing is enhancing resistance training by forcing a higher level of fatigue.

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There's no real incentive to go out and start running 10 miles a day if you're after size, but throwing in a nod to strength-endurance looks to be helpful.

In my mind, it's not actually the occlusion training in itself that's interesting, but rather what this tells us about the effects of metabolic fatigue. It's not practical to use a pressure cuff for torso muscles, even though it would be workable for arms and legs. Nevertheless, you can occlude blood flow in different ways, by not allowing the muscle to relax during a set.

For example, we see similar changes in other circumstances that we'd expect to create high fatigue. The so-called 'hypertrophy protocol', which is four sets of 10 reps at 75% of the 1RM and 60 second rests, is going to have similar, if not identical, effects on the muscles.

Some data indicates changes in muscle activity following a 'hypertrophy protocol' in comparison to strength or power groups (McGaulley et al. 2008), which is suggested to happen as a result of fatigue in the muscles. According to the authors, that finding agrees with previous studies that have caused neuromuscular fatigue by using vascular occlusion, although their study was the first to show that effect with normal resistance exercise. They suggest that short rest periods and fatigue may increase motor unit recruitment in spite of a reduction in force, which may explain the increased muscle activity.

It's neat stuff, in any event. More importantly, it provides a potential rationale for doing higher-rep/short rest/fatigue-causing weight training along with the heavier stuff.

Resistance To Change: The Repeated Bout Effect

One of the conclusions that we can see just from observation is that muscle growth is not a linear process. You can't expect to just add a pound a week forever.

Rather, the rate of muscle growth reaches towards an asymptote. You might experience rapid growth at first, but gains will steadily decrease as you grow. You'll never really stop growing completely, but you'll hit a point where growth becomes so slow that you might as well have.

There's several reasons this happens, but keeping with the theme of this chapter I want to look at the local or muscle-level causes.

The first clue is what researchers have identified as the *repeated bout effect* (McHugh et al. 1999, McHugh 2003). What happens is that the test subjects are exposed to a large eccentric stress which does a number on the muscles. Now, you'd expect that if you repeated that workout a day or two later, the extra workout would make matters worse.

However that's not the case. It appears that for whatever reason, the muscle actually adapts so that repeated bouts of exercise don't make the damage any worse.

The cause hasn't been entirely narrowed down. Some work has suggested that additional layers of connective tissue are laid down, which prevents damage from subsequent workouts. Others have suggested that it's a neurological adaptation, which would explain why it occurs so quickly.

There does seem to be some kind of stretch-induced signal in play (Butterfield and Best 2009), and the repeated bout effect appears to be associated with the activation of inflammation-related genes (Hubal et al. 2008).

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Remember that, while resistance to damage might make you resistant to growth signaling, it doesn't necessarily follow that damage is signaling growth. In the short term, we actually see that the repeated bout effect isn't associated with increases in muscle growth factors (Falvo et al. 2007). This suggests a disconnect between the healing process and growth signaling.

In any event, it seems that the muscle is making itself less sensitive to stimulation. This is corroborated by the behavior of another class of compounds which exist in the supportive structures of the muscle fiber's membrane, the cytoskeleton. The repeated bouts are often associated with changes in these compounds (Lieber et al. 2002, Lehti et al. 2007), yet the cytoskeleton is also associated with transmitting mechanical stress into the fiber. In cases where some of these compounds are missing, muscle dysfunction and atrophy will set in as the muscles simply receive no stimulation at all (Liu et al. 2007).

If you think of the muscle fiber as being surrounded by a sheet of rubber, the repeated bout effect would be like adding new layers. As the sheet gets thicker, it's harder to stretch it and harder to disturb the inside of the fiber. This is good for preventing damage, but it's bad for growing – you have to keep adding more and more stress to prevent your muscles from plateauing. The more adapted the muscle fiber is, the less responsive it is to mechanical stress.

We also see the effects of myostatin at work here, myostatin being a signal that negatively regulates muscle growth and protein synthesis. Myostatin is blunted in the short-term during resistance exercise, but tends to increase in the long-term with consistent training.

The gist of this is that the more you train, the harder it is to make the muscle grow. The muscle becomes more and more resistant to further stimulation.

Some groups have suggested that this is cause for taking time off every so often, so that the regulatory stuff can reset and the muscles will become more sensitive again.

We do in fact see some signs of this as we detrain, or 'unadapt' from strength training. One older factoid that gets brought out to support this on occasion is the shift in 'fiber types' away from type IIx and towards type IIa with strength training. We observe this in virtually every strength-related sport, and it doesn't seem to affect performance negatively (Fry et al. 2003a, 2003b).

For some reason, people are so hooked on the fiber-type stuff that this has become a cause for concern. We also see that one of the hallmarks of detraining is an explosion of type IIx fibers.

This is called the IIx overshoot phenomenon (Andersen and Aagaard 2000). However, I have some issues with this. Muscle fibers are classified according to the type of myosin in them, regardless of how they behave – you're not actually losing your 'good fibers', they're just shifting towards a different structure.

The actual myosin IIx isoform is a funny thing. On paper, it appears to be optimized for high-speed movements. In reality, it appears that any sort of activity in the muscle fibers begins a shift away from IIx and towards the IIa isoform.

I've heard it suggested that myosin IIx actually represents a 'reserve capacity' for our fibers, in that it only shows up in fibers that are untrained, or detrained in the case of the overshoot effect.

Indeed, it appears that a calcium-dependent signal pathway actually does trigger a shift away from the IIx isoform and this signal is strongest in inactive fibers (Chin et al. 1998, Dunn et al. 2001, Liu et al. 2005),

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meaning that any activity in the fiber would be enough to encourage the change. Remember that the body doesn't just do things for no reason. It's shifting these fibers for a purpose, and the logical explanation is that the IIX isoform just isn't useful in strength activities.

I don't see this as a drawback, as many do. I just see it as the body doing what it's supposed to do. You're not actually losing your good fibers; they're just adapting to the job they've been given.

Anecdotally, you often hear stories of remarkable 'muscle memory', where guys that used to be really strong took a break, sometimes for years, and then get back to the gym. Within a few months they're just as big and strong as they ever were – sometimes even better than they were.

One extreme idea I've heard has used this as a rationale for only training part of the year. Spend some time getting big and strong, then detrain for a few months and get back to it. That sounds nice on paper, but I imagine you'd end up losing far more than you'd gain from doing that.

Same goes for even the short-term detraining or 'strategic deconditioning' that's sometimes suggested. Yeah, a week or two off is long enough to get sore again, and hell there might even be something to that if it's easing up on the stuff that's making your muscles resistant. Problem is, that's a questionable assumption with the current data.

The question that's relevant to us: will your net gains over any period of time, say six months or a year, actually be greater for doing this?

Realistically, I'm not sure I can justify that position. Yeah, you do need rest breaks from time to time, but that really has nothing to do with this. In practice I think the decreased growth-sensitivity is going to be an unavoidable consequence that we just have to deal with.

We can get around it with progressive overload, by making sure to push our weights up over time, but in the scheme of things I don't think you can undo resistance in short periods of time, not enough to actually create any significant growth.

There may also be something to this with more advanced training programs that intentionally overload your entire body, then back off to allow adaptations to actually happen, but short of that I don't think I see any utility.

Muscle Atrophy

So far I've been dealing with the positive half of the protein balance equation, the anabolic signaling. If only it were that easy we'd all be better off. The catabolic side has its own set of regulating factors, and they're just as important to understand. Remember that our goal is to create a net positive protein balance. Reducing the negative influences on that balance is an important strategy. You can increase your bank balance not only by making more money, but by reducing the amount you spend.

The fancy word for protein breakdown is *proteolysis*, literally the breaking down of proteins. In the last section I went over this a little bit, how it can occur during and right after the muscle contracts. It turns out the chemical signals responsible for proteolysis and muscle atrophy are just as complex, if not more so, than the signals regulating growth (Attaix et al. 2005, Franch and Price 2005, Glass 2003, 2005, Ventadour and Attaix 2006).

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Some of this is normal, as anabolic and catabolic signals are going to fluctuate. If you end up in a net negative protein balance for too long, the result is muscle atrophy - a decrease in muscle size. Atrophy happens primarily from disuse. When you don't exercise, or the cell faces a large energy deficit, atrophy enzymes will gradually break down tissue. It's no surprise that one of the key activators of the atrophy systems is our friend AMPK. Glucocorticoids, which are the body's catabolic hormones, are also strong activators of this system.

As you'd expect from the opposite process of growth, atrophy results from the opposite conditions. While lifting weights and post-meal amino acids work to stimulate MPS, inactivity and fasting tend to stimulate proteolysis. Not surprisingly, the main atrophy pathways in this area are regulated by Akt-mTOR, providing a link between both growth and atrophy processes (Latres et al. 2004, Satchek et al. 2004, Stitt et al. 2004).

Atrophy can result from a more aggressive breakdown of the tissue, too. You'll see this happening during and right after workouts, and under conditions of massive traumatic injury or infection. Certain muscle-wasting diseases will activate the atrophy pathways as well, which is where a lot of this research is done. This is generally due to a calcium-dependent atrophy pathway; during exercise, accumulation of calcium will tend to trigger this.

As you'd expect, these signals tend to thwart each other. Any time you turn on the anabolic signals, you're working to foil the atrophy signals. This works the other direction too – strong activation of atrophy signals will work to cut off protein synthesis. Lifting weights tends to turn on the growth signals and cut off the atrophy signals, as will a meal containing amino acids. Likewise, inactivity and fasting will both exaggerate the atrophy signals while working against the growth signals.

I tend to look at this as a sliding scale. Do nothing, and muscles will tend to shrink (well, they'll shrink to an equilibrium point; even the act of getting up and walking around represents a tension stimulus, which is why you don't shrink away to nothing). Do just a little, and the light stimulus will mainly serve to inactivate atrophy. A full-blown hypertrophy program will not only blunt atrophy signals, but create enough stimulus to trigger actual growth. What you're seeing here is how the two balancing forces of anabolism and catabolism are regulated in the muscle.

This is a micro-level look at the process. As far as 'getting bigger' goes, we have to look at how the entire body responds to these signals. The micro-level effects definitely influence this, as they represent a stress on your body, but we have to zoom out and look at the global processes as well. While growth is stimulated locally, through all the processes I've mentioned, it's ultimately regulated by systemic factors that affect the entire body.

Stress And Adaptation

Understanding how muscle grows is the first pillar of our methodology. We've now got a grasp of the basics that go into making a muscle get bigger. As mentioned, all that information in the last section deals with just the local effect, all the things that happen within the muscle itself. The actual process of 'getting bigger' is regulated as much by central factors as it is by the local stimulus. The body's stress response and adaptation process is the second key component.

The original model still used to define the process of adaptation was formulated by Hans Selye in the early 20th century. Selye called this the General Adaptation Syndrome (GAS) model of adaptation.

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According to this outlook, we can define three stages of the adaptation process:

Stage 1 - Alarm – *The organism becomes aware of a stress.*

Stage 2 - Resistance – *The stress hasn't gone away, so the organism mounts a response. Despite the stress, it's managing to cope.*

Stage 3 - Exhaustion – *The stress still hasn't gone away, and the organism has worn itself out. The coping strategies might have worked for awhile, but the stress was ultimately too much.*

In the GAS model, 'stress' is defined as the organism's reaction to a threat; this applies to psychological/emotional threats just as much as physical threats. A stressor would be the external stimulus that causes stress. Selye further divided the stress concept into two categories. Stress that ultimately leads to positive effects is eustress; a persistent stress that isn't (or can't be) resolved is called distress. Distress is what will eventually wear down the organism if not removed.

Selye's GAS model was never meant to be more than an abstract explanation for an underlying physical process. Nevertheless, it's the popular interpretation. The most important point to take away is that the body's response to stress is a general, system-wide process; it doesn't matter if the stress is 60 hours a week at a job you hate, a bad cold, or too much time in the gym. As far as your body is concerned, stress is stress.

This means that we have to consider the positive and negative effects of exercise in the context of this model as well. In exercise science, two models have been put forward that do just that.

The first is the *Supercompensation Model*. The idea is simple: life processes depend on certain biochemicals. When you encounter a stress those chemicals will be depleted and the cells undergo a kind of damage. When this happens, the organism doesn't just compensate – it supercompensates by building up higher levels of whatever biochemicals were depleted. When dealing with muscle, protein is supercompensated after a workout – the muscle adds more in order to prevent further stress.

However this model has a drawback. It tends to look at everything on the same wave. You work out, fatigue sets in immediately after, then the body responds and restores itself to a new state – the stage of supercompensation. If you don't train again, that supercompensated state will eventually return you to normal.

This model would have you timing each workout so that you'd train again at the point of supercompensation. Train too soon, and you make the situation worse. Train too late, and you won't make optimal progress since your body's detraining.

For a long time, this is the model that bodybuilders have adhered to. Train the muscle, then rest while it recovers. As we see, though, this idea disagrees with what we know about protein metabolism. Bodybuilders will often report being sore for a week or more after a session – yet protein synthesis and the rest of the growth chemistry is back to normal after 2-3 days.

This would indicate that there's not just one 'wave' of recovery – protein synthesis does its thing, inflammation and muscle repair does its thing, the nervous system does its thing, the body's stress response – and so on down the list. All of these things have their own wave.

Further, a lot of research has called the underlying assumptions into question. Some things do supercompensate, like glycogen stores in the muscle, but a lot of things don't.

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What we see isn't so much a simple hoarding of molecules, but physical changes to the cell – a process called adaptive remodeling. This is especially true in muscle fibers (Yu et al. 2003, 2004).

Basically the supercompensation model doesn't really hold up except in a few instances. These problems have led us to a second model: the Two-Factor or *Fitness-Fatigue Model*, which is the more widely-accepted of the two.

This model takes a more abstract look at the process, breaking adaptation down into positive and negative after-effects, or 'fitness gains' and 'fatigue'. Where the single-factor model just looks at the body's state from session to session, the two-factor model breaks that state down into the factors affecting it.

When you do a workout, you see both a rise in fitness potential and a decrease in performance (fatigue). Over time, both will gradually return to normal. The idea is that the fitness effects last longer than the fatigue effects. Dr. Zatsiorsky mentions something like a three to one ratio (Zatsiorsky 1995), but I'm not sure if that has any real research backing.

If we assume that to be the case though, we can say that the benefits of a workout might last for three days, while the fatigue will only sideline you for a day. That's obviously a generalization, but the point is to realize that stress and recovery aren't necessarily a linear process. We have to look at it as more than just workout to workout.

You can train with a degree of fatigue over days, weeks, or even several weeks without any problems. You'll be digging a hole into your recovery ability and racking up fatigue, but the positive fitness effects are still adding up too. When you start seeing the symptoms of fatigue wearing you down, you back off. Light workouts and rest time will hang on to your gains while allowing you to recover from the fatigue.

The magnitude and amount of stress matters, too. It's been observed that an 'intensity' stimulus will have a much greater effect on the body, both positive and negative, but it won't make long-term changes. Likewise, a 'volume' stimulus won't have a very strong effect, but those effects will be relatively long-lasting.

This is very likely related to the physical effects. We know that 'intensity' tends to be a strong neuromuscular effect, while 'volume' tends to be limited to the muscle tissues. Neuromuscular adaptations tend to be strong, but short-lived. Structural, or tissue, adaptations are less extreme, but they have a lot of inertia to them.

To be fair, the supercompensation model does seem to apply in beginners. The problem is, as you get bigger and stronger, it 'stretches out'. Both fitness and fatigue will build up over longer time frames – and require just as long to de-train. In that sense, the fitness-fatigue model can be thought of as an extension of the supercompensation model.

Instead of recovering between individual workouts, you build up fitness over a span of time, then recover over a span of time.

What bodybuilders will notice is that even a week or two off will end up making them look better and feel recharged – not surprising considering how many people do too much work on a regular basis. Recovery is important, and it's not just a matter of recovery between workouts. If you exploit this, it can be a powerful tool in your favor.

The take-home point is that, while muscle growth is stimulated locally, your actual gains are determined by your body's systemic responses.

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FATIGUE EFFECTS AND THE SINK OF RECOVERY

What is fatigue anyway? Anecdotally I think everyone knows what 'fatigue' is; it's why you get tired from exercise. In strict terms, fatigue is defined as a measured decrease in performance, just a fancy way of saying you get tired and can't perform at the same level.

We've established that strength training represents a stress on your body. Any exercise will create a hormonal response and a change in your brain's activity. Fatigue represents one of those changes.

This is a fairly well studied phenomenon that we can classify as either *central* or *peripheral*.

Central fatigue happens when the central nervous system loses the ability to 'turn on' motor units, being defined as 'a progressive exercise-induced reduction in voluntary activation or neural drive to the muscle' (Taylor et al. 2006). Put simply, you just lose the ability to voluntarily activate your muscles, even though the muscles themselves might still work just fine.

This has been measured with electro-stimulation devices - hook up an electrode to a muscle and it'll fire perfectly. Ask the subject to give his best effort, and it will fall short. The muscle is obviously fine, otherwise the ES device couldn't make it contract. It's the brain that's not firing properly.

Peripheral fatigue is a failure of the muscle itself to contract, due to the buildup of waste products or the muscle becoming unresponsive to nerve impulses.

The neuromuscular junction, where the nerve connects to the muscle, has a way of becoming 'jammed' due to accumulation of potassium ions which are usually involved in firing the muscle. Further, calcium ions inside the muscle, which actually trigger contraction, can build up faster than the muscle can get rid of them. The accumulation of calcium can actually damage the elements that release it. Finally, the muscle can just exhaust itself of energy or become too physically damaged by contractions to function properly.

Central fatigue is commonly seen in strength and power athletes, who rely on high CNS output. This means powerlifters, Olympic weightlifters, sprinters, shotputters, and anyone else of that nature. Peripheral fatigue is associated more with endurance training, so this will affect your marathon runners, triathletes, cyclists, and so on. Even bodybuilders can experience this to a degree due to the fact that their training tends to impact a lot of muscle tissue.

Although we don't know in detail what causes central fatigue, we've got a lot of clues. Research has shown us that the source of fatigue lies 'upstream' of the motor cortex. This means that the structures that actually create movement aren't being fatigued - it's something that sits 'above' them and regulates their action.

It's thought that this effect occurs deeper in the brain, in the regions responsible for mental arousal and alertness. This is one reason why people like stimulants before a workout. It revs you up, letting you focus more and create more of that mental effort that some groups like to call 'intensity'. On the flip side of that, think about how you feel after you've been up studying all night, or had to make a really long drive. You're worn out, even though you didn't really do anything. The same idea applies to lifting. If you have a good solid ass-kicking workout, you just might feel crappy the next day.

Research points to neurotransmitter activity as being a key factor in central fatigue. Specifically we see that changes in dopamine (DA), serotonin (5-HT), and noradrenaline (NA) levels are relevant. The 'central fatigue hypothesis' is actually based on the increase in the concentration of brain serotonin during exercise (Meeusen

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and Piacenti 2003). Serotonin has been linked to fatigue because of it's associated with being sleepy and unmotivated; on the other hand, increased DA and NA favors feelings of motivation, arousal, and reward (Meeusen and Watson 2007).

Serotonin tends to increase with exercise. However it's thought that fatigue is not simply a result of high serotonin levels, but rather a high ratio of serotonin to dopamine; likewise, a lower 5-HT/DA ratio helps improve motivation and arousal (Meeusen et al. 2006).

The availability of the amino acids tryptophan and tyrosine are involved in the synthesis of these neurotransmitters, which may be one way that exercise affects these levels – by using up circulating amino acids (Meeusen and Watson 2007).

Beyond that, we can observe changes in the behavior of both neurons in the brain and motor neurons in the spine during fatigue. With sustained activity, motor neurons are observed to become less sensitive to stimulation, so that it takes more 'oomph' to get the same effect (Taylor and Gandevia 2008). Further, receptors in the muscle can pick up local effects of fatigue and relay this back to the brain, where it can limit neural output even without any fatigue in the brain. Fatigued muscles can actually decrease your voluntary neural output (Taylor et al. 2006, Taylor and Gandevia 2008).

It's worth noting that this kind of thing makes the separation between 'central' and 'peripheral' somewhat murky. The body seems to treat it all in much the same way, as just stress, regardless of the source. Central fatigue signals effects across the entire body, and peripheral fatigue signals effects in the brain; it's not quite as simple as the categories would indicate.

What this suggests to me is that we're seeing several effects contributing to this overall fatigue response. Feedback from the muscles creates a sort of circuit breaker that works to limit CNS output. This is probably a safety measure, making sure that you don't overwork muscles that are too tired, or put more stress on the body than it's capable of handling.

This 'circuit breaker' effect probably accounts for the rapid loss of performance during and right after a workout session. Meanwhile up in the brain, neurotransmitter levels can go all wonky with a sufficiently difficult workout, creating potentially longer-lasting effects. It's not hard to imagine how a very heavy workout could limit neural output due to feedback signals at the same time as it altered neurochemical action.

The neurotransmitter linkage is what connects this to behavioral changes. It explains why you get tired, sluggish, unmotivated, and so on. The exercise-induced changes in these chemicals makes you less likely to want to exercise.

These are just the short-term effects, too. As the adaptation models tell us, fatigue can be a long-lasting effect and it can also add up with consecutive workouts. As you might imagine, there are some long-term effects to consider.

The easiest way to think of this is a sink full of water. Your body has only so much 'adaptive energy' to go around, when it comes to stress. That adaptive energy will be water in the sink. Your recovery ability is the faucet, putting water back into the sink. The drain is stress, taking water out.

In most instances, this will tend to balance out. The water coming in (which is sleep, relaxation, and nutrition) will balance the water going out the drain (exercise, work, dieting), so there's no change in the water level. Problem is, people will go in and blow themselves out workout after workout; this is not only opening up the

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drain, it's like putting a huge hole in the sink. Sooner or later the sink's going to empty out. The analogy is even more apt because once you get past a point the faucet just can't cope, even if it's wide-open. When you try to diet on top of this, you've now just cut the faucet off. Even though it probably wouldn't help that much given a massive leak, it would at least be putting something back in.

Try to look at it in this sense, and you'll have a pretty good handle on what happens. Ideally you want to keep the sink as full as you can, only dipping into it slightly. You definitely don't want to empty it out, as that can lead to bigger issues.

LONG-TERM FATIGUE: OVERREACHING AND THE OVERTRAINING SYNDROME

The dreaded overtraining. This is the bane of all bodybuilders, that state of being where you don't grow because you did too much work.

What most people like to call 'overtraining' is actually something different from the classical definition. Overtraining is properly known as Overtraining Syndrome (OTS), and this is a pretty well-defined collection of symptoms (Meeusen et al. 2008). Performance will be reduced, sleep disrupted, the athlete will be unmotivated – there's a whole list of things, and it's remarkably similar to being sick.

Stress responses, at least in part, seem to be signaled by exercise-triggered inflammatory signals. Inflammation is the way the body copes with damage, by releasing a number of signals that trigger a repair response. Specialized cells invade the tissue and aggressively break down any damaged parts so they can be rebuilt. It's like cleaning up after a fire so you can rebuild.

This is why you'll see a cut or a burn turn red and become tender, and it's also related to why your muscles get sore a day or two after the workout. Inflammation is an inevitable side-effect of weight training. Like it or not, the entire process is damaging to some degree or another.

It shouldn't surprise you to hear that this is also one of the peripheral fatigue signals, either. We know that a muscle damaged by eccentric activity releases signals called *inflammatory cytokines*, specifically Tumor Necrosis Factor-alpha (TNF-alpha) and Interleukin-6 (IL-6). Interleukin-1beta (IL-1b), released in the brain in response to exercise, is also tied in to fatigue (Carmichael et al. 2006).

TNF-alpha is the really nasty one, though IL-6 and IL-1beta are also involved in the process to varying degrees. IL-6 in particular seems to have both positive and negative effects, depending on the context. With regards to the body, it appears to have an anti-inflammatory effect, yet it can signal inflammation in the brain at the same time.

While these cytokines have many inflammation-related effects, the one we're concerned with is signaling inflammation in the brain. These cytokines can trigger the brain's stress response to exercise in large enough amounts. We call this the cytokine hypothesis of overtraining (Smith 2000, Smith 2004, Steinacker et al. 2004).

Not eating enough, especially protein, can be an issue as well. Cytokine release from muscles is partially dependent on glycogen stores, so having enough carbs and sufficient calories to support your activity is important to prevent that, too. This is one reason (among many) that it's important to match your diet to your activity level.

The hypothalamus, which is the brain's control center for many of the body's functions, takes signals from a variety of sources, including cytokines and feedback from those fatigue-receptors in the muscle, and uses that

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to adjust your hormonal status. If you're working yourself into paste and not eating enough or resting enough, then your physical state is going to reflect that.

The hypothalamus is an interesting little thing. It regulates both neurological activity and hormonal signals across the entire body. Both stress hormones (cortisol, adrenaline) and sex hormones (testosterone, estrogen) are regulated by it. When it's getting a lot of fatigue signals, it tends to shift your entire body to reflect what's going on. If you're well-fed and rested, you'll reflect that with a positive hormonal condition. If you haven't eaten in a week and try to run 20 miles, you can expect the opposite situation.

Once this happens, you're basically going to be sitting in a constant catabolic state – and even though I don't think cortisol is an issue for people eating properly, by definition you *aren't* if you hit this point. We also see that when your body is overreached or overtrained, protein turnover is depressed in muscle in a way that is similar to a disease state (Steinacker et al. 2004).

This is why you'll see so many people fail when they try to starve themselves and chain to the treadmill. It's also why all the 150 lb kids never see results when they lift six days a week and eat 2000 calories. Once you empty out the recovery sink, your body's not willing to play ball. It's just trying to survive.

The body's stress response is thrown way off kilter once you dip into the adaptive reserves too deeply. The linkage between the brain and the adrenal glands, which regulates said response, becomes dysfunctional (Urhausen et al. 1995, Meeusen et al. 2004). OTS is further marked by both inflammation and oxidative stress after a workout (Margonis et al. 2007, Zoppi and Macedo 2008). These changes also affect the nervous system so that resting heart rate and blood pressure are affected. Along with changes in hormone levels, we can use these symptoms to measure the athlete's condition (Vervoorn et al. 1991, Banfi et al. 1993, Mäestu et al. 2005, Banfi and Dolci 2006).

The trend is that it's much, much easier for endurance athletes to get into this condition, due to the volume of work they do. In reality, the Overtraining Syndrome is its own set of conditions that most strength athletes will never actually run into. It's the severity and the duration that distinguishes true overtraining from other similar symptoms.

What our bodybuilders actually experience is called *nonfunctional overreaching*. Overreaching is similar to OTS, with the key difference that it's a short-term process. You can cause it with a few weeks of excessive work, but you can also reverse it with a week or so of rest time.

Where overreaching will mess with you for a few days, it can usually be fixed with a couple days off, good sleep, and eating well. The OTS on the other hand is a result of weeks to months of extreme fatigue. It takes time to happen, and it can take just as long to undo. Fortunately OTS is usually only seen in athletes that are athletes for a living. The gym-rat hitting the iron 4-5 times a week doesn't remotely cut it.

It helps to think of this in the context of the fitness-fatigue model. Fatigue builds up over time, digging into your body's recovery ability; the sink starts to empty out. If you allow for time to recuperate before the sink empties out too much, you can recover just fine. If the water gets too low, it's going to take more time to fill back up. Both overreaching and overtraining are a direct result of fatigue building up over time with too little recovery – it's just a matter of how much water is drained and how long it takes to fill the sink back up.

That said, too many people get hung up on the idea of 'overtraining' as being a consequence of a single workout, or even a weekly routine. While I do appreciate that people are at least trying to give a nod to recovery, most of them aren't looking at the process in the right way.

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It'd be better to think of overtraining as a state of being that happens when you don't rest or eat enough – once your sink gets too low or empties out. Too many folks assume that a workout can be 'overtraining'. Overreaching and OTS are not the result of any one workout routine; they're a *condition* that your body reaches after being pushed too hard with too little resources.

It's like getting sick. You expose your body to germs all the time; it's only when a bug gets a foothold and reaches critical levels that you actually come down with symptoms. This isn't any different. You expose your body to stressful exercise all the time - it's only when the effects reach critical amounts that you come down with symptoms.

To summarize: A single workout session creates fatigue. A few weeks worth of fatiguing workouts without enough rest can push you into an overreached state (the sink gets low). Continuing to train and accumulate fatigue while overreaching your ability to cope with stress, and you wind up overtrained (the sink is almost empty). This lines up almost exactly with Selye's model.

Some people have made the case that this phenomenon is not actually a result of 'over-training' but instead it's 'under-recovery'. This is valid, though only up to a point. While recovery ability is certainly the bottleneck, it also doesn't take *that much* exercise to completely overwhelm your ability to cope. Remember, a faucet can only put so much water back into a sink.

Considering that it's easier (and generally more effective) to just do less exercise, and it's practically impossible to substantially increase recovery ability (without drugs), the conclusion is fairly obvious.

Now in some instances, a degree of overreaching is actually desirable. This is called *functional overreaching*, and it's exploited by deliberately training too hard, then providing a planned period of rest to let the body recover (Kilgore and Pendlay 2001, Nederhof et al. 2006).

In this case, you deliberately wear yourself down by training too often and too heavy – called *concentrated loading* or a *shock microcycle*. The body responds how it's supposed to by gearing up the stress response – all the hormonal feedback loops get thrown out of whack. Then when you back off the training, that huge response that was meant to handle all that stress overshoots.

We see this in effect in training programs that intentionally allow for a taper, or a period of reduced stress. The hormone levels rebound and overshoot (Mäestu et al 2003).

If you do it right, the end result will be a pretty substantial adaptation.

However this is something that you should use with caution, as it's easy to push things too far. It is a useful strategy for breaking plateaus, though. This even applies to bodybuilders; it's likely that the hormonal shifts set you up for muscle growth, if you time things right.

IMPLICATIONS FOR TRAINING

One of the most common misconceptions I hear is the idea that you have to 'tear' or damage the muscle fibers in order for growth to happen. I'm thinking that this belief comes from what happens in some animal muscles. In other mammals, we see that there is a degree of actual damage involved in response to exercise.

Human muscles are different, though. Our muscles don't actually require damage for growth to happen. In fact, damaging them can be counter-productive (Wernbom et al. 2007).

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More recent research in humans by Yu et al. (2003, 2004) has pretty much thrown this idea out. In this research, it was found that what was originally thought to be damage in human fibers was actually changes to the structure of the muscle fibers that were the beginnings of adaptive remodeling – the early phases of growth in other words.

I think there's a potentially large problem with workout routines that suggest you work the muscle to extremes, especially when it's done each and every workout. Damage requires repair, and repair requires inflammation, which brings its own set of problems.

The body's stress response is heavily tied in with a normal hormonal balance. When you throw this out of whack with excessive training, you also disrupt these hormonal loops. This can affect everything from sex drive to body fat levels to appetite.

These changes knock the body out of its comfort zone; it's not going to like this, and will try to bring you back into balance. Part of this involves getting you to change your behavior - that's why you feel like crap when you're in this state. You'll feel tired, unmotivated, sleep might be disrupted, appetite will be affected, and so on. The list of symptoms isn't all that different from what happens when you come down with the flu - and the cytokine hypothesis explains that it's not very different from actually getting sick.

I'd actually go as far as to suggest avoiding damage-causing workouts as much as possible. By doing so, you won't push yourself into that stage of chronic inflammation. We already know that protein synthesis can be increased without any requirement for muscle damage. We've also seen in several studies that eccentric damage may actually overwhelm the actual growth process (Wernbom et al. 2007). Same goes for training too often; even a series of less stressful workouts can add up over time if you don't allow enough rest between them.

This is why you can see one guy get burnt out from training with very heavy but infrequent sessions, then see a cardio bunny that won't stop doing three hours of cardio every day with the same problem. In both instances, the body's systems are being over-stressed, just in different ways. With all of this data in mind, my belief is that it's about working with the body, not trying to fight it at every step.

But there's another potential curve ball. Some degree of inflammation in the muscles seems to be beneficial for the satellite cells and for muscle growth in general.

I don't know if this is necessarily a reason to do 'harder' workouts, but it's certainly not an unreasonable idea in concept. Inflammation is obviously contributing to the growth process in some way. The trick here is balancing the degree of damage and inflammation with recovery time.

Normally I don't think the overreaching/overtraining problem is an issue. If your workout routine is even remotely reasonable and you're eating enough to provide for your activity level, you won't run into problems. There might be a case to be made for taking a rest week every month or three just on general principles, but by and large I don't think this particular matter will cause you problems.

Where I think this becomes relevant is when people want to do poorly-designed workouts – either too much volume, too many max attempts, or not enough rest days – not eat enough, or D) all of the above.

If you're hitting the gym seven days a week, doing two-a-days for cardio and a 4-5 day weight split, then you're going to be pushing some limits unless you're eating a lot. Problem is, most people doing this are on some

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pretty severe calorie restriction at the same time. You may not be actually overtrained by the strict definition, but you won't be helping yourself out – unless you're getting some pharmaceutical assistance.

The same goes for taking too many max attempts. I don't even mean 1RM lifts as powerlifters are prone to do, but anything that has you constantly trying to grind out hard sets week after week. While we can distinguish two separate types of 'overtraining' or residual fatigue effect, the end result is the same in both cases.

I'd just look at it as a sliding scale. If you're not eating a lot, say while you're trying to drop some fat, then your activity should reflect that. If you're doing a lot of activity to train for some particular goal, then your diet should reflect that.

You just have to realize there is an upper limit to how far you can go on that sliding scale. Eating more food can help with recovery, but even that has limits. If you do too much activity, you'll eventually hit a point that no amount of calories will fix.

In my mind, this is just a rationale for a strategy that fluctuates the difficulty and stress of your workouts – both across the week and from week to week. We want to work with the body, not fight it. I'll get into the details of this in chapter four.

Hormones: Are They Really Important?

I want to talk about hormones for a minute. This is one of those sections that I'm putting in not because it's important, but because people have gotten the wrong idea.

Hormones do play a role in the process, and they are important. That's not in question. The thing I take issue with is the idea that manipulating hormones should be the goal of a workout.

It's taken for granted in some circles that you need to train until your testosterone level drops, or you need to create growth hormone spikes, or you need to block cortisol because it makes you catabolic.

I think people are looking at this in the wrong way. The hormones are not a cause, but an effect. If you're doing what you're supposed to be doing, the hormones will play along.

If you're not interested, this is one of those optional sections that you can skip without missing much.

TESTOSTERONE

When we talk hormones and muscle mass, the first on the list is testosterone. Testosterone (test, T, among other names) is an androgen, or male sex hormone, that just happens to promote muscle growth. This is why men are on average bigger and stronger than women; women have about 1/10th the normal circulating levels of testosterone.

One of the key advantages of testosterone is that it increases the rate of protein turnover and the re-usage of amino acids that get broken down by normal processes. In short, testosterone and other androgens help to increase the total amount of protein that is held in your muscles.

Testosterone has a powerful effect on satellite cells. Not only does it activate these cells, causing that whole donation of nuclei thing, but it causes an increase in their number. This translates to a direct increase in the number of nuclei in your existing muscle fibers, aka a Very Good Thing.

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This process is strongly correlated to how big your muscles can become. While it doesn't directly make your muscles larger, per se, it gives you the ability to support that much more muscle protein.

More nuclei equates to more protein synthesis, and eventually this results in a bigger muscle.

Test also works directly to increase protein synthesis through several pathways, so it's an all-around good thing for muscle mass.

A given amount of circulating testosterone seems to create a ceiling for the amount of muscle your body can hold. This is a big reason that men are on average larger and more muscular than women. Men have something like 10 times the amount of circulating testosterone as the average woman.

Research into anabolic steroids, which are testosterone and artificial derivatives of it, has demonstrated a dose-response relationship between androgen levels and muscle mass, at least to a point. Although this is hardly the only factor involved in muscular growth, the fact that anabolic steroid users tend to notice a new ceiling of muscle for any given dose would seem to lend some credence to the idea.

Indeed, there's research showing that even in men with prior weight training background, a sufficient dose of testosterone will cause greater gains in lean tissue *without lifting weights* than lifting weights without a testosterone dose. By artificially stimulating protein synthesis, testosterone can have near-magical effects. This is power chemistry indeed.

CORTISOL

On the allegedly negative end of things we have the hormone cortisol. Cortisol is an adrenal hormone, a type called a glucocorticoid, responsible for tissue breakdown.

Because of that little nugget, cortisol has acquired a very negative reputation among bodybuilders. It's often considered the mortal enemy of testosterone.

Make no mistake, cortisol absolutely required for life. Those having abnormally low levels of cortisol experience chronic joint pains and poor overall recovery; tissue that can't be broken down is tissue that can't be repaired.

The hormonal spikes from exercise are usually trotted out as reasons to keep workouts brief and hard. The common notion is that you need to keep your workouts to a limit of 45 to 60 minutes, because this is when testosterone begins to drop and cortisol will spike. It's known that testosterone will reach peak levels about 20 minutes into exercise, and that peak will last around 45 minutes before starting to fall off quickly. It's widely believed that this crash in testosterone levels will allow cortisol to take over and compromise your gains. Any training lasting over an hour is done under catabolic conditions, and this will eat up all your muscle. So the story goes.

Since, you know, cortisol is bad. I think the logic in itself is flawed. Namely, it's the belief that the cortisol spike will lead to muscle breakdown that I have issue with. That sounds well and good as a convenient sound-byte, but looking only at the acute effects without considering the long-term outcome doesn't tell us a whole lot.

What we need to know is how cortisol itself affects protein metabolism along with exercise and diet. After looking through the research, I can take a strong guess that nobody spouting the 'cortisol bad!' line has really bothered to put much thought into this. A review of the literature was pretty illuminating.

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While looking around, I found some interesting things. While there's not a lot done in athletes, there's a ton of research into cortisol's effects on catabolic activity in trauma victims - people that have undergone some form of severe injury. According to this research, trauma victims will reach catabolic levels that no healthy person will ever reach, even at that magic 60 minute mark during a workout session. This is useful to us just because no bodybuilder will ever reach that kind of extreme.

The researchers were looking for ways to combat muscle-wasting in these people. What they found was interesting.

Diet is the first key regulator of protein balance. Even in the presence of catabolic hormones, the anabolic effects of amino acid (AA) intake can help to counteract protein breakdown, both with and without carbohydrate (CHO) intake (Hammarqvist et al. 1994, Rankin et al. 2004, Bird et al. 2006b, Baty et al. 2007).

Intake of AA+CHO has been demonstrated to reduce blood levels of cortisol post-exercise (Bird et al. 2006a). Interestingly, while AA+CHO has been shown to blunt cortisol levels, AA alone has not (Bird et al. 2006c). Some have dubbed this as an 'anti-catabolic' effect of CHO, as it seems to blunt MPB instead of increasing MPS. Intake of CHO alone will affect cortisol levels, but will not affect MPS levels (Thyfault et al. 2004).

Now make sure you read through this carefully, as it might be confusing. What we see here is that AA availability is the key regulator of protein balance, as opposed to cortisol levels. This is interesting, because it basically means that eating protein will have a larger effect on protein balance than cortisol. Eating a meal with AA+CHO will work to both increase MPS rates and blunt cortisol.

It's been shown that inactivity can increase the body's sensitivity to cortisol, causing an increase in muscle protein breakdown (Ferrando et al. 1999, Fitts et al. 2007). These studies tested the effects of doses of hydrocortisone (synthetic cortisol), dosed to mimic the cortisol levels of a trauma victim, on bed-resting subjects. Both found that inactivity and high levels of cortisol were the worst possible combination with regards to muscle mass and protein balance.

Ferrando et al. found that high chronic levels of cortisone didn't affect MPB any more than regular fasting before the period of inactivity. It was only after 14 days of bed-rest that increases in MPB were noted in response to increased cortisol levels. Fitts et al. did show that supplementing meals with amino acids and carbohydrates was helpful in preventing atrophy. Likewise, another study (Paddon-Jones et al. 2005) determined that amino acids and carbohydrates added to a normal meal was enough to offset the negative effects on protein balance, under similar conditions.

Paddon-Jones et al. (2006) showed that during prolonged bed-rest with chronically elevated cortisol there were no changes in MPB. Instead, atrophy was brought about by a reduction in MPS rates. Wernerman et al. (1989) suggest that this is caused by a reduction in the number of ribosomes. Ribosomes being the tiny protein factories inside your cells that are responsible for building proteins; reduce the number of ribosomes, and you reduce MPS rates. This would fall into line with the idea that your muscles need regular exposure to resistance in order to maintain their size – something you don't get during bed-rest.

We know that inactivity by itself is enough to reduce MPS and cause atrophy (Ferrando et al. 1996). Inactivity also reduces the body's overall anabolic response to amino acids (Biolo et al. 2002, 2004). Resistance training helps to mitigate the loss of muscle during inactivity specifically by increasing muscle protein synthesis (Ferrando et al. 1997), while calorie restriction during bed-rest also tends to increase the negative protein balance caused by inactivity (Biolo et al. 2007).

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Now, looking at all this, it may be a bit hasty to assume that it's the catabolic hormones at fault. It's certain that they contribute, but the question is, to what extent?

Dramatic muscle loss is only being observed under conditions of extreme inactivity and/or poor nutrition, if not outright injury or illness. It should go without saying that this won't reflect what you, the average healthy person, will experience. Even in the extreme cases using levels of cortisol on par with a trauma victim, just eating properly and exercising is enough to counteract the negative effects on protein balance.

The artificially high levels of catabolic hormones seem to make the matter worse, but they don't seem to be causing problems when subjects are active and eating properly. This conclusion is also reached in the literature (Bessey et al. 1989, Brown et al. 1994); the authors conclude that stress hormones are a necessary, but not sufficient, factor in creating a negative protein balance.

In other words, the catabolic stress hormones may exacerbate protein loss when present alongside other factors, but they aren't enough to cause it on their own. All of this makes it very questionable to implicate cortisol directly, as bodybuilders are wont to do. It doesn't seem to be helping things, no, but with proper nutrition in place it doesn't seem to be doing that much damage, either.

With all this in mind, it doesn't seem terribly likely that a normal, short-term pulse of cortisol towards the end of a workout is going to make that much difference in your results, assuming you're getting sufficient amino acids and carbohydrates in your diet.

Wolfe (2001) makes the argument that the MPB rate alone is meaningless without context; it appears that MPB is elevated along with MPS after resistance training so as not to deplete the amino acid pool, suggesting that this increase in catabolism is completely normal.

We can't simply look at things on the micro-level and assume they apply to the bigger picture. Looking at the immediate post-exercise effects, in the absence of nutritional considerations and any net changes over the long-term, just doesn't cut it. Simply pointing to cortisol as *the culprit*, without any sort of context, is oversimplifying matters.

There are some papers out there indicating a more direct relationship between catabolic hormones and acute MPB in response to exercise (Gore et al. 1993, Hammarqvist et al. 2001, Tarpenning et al. 2001). However, these papers have problems generalizing to the bigger picture.

Tarpenning et al. used a four-hour pre-workout fast, followed by administration of either a CHO beverage or a placebo. We already know that a AA is the critical factor regulating protein balance, with CHO only serving to blunt the cortisol response. AA+CHO is also superior to CHO alone (Borsheim et al. 2004a, 2004b). It just goes without saying that fasting throws out all the rules. It's no surprise that exercise under fasting conditions caused an increase in protein loss.

In all cases, it was held as an assumption that cortisol levels are directly correlated to protein balance, even in the presence of potentially mitigating factors. We know that exercise will increase MPB, even alongside an increase in MPS rates. This is a normal response to training, and doesn't reflect long-term changes in protein balance.

An earlier paper by Hammarqvist reached the conclusion that amino acid infusion counteracted the MPB caused by stress-hormone infusion (Hammarqvist et al, 1994); so the effects on overall protein balance, and the influence of diet on this balance, would seem to be important here.

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Beyond the lack of any concrete links to protein balance, with no control for dietary factors, there's also the tiny fact that both testosterone and cortisol tend to peak in the morning, then decline throughout the day. Most research doesn't account for this, and it could be a potentially large wrench in the works.

Yes, cortisol and its relatives are indeed going to increase the levels of protein breakdown in muscle. But net muscle growth occurs when synthesis rates are higher than breakdown rates; even if MPB increases, you can still end up growing if MPS increases more. As Wolfe points out, a simple increase in MPB rates is not necessarily an indicator of net protein loss.

Considering that virtually every bodybuilder I've ever heard of is lifting weights and eating food on a regular basis, I find myself wondering exactly how a brief pulse of cortisol is going to cause more protein loss and muscle atrophy than what's observed in trauma victims with chronically elevated levels - especially when the trauma victims can counteract the effects with diet and exercise.

The answer is obvious: nobody that has taken the time to eat is going to be negatively impacted by a workout that lasts over an hour.

The normal rhythmic behavior of cortisol, usually highest in the morning and dropping throughout the day, is harmless and in fact quite necessary for the body to function normally. The research has shown us that high levels of cortisol don't increase tissue breakdown on their own. *Very high* levels for long periods of time (12 hours or more) can make matters worse under conditions of inactivity or in conditions of fasting, but even this is easily countered with ingestion of amino acids and by including some form of resistance exercise.

Otherwise, cortisol won't really be a matter of concern unless you're taking extraordinary steps to make it a concern. If you're doing what it takes to make cortisol a problem, then you've got bigger issues to worry about.

The conclusion I'm sticking with is that cortisol by itself is not sufficient to cause net protein loss from muscle tissue. Fasting and bed-rest were the real culprits in the studies presented; while chronically-elevated cortisol did make protein loss worse under those conditions, exercise and a diet containing enough protein and carbs was enough to counteract all of it. Cortisol alone was not the cause.

GROWTH HORMONE

Much like testosterone, growth hormone (GH) is known to spike during exercise. However, GH is more associated with challenging endurance-type exercise, stuff like aerobics and even high-rep weight training that produces lactic acid. Lactic acid being a side-effect of anaerobic (sugar-burning) metabolism.

Growth hormone falls into the same boat as testosterone and cortisol: massively over-wanked. For the same reason cortisol isn't going to come along and ruin your gains, spikes of testosterone and GH aren't likely to help it along much either.

For one, GH is known to spike multiple times throughout the day, on a normal cycle. Virtually anything can trigger GH release: fasting, eating, sleeping, being awake, pain, contentment...the list goes on. People that experience the normal GH spikes don't become abnormally large.

This is reinforced by the fact that GH, even in large administered doses, doesn't really do anything for muscle size. It's considered good for fat loss and for joint repair in the Bro-lore, and is reputed to work well with testosterone and insulin, but by itself it just doesn't show the effects.

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In those that are GH deficient, it has positive effects, but increasing it to above-normal levels just doesn't do much. That fact alone is enough to rule out normal GH spikes as having any sort of anabolic effects.

Funny enough, the same group that's been pushing the importance of growth hormone responses to exercise recently released a study showing that the GH spike had no measurable effects on the Akt molecule, which is a direct regulator of protein synthesis (Spiering et al. 2008). In this study, subjects were divided into a 'high hormone circulation' group, where a lower-body workout was preceded by an upper-body workout designed to create a hormonal spike, and a control group that performed the lower-body workout after rest. The spike created no significant effects.

They hypothesized that this was due to a corresponding increase in cortisol levels working to blunt that signaling pathway, even though the relationship wasn't statistically significant. Here's the thing, though: the study only had seven subjects. It's very hard to generalize things based on such a small sample. Four of the seven showed a correlation three hours post-workout, while one subject showed no differences. Even worse, this workout was done after a 12-hour overnight fast, which can skew things on its own; recall how cortisol levels can magnify protein breakdown under fasting conditions, even though it will have little effect when amino acids and carbohydrates are available.

Despite the weaknesses in this study, it's still telling that the hormonal spikes had no effect on protein synthesis chemistry. If hormone spikes can't even overcome a lack of nutrients, then I'd have to question the usefulness – effective muscle-building doses of testosterone will activate MPS even under fasting conditions.

In short, GH spikes just don't mean much as far as muscle growth goes.

HORMONE SPIKES IN GENERAL

There's a lot of interest in the hormonal responses to different workout programs. People tend to assign a lot of importance to these hormone spikes, though I'm of the opinion that it's a bit misguided.

My pet hypothesis is that the acute spike of hormones in response to exercise is nothing but a marker of an intense stress. Something like a workout, for example. You'd also expect similar changes after any sort of disruptive event, and indeed we do. Physical, mental, and emotional stress of all sorts evokes a similar response. The magnitude of the stress seems to correlate with the magnitude of the hormonal changes.

At the end of the day, the CNS and the hypothalamus in particular are going to be the arbitrator of your body's condition. The hormones are just the effect of that – not the cause.

If we want to talk about using hormones as an indicator of the body's condition, it's the chronic changes in the resting levels of the hormones that matter. To see a significant effect on the body, you're talking about a pretty substantial increase over normal resting levels.

What bothers me here is that it's taken as an assumption that these changes in short-term hormone levels correspond to the efficacy of a workout. From everything I've seen, there is no data to establish a causal link; it's just taken for granted.

Here's the thing about that. I actually went looking for research to support the idea that a temporarily decreased testosterone/cortisol ratio would really make that much of a difference after a workout. The research I found on cortisol by itself was interesting, but I wanted something more specific to the audience.

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While there's a lot of research out there looking at the overall hormonal response to strength training, there's surprisingly little that looks at the actual effects of these hormone spikes. All we know is that these hormonal levels correlate with workout sessions. Nobody's actually shown a direct link between these hormone levels and the adaptations caused by exercise. It's simply been assumed as a truth.

In truth the hormone response to exercise is little more than an indicator of a novel stress. The response seems to be affected mainly by the volume of work done and the rest intervals - a matter of local metabolic action and muscular work - along with the weight used (Kraemer et al. 1991, Ahtiainen et al. 2003, Smilios et al. 2003, Ahtiainen et al. 2005, Kraemer and Ratamess 2005, Crewther et al. 2008, McGaulley et al. 2008).

Among the protocols used, the greatest hormone response is almost always generated with 'the hypertrophy protocol', usually several sets of 10 reps and a weight around 75% of the 1RM.

This has led to the assumption that this style of training is the best for muscle mass - simply because of the neuroendocrine response. The problem with this assumption is that it doesn't necessarily pan out in reality. With no data to show a causal relationship between a hormone response and training adaptations, it remains an assumption. Most of these studies don't control for long-term strength or muscle gains; they just measure acute hormone response and send them on their way.

One study (Ahtiainen et al. 2003) did show a correlation between acute changes in testosterone levels and muscle CSA during the 21 weeks of the study - but only in a non-athlete group. The trained strength athletes that also took part in the study did not show any correlation. In fact, with an equivalent program, the strength athletes actually noted a *loss* of muscle CSA. The authors concluded that the correlation in non-athletes was worth investigation, but considering the difference in responses between newbies and trained athletes, I'm not so sure.

What it would seem to me is that this is a case where newbies respond to anything, while the trained need more specialized and more intense training. Other work has shown us that trained athletes have very different hormonal responses than beginners (Ahtiainen et al. 2004), so it's likely that the hormones are just correlating to size gains.

Work by McGaulley and colleagues (2008) showed a more pronounced hormonal spike from a hypertrophy protocol in trained individuals, as compared to either a strength or power protocol. Hormone levels had returned to normal by 60 minutes post-session, with no changes found at 24 and 48 hours after. The authors caution that there is not enough data here alone to establish a link between hormone levels and muscle hypertrophy, however.

Hansen et al. (2001) compared arm-only training with a group that combined both legs and arms. Only one arm was trained in both groups, leaving the opposite arm as a control. While the combined arm and leg group showed both a greater increase in strength and the greatest hormonal response, that group also started out 20-25% stronger than the arm-only group leading the authors to note that the results may be skewed by this. Both groups displayed strength gains in the opposing arm, leading to the possibility that the strength gains in the combined arm and leg group were caused by neurological factors.

All of this is consistent with the notion of measuring a stress response, not a direct link between hormones and gains. An untrained lifter is going to be experiencing a novel stress, while a trained lifter is conditioned to that same stress. But a trained lifter can still get bigger and stronger. The effects correlate, but they don't seem to be linked.

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The thing is, even if we wanted to attribute any real effects to the hormone spikes, there's little to explain how such a brief change in hormone levels can create long-term changes.

It's been observed that positive changes in your hormonal state, such as increases in testosterone or growth hormone, aren't a cause of the training effect on their own (Wilkinson et al. 2006, Spiering et al. 2008), but they can and often do correlate with positive training effects at least in the short-term (Ahtiainen et al. 2005, Crewther et al. 2008, Beaven et al. 2008a, 2008b). This is an important distinction to make. If hormones were a causal factor, then you'd need them in order to see any effects. Since we can observe muscular changes without any substantial hormonal changes, the hormonal spikes don't seem to affect anything.

It's reasonable to assume that the short-term hormonal responses to strength training are more of an indicator of stress than a direct cause of adaptation. Experienced athletes will have a much different hormonal response than untrained and novice lifters (Ahtiainen et al. 2003a, 2004), indicating that the body adapts to that stress over time. Testosterone and cortisol are also correlated highly with both the volume and intensity of exercise, with a greater magnitude of either corresponding to greater hormone levels. Training to failure (Izquierdo et al. 2006) or with forced reps has been shown to cause greater increases in circulating hormones compared to less-stressful workouts.

Some work has attempted to link acute hormone fluctuations with androgen receptor activity and strength training (Inoue et al. 1993, Bhasin et al. 2000, Raastad et al. 2000, Ahtiainen et al. 2003b, Smilios et al. 2003, Ratamess et al. 2005).

The androgen receptor (AR) is how testosterone creates effects in the muscle; you can think of androgen receptor number as how sensitive the muscle is to testosterone. It is known that moderate levels of androgens will increase the AR number in muscle, so perhaps the spikes are making the muscle more sensitive to circulating test.

The basis for this is the use of drugs to block the receptor, thus preventing testosterone from having any effect. The problem with this is that it doesn't necessarily control for baseline levels of testosterone; blocking the androgen receptor will block the effects of *all* circulating testosterone, not just the post-workout spike.

We also see an increase in glucocorticoid receptors under the same conditions (Willoughby 2004), which is probably an attempt by the body to maintain balance; this is consistent with the observation that protein breakdown also occurs post-workout. Remember that catabolic effects in and of themselves don't really matter that much; it's the net balance we're concerned with.

I will admit that greater concentrations of androgen receptors in the muscle could at least account for some training adaptations. The thing is, increases in receptor levels would indicate a relatively long-term change in the sensitivity of the tissue. This could have an affect, but I'm still not sure – muscle contractions during resistance training will also increase AR number.

There's also the simple fact that testosterone's effects are dose-dependent. The more you take, the greater the effect (Bhasin et al. 2000, 2001). With physiological levels, even spiked, you're not getting a lot of 'dose'.

We also have to keep in mind that MPS will stay elevated up to 72 hours after a workout. Testosterone levels, unfortunately, do not. If there's a correlation, it's subtle; increases in androgen receptor number probably won't account for this, although I'll admit that it's at least plausible. Considering all the material out there on direct triggers of muscle growth that are independent of systemic hormones, it seems unlikely that acute fluctuations are having any significant effect.

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While I can't completely rule out the idea of free testosterone levels having an impact on strength and muscle gains, when you consider that the elevation is so brief - we're talking 30 to at most 60 minutes here - it's a bit of a stretch to assume that post-workout hormone response is any predictor of strength or muscle mass gains. While there are some studies that indicate a link, they all have some weaknesses that leads me to believe it's very unlikely.

I'm much more open to the idea of these hormonal spikes as indicators of stress, and potentially limited modulators of growth, as opposed to being a directly necessary cause or even a significant influence.

Realistically, we need more research in this area. If we can nail down more specific links between hormone levels and strength/size gains (or not), it'd be easier to say what's going on. As it stands, there's not enough data to make the call. If you pressed me for an answer, I'd say no, there's probably nothing going on here.

My suspicion is that all this obsession over hormone spikes comes out of the performance enhancing drug culture. These guys all see that taking large amounts of these compounds has an amazing effect on their bodies, so they extrapolate this to the idea that comparatively small, natural pulses of these same hormones will create the same effect. They point at steroid users and say "see, they have increased levels of anabolic hormones and look what it does for them!". We can't do that.

Let me say first off that there is a huge difference in the levels involved here. Even a mild steroid cycle can create circulating androgen levels 3-5 times higher than any natural level of testosterone. An average male will make the equivalent of around 70 milligrams of testosterone per week, where an average steroid cycle will run doses of 200mg to 600mg of testosterone, which some users running double or triple that. Further, those levels are maintained for several weeks at a time at the minimum, with some guys basically never stopping, which gives the body a lot of exposure to dramatically higher levels of androgens.

By contrast, the post-exercise spike won't ever exceed the normal range of human production. In terms of blood levels, the response you get from lifting weights is a drop in the bucket compared to the dose of a steroid cycle. And that blood level stays high for much, much longer. It's a flawed argument for that reason; there's just no comparison between chronic elevation and acute spikes. Creating a supraphysiological level of hormone is not even remotely the same thing as exploiting natural pulses. The natural fluctuations just aren't strong enough, nor do they last long enough, to make any difference.

This is reinforced in some work, showing that short-term spikes of both testosterone and cortisol, despite correlating with stressful protocols, don't actually translate to realistic gains in either strength or muscle mass (Buresh et al. 2008). In fact the Buresh study showed superior size gains (12% vs. 5%) in the protocol in the group that had the *lesser* hormonal response over the 10 weeks of the study. Additionally, the hormone response decreased consistently over the duration of the study until there was no difference in the two groups by the final week. According to the author, the hormonal response is highly variable and may not necessarily be predictive of strength and lean tissue gains in a 10-week training program.

This does back up my thoughts that the hormonal spikes are a response to stress - which is why those spikes disappeared over the course of the program. The subjects were adapting to the novel stress. We do have to be careful considering the small sample size (10 subjects) and the fact that the subjects were untrained, but this is at least one data point that looks at actual outcomes over a long period of time.

One thing that is potentially of interest is using the magnitude of these hormonal changes to determine the potential effectiveness of a workout protocol. A study out of New Zealand tested salivary testosterone levels

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after different protocols, and found that individual responses varied between different protocols (Beaven et al. 2008). This study was performed in elite rugby players, making it especially interesting. What they found was that the pooled data showed no real differences in testosterone changes between groups. Cortisol decreased from pre-workout to immediately post-workout, and there was no real difference between the groups. Interestingly, the study found large individual differences in response to different protocols, which suggests that the hormonal response to different protocols is going to vary from person to person. The authors note that the salivary testing model used in the study could be useful to assess stress and maximize adaptation, but they also note that these hormone changes have yet to be linked to any training adaptation.

Over the long-term, the story is a little different. Chronic changes in the testosterone/cortisol (T/C) ratio can similarly work as an indicator of the body's overall status (Kilgore and Pendlay 2001, Haff et al. 2008). Recall that the hypothalamus is the body's stress regulator, and it gets all messed up if you don't provide enough recovery from stressful exercise.

The T/C ratio is one of the hormone loops I mentioned that can be disrupted by chronic stress - measuring how it changes over a period of weeks can show the effect of a training system on the athlete's condition. Likewise, we can observe a rebound in hormonal status once the workload is reduced from high levels (Izquierdo et al. 2007). These hormone shifts definitely seem to indicate changes in stress levels.

Taken as a whole, the research doesn't strongly support the idea that all this hormonal-manipulation stuff has any direct effect, in terms of the short term spikes. Something like Kilgore and Pendlay's Hormonal Fluctuation Model, which intentionally exploits functional overreaching and long-term shifts in the T/C ratio, is worth a look because it has demonstrated measurable effects. The same can't be said for obsession over the acute effects - over the span of a few hours, the peaks and troughs of testosterone, cortisol, and growth hormone are effectively meaningless. What matters is the trend over time, and even then what you're seeing is not causing adaptations - hormonal levels are functioning as an indicator of the body's condition. What I take away from this is that greater volumes and greater densities of work will lead to a greater impact on the body, and that can definitely be taken advantage of.

My entire rationale for discussing this is because I can't tell you how many people I see arguing over what program will create the most growth hormone or the biggest testosterone spike. This is no different from the endless wanking over training your fiber types.

What you need to be looking at is your goal. Train for your goal and the body will adapt accordingly. Regardless of whether the hormone spikes modulate the growth response or just happen to correlate with it by indicating stress is really not important either way - if you're training towards your goal, the body will adapt how it's supposed to adapt.

Keeping It Real: What This Means To You

Assuming you read this whole chapter and braved the dangers of strong labcoating, you've hopefully picked up a little understanding of what we're dealing with here. Just to make sure everybody's on the same page, I want to summarize the gist of it.

Simply put, your body as a whole is going to be in a state of building tissue up (anabolism) or breaking tissue down (catabolism). There's no getting around it. If you're not in an anabolic state, don't expect to be adding

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muscle tissue; the body won't do this for the same reason it doesn't make sense to buy luxury items when you can't pay your rent.

The overall condition of your body is regulated by a complex web of hormones, growth factors, and chemical signals in your muscles. This is what ultimately determines whether or not your muscles will get bigger.

The growth process is triggered by directly stimulating the muscle with external resistance. This growth, called muscle hypertrophy, is the result of adding new proteins to the muscle and being able to keep them there. Your goal is to maximize protein synthesis while minimizing protein breakdown. We do this with strength training and by eating a proper diet.

In order to increase the amount of muscle proteins a muscle can hold, we have to look to the satellite cells that surround the muscle. These immature cells must be stimulated to reproduce and fuse with a muscle fiber after exercise.

These two variables, protein metabolism and satellite cell activity, are absolutely necessary for your muscles to grow larger over time.

Protein synthesis and all the associated chemistry are stimulated by a workout, increase to a peak over the next day or so, then return to normal around 72 hours or so after a workout. It might be a good idea to train your muscles with that in mind.

Satellite cells are crucial for long-term growth. This seems to require a degree of inflammation in the muscle, which might make an occasional thrashing a good idea. However if you do too much, you either have to work out less often, or suffer the ill effects.

At the micro-level, muscle hypertrophy is determined by four main factors: 1) mechanical stress caused by external resistance, 2) the availability of energy in the muscle, 3) the availability of amino acids, and 4) Mechano-Growth Factor (MGF), the local form of IGF-1 (Wackerhage and Ratkevicius 2008).

These local factors are in turn regulated by your body's overall condition – which is determined by several feedback signals. The largest of these are residual fatigue signals, exercise-induced inflammation, and your daily calorie intake.

Summed up, this means that you need to do some kind of resistance training, stay well-fed, and have amino acids available by eating a good amount of protein.

If you fit these conditions, everything else will fall into place. You don't have to worry about how your hormones behave. Hormone responses to exercise don't mean much except as an indicator of stress on the body; lifting weights and eating are the only tools we have to influence them. Unless you want to turn to drugs.

On the flip side of this, if you're doing too much and/or eating too little, you can expect the body to fight back. Hard. It's always better to work with the body, instead of trying to fight it to get results. Too many people try to brute-force their way to gains, when it requires a more subtle approach.

Bottom line: If you're training right and eating properly, your body will cooperate, and there's not much else you can do.

Reality check: The biochemistry that underlies muscle growth is interesting because it explains the effects we have observed. The same goes for the hormonal changes. What we are seeing here is the body's specific

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reaction to a specific stress. This is why I want to drive home the point that the biochemistry and the hormones and all the rest of that are not things that you should seek out in your training.

A lot of people have taken this kind of labcoating to the extreme, looking at all these biochemical pathways and trying to extrapolate on new training methods based on them. That's going about it bass-ackwards.

The only reason I even included this much discussion of the topic is because it's interesting background material. It shows you why things are working, and it's one more piece of the overall puzzle. This stuff is interesting only because it validates the empirical observations – it explains why lifting weights makes your muscles bigger. It's a whole different animal to look at this stuff and then start theorizing over what might work if X did Y.

Sadly, a lot of people do that – and not just with lifting. It's a key scam of the supplement industry, too. It's deceptive, and effective, because most people don't know any better. The trick is to find something in the research that has some effect – usually in diseased rats – then start claiming it will have the same effect in healthy humans. The truth is that the picture just isn't complete enough for that. We don't know nearly enough to start theorizing about how the various signals interact and what should happen. I don't care how much the Internet tells you otherwise.

All we can go by is the empirical evidence. The chemistry is only interesting from a completeness standpoint, because it serves to back up and to explain the empirical evidence. It's far too easy to get carried away with it, though. I can guarantee you that somewhere out there, somebody's putting together programs with the rationale that they'll target mTOR or some other inane thing like that. What matters is the end results. You don't have to know the real micro-level details.

I know this might sound counter to the point I made in the last chapter, where I said that we need to understand causes in order to understand effects. That's still true. My point is that the effects are the number one arbiter. We only use the labcoating to explain why those effects happen. The rest of the information was put here for one reason only: to show you that reductionism – looking at things from the bottom up – is pointless. It's too complicated, there's too much conflicting information, and at the end of the day it's not going to affect your results one bit.

Instead, we look at things from the top down, observing the effects and then using science to explain it. This will go a lot farther than looking at incomplete data and trying to theorize about something never observed.

Remember: complexity is not a virtue. Keep this in mind next time someone is telling you how important these variables are. They're important to the process, but not to what you will be doing. There's a big difference there.

That pretty much covers the relevant physiology. Now we can move on and start to look at the practical side of things.

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SHUT UP AND LIFT, LABCOAT.

Assuming your brain isn't melted from the last chapter, what you read there provided you with the scientific justification for a model of hypertrophy. By now you hopefully understand the theoretical basis of muscle growth, as well as how that process fits into the bigger picture of your body's adaptation to stress. These are the two cornerstones that everything else is built on; from here, we can set about putting together an intelligent training system.

I try to look at this as a holistic top-down process, considering the big picture first and then filling in the details from there. Most approaches work from the bottom up, putting together details into a larger ideology. I think that's going about it backwards; there's no consistent theme or goal to hold everything together. When it comes to strength training, the details are trivia in comparison to the big fish.

There's still plenty of labcoating to go on in this chapter, but at least this is directly applicable to lifting. I want to start looking at how to connect the dots between the labcoating of the last chapter and what you'll want to do when you actually go to the gym. Practical advice in a book on lifting weights? Yeah, I know it's a stretch.

You might be asking yourself how detailed it can get. I mean, just lift heavy stuff and pile on more weight, right? That's the gist of it, yes, but there's some finer nuances that have to be covered. While it is tempting to just say 'shut up and go lift', it's a bigger deal than it would seem. The biggest evidence of this is the fact that most people screw it up. There are nuances that the 'go lift, labcoat' mindset forgets or tends to overlook.

We know fundamentally what makes the muscle grow, and we've established the basics of adaptation, as a process of stress and recovery. These facts will form the cornerstones of our philosophy of weight training. We just have to use a little common sense to flesh out the details.

In writing this, I assume you've already had some exposure to weight training: you understand the definition of a set, a rep, a barbell, things like that. I'm keeping it simple, but not that simple.

The Fundamentals: Why You Need To Lift Weights

At this point, we know that the goal of muscle-building exercise boils down to protein metabolism. We have to 'convince' your muscles to build and then hold on to more proteins. The trigger for this is high tension in the muscle. When the muscle is under tension, large mechanical stresses are placed on the fibers, just like stretching a tight rubber band. This loaded stretching, as a result of high tension, is the strongest signal for both protein synthesis and satellite cell magic.

Obviously, the muscles need to be exposed to high-tension exercise, which goes by many names: strength training, progressive resistance exercise, or just plain-old liftin' weights. The pedantic nerd in me wants to point out that it would be best phrased as *progressive resistance training*. After all, it's any form of external resistance that matters; doesn't necessarily have to be weights. Further, the progressive part is more crucial than many people realize.

While we all know that nerds and strength training go together like icing and cake, 'lifting weights' is so ingrained in the lingo that I might as well keep it. You can stop laughing now.

Regardless of what you call it, you're using outside resistance to create tension in the muscles. Just flexing hard isn't going to cut it. The greater the resistance, the more tension you can create. As you might imagine, your this is highly correlated with your ability to overcome resistance - creating muscular tension and applying it against objects is the definition of 'being strong'.

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More importantly, getting stronger means that you've increased your ability to stimulate the muscle. Progressive increases in tension translate to increased stimulation of the muscles. This is why bodybuilders lift weights in the first place. There's a direct relationship between slinging iron around and having bigger muscles. Strangely enough, despite that obvious link, the idea of being strong tends to be underestimated in bodybuilding circles. The entire notion of being concerned with strength is alien to many of them.

Some bodybuilders do actually understand that using heavy weights is a must, but quite a few don't. Most of them are under the impression that pumping up the muscle is important. It can be in some cases, but focusing on it as your number one goal is a big mistake.

It's even worse in the general fitness 'I just want to tone up' crowd. Same goes for all the ladies out there trying to build a lean and sexy body. Pumping and toning with aerobics and high-rep/low-weight exercises is the rule in those circles. There's many things wrong with this thinking, and I'm going to nitpick the hell out of all of them.

Think about the guys you see doing 100 sets per part, set after set of pumping and flexing with relatively tiny weights. Occasionally you'll find a really big guy that trains this way, but for every big guy you see doing this, there's a hundred that do the same thing and get nothing for their trouble.

This is where it's important to distinguish between a guy that's big as compared to a guy that made himself big. It may sound like word-games, but there's a difference in the two. Being naturally big is one thing. Getting big, in a muscular sense, by hammering away for years is something else. As a general rule, the guys that have put in the work and gotten significantly larger are almost always significantly stronger, too.

Even then, the guy with 20 years of experience under his belt can get away with things that a beginner has no business doing. This is a case where correlation is assumed to be causation; the fact of the matter is, you can find big guys that train any way you can imagine. For all these reasons, using the big guy at the gym as an example of how you should train is flawed to begin with. So we can throw that line of thinking out from the get-go.

This is where more objective standards are helpful – the one common denominator is that guys that get big are also strong, and based on the muscle growth research, we see why. So that's where we need to look.

What do I mean by get stronger? Strictly, we define strength as the maximum force that a muscle or muscle group can create voluntarily. In research settings, strength is defined by the *maximal voluntary isometric contraction* (MVIC), which is the heaviest weight that can be held without motion. The isometric bit just means that the muscles aren't moving.

This translates to the limit of your strength under voluntary conditions. Sometimes, your muscles are actually capable of creating more force, but it requires electrical stimulation to make it happen. The voluntary contraction is what we're interested in.

In realistic settings, like situations where you have to move, strength is measured by your one-rep maximum (1RM) in a given exercise. Maximum strength, as this is called, represents the heaviest weight that you can move in an exercise. Because the weight is heavy, it's not going to move fast. As a result, maximum strength is sometimes called isometric or static strength. Heavy, slow, and grinding is the name of the game. The MVIC just takes this to an extreme. In practice, the true 1RM and the MVIC number won't be very different for a well-trained person.

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Now, think about 100-set pump 'n tone guy (or girl). His focus is on doing a lot of work, rather than using a heavy weight. Doing a lot of sets and reps like that will pump up the muscles, but the drawback is that you can't use heavy weights. Problem is, bodybuilders have been obsessed with the pump for so long now that it's just taken for granted. Whole generations of guys have gone to the gym with the express goal of pumping up the muscles, with little if any concern for getting stronger. Unfortunately, the body doesn't agree with this approach.

Even without knowing the fine chemical details, we've known for quite some time that it's not the amount of work that is important. In a 1981 review paper, John Atha summarized pretty much all the strength research that came before that; what he found from all that data is that the weight on the bar is more important than anything else. It's the magnitude of the work – the intensity, or weight on the bar, that matters. If you're not handling heavy weights, or at least heavy-enough weights, you're not working in the most effective zone.

What do I mean by work? I mean in the physics sense of the term. The old-school formula physics formula for work is just force times distance.

When a force moves an object over some distance, mechanical work is done. If you knew how far the bar moved and estimated the force involved, you'd know how much work was done. Only the largest of labcoats would actually measure things to that detail, but I've seen it done.

But! There's a trap here. That formula only explains how the bar moves – and what we're interested in is what's happening in the muscle. Turns out we use work to describe that, too, but in a different way. We measure work in the muscle by the amount of energy that it uses up while it's contracting.

What I'm saying here is that the weight you're moving is more important than the energy you're burning up. Working at a relatively high percentage of your 1RM is important if you want to see muscle growth. The amount of work you do is not as important as the weight you're using.

There's a simple reason for this. If the weights are light, then they aren't going to cause enough stress to the muscle fibers on any given rep. You can work all day long and still not cause any significant growth stress. You'll eventually get tired and get that burning sensation if you do too many reps. Usually this kicks in around 12-15 reps for most people. But that's not growth happening, or 'tearing the muscle fibers' as some people seem to think. That's the build-up of lactic acid in the muscles, which is a by-product of anaerobic (sugar-burning) metabolism.

We're after protein synthesis, not metabolic endurance. The burn you feel isn't muscle breakdown or tears or anything like that. It's just the after-effects of your muscle trying to create energy. The burn and muscle pain like that doesn't have anything to do with growth. Doing a lot of sets and higher reps makes it difficult, if not impossible, to use heavy-enough weights.

You can test this for yourself at the gym. You can do more reps in a set with lighter weights than with heavier weights. The heavier the weight, the less reps you'll be able to knock out at one go. You also won't be likely to get as many total sets, either. Some amount of work is required. The problem is that too many people assume that the volume is the goal, rather than simply permitting growth when other conditions are in place.

This whole pump-centric philosophy follows along with another fallacy that's targeted at the general fitness crowd, especially women. Let me not mince words: the notion that you can 'tone up' or 'lengthen the muscles' using high-volume and low-weight training is ridiculous. If you understand anything about muscle anatomy, you'd know right off the bat that a muscle simply can't get longer.

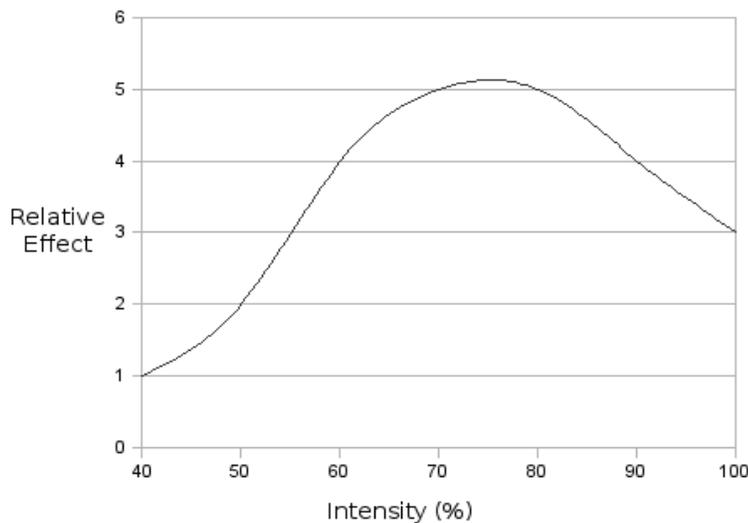
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Things like Pilates and yoga are promoted under this myth. How do you make a muscle longer, anyway? That just doesn't make sense to begin with. To make a muscle longer, you'd have to lengthen your bones too. I don't see all these people getting taller, or getting longer arms. Maybe I'm missing something.

The implication here is that you need to be using weights that are heavy and challenging. You also need to work to get stronger, simply so you can handle heavier weights later on. Atha's review reached the conclusion that it wasn't necessarily the heaviest weight, your one-rep maximum (1RM), that caused the best growth, but rather an optimal weight that was somewhat less than your best.

Your body's response to a given weight forms a *dose-response curve*. On one end, you get weights that are too light; they can't cause the required mechanical stress. If you go too heavy, you'll cause stress, but you won't be able to do enough of it to matter. Moderate weights that lie in the middle ground, between 70% and 90% of the 1RM, end up being most productive.

Figure 3.1 - Dose-response curve of intensity to relative effect



That's when volume becomes important. Once you've chosen the proper weight, then and only then does volume become an issue.

You could go as heavy as you can, I guess, and try to knock off a lot of sets. But handling maximum and near-maximum weights for a lot of reps in a single workout isn't something I'd advise to anybody - remember that you still have a stress response to deal with. If you don't wreck something during the workout, you probably won't be coming back to the gym any time soon.

So we go heavy, but not quite maximum. This gives us a range that is optimal for developing size. Atha found that in general, 4-6 reps produced a greater strength response than anything heavier or lighter, although in practice anything from one to 12 reps would create gains. While strength and size gains aren't proportional in the short-term, over the long-term they will tend to match up, which makes the strength research very relevant.

Other authors have echoed this conclusion. Several more recent meta-analyses have looked at the research and found that trained individuals and athletes all see the best results in a range of 70% to 90% of the 1RM, with the most effective range being around 80% to 85% (Rhea et al. 2003, Peterson et al. 2004, 2005,

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Wernbom et al. 2007). This jives squarely with Atha's conclusions, as the 6-8RM will tend to fall in that range. Wernbom et al. directly studied changes in muscle hypertrophy, and the recommendations for working weights are virtually identical to the suggestions for strength.

One issue that will be relevant is your experience. Beginners respond better to high reps and lower percentages than more advanced lifters. But beginners will respond better to *anything* compared to more advanced lifters. That fact isn't necessarily an endorsement of effectiveness, though there are some practical factors to consider. Beginners might feel more comfortable with higher reps and lighter weights.

The big hurdle in this thinking is the accepted standard of the hypertrophy protocol. You know what I'm talking about; you see it in every book ever written on lifting weights, and I talked about it in the section on hormone responses. In every book you'll read on the subject, there's always a table that lays out how to train for strength, for power, for endurance, and so on. In the section on muscle hypertrophy, there's always a section that says 3-5 sets of 8-12 reps at roughly 75% of your 1RM. If it lists any rest intervals, it says keep them from 60 to 90 seconds, and you're suggested to do multiple exercises for each muscle group.

That's a convenient way to label things, I guess. Seems like a lot of folks have developed a hard-on for the idea of doing lots of sets of 8-12 reps for muscle size. Near as I can tell, this suggestion based on two things: one, it creates a strong hormonal response. Mostly growth hormone, but testosterone as well. Two, it's what bodybuilders supposedly do, with their pump 'n tone training.

The whole three sets of 10 thing comes from a much older protocol called the DeLorme method, named after the researcher that popularized it back in the 1940s and 50s. It consists of three sets: one at 50% of the 10RM, one at 75%, and one at the 10RM itself. The DeLorme method and its variants have set the gold-standard for research into strength training, and as a result it's seeped into the consciousness as how you train for muscle mass. It's not a bad setup, really, but that's not the point. The thing is, based on the rest of the data, it's not so clear-cut that there is any such thing as 'the hypertrophy protocol'.

Consider what the research actually says: the weight must be heavy enough, you must get stronger over time, and finally, advanced lifters will respond to higher percentages than beginners. For these reasons, trying to narrow down any one method as the hypertrophy protocol is pointless.

That's my running hypothesis from here on out: as long as you're working with weights that are heavy enough to stimulate growth, and you're getting enough work with those weights, you'll be doing all you can do. What matters is that you're training the muscles in a way that puts them under mechanical stress. The actual rep range doesn't seem to be that important.

The Tension-Time Integral

Now that we've established this, let's look at why this is the case.

We know that we have to train heavy, and we have to work to get stronger. You're trying to stimulate the muscle to get bigger – and to do that, you have to give it a reason. If you want to increase your muscle mass, your goal when you go to the gym is overload. You want to stress the muscle in a way that pushes it out of its comfort zone. When you do this, you give it a reason to adapt.

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The muscle grows in response to stress. If you keep serving up the same stimulus for months on end, you're not triggering that process - there's no stress. The body has adapted and become comfortable again, a process called accommodation.

When that happens you don't grow. If you're not challenging the body, it doesn't adapt. The actual term used is *overload*. What the hell does overload mean, though? The word might give you some ideas, but it doesn't really tell you anything.

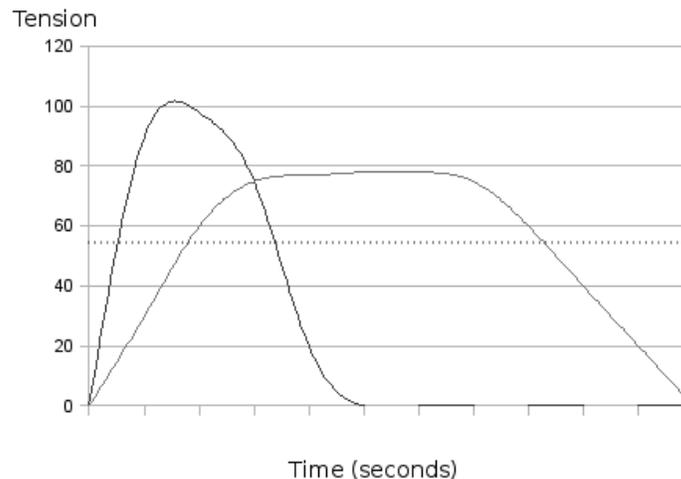
It shouldn't be any surprise that vague wording like this has led to a lot of the Bro-science mythology. Depending on who you ask, overload can mean doing 100 sets per part, or it can mean taking one set to failure, or it can mean having all your reps take 30 seconds. And yes, those are all recommendations from people that seem to take themselves seriously. Overload is right up there with 'keep the body guessing' as a Bro-speak mantra.

Just about any kind of exercise you can name is some kind of overload if you do enough of it. We have to be more specific.

The good news is that by now you should know the answer – you're creating overload with heavy weights, because this creates high tension in the muscles.

But let me throw a little curve ball. What you're really after when you lift a heavy weight is called tension-time overload. Tension-time overload involves tension, obviously, but there's a little more to it. The *tension-time integral*, which is how we represent this idea, is a mathematical concept which I can't fully explain without integral calculus. Which is to say, I can't fully explain it. Fortunately I don't need to. To save that headache, you can say that tension-time is how much tension is created, with respect to how long your muscles are exposed to that tension - called time under tension (TUT).

Figure 3.2 - The Tension-Time Integral



A really high-tension movement that lasts only briefly (the short peak), something like a 1RM attempt, can net you the same growth stimulus as a lighter movement done for a longer time (meaning, higher reps as in the shallower, longer curve). We want to look at the area under the curve as the growth stimulus.

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A lot of short, heavy sets can equal the same stimulus as a few longer, lighter sets. The tension-time integral not only applies to individual reps, but to every rep you do in a workout.

As long as the tension-time factor is nearly equal, there won't be a ton of difference in muscle growth that's stimulated between any two workouts.

To further dumb it down, you can do really heavy movements that don't last long, or you can do somewhat lighter movements that last longer; both can make your muscles bigger.

The graph above is a bastardization that I made based on one presented by the late Mel Siff on his Supertraining list. Siff noted that this wasn't the only determinant of growth, but it's an easy way to visualize how different combinations of weight and time under tension could create growth. We can look at this as an interplay between the tension and time under tension (TUT) variables. You can play around with different combinations; as long as the muscular tension is above the threshold level, you're going to be stimulating growth. This is the fundamental reason why all sorts of different methods and programs can be effective; they're different ways of achieving tension-time overload.

You may notice that there's a dotted line in that graph; that notes the minimum stimulus threshold. Any tension below that point isn't stressful enough to cause growth. But anything over that line is plenty.

The tension-time integral has some interesting implications. We can't just rely completely on weight, even though it's the primary signal and absolutely necessary for growth to happen. There has to be some amount of muscular work done too. The tension-time integral is not simply about work, but rather work with a given amount of tension. Indeed, there's research showing that both tension and the tension-time integral are important in triggering the muscle-growth chemistry (Martineau and Gardiner 2001, 2002). Once you've got a heavy enough weight, the amount of work will tend to modulate the actual hypertrophy response (Wernbom et al. 2007).

Atha's review showed us that the weight, not volume, was the key factor in improving strength, and that anything heavy enough would trigger gains. The tension-time graph describes why moderate weights and moderate reps showed superior results to anything heavier or lighter - sets of 5-6 reps tend to balance tension and time under tension. You reach an equilibrium point between tension and total work done.

At the same time, it also accounts for why anything heavy enough produces growth. In reality, heavy weights and lighter weights can both create gains as long as they're heavy enough and cause enough total stress in the muscle. Specific rep ranges don't really matter as long as you're getting enough total time under tension with the weight.

Pump-guy with his 100 sets has assumed that doing a lot of sets and reps is important. So has fitness girl that uses the 15 lb dumbbells for 25 reps in an attempt to tone up. Now you've got no excuse for that kind of thing - you need weight first, then some amount of work with that weight. One guy could train with very heavy sets of single reps, and another guy could train with lighter sets of 10. All else being equal, as long as they're both creating enough tension-time overload, they'll be growing.

This concept is going to be the foundation of all our strength training. Manipulating different combinations of tension-time will form the basis of every kind of lifting you do. Some exercise focuses more on the tension, while other methods focus on the time under tension.

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Tension is represented by the intensity of training. Usually we represent intensity with a percentage of your 1RM. The definition of intensity has been hotly debated, with some preferring a more subjective definition that accounts for 'how hard' your sets are. That has a place too, but for our purposes, intensity will represent your relative ability to create strength – and for that, we use percentages of your 1RM. A good substitute is to use a rep-maximum (RM), which is simply how many reps you can complete in a single set before fatigue stops you.

Time under tension is usually represented by volume of training. Where intensity is the magnitude of the exercise, volume is the amount. You'll see volume handled in several different ways. Some people count the total number of reps done, sometimes abbreviated as number of lifts (NL) or number of barbell lifts (NBL). This originated in Olympic weightlifting, where quality of individual reps is very important. However, it's also a useful measure for other sports.

Others use a calculation called tonnage, which is total number of reps done multiplied by the intensity (given as weight on the bar), giving you a total number of pounds (or kilograms) lifted in a session. Lifting 200 lbs for 5 sets of 5 reps would give you 5125 total pounds lifted. Finally, some people just count out the actual time it takes to complete each set, then add up the time for all sets to get the total TUT. Personally I find this to be useless on its own, but it can be helpful if taken along with the volume calculation.

Both TUT and volume numbers actually serve as stand-ins for what we're really trying to describe – the amount of physical work that your body has done. What you'll find is that both the TUT and the volume (either as number of lifts or tonnage) are really required to get an accurate idea of how much work you do. I think that tonnage is the best number to keep track of, but I'll be honest – I'm saying that from the theory side of things. I've very rarely bothered actually tracking the tonnage, and can count on one hand the number of times I've attempted to seriously figure out the TUT of a set. For most people, having an idea of the total reps done, relative weight used (as a percentage of your 1RM or as a RM), and some clue as to how fast you were moving is really all you need to know as far as that goes.

Regardless of the details, intensity and volume taken together form the foundation of any exercise regimen, so you should have some system in place for tracking these things.

Progressive Overload

As mentioned, there's a lower limit on the tension required to stimulate muscle growth. If you use weights below that limit, you're not doing anything to cause changes. This limit will vary, but it's usually given to be around 65% to 70% of your one-rep maximum (1RM) in a given exercise, if you're relatively untrained. This will translate to somewhere in the neighborhood of 15 to 20ish reps, depending on the person and the exercise in question. Sometimes it might even be more than this. Usually, though, you're going to find that the cutoff will be around 10-15 reps per set. Sorry I can't narrow it down more than that, but the body's a diverse thing.

The more advanced you become, the higher the threshold goes. A really advanced lifter might find that he can't grow on anything less than 80-85% of the 1RM – otherwise, the tension created in the muscle isn't high enough to do anything. Adaptation sucks, but we have to deal with it.

The results that the advanced guys get are less than a beginner, too. Way less. For all the time and energy invested, advanced lifters don't get very much back. The more you gain, the more you have to really beat up the body and force it into adaptation.

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Since progressively heavier weights have the strongest effect on the body, it's heavier weights that you'll have to use. This is the foundation of *progressive overload*, the idea that you have to consistently apply a larger stimulus to the body. Progressive overload is one of the foundations of strength training. The idea is that you have to add weight to your lifts over time, becoming stronger, in order to continue challenging the body. This is why the recommendations from strength research so closely mirror the recommendations for hypertrophy.

Taken to a logical conclusion, progressive overload not only implies that you'll have to use heavier weights in an absolute sense, but that the relative weight, compared to your 1RM, will have to increase as well. This explains why sedentary and untrained people can gain muscle mass from literally any activity. The housewife that's never exercised in her life might very well find herself gaining leg muscle from those daily walks on the treadmill. This causes all kinds of confusion, from people thinking that walking and light weights are enough for them, to people (male and female) thinking that they 'bulk up easy'.

Truth is, those so-called newbie gains won't last, and they won't be that significant in the first place. The body will respond in a hurry, but unless you add some kind of resistance to that exercise – and create more tension in the muscles – then the effects will stop. That's why I always get a chuckle out of people that freak when they gain a few pounds after beginning to exercise. It's a short-term problem; nobody accidentally gets too big.

This is my pet theory on why many women are attracted to lots of cardio and high-rep work, while thinking they'll bulk up if they touch any non-pink weights. That kind of training to 'tone up' builds just enough muscle tissue to create a defined appearance (if body fat is low enough), while creating a calorie burn. Get lean enough with such a method and you get your 'long, lean muscles'. Thus the myth of toning is born, based on people who are already in shape and with the genetics to succeed on that kind of exercise. Remember the mantra: copying what the best do is no guarantee you'll become the best.

Progression of resistance is the biggest thing that we have control over when trying to cause muscle growth. In some form or another, you have to add more weight to the barbell, dumbbell, machine, or whatever you're using. Your body is going to adapt; heavy and progressively-increasing resistance is required to keep pushing the boundaries.

Here's another fun analogy. When you're driving a car, which of these has the most impact on the car's maintenance schedule: Driving it on the highway for a long trip, or having to regularly stop and go in city traffic? A car that's mostly highway driven is usually less beat up than a car that gets a lot of city miles. The same idea applies here. Taking a long trip at a decent pace will still put wear and tear on a car, but not to the extent that pushing its limits will. Constantly having to accelerate and slow down uses up more gas, wears down the tires, and will burn up the brakes faster. The stimulus is stronger, and it has a greater effect. That's how you should think of heavy progressive weight training. It should be understood that you need to work to improve your strength levels in order to see benefits.

All you guys and gals out there that are operating on the idea that you need to do really high reps to pump up and get sore, you are pretty much wasting your time. Since an untrained person can gain off just about anything, you can certainly see gains off that kind of pump 'n tone crap. But beginners will see gains on just about anything. That doesn't mean that situation will last forever. If you want to see muscle mass improve, at some point you'll have to add some weight. Just because it worked when you started doesn't mean it's going to keep on working.

Bottom line: strength is the foundation of big muscles. If you want size, you need to get stronger.

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Now, the big question that comes up a lot is when you should be adding weight to your lifts. Some people are going to tell you that you have to add something at every session, or the workout is wasted – a strategy called *single progression*. This is progressive overload taken very literally.

The prevailing idea here is that once you've used a weight in a workout, the body adapts and that weight is no longer going to be effective. I think that's garbage.

Blind progression may hold up for beginners, but as you get stronger, it will become impractical if not downright impossible. Consider this. A beginner may be able to consistently add 5-10 lbs to his exercises every time he goes to the gym. More advanced lifters will have to spend an entire training cycle, anywhere from 6-12 weeks usually, to get a 2-5% improvement on their 1RM in a big lift. The actual number will vary according to the exercise, the person, history, blah blah, but that isn't the point.

The rate of progress is the important thing here. We're dealing with two key things when we discuss progression – neuromuscular adaptations and muscle hypertrophy. Strength and size.

Strength can increase very quickly in the short term. Muscle mass has a longer lag time, usually taking several weeks or months to become noticeable, even though hypertrophy is thought to begin almost immediately. If you look at the real numbers, this can become a considerable issue. Consider that adding 5-10 lbs to an exercise each week is reasonable progress; for most people of average to good strength, even a 5 lb gain on an exercise will be anywhere from a 1-5% increase. Even on a lift where you max at 500 lbs, a 5 lb gain still represents 1% of your strength level – more than the gains in muscle size from that session. At a max of 100 lbs, adding 5 lbs is a 5% gain.

But think about this - did you actually increase your strength level by 1% or 5% or whatever the math works out to be? Not necessarily. Just because you added more weight to the bar doesn't actually mean your strength jumped that much. You don't actually know that you weren't capable of it before. In fact, if you're working with sets that are close to your best, odds are that you're only going to be able to milk a few weeks of true progress.

Anecdotally, it seems that there's a kind of momentum that builds up when you work with comparatively light weights. You'd start out with less than your best, on purpose, and then add weight until you reach or break your old personal record. The problem is that it's hard to measure this in any objective way, so we usually just assume that moving from 100x5 to 105x5 means that your strength improved by five pounds. The logical implication is that working with sets that are less than your best are still building strength. That's the only way to account for the 'momentum' - the lighter sets are still heavy enough to create strength gains.

If we dig through the Wernbom meta-analysis, we see that the rate of muscle mass gain is a paltry 0.05-0.25% per session, with an average of around 0.1%. On a muscle that measures 15 inches around, you're talking 0.0075 to 0.0375 inches per workout. With time and consistency it will add up, but on a per-session basis, this is a tiny change. Bear in mind also that the Wernbom analysis only looks at relatively short spans of time, not long-term on-going progress. Based on any realistic observations, the rate of gain is going to drop even further with time and progress. The point being, any way you shake it, changes in muscle mass are simply not accounting for the short-term rapid gains in strength; likewise, it's unlikely that the short-term rapid strength gains are actually triggering growth in a direct sense.

Of course heavy loads are going to trigger growth in a more general fashion, but I'm talking about the idea that you *must* add weight as often as possible. The disconnect between rate of strength gain and rate of muscle mass gain would suggest that as long as the weight is sufficiently heavy, you can potentially grow from it for

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quite some time. The hard numbers suggest no link in the short-term changes. What matters is the change over the long term.

Even if we assume that weight added to the bar equals real strength gains, the cross-sectional area of your muscle fibers isn't increasing at the same rate.

It's not the rapid progress, it's the fact that you're handling heavy-enough weights.

Progress is always a matter of diminishing returns. In the short term, say 6-12 weeks, hypertrophy is indeed stimulated quickly, but it starts to level off over the course of the program. Now it's tricky to generalize, because this examines only short slices of time and in many cases, the beloved 'untrained subjects'. Regardless, the general idea of diminishing returns and a relatively slow process of hypertrophy are both givens. As it appears that hypertrophy is a gradual adaptation to long-term strength gains, then it would stand to reason that it's only the long-term progress that matters.

At the very least, this information calls into question the idea that you must add weight at every single session. If the muscles are adapting that slowly, then there's no fundamental reason why a weight would suddenly become useless for the purposes of stimulating said muscles. Neurologically, that weight might become easier and you might be able to do more total reps with it, but this doesn't change what happens in the muscle.

Now what happens if you follow the philosophy of adding weight at each workout? There's a very good chance that adding 5 lbs or 10 lbs to your lifts each week is going to wind up with you adding weight faster than your muscles are adapting and faster than you're getting stronger. Don't get me wrong, this will still work – for awhile. Eventually you're going to hit the wall. It's not a matter of if, it's when. This isn't a bad thing, but you have to know how to react when that happens.

The most obvious answer here would be to simply decrease the rate at which you add weight to your exercises. But that has problems of its own. The progress in strength might be so slow that you literally won't have weights small enough to account for it. If you max at 500 lbs on a lift and it's only going up by 0.5% each session, that works out to 2.5 lbs per session. That's the minimum weight plate in most American gyms, roughly equivalent to a 1.25 kg weight – meaning that you can't vary the weight any less than 5 lbs (or 2.5 kg) unless you invest in plates with smaller increments. If you're not lifting that much on an exercise and/or you aren't getting that kind of strength gain from each session, then the rates of gain will be even more out of whack. You can see the potential pitfall here.

A good compromise is to back off the weights from time to time, as you approach a wall. By dropping the weight back 5-10% or so, you'll get back to a lighter relative percentage and you can start back with the weekly progress again. This is the basis of cycling, and you should probably get used to this idea. One way or another, you're going to end up cycling your weights whether you realize you're doing it or not. This approach has the net effect of alternating heavier and lighter phases of training. The upswing has you making rather quick progress, but this is balanced by the downswing. The net gain over time will average out to be more gradual.

Some programs will deal with this by changing rep ranges, which forces you to cycle between heavier and lighter weights automatically. Some programs sneak this in on you, by having you change your exercises or some other kind of deception. While it's not labeled as cycling per se, this does have the effect of forcing you to start with lighter weights and then build back up. It's cycling in principle if not in name.

Another option is microloading. This is where you use very tiny weights to gradually add weight to the bar. This way, your weekly progress will more closely match your actual strength gains. I've never used this method so I

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can't really comment on it, but some people swear by it and it's not a completely outrageous idea in concept. The only problem is that you'll have to invest in the tiny weights, or a set of PlateMates, which are tiny magnets that attach to existing weight plates. Some people won't consider this worth the bother or the expense, though.

Of course you can also milk a single work weight for multiple sessions, too. There's no reason you couldn't stick to a comfortably heavy working weight for quite a few sessions, only pushing the weight up when it stops being truly challenging. This is the *double progression* approach.

The implication here is that any given weight can be 'useful' for a rather extended period of time. It's not a matter of doing it for one workout and that being the end of it. In fact, while the rapid progression type of cycling can certainly be effective, I'm not sure it has any real benefits over more gradual, steady progress when we're just talking about growing. The progression schemes that don't rely on the simple idea of adding weight at each session fit this role, as you stick with a single weight until you reach some total number of reps. You'd stick with your working weight until you reach the goal, then add weight and start over. Double progression has you adding reps, while *triple progression* adds both sets and reps before allowing weight increases.

For example, a double progression might have you start out with a best set of eight reps. Over the next few workouts, you'd try to do more reps until you hit say 12 reps. Once you get to 12 reps, you'd add weight and start over. In this case, hitting 12 reps is the trigger to add weight. If you hit 12, you go up. If you don't, you work with the weight until you do.

A triple progression would be similar, something like starting out with three sets of five and working until you hit four sets of eight. Again, you'd work with the weight until you hit the goal, then bump it up.

You might notice that all of these methods create a slower rate of gain than the linear single progression approach. That's exactly the idea. You want to slow down the gains, especially as you get stronger, to avoid stalling out or getting hurt. It's very easy to push yourself past your limits, so we slow down the rate of progress so that it closer matches the rate of adaptation. We've now moved away from the idea of progressive overload into what's called *fluctuating overload*.

If you map your rate of gain over time, progressive overload would be a straight line that gradually moves upwards. With fluctuating overload, that graph would trend upwards over time, but if you zoom in and examine any particular time frame, you might find that the trend is up, down, or even flat depending on where you happen to be. The micro-level slices don't matter as long as the trend line is heading upwards over time.

Regardless of what method you pick, the net effect will be the same – gradual progression of the weight over time. Single progression might feel better psychologically, since you get the instant feedback of being stronger, but over the long term it's not necessarily superior especially for size gains.

I'm of the mindset that there's no inherently superior method. Any rapid progress in the short term will be balanced out with stagnation and even regression (whether planned for recovery or for 'time out' if you push yourself too hard). Contrast this with double or triple progressions, which represent more gradual rates of gain, and you aren't likely to see any real difference over time. The average rate of gain won't really differ between the two if you examine the long term results.

The best approach is the one that you'll stick to, the one that has you going to the gym and working hard, and the one that keeps you from getting injured. As long as you're lifting heavier weights in a year, the actual details of how you get there don't really matter that much. It's the net gain in strength over time that matters,

not just the short-term changes in weight on the bar. Short-term changes are typically neurological. It's long-term stable progress that matters with regard to muscle mass.

How Much?

The key thing to remember from all of that is that intensity, load, or just plain weight on the bar is a necessary condition for growth to occur. Progressive overload is a necessary condition for growth to occur. If these factors aren't present, then you don't grow regardless of what else you do.

However there is evidence that despite being *necessary*, these conditions are not *sufficient* for growth by themselves. While the bar weight must be there, it's not always sufficient to create growth on its own. You have to do some degree of work with that weight in order to see size gains.

You do need some amount of volume; it's just that the you have to realize it's not important until the weight is taken care of. Just how much work do you need to do? In order for that question to make sense, we have to look at how we figure out work done.

As I said earlier, work is classically measured as force times distance, but we can't use that here. We're actually talking about energy expenditure inside the muscle. Sadly that's kinda hard to measure, so we have to use some numbers that estimate it.

This is where volume comes into the picture. Volume is usually measured by the total number of reps done, but some people will count it as the number of sets done or as the tonnage of a workout. Tonnage is the weight used multiplied by the number of sets and reps done (sets * reps * weight). Finally we can count the time under tension as a measure of how long the muscle was actually doing work. Volume is *how much* work you do.

Related to this, we can also speak in terms of *how often*, which is your workout frequency. Frequency determines how much total work you do per unit of time, whereas volume tends to look more at how much you do in any given session. Both volume and frequency are hot button topics in the strength community, stuff that people like to argue over. Volume and frequency go hand in hand, and for good reason since both of them determine your overall dose-exposure to exercise.

Think of dose-exposure like taking aspirin. You have an aspirin that's say 1000 milligrams. That's your dose of each aspirin pill. The 1000 milligram dose would be intensity – how 'hard' the exercise is. The amount you take is your volume – you can take just one, or you could take 12. You can take one a day, or you can take one every two hours. That's your frequency.

Changing any of those numbers would create different effects. Take one aspirin and get mild relief. Take three and you'll feel a lot better. Take 12 and you die. Space those 12 pills out over 14 days and it's a different story. The dose-exposure is how much your body has to handle at any given point.

To continue with the drug abuse analogy, doing just one set will give you an effect, sure. But you'll get a better effect the more you do, up to the optimal amount. After the optimal number, the effect drops off, though you'll still see smaller marginal gains. Do too many sets and you'll wind up actually hurting your gains.

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The meta-analyses by Peterson, Rhea, and that group (2003, 2004, 2005) along with the one by Wernbom's group (2007) will provide most of our scientific grounding here. These papers took a long look at a large number of studies in this area, and their results demonstrate a dose-response relationship quite clearly.

Going from one set to four sets might create large *marginal gains* for each set – it's worth it to do the sets, because each additional set gives you a large return for the effort. Say each additional set might give you an additional 10% gain. It'd be worth it to spend the time and effort for almost anyone.

Going from four sets to six might create smaller relative returns – you'd still gain strength in absolute terms from doing those sets, but those gains would be smaller for the time and effort put in when compared to the earlier sets. You might only see a 2-3% return for each additional set. If you're just interested in economy, you can skip these, but if you want the best results you can get, you'd be smart to do them.

Doing more than six sets could create negative returns, doing more harm than good by creating muscle damage and extending recovery times.

So in effect we can define three ranges: adequate volume, where you'll gain, but can gain significantly more by doing more sets; ideal volume, which is where you milk all the gains you can get even though it's not really efficient; and then there's just too damn much.

Obviously our goal is to hang around the optimal range, or at least in the adequate zone. Note that the most efficient use of your training time (in this example) would be four sets – that's where you're getting the most return for your effort. You'll still get stronger from doing six sets, but it's inefficient as compared to just doing four sets.

I'm going to assume you don't really give a damn about efficiency, though – you want results, right? Seriously, this is good to keep in mind for those of you looking to maintain, or those that may have limited time for working out. You can still get results with limited programs. You just have to accept the trade-off – doing less is more efficient and economical, but doing more will create the best absolute results.

For those of you dieting or otherwise not trying to get 'too big', you should remember this too. This ties right back to what I said in chapter two about a continuum of effect. Doing only a few sets might just maintain the muscle you have by providing some activity to cut off atrophy signals. Doing the most you can get away with would not only turn off atrophy but increase growth signaling.

The meta-analyses by Peterson and Rhea's group suggest that, even for the untrained, the potential for strength gains isn't fully realized until the fourth set for a given muscle group (on average). The first set represents around 50% of potential gains. Advanced athletes can take up to eight sets to realize the full strength-gain potential, with the first set representing a piddling 26%.

Wernbom's analysis notes that increases in volume can initially result in greater gains, but doing too much can result in negative gains. The best results tend to come from moderate volumes, around 30-60 reps per session.

Most sane people think that a single set just can't provide enough stimulation to the muscle to be practical for most people. It may or may not be, depending on how you define 'single set'. By the usual definition, this is true and the preponderance of evidence agrees.

Some workout programs that claim 'one set' that could actually be thought of as 3-4 sets if you look at it by muscle group. They'll do one set for bench press, one set of flies, one set of dips, and so on. Well that's not a

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single set routine. It's one set per exercise, but each set works the same muscle groups. This is more semantics than anything, though. The actual volume that the muscles are exposed to is what matters.

By the strict definition, doing one set to failure isn't enough for anything but basic fitness. It's in that zone of adequate volume - better than sitting on the couch doing nothing, but won't maximize results.

It's rare to see someone improving over the long-term on true single-set protocols. The key word here is 'long-term'. Anything is effective over the short-term; what I'm discussing here is guys that think they can do one set to failure once every 10 days for years on end and still keep improving.

The effects of training accumulate over the short-term, affecting the assorted chemistry that regulates protein synthesis and satellite cells. If you're not getting enough of a training dose on a regular basis, then you're not going to be growing. If you are growing, then you're not growing the best you could be. You can still get stronger from neural factors (to a point), but the chemistry behind growth just isn't there.

Point blank, the research shows us a dose-response relationship between training and results, not a simple on/off switch. For a given dose of exercise, you can expect a certain response. Just like the aspirin analogy, if you take too little you get nothing. Taking too much will be harmful. You need to be in the right zone to get the effects you want.

If you're just after basic fitness or whatever, fine, do one set and go home. If you're really wanting to get bigger and stronger, you need to do more. The marginal results won't matter to somebody after fitness, but if you're after maximum results, those marginal gains are necessary.

There's a cool word that describes this: moderation. Unfortunately, this has kinda gotten lost in the noise, leading to polarized arguments between so-called 'high intensity' and 'high volume' advocates.

And then we have HIT. The High Intensity Training (HIT) crowd has felt this position is somehow wrong for decades now. Even with on-going research that explicitly disproves their single-set claims, many of them don't want to buy it. In arguments, they're always ready to argue against some high-volume strawman, as if you're either training with one set or 50 sets.

The HIT guys think that the body responds to lower and lower doses of exercise as you keep on getting stronger. The logical outcome would have you reducing your workouts to a single set once every 10 to 21 days. I'm not making this up, these guys really suggest this.

I'd be more sympathetic to that case if it was just one study or something, but there's a lot of studies, and drug-free bodybuilders, and protein metabolism to ignore too. HIT has gotten really good at ignoring things, like 30 years of obvious conclusions. It's not an on/off, yes/no thing. Exercise isn't a light switch, where growth is either on or off. Exercise is like taking aspirin.

They like to assume that the body becomes less able to tolerate the stress of exercise as the intensity increases. There's some truth in this. The more fatigue you cause in a workout, the longer it will be before you can repeat that workout. But this entirely ignores the dose-response relationship.

Most of this is predicated on the idea of quality. The more you do, the less quality you can achieve. Hey, that's not such a bad idea, and it's actually true. But this is one of those situations where their idea of quality and yours may be two different things.

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HIT is founded on the idea of 'quality' as being your ability to fight through extreme fatigue. After you've pushed yourself through an extended set or two that made you want to puke, you're not going to want or need any more. I'll buy that one too.

What I don't buy is their series of highly questionable assumptions that bring them to the conclusion that this is the best way to do things. I'll tackle the idea of 'intense training' shortly.

Here's a novel conclusion: A less taxing workout can still be used to maintain gains between harder sessions. This way you can still hit a decent frequency to keep the anabolic processes switched on, but you don't have to impact your recovery. Brilliant.

The body's work capacity doesn't decrease to begin with, so they were wrong about that anyway. Our ability to handle stress can be trained too. This has been seen in research on endurance training, which can rack up some monstrous volumes. Even though endurance athletes aren't really huge and strong, it does show us what can happen in general. There's no reason the same wouldn't apply to strength-based training, either.

If anything, having increased work capacity can translate into long-term improvements. If you're able to handle more stress and work load, then you'll be that much better equipped to handle strength gains. Even powerlifting, long considered the realm of out of shape fat guys, can benefit from added fitness and conditioning. A body that's in shape is a body that's better suited to adapt.

To go off on a little tangent, this is one reason you'll hear people say 'be an athlete first, a <whatever> second'. This means that you want to be in shape and conditioned before doing whatever else for your actual sport. I don't see any reason for bodybuilders to be any different.

Anyway, as much as the HIT Jedi would love for it to be the case, it just happens that there are no high-level athletes in any sport that go by one-set-to-failure every 10-21 days. Just doesn't happen, because nobody operating at that level actually works that way.

Of course their mortal foes the volume guys miss the point too, because they're after a pump. Heavy weights and hard work are irrelevant as long as they get their blessed pump. We can blame Arnold for this one I guess. HIT at least gets credit for focusing on hard work and quality – even if they've got skewed ideas on what those mean.

Moderation, people. Some amount of volume is necessary for growth. Too much volume is bad. Too little won't give the best results. And neither matters if the weight isn't heavy enough in the first place.

What it boils down to is finding that optimal dose of exercise that gives the best results. You don't want to do the minimum that you can get away with, but rather the minimum that will still provide the best results. This is easier said than done. While we can lay out general guidelines, you'll never nail down an exact number that will apply to all people in all situations.

We can come up with a range of volume that seems to be about right, though. Three to eight sets per muscle group, with a range of 20 to 80 total reps, works out to be around the ideal for a given workout session. A further narrowing-down would yield maybe 30-60 reps per muscle group, spread over 4-6 sets, as being about right for most instances.

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The trend is that more advanced athletes will respond to progressively larger volumes and more sets with time, with less return on investment for this increased volume. Even so, there are limits. It's unlikely that a strength athlete will ever wind up needing more total reps than what's outlined above - mainly because increased volume doesn't necessarily mean doing more total reps. Volume (as tonnage) increases simply by getting stronger.

Instead, this increase in volume may be deceptive – it may not come as doing more actual reps per session, but rather using heavier weights, fewer reps per set, more total sets, and (perhaps) more frequent sessions. The total number of reps per session may not increase, but the total tonnage per session will go up, and the total number of sessions might increase.

Of course this can just as easily go the other direction too, with fewer total sessions. One thing about advanced lifters is that there really are no hard and fast rules.

That gives us a working range and a starting point at least, and it's better than just making something up. The actual volume will depend on how heavy you go, how often you train, how well you can recover, and what you're trying to improve, among other things.

Training at 90% will require less reps to achieve an effect than training at 75%. Training a part four times a week will require less total reps in each session than training it twice a week. And so on.

Practically speaking, 20-30 reps seems to be about right with 4-6RM weights, and you could probably get away with 30-60 reps in a range of the 6-12RM. This would jive with recommendations for things like the 5x5 routine, or DeLorme's 3x10 progressive resistance training.

A max of 10-15 total reps would be a cutoff point for anything heavier than the 4-6RM. Really heavy weights would benefit from no more than 4-7 total reps. Wernbom speculated that this has to do with the eccentric phase of the lift. The greater the eccentric stress, the less volume required.

For strength and power training, there's another resource that's often drawn upon to determine volume. This is the (in)famous Prilepin's Table, based on AS Prilepin's research into the volumes and loads used by Russian weightlifters.

Table 3.1 - Prilepin's Table

Intensity	Reps per Set	Optimal Total	Range
60-70%	3-6	24	18-30
70-80%	3-6	18	12-24
80-90%	2-3	15	10-20
90-100%	1-2	7	4-10

Again, this is hardly an exact blueprint, but it is a pretty decent starting point that jives nicely with the other numbers. Moderate volumes of weights in the 70-80% range are optimal for strength gains.

Doing more or less than these suggestions would take some unusual circumstances, but it could come up from time to time if you're trying to create really hard or light workouts.

While intensity determines the actual impact on your body, volume is what modulates the amount of stress you experience. The more volume, the more stress. Intensity tends to produce powerful, but short-lived

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effects, while volume-based training tends to create more subdued but longer-lasting after-effects. When you combine different intensities and volumes, you produce different effects.

The Russians looked at this, too. A guy by the name of Chernyak came up with loading recommendations for strength athletes, based on different combinations of volume and intensity. I'm not going to list the exact chart because it's not really relevant for those of us not following precisely-mapped multi-year plans. I know I for one am not going to sit down and map out how many weeks of each I'm doing in a year, and if you do...well, have fun with that.

The take-home point is that your most productive training will be with moderate volume and moderate intensity, and that's how you should train most of the time. Using high volume and low intensity is next on the list, followed by low volume and medium intensity. Other combinations, using very high or very low volumes can be used, but only sparingly, maybe 1-4 weeks per year.

From time to time, you'll benefit from a really heavy strength session where you only get 5-6 total reps, or a session that's lighter in weight, but racks up 100 total reps. Even less often, it wouldn't hurt to have a really heavy session that racks up a ton of reps. But your most productive training will tend to be moderately heavy weights, between 70% and 80%, for around 20-60 reps per workout – moderate volume and moderate intensity.

As you get stronger, the required stimulus will increase – that means that both volume and intensity will increase. As a rule, volume tends to drop as intensity goes up. This more or less holds up.

What you'll find though is that volume *per session* will decrease, but the overall volume in any given time frame will increase by playing around with frequency. You can do more sessions, with less volume per session, and still end up with a net increase in volume. The role of specialization will increase, requiring you to focus on more specific goals in order to improve.

Indeed, these varied combinations of intensity, volume, and frequency will form the basis of any workout you do. If you look at any of the result-producing workout protocols, they'll more or less tend to fall under this umbrella with very few exceptions. I can't think of any off hand that don't.

I feel a need to repeat myself right about now: volume is still secondary to the weight used. If you're not going heavy enough, all the volume in the world won't get around that. If the dose of your pill is so watered down that it can't do anything, it won't matter how many you take.

At the same time, volume ensures enough of an exercise dose if the pills are strong enough. There's occasions when you need a higher stress. Taking more pills will do this. If you need a lighter session, take less.

Note: Please don't go out and start taking aspirin, claiming that I told you to.

How Often?

Ideally, a muscle will get some work at least twice a week. However, that needs some qualifying. 'Some work' doesn't mean you have to go in and do an all-out back-breaking workout with your big lifts. We can use a dose-response relationship to analyze workout frequency also. Frequency and volume go hand in hand. The more you do of one, the less you'll need of the other.

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While volume impacts the immediate response to exercise, frequency impacts your recovery from it and your overall volume dose.

The physiology of protein metabolism gives us some rough practical limits on the frequency to train each muscle group. We know that by around 72 hours after a workout, protein synthesis is more or less back to normal. With this in mind, you'd probably want to go no longer than 4-5 days between training a given muscle group. Three days might be a little better, and a little less than this could be possible in some cases.

We can go back to Rhea and to Wernbom for validation. All of these works show that muscle groups tend to respond best to two or three workouts per week, with more advanced folks showing a little advantage with two weekly sessions.

This is further backed up by the old-school Golden Age bodybuilders, the guys that got big and strong in the pre-steroid days. These guys were big fans of high frequency workouts, lifting on average 3-5 times per week.

But this doesn't really jive with what contemporary bodybuilders seem to do. The large majority of bodybuilders seem to like muscle group split routines, where you only train a muscle group once a week. I'm sure we all know bodybuilders that swear by this idea.

In fact if you're like me, most of the people you run into will swear by this method regardless of their actual results – most of them won't even realize you can train any differently. It's so ingrained in the culture that most people won't even think to question it. It's just how things are done, and there's obviously people getting results from it. Why do some seem to thrive on lower-frequency workouts?

The first and most obvious response is the big pink elephant in the room: anabolic steroids. These interesting little chemicals can actually turn on the protein synthesis chemistry in muscle with no exercise required. There's been research done showing that guys on a decent dose of testosterone will grow more, by simply sitting on the couch, than a natural guy who works out regularly. That's some powerful chemistry right there.

The average gym-rat just trains too much and too often to begin with, usually without eating properly. Take somebody that's been training with a 'volume' approach, then shift to him something like HIT, which uses low-volume, an emphasis on hard-work type training, and puts a premium on rest. This is where the HIT advocates are made, because inevitably they'll see rapid strength gains. Well, no kidding.

All the volume training has built up their work capacity, improving overall fitness, and generally laying a foundation. Now HIT comes in, takes away all the extra volume, and starts piling the weight on. The muscle, which has never been allowed to rest and actually grow, is finally being given adequate rest time between workouts and being challenged with heavy weights.

This effect, where muscles respond strongly to sharp changes in volume, is pretty interesting. When you train a lot with higher volumes and higher frequency, then reduce both of those and really push the weights up, the body seems to respond favorably. This has been tested time and again in athletes. Actual performance and hormonal indicators back this up.

It happens in bodybuilders, too.

It's possible that some of the regulatory junk in the muscle fibers, like myostatin, gets switched on when you go through a ton of training. Myostatin, as you may or may not know, is a compound in the muscle that works to

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limit muscle growth. We see that myostatin is blocked over the short term in response to a workout, but tends to increase over the long term in response to weight training.

There are also other adaptations that can work to make the muscle less sensitive to training.

When you move to low-frequency and low-volume, HIT-style, you give that stuff time to reset while providing a new stimulus in the form of heavy weights and high fatigue. This effect could also be something to do with the irrational adaptation I talked about back in chapter two, where the muscle gets big too quickly for its own good. If there's not sufficient resources, in the form of energy-producing structures or a satellite cell bottleneck, then growth isn't going to be sustained past a threshold. Putting in some time with high volume work might be laying the groundwork for later progress.

Despite some hints like that, I don't know honestly what's behind it, but that 'rebound' effect is definitely real. HIT tries to use this as justification for full-time low-volume/low-frequency training. I actually think they're just exploiting this rebound effect by shifting guys from high volume to low volume.

Even if I'm wrong about that, the point is simple – HIT is taking people from unproductive training to a more effective mode. Just because that is more effective than pure chaos doesn't mean it can't be improved on, though. Even a broken clock is right twice a day and all.

Anecdotally, bigger and stronger guys with a lot of experience seem to be able to get away with doing more each session and less total sessions. Muscle mass tends to be very inertial – it builds up slowly, but it also takes a long time to atrophy. This is contrasted to rapid gains in strength which are normally attributed to neural factors. In this case the gains come quickly, but can be lost just as fast.

Now this could just be written off as steroids, and in a lot of cases that's probably got a lot to do with it. But play along for a minute, because I think there is some justification here.

An advanced guy will already have a foundation of muscle, and he's going to require more *oomph* in any given workout because his body is extremely adapted to training. It's not a stretch to assume he can get away with less frequent sessions, with the trade-off being that he's doing harder sessions that require longer recovery times.

Training frequently is still a good idea whenever possible, since being big doesn't change protein synthesis, but at least the advanced guy might have an excuse. Along those lines, there may be something going on with the satellite cells and all their freaky voodoo. If it holds up that high stress workouts work to increase satellite cell number and activity, then that could be some rationale for doing somewhat harder and somewhat less-frequent workouts. The advanced guy is having to think over the long-term if he still wants to grow.

I'm saying all of this with the caveat that I could be just plain wrong, too. This explanation works, but it could just as easily be a pile of BS, so take it with a grain of salt.

We have to remember the key rule: What the big guy does now is not necessarily what got him big. Plus he's probably on steroids anyway. For those of us without steroids, genetic advantages, and three decades of experience, it's about moderation. And taking your aspirin.

Different Kinds Of Strength Training

When you talk about 'lifting weights' or 'resistance exercise', what comes to mind? What notions do you associate with strength training? I'd guess there's similarities for everyone. People will think of a gym, dumbbells, barbells, that sort of thing. That's not what I'm talking about, though. What I mean is, what do you actually do when you go to the gym? What exercises? How many reps? Sets?

I don't know how many people really put any thought to it, instead just sticking to the old tried and true of three sets of 10, or whatever the current fad is. Girls tend to go in and do their sets of 20 reps to tone up or whatever they think it's doing. My question is, have you ever stopped to think about why you do things the way you do them? Whether the exercise you do has any bearing on your goals?

There's actually different styles of 'lifting weights' that will have different effects on the body depending on how they affect the nervous system and the muscle tissues. As a general rule, lower rep ranges will equate to heavier weights, and vice versa. The heavier the weight used, the greater the impact on the nervous system. Likewise, the more reps done, the greater the impact on the muscle tissues and the greater the energy expenditure.

When you're deciding on a set/rep scheme to use when you exercise, you have to consider what effect that's going to have on the body. Remember that the body adapts in a specific way - it's going to adapt to handle whatever it was that stressed it. If you want to get better at handling heavier weights, you need to handle heavy weights. If you want to get better at doing a lot of reps, then you need to do a lot of reps.

We also have to consider complementary factors. Even though these different methods might look different, at the end of the day they're all 'strength training'. They might have a greater effect on the muscle, or a greater effect on the nervous system, but by and large it's all just variations on the same idea. Because of that, we can say that these methods are all complementary - they tend to work together, not to cancel each other out.

Training to build muscle mass can improve strength. Training to get stronger in specific exercises can improve muscle mass. It's never going to be an either/or proposition; it's always going to boil down to priorities.

Earlier I said that 'lifting heavy' is what it takes to trigger growth. Now I want to look into what that means exactly. I'm going to loosely group training methods into three main 'styles': heavy lifting, explosive lifting, and classic bodybuilding. There's other ways to do it, but this is the easiest way I can think of that accounts for both weight used, reps done, and the overall focus of training. For those of you *in the know*, this will roughly correspond to maximal-effort, dynamic-effort, and repeated-effort methods of strength training. These three approaches are all different ways to maximize the tension-time overload of a workout.

HEAVY LIFTING - MAXIMAL EFFORT TRAINING

At the top of the list we have very heavy weights. This particular method is most commonly associated with training to get stronger, and it's very effective for that purpose. Heavy training is characterized by brief, difficult sets with weights that are near your maximum. This is sometimes called quasi-isometric training, since heavy weights don't usually move very fast. You'll know this when you do it, because the best description of each rep is 'grinding'. That's exactly what it feels like.

Training with very heavy weights also creates a lot of eccentric overload. It's unavoidable with this method. Recall that this is important due to the strain it places on the muscle; the resultant effects can stimulate both

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strength and muscle-mass gains. You're creating eccentric overload with each rep. However we also have to remember that there can be too much of a good thing - a little is great, but too much is counterproductive for muscle growth.

At the top of this ladder we have so-called max effort training, which is very heavy sets of 1-3 reps. If you're a percentage fan, this will have you up around 85-90% or even higher. The big thing always trotted out about maximal training is that it trains the nervous system. This is true, the dominant effect is neurological. Just keep in mind that *dominant* does not mean *exclusive*. In fact, due to the heavy weights involved, this approach can be very productive for building muscle, and it's often underestimated by many bodybuilders.

That said, you can shift the emphasis slightly towards a 'muscle' effect by just doing slightly higher reps. Working with 5-6 reps per set will create more impact on the muscles than 1-3 reps will. In fact, 5-6 reps per set tends to be just about perfect for building muscle mass. You'll have to come off the percentages a little, but not that much. 80-90% is usually possible here.

This starts to cross into what's called *intensive bodybuilding*. Intensive training is characterized by doing a limited number of sets, but focusing on heavy weights and giving each set your best effort. This is a staple of High Intensity Training (HIT) programs, but the general idea of 'work hard and keep it brief' can be used with a less restrictive program style.

The fact that these two methods are so blurry is why I just lumped them together as 'training heavy'.

The research suggests that the heavy training methods should be limited to no more than about 20-30 total reps for a given movement. This might work out to 3 sets of 8, 4 sets of 6, 5 sets of 5, or what have you; these are set/rep combinations that are fairly common, and this would be why. For really heavy weights, the optimal number might be less than 10 total reps. According to the Wernbom analysis, less than 15 reps per session can be effective for stimulating growth if the weights are very heavy. Note that when I say 10 reps per session, I don't mean one single set of 10 reps. You might break this up to 3 sets of 3, 5 sets of 2, or what have you.

Heavy lifting as I've defined it here is something I consider foundational to any strength training program, regardless of goals. It doesn't have to be the centerpiece of the program, but it needs to be in there somewhere. This even goes for you ladies that just want to tone up. Muscle tone, aka tonus, is the resting tension of a muscle fiber. The stronger a muscle is, the more toned it is. So now you have no more excuses.

That said, as much as I love this kind of lifting, you can't do it all the time. Well, you can I guess, but you're not really going to like the long-term outcome. There's potential issues with burning out and CNS stress and all that as I've mentioned. You can largely get around this by building in phases of lighter, less taxing lifting. You don't have to be like a HITard and try to kill yourself with every workout. If you're one of those that has to go in and slam the weights around each and every workout, more power to you but I don't see that as being terribly productive.

The real concern I have is potential joint and connective tissue problems. Lifting hard and heavy is rough on the body, and no matter how much mobility work and foam rolling you do, you're going to get hurt sooner or later. It won't necessarily be a career-ender or something that'll need surgery like a hamstring tear or busted shoulder, but little things like bicep tendinitis or achy knees or something like that. The harder you push yourself and the longer you go without a break, the greater the odds.

Ironically the same physical stress that causes these injuries will make you more resistant to them. The tendons will adapt to heavy loads given time. It's when you push things past the limit that the nagging pains start to

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come up. Again, this can be easily solved by recognizing that heavy training needs to be offset with lighter training.

Nevertheless, I still feel that training with heavy weights should be the foundation of any bodybuilder's workout routine. You can and should use other methods, but don't forget your foundation.

EXPLOSIVE LIFTING - DYNAMIC EFFORT TRAINING

This particular method is the odd man out. It's dominantly neurological, like the heavy stuff, but it uses relatively modest weights. Instead the emphasis is on moving quickly and explosively.

Explosive lifting is a little different than the standard bodybuilding fare, but it's still got some advantages that need to be discussed.

Most people today would know this as 'dynamic effort' training or 'speed' work. I was first introduced to it as 'compensatory acceleration training' (CAT). As per SOP, the label doesn't matter – only what it does.

There's some nuances I have to bring up, so get ready for a little physics lesson.

When we talk about human movement, we have to remember that we're dealing with both external and internal activities. When the bar moves, we use certain terms to describe it, like force, work, and power. Those same terms can describe the activity inside an active muscle. The external movement and the internal effects in the muscle are not the same thing.

What the hell am I talking about, you ask? Think of it this way. When you contract your muscle, you're generating force. That force transmits through your skeleton and into the barbell. That's what we call 'strength'. Strength just measures force. However we can also measure the time it takes to apply force.

How do we apply force quickly? This is where the nervous system becomes important. Recall that your motor units have to 'switch on' to make the muscle contract. The faster you can voluntarily switch those MUs on, the faster force is generated. This is measured as the *rate of force development*, and is loosely synonymous with *explosive strength*.

Generally speaking, the faster you apply force against a given object, the more powerful that motion will be. In nerd-talk, *power* is the rate of doing work, or force multiplied by velocity. As measured by the barbell's movement, power is highest when you create both high force and high speed. Research tells us that most barbell exercises will hit this point somewhere between 50% and 70% of the 1RM. A powerful movement is both heavy and fast.

I don't want you to get confused here. Power is external, explosiveness is internal. Power is a consequence of explosiveness, but explosive movements aren't always powerful.

There's another quirk too. Research has shown that it's not the speed but the actual intent to move the bar quickly that's important (Behm and Sale 1993), so even a relatively heavy and slow movement can still be explosive. All that matters is that you quickly develop force.

I want to note also that before you can apply force quickly, you have to be able to apply force in the first place. To paraphrase Dr. Zatsiorsky, 'a powerful athlete is always strong, but a strong athlete is not always powerful'. This means that you need to be strong in the first place before you consider 'power training' as an option.

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This is why you'll hear coaches talking about not worrying with speed or power training until an athlete can lift such and such weight – it's not because of injury or anything like that. It's because it simply won't be effective until you've got the strength in place.

As you might imagine, the discussion so far hasn't really been applicable to our strength athletes and bodybuilders.

Where this becomes relevant to you, the reader, is the motor-recruitment with light-ish weights. See, fast bar speeds, even if the set is brief, require high forces within the muscle. Force applied to the bar may not be optimal, because it's moving quickly, but that means exactly nothing when we're talking about tension developed inside your muscles.

High speeds and high power outputs demand high muscular tension. It's as simple as that. Moving fast is a way to ensure maximum recruitment in your muscles even with relatively light weights.

Now I'm sure you've heard some jerk or another tell you that you need to lift with a slow and controlled tempo. Moving fast is bad and will destroy your joints and all that.

It doesn't take much but simple physics to take this argument apart. Force equals mass times acceleration. For any given mass, higher acceleration will require a higher force.

Then they'll trot out momentum. *Momentum is lifting the weight for you!*, they'll shout.

Momentum is a property of mass based on Newton's laws, which can be thought of as 'how much' motion an object has. Momentum is just mass multiplied by velocity – meaning, any moving object has momentum. It's unavoidable.

There's a problem with this reasoning. Moving fast does involve higher momentum, by definition. A fast-moving baseball will have more momentum than a slow-moving baseball. But let's think about what that means. Momentum doesn't just come from nowhere - it requires that something apply a force against the baseball, and that will be your muscles. It can't be anything else.

Now, the HIT and anti-explosive guys do have one point: the tension isn't sustained across the motion, due to mechanics. You create a brief spurt of force, very rapidly, at the beginning of a lift - and because of this, you probably won't sustain that tension throughout the movement. That's what they mean when they say 'momentum is lifting the weight for you'.

What actually happens is that the forces are very high at the start of the lift, then drop off during the movement. Bodybuilders have always been hung up on the idea of constant tension, which tends to exhaust energy supplies and make the muscle feel 'pumped'. If you're used to that, a more explosive style of lifting probably won't give you that same feedback.

This thought process also conflates external and internal processes. Even though the force as measured by the barbell does tend to drop with speed, it doesn't say anything about what's happening inside the muscles.

They've just had to contract very hard and produce a lot of force very quickly. If you're doing multiple reps and multiple sets, that can add up to a lot of stress over a workout.

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The tension-time integral pretty much destroys the notion that you have to keep constant tension on the muscle. All that matters is that the muscles are exposed to sufficiently high tension (check) and that they receive a high enough dose of that tension, which is just a matter of doing enough total reps.

There's no physiological reason why dynamic or compensatory acceleration training wouldn't cause growth. As far as I'm concerned, it's just another method of creating tension-time overload.

Explosive lifting is used in the Westside powerlifting model to develop bar-speed which is thought to contribute to strength levels. The idea is that it will translate to better strength gains, by training the ability to be explosive. I can recall hearing years ago about compensatory acceleration being useful for many of the same reasons.

The interesting thing about dynamic or accelerative training is that it doesn't necessarily have to be fast. Remember, it's not about the actual speed but the intent of speed – if you max at 200 lbs and you've got 100 lbs on the bar, you need to push the bar like it's 200. A big heavy thing is going to be slow, while a lighter thing is going to fly off, but both instances are explosive.

You can still use fairly heavy weights, but the trick is to make each rep 'smooth'. Contrast this to the 'grinding' reps I talked about above and you'll find that there's a big difference. This is somewhat vague language I realize, but when you actually do it, you'll understand what I'm talking about. A smooth rep doesn't necessarily have to be fast, but you won't really have to fight it at any point, either.

WHAT ABOUT PLYOMETRICS?

Somewhat related to explosive lifting is the idea of plyometric or 'shock' training. Plyometrics have been in vogue lately, especially marketed to women as some new fitness fad.

Plyometrics are used for power training, but they're actually doing something completely different from what I just discussed. They actually train an entirely separate ability called *reactive strength*.

Think about what happens when you walk down stairs. Each step is an impact, right? Now what happens when you run down the steps? It jars you. That's what happens when your body has to absorb force quickly. The faster you move, the greater the force.

Plyometrics use this high-impact effect to develop your ability to absorb and rebound force very quickly. The idea is that if you rapidly stretch a muscle and then reverse the movement, you'll be able to make use of that energy from the stretch.

This is called the *stretch-shortening cycle*, and it's not any different in principle from stretching a rubber band and firing it across the room. The more you stretch it, the farther it goes.

So far so good. However there's a problem with generalizing this. Plyometrics are not a 'muscle' effect. Most of their training effect is neurological and on the elastic parts of the muscles. Yes, your muscle has elastic parts, the connective tissues that surround it and connect it to the bones. And they operate just like the rubber band.

When you jump off of something and land, you absorb that impact and then immediately reverse it. The idea is that the force of the impact will be rebounded, letting you jump higher and farther. And yes, plyometric training has been fairly well studied; this does actually work for developing power.

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The problem is, it's going to do jack for bodybuilders. Plyometrics require a baseline of strength to even be effective – otherwise you just won't see benefits. Getting stronger will do more for your power.

There's also the issues of high-impact training. If your joints aren't up to the task, you'll learn soon enough. Even though it's 'just bodyweight', the forces developed on landing are substantial, even though they're brief.

All in all, I'd just assume that bodybuilders avoid this for the most part. Performance athletes, knock yourselves out. Even some high-level strength athletes might see benefits, but if you're not a brutishly strong person with robust joints, I'd skip the plyos.

CLASSIC BODYBUILDING - REPEATED EFFORT TRAINING

When we back off the intensity a bit, we can not only move faster, but we can also do more reps. This is where bodybuilders tend to spend most of their time, with somewhat higher reps and lighter weights. Generally speaking sets are also done to a point of fatigue.

Unlike the other two approaches, classic bodybuilding is designed to create stress on the tissues. This is considered a 'structural' training method, since it impacts the muscle tissues more so than the nervous system or any specific skill.

This method, called repeated effort training, focuses more on the volume of work and fatigue than it does on the weight used. The weight still has to be heavy, but the goal is to do more work with that weight. This emphasizes the work or volume/TUT aspect of the tension-time integral.

Bodybuilding is designed to build mass, plain and simple. This is really a specialized type of strength-endurance training, intended to overload the muscle with a heavy-enough weight. Bodybuilding training can run the gamut from very heavy, low-to-moderate rep lifting all the way to moderately heavy, moderate-to-high rep exercise.

Using heavier weights, this method will overlap with maximal strength training. An intensive setup might have you doing 2-3 sets of 5-6, either coming near or reaching failure on the last rep of each set. Of course, there's plenty of ways to intensify your sets. Favorites include rest-pause work, where you briefly rack the bar and rest, then try to do more reps; and drop sets, where you don't really rest, but drop the weight and shoot for more reps.

Intensive training is basically anything that has you trying to do more reps under conditions of fatigue. Questions of training to failure aside, I think that intensive training tends to be the most productive way to do things for most people.

As weights get lighter and the volume increases, it will start to look more like the pump 'n tone training that so many people are fond of. In fact the average person seems to think of training for the pump, using higher reps, lots of sets, and lots of exercises.

This is *extensive bodybuilding*. With extensive training, quality is sacrificed for quantity. High volumes are used, with high-rep sets, short rest periods, and a high number of total reps, but only moderate weights. Instead of generating fatigue on each set, the effect comes from all the volume. This is sometimes called 'pump training' because it tends to make the muscle swell with blood.

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An extensive setup might be something like 4-5 sets of 10-12 reps. Or even 3-4 sets of 15-20 reps. The emphasis is on doing a lot of reps and a lot of sets.

Bodybuilders and girly-girls seem to like this a lot, probably because it gives a great pump. It's not that great at building muscle because of the lower weights used. There's also a pretty nice growth hormone release from this, which makes a lot of people think it's good for muscle size.

Extensive bodybuilding is more closely related to strength-endurance training than pure strength training. While I'm not willing to write it off, I also think that extensive training should take a back seat to heavier exercise. The weight on the bar has proven time and again to be more important than the volume. However as I explained before, there can be some exceptions.

Still, there are some positive effects worth mentioning. Heavy stuff can play hell on the joints; lighter pump 'n tone training can be easier in that department. This type of training also pumps the muscle up with blood, which can make it a nice light workout to help out recovery. It's also possible that this kind of thing can help to prime the muscles for future gains by working on all the energy-producing stuff.

Whether intensive or extensive, the goal is to overload muscle groups with a combination of high tension and total workload. And I mean workload in the sense of energy expenditure, just so I'm clear on that.

The simple fact that bodybuilding methods allows more volume is one reason why they tend to be good for increasing muscle mass. For any given weight and any given volume, the repeated effort method will tend to have the greatest payoff in terms of muscle gains.

As we know, when your muscles get worn out and start to fatigue, you'll notice that the motion will slow down. You'll have to push harder and harder to complete your reps as you approach the point of muscular failure.

We call this grinding or straining, as that's exactly what it feels like. What's happening is that motor units are tiring out and dropping out of the movement. But you're still holding the weight, so the nervous system tries its best to help out by bringing in some of those higher-threshold motor units, ones that normally wouldn't be needed to lift this weight.

In this way, working with slightly lighter weights and higher reps actually works to *train* different groups of motor units. This is the difference between doing a very heavy set of two reps and a set of 10 reps where you had to really struggle to get the last rep – the set of two started out with all those MUs recruited, while the set of 10 had to wear out another group of MUs beforehand. That wearing out bit is what you're after.

In the case of max effort work, all motor units are *recruited* but not necessarily trained to a point of fatigue; with repeated effort work, you might not recruit all possible MUs, but you're *training* a large number of them to the point of fatigue. This has been verified in research showing that higher rep-maximums will create more total fatigue than heavier sets, as well as the specific adaptations created by different rep ranges (Behm et al. 2002, Campos et al. 2002).

In this case the weight is heavy enough to affect the muscle tissue, but you can also do enough work with it to exhaust the fibers. It's this combination of heavy weight and metabolic demand that ultimately causes growth. Repeated effort training maximizes both factors.

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This kind of training improves maximal strength, too. Heavy, slow training makes you better at slowly lifting heavy things. The principle of specificity applies here, and it seems to be specific to different weights and rep ranges (Behm et al. 2002, Campos et al. 2002, Lawton et al. 2004).

What I really want you to remember here is that the rep range by itself only tells you part of what's going on. The number of sets and total volume matters, too. A true 10RM is a different animal from the weight you'll use for five sets of 10. Just because you're doing 10 reps doesn't mean a whole lot without knowing the rest.

Occlusion/Ischemic Training

I mentioned this before in the bit about the contributions of metabolic activity. I would technically classify this as a style of bodybuilding, on the extreme end of extensive training, but it does bear some discussion on its own. The idea here is to block the flow of blood to a working muscle, thereby creating fatigue effects.

Just as a quick refresher, the Japanese KAATSU research has investigated the effects of vascular occlusion on muscle size and strength. They've had some rather interesting results that have been duplicated by other groups.

This research uses pressure cuffs on the arm or leg to block off blood flow into the muscle. While performing work with very light loads, they've managed to display some occasionally impressive improvements in size and strength.

There's one slight snag, though. KAATSU training relies on a pressure cuff to manually restrict blood flow into a muscle. Although this is possible for your limbs, it's not quite so easy (or possible) to do that for your torso and midsection. That's a neat trick, but it's not practical for most of us.

The reason this is interesting to me is not because of the occlusion work in itself. What this tells me is that the occlusion is creating a short-cut in the process of tension-time overload.

When you contract a muscle, blood is automatically blocked from flowing. When you keep constant tension on a muscle, you're effectively doing the same thing. So what you do is just lift in ways that keep the muscle under a constant contraction, forcing the blood out of it. If you keep a muscle tight and contracted for long enough, you're essentially doing the same thing as the occlusion research.

I want to stress that it's something of a leap on my part, but all things considered it's not too far out there. If there's any truth to this idea, it would mean that extended slow-tempo sets and isometrics would be another contributor to growth. Indeed, there's a paper that supports this idea (Tanimoto and Ishii, 2006).

There's also the unavoidable fact that this is what a lot of bodybuilders tend to do anyway while chasing a pump.

Why does this work? There's a very simple explanation that fits in with what we already know. When you block blood flow, the muscle starts scrambling for energy. Fatigue occurs in a hurry. This is not dissimilar from the conditions that occur during a normal set. You fatigue the muscle fibers, and subsequent work damages/trains them.

Occlusion cuts out the middle man. You create that fatigue or ischemic effect manually, thus short-cutting the process. This is why very light loads can have this effect – they don't have to go through the process of recruiting and fatiguing various pools of motor units. The effect is created artificially.

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In effect, we can say that occlusion lowers the minimum tension threshold, making lighter weights useful for both strength and muscle-mass gains.

If the KAATSU research is reliable, it seems that low-intensity extended sets are a good idea if used along with a more traditional strength-based routine. That's where I think the traditional bodybuilding goes wrong, by not pairing this method with heavier work.

I should add though that this will not be pleasant. Very long sets, even with light weights, are painful. Fortunately you adapt quickly, but this kind of training never stops sucking.

In terms of program design, lighter weights have value for those feeling beat up and sore in the joints. There's also the fact that slower movement speeds seem to focus on the muscle tissue (as opposed to neurological factors) would make it a good idea during periods when you're avoiding high-stress training.

All the pump 'n toners will no doubt be glad to know they were at least partially right.

It's not out of the question to assume higher reps and higher time under tension in general is positive for hypertrophy. That's been one of my premises from the beginning – this kind of training is how you'd develop the energy-producing metabolic stuff. It might just be sarcoplasmic stuff, but size is size.

The occlusion research indicates that metabolic stress plays some role in the signaling of muscle growth (Fujita et al. 2007). Which we kinda already knew, considering the effects that fatigue can cause on all the signaling stuff, but it's nice to have your case reinforced by different avenues.

This just comes back to what I said before – we can train muscle by targeting different combinations of tension-time. Heavy and brief sets will work, as will lighter extended sets.

Now let me take my labcoat off.

High Intensity Training And Muscular Failure

Besides the written-down, on-paper elements, there's an X-factor that I haven't gone over yet – hard work.

Unfortunately, that's yet another vague term that's taken on a lot of different meanings. Ideally, it means just what it says. If you go into the gym and work hard, you'll reap rewards. But there's obviously room for interpretation. The good news is that we've already got most of the caveats covered. You have at least an idea of the weights to use and how much to do.

With that in mind, we can narrow down 'hard work' a bit. The work you're doing needs to be challenging. This gets into a very subjective area though. It's not always easy to measure how difficult the work is.

The concept of 'working hard' originally came to prominence, in a bad way, in the 1970s under Arthur Jones, Ellington Darden, and Mike Mentzer, the core group behind HIT. At the time, in a bodybuilding culture based on high volumes of endless exercise, the ideas behind HIT were somewhat out of place.

One of the core tenets of HIT is training with 'intensity'. Hence the name High Intensity Training. The HIT guys realized that there's a trade-off between quality and quantity in a workout, which is actually not a bad observation. Only, there's a problem. What HIT calls intensity and what the rest of us call intensity aren't the same thing.

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Worse, they've got a rather unorthodox idea of what actually stimulates muscle growth. By unorthodox, I mean completely incorrect and not supported by any real data.

What HIT suggests is very mentally-taxing training. According to them, it's all about the effort and strain you put into your sets. The more you have to fight and push with a lot of exertion, the better your results.

Of course the Bro-crowd has latched on to this too. 'Intensity' to your typical gym bodybuilder means loud music, yelling, and a brow-furrowing scowl. Now, since we have other information to go on, I think this is pretty stupid to do on a regular basis. But as always, there is a point to be taken away.

This idea of 'intensity' - which is really intensive training – focuses on the idea of perceived effort. While I don't see any need to do this every time you set foot in the gym, there is something to be said for workouts where you try to push past your previous limits.

Training with a high exertion is one way to do this. And this isn't complicated – it's exactly what it sounds like. You train to a point where you have to focus and really exert yourself to complete your reps. HIT took things a step further, though. They reached the conclusion that if hard work created results, then hard work must be the goal in itself. If hard work is responsible for muscle size, then the harder you work, the greater your results.

Thus, in their view, intensive training goes hand in hand with the idea of reaching muscular failure.

Muscular failure is defined as the inability to complete a repetition without external assistance (such as having a partner taking the weight from you). This can occur in different stages of the lift.

Concentric failure is inability to complete the lifting phase, while isometric failure is inability to hold the weight. Eccentric failure, on paper at least, is inability to control the weight on the lowering phase, but as a matter of course that doesn't occur. If you can't lower the weight under control, you're either injured or it's just too damn heavy in the first place. The inhibition reflexes mean that you'd just as likely drop anything this heavy in the first place.

So in practice, 'taking sets to failure' in this context means doing reps to the point where you can't complete another rep, or can't hold the bar in place after a missing a rep. HIT calls failure your momentary muscular ability - to them, failure is the limit of your ability to work hard. Therefore, training to failure yields the best possible results.

For some reason the HIT proponents got it in their heads that muscle growth was an on or off thing. You either stimulated the muscle to grow, or you didn't, and that stimulus to grow was the inroad created by working as hard as possible. By training to complete failure, you achieved the hardest work you could achieve. Pushing to the limit would dig in to the muscle's ability, and if you dug in hard enough, growth was triggered. Easy, simple, to the point. Assuming even a shred of it were true.

If you didn't have any research to tell you otherwise, I could understand the reasoning behind this thought process. If you're just going by logical extrapolation, which is what Mentzer prided himself on, it's not an unreasonable conclusion in itself.

However, pretty much all of those assumptions and leaps of logic are questionable, even without more recent research. The knowledge gained in the past few decades has pretty much put the last nails in that coffin.

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First, the assumption that muscle growth either happens or it doesn't. This is directly at odds with the dose-response relationship that has been established between exercise and muscle growth. There's no on/off switch, it's a matter of degrees.

Second, you have to assume that a handful of sets, potentially as few as one, would be enough to sufficiently recruit and train a good portion of the motor units in a muscle. Research supports a dose-response relationship. One set will have an effect, but more sets will create a greater total effect.

Finally, you have to assume that going to failure stresses the muscle in a way that's superior to other approaches. That one hasn't held up, either.

Unfortunately for the simplistic HIT ideas, we've learned a great deal since the 1970s. If you've read anything I've written on the growth process and the nervous system so far, you'll know right off the bat why the basic premises are flawed.

The growth response is not signaled with a simple on/off switch, and muscular failure doesn't have much to do with growth signaling to begin with. Failure has a lot more to do with wearing out certain components of the nervous system than it does with the actual muscle fibers. Further, one set is not likely to bring about the best growth due to the dose-response relationship between exercise and gains.

If anything, it's some blend of weight, volume, and fatigue, to create tension-time overload, that triggers growth. HITs central premise has been proven incorrect.

To look into the topic a little deeper, consider what failure means: you've lost the ability to move the weight. Why does this happen?

It ties back into the motor recruitment stuff. The higher the intensity (as weight on the bar), the shorter the time that intensity can be maintained. The motor units with the highest force potential tend to tire out the quickest.

We're mainly discussing the 'strength zone' here, where failure occurs because of neurological and muscular factors. This is going to vary, of course, but as a rule this will limit you to somewhere around 12-20 reps in a single set. Sets longer than this starts to shift over into strength endurance, where metabolic effects can cause you to fail or stop a set due to pain.

With maximal weights, above 85% of the maximal voluntary contraction give or take, the movement is dominantly neurological. There will have be little relative impact on the actual muscle; it simply isn't active long enough to experience a lot of stress.

Failure at this point results from neurological factors: your ability to recruit motor units and keep them turned on. The high-threshold motor units, the weak links in the chain, will fatigue very quickly under those conditions. Sometimes, you just won't have the ability to keep neural drive turned on. When either of these things happen, you fail.

Once you go a little further down the intensity ladder, this changes a bit. The sets last longer – you might get anywhere from 4-10 reps, and failing will involve more of the muscle tissue.

Actual disruption of the myofibrils and fiber membrane starts to occur at this stage. As the set progresses, more and more motor units start to fatigue. As I've said several times already, fatigue sets in and the set starts to grind.

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Now what happens here is interesting. We've seen that high levels of arousal or psych-up can influence this. The more focused and worked up you are, the more you can grind through the fatigue. This is where the 'intensity' or perceived effort comes into the equation. You're literally pushing yourself through the fatigue. When you work to failure, or even just grind through fatigue during the course of a set, you're tiring out those motor units and then causing disruption of the actual muscle fibers with further reps.

This is probably where the mystical beliefs around 'intensity' and training to failure come into the equation. Training to a rep-maximum with moderate reps (4-10 or so) will do a number on the muscle, and train (not just recruit) both a wider range of motor units and their actual fibers. Research has shown for quite some time that training in this manner is at least efficient for developing strength, given equal amounts of work (Atha 1981, Zatsiorsky 1995, Lawton et al. 2004, Drinkwater et al. 2007).

In fact, the study performed by Lawton et al. (2004) really illustrates this in effect.

The study compared the effects of training with a fixed intensity between two groups over six weeks. One group (CR) used continuous repetitions done for four sets of six reps. The other group (ISR) used intra-set rests, performing 8 sets of 3 reps. Both groups were controlled for intensity, total number of reps, and total time to completion of the exercise. The only difference was that the CR group completed the sets normally, without resting, while the ISR group took a 30 second rest interval in the middle of the set.

In other words, if they were using a 6RM weight, the CR group did six reps. The ISR group did three reps, rested for 30 seconds, then did the remaining three reps. That way, the volume was controlled – the only difference was that short rest within the set.

After six weeks, it was found that the CR group had significantly improved bench press strength, as tested by the 6RM, compared to ISR group. Neither group showed an advantage in tested power output.

It was found that the concentric time under tension (TUT) was significantly higher for the CR group, and this was thought to be due to the fatigue accumulated during their sets. The ISR group didn't develop fatigue since they were given rests, and thus they experienced a shorter TUT since they didn't slow down.

At first glance this might lead you to believe that higher TUT alone yielded the gains, giving support for training to fatigue. But that would be jumping the gun a bit; there's other conclusions we can draw from this.

The advantage in the CR group is obvious. They created more fatigue, and thus for the given volume and intensity, they worked harder.

It's not the higher TUT in itself that *caused* this – the TUT is just describing how the reps slowed down as fatigue set in. The higher TUT is showing that the CR group worked harder given an identical intensity and volume.

There's one obvious conclusion to be drawn: for any given amount of volume, intensive training will get the job done most efficiently. I'm not sure that's ever been in question, at least where pure size or strength is the goal.

But what about the intra-set rest group? For our purposes, this group will be the 'dynamic effort' or speed-training group. They generate less fatigue, with the trade-off being higher-quality reps.

With just a glance it seems inferior, based on the results of this study. The ISR group had no advantage in power output, and it didn't even improve strength as well as the other group.

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However, I'm not so quick to write it off. The main benefit to dynamic-type training is not economy. The advantage is that it lets you either use heavier weights, do more total volume, or both, without fatigue wearing you out.

Intensive training will give you the greatest effect for a small volume of work. The drawback is that the fatigue you create on each set will limit the amount of work you can do.

The take home to me is not that intensive training is better – it's that intensive training is better for small volumes of work. If you choose to use dynamic-type training, the trick is to create stress by either doing more volume (instead of 24 reps like the example, do 36) or using heavier weights (instead of 6RM weights, use 4RM weights).

In my mind, the protocol that has you working the hardest will translate into the greatest effect. With small volumes, work until fatigue sets in and your reps slow down. If you're using non-fatiguing sets, then do more of them and use heavier weights.

What you'll tend to find is that 'working hard' makes you better at RM attempts, since the body adapts specifically to the type of training (big shocker). This is a good thing, obviously. There's drawbacks, too.

The thing is, though, it seems that the grinding is what is important, not the actual act of reaching failure. Those last hard reps are creating the effect, and there's just nothing magical about the point where you lose the ability to move the weight.

Intensive training, which is lifting to failure, forced reps, and any other kinds of high-fatigue lifting, has been shown to require longer recovery times than non-failure training, along with causing significant negative changes in hormonal state (Raastad et al. 2000, Ahtianen et al. 2003, 2004, Izquierdo et al. 2006). There's also some changes in muscle function that are more severe with high-stress training (Raastad and Hallen 2000, Raastad et al. 2001).

There just doesn't seem to be a lot of difference between training to a point near failure and training to a point where you can't move the weight on your own. HIT is convinced that the point of failure is the magic threshold – but there's nothing to support that. Certainly nothing convincing enough to deal with the hit to recovery time.

It doesn't seem to be reaching actual failure that's important, but those slow and grinding reps that lead up to it. If that's the case, then it means anything that has you operating under conditions of fatigue could have similar effects.

This isn't really surprising, either. The harder you work and the more fatigue you create in the body, the greater the shock to the system. The down side is that if intensive or failure-based training is used frequently, you could be impairing your recovery.

The stuff you'll be recovering from is mostly damage to the cell membrane and other connective tissues. There's also some disruption to the structures that conduct nerve impulses, due to high levels of calcium that build up during fatiguing exercise. These issues have little to no impact on protein synthesis rates, although there's reason to believe that some inflammation will do good things for the satellite cells. Remember also that too much damage can also be counterproductive to growth.

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You have to take into account the psychological effects of failure as well. It can be hard to psych up for workout after workout, knowing that you have to go in and effectively try to break yourself. Since arousal, neural drive, and your overall well-being are closely tied together, it wouldn't surprise me a bit to see some very real negative consequences from hammering yourself like this on a consistent basis.

A hard workout will have positive effects, but it's balanced out by some pretty hefty negatives. If you train like that each and every time, you won't be able to train with the frequency you need. HIT says you need to train less often; I think the case is made for harder and lighter workouts.

However, you do have to keep some perspective too. It's easy to get wrapped up in these little details, like they dominate the whole workout, but in practice you can apply things like this in different ways. Taking a set of dumbbell curls or calf raises to failure isn't quite the same thing as a set of squats or bench press, either mentally or physically. Smaller muscle groups and exercises that don't require a lot of focus (meaning, isolation work) aren't going cause the same negative impact.

Failure or not aside, I think the more important point is that you need to have some degree of exertion in your workouts; otherwise you're just going through the motions.

I'd also like to point out the difference in training to a rep-maximum – which is where you complete all your reps, but couldn't do another – and training to failure, which is where you don't complete the rep because you literally can't. These are two different animals.

The studies that have been done comparing training to failure or beyond vs. staying shy of it have shown no real difference in outcome (Izquierdo et al. 2006, Drinkwater et al. 2007). If anything the advantage is given to non-failure training, which seems to create equal (if not better) strength gains while limiting the fatigue in a session and the recovery time between sessions. You're still taxing the muscle, but you're avoiding some of the negative neural stuff.

So there's that to consider also. Of course on the other side of this argument, we get the assertion from some that 'training to failure is training to fail'. I think that's a bit hasty when you don't consider your target audience. Yes, training to failure can impact recovery, and if used carelessly it can impair power output – something critical for many athletes.

That statement has largely been used to discredit the use of bodybuilding, and HIT specifically, in training athletes for sports. From that viewpoint, it's pretty well dead-on. Just remember the context. For bodybuilders and strength-focused athletes, I'm not sure I see the issue.

In as much as this affects recovery, you should certainly be mindful when you have any kind of hard workouts. But there's plenty of evidence showing that intensive training is actually good for maximal strength – the heavy, slow type of lifting that powerlifters and bodybuilders would be concerned with.

I'm really not for or against, as you can see. I think reducing it to a black and white argument is a bit naïve. There's some instances where going to failure and otherwise pushing the limit will be useful; in other situations, it's not a good idea.

A 2007 review paper by Willardson backs up this viewpoint, discussing the idea of training to failure as a means of breaking plateaus in more advanced lifters. Going to failure has advantages due to motor unit voodoo and the higher stress involved, but if you use do it often for long periods of time, you increase the possibility of overreaching yourself.

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The HIT guys and other failure advocates are going to fire back. Usually their argument will be something about how you can't know you're working hard unless you work to the limit. Of course, that's nonsense to anyone that's ever actually lifted a weight. You can tell when a set starts to get hard, when you start to slow down and really have to focus on pushing and grinding. As it turns out, there's a pretty easy and reliable way of recording how difficult your sets are, which I'll touch on later.

To me, the real goal here is to reach a point where you have to strain and grind. As long as you're doing that, it doesn't matter if you actually hit the point failure or not. There's nothing particularly special about it, other than the degree of stress it causes.

Limits Of Muscle Mass

Whether we like it or not, there's a limit to the amount of muscle mass that any given person will be able to add over the course of a lifting career.

As you know, your system is going through a constant process of adaptation. This is good - in the sense that you get bigger and stronger - and bad - in that the more muscle you add, the harder it is to add more. It's a continuing process of diminishing returns. You have to put in more and more work to see less and less gains. The amount of muscle you carry can be thought of as approaching an asymptote. While it's not likely that you'll ever completely stop growing, the rate of gain will slow down so much that it might as well be zero.

This may not seem like an issue: just keep training and adding muscle, no matter how slowly, right? Consider though that a bodybuilder's prime years will tend to be in his/her thirties. That's enough time for several decades of training and 'muscle maturity', but not so long that the body loses its youthful condition. In men, it's known that testosterone and levels of other 'good' hormones start to really drop off around the mid-30s, and this continues on into old age.

Your life span and the aging process will place the ultimate upper limit on how much muscle you can gain in a lifetime, although if you're that serious about it, odds are you'll hit your own limits much sooner than that. Of course, there's always the drug option – and that's the route that many end up taking.

In the most abstract sense, anabolic steroids work by artificially raising the ceiling on the amount of muscle you can hold, as well as how quickly you can add it. They do this by stimulating both protein synthesis and satellite cell activity, and doing so in ways that will never happen naturally. In fact, it's been shown in research that someone using anabolics can literally sit on the couch doing nothing and gain more muscle than a natural person who goes to the gym and trains his ass off. Further, there's evidence that anabolic steroid users can permanently hold on to some of those changes in the muscle.

Your ability to gain muscle is inversely proportional to the amount of muscle you carry, in other words.

Like it or not, muscle gain is a slow process, and it takes patience. It can take 10 years or more of dedicated, proper training in order to really develop a bodybuilder-quality physique. In studies it's been shown that growth occurs at a fraction of a percent from each workout, something like 0.2%, often taking several weeks to notice even small changes in CSA. This means that you are not advanced after three months or a year of training.

There's some implications to all of this that need to be explored.

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As depressing as it might be, everyone is going to have a limit, and it's almost certainly going to be lower than you've probably been lead to believe. The public image of bodybuilders, thanks in no small part to supplement marketing, has led the general public to believe that getting to 300 lbs at 8% body fat on an average-height frame is just a matter of working hard and eating enough food.

If only that were the case. Muscle mass is a self-regulating thing. Not only does your body as a whole regulate how much mass you can carry, muscle itself will tend to limit its own growth after a certain point.

The feedback loops that regulate your total body mass are based on a variety of factors, such as how much food you're eating, how fat you are, and so on. Most people are going to find that their natural hormonal status will only allow so much mass to be added before negative effects start to happen.

When you're relatively small, nutrient partitioning is in your favor. The body will tend to preferentially send excess calories into muscle. As you grow, this partitioning effect stops and will eventually turn negative – meaning, muscle will be less likely to soak up excess calories than fat tissue. When you overeat, you just get fatter. Woops.

Unfortunately most of this regulatory crap is out of our hands. Your body is pre-programmed with these limits and short of drugs there's just not a lot to be done about it.

This is compounded by the fact that the muscle itself has its own growth-regulating signals. You might have heard of the dreaded myostatin, a regulatory compound released in response to activity which negatively influences muscle mass.

When you first start training, the growth signal is strong enough to overcome myostatin. The bigger and more adapted your muscles become, the less responsive your muscles will be to further signaling. Myostatin is probably a safety mechanism to prevent your muscles from growing too large and requiring too many calories; much like some of our body's other survival mechanisms, it's a pain in the ass if you want to be pretty.

In people and animals born without the myostatin gene, we see that they can grow to impressive size with relatively little effort. In fact it's thought that some of the genetically-gifted bodybuilders have the myostatin knock-out mutation, which gives them higher than normal levels of muscle mass.

For awhile there, the supplement industry had a huge buzz about myostatin blockers. As with most of their promises, it fizzled. However research into pharmaceuticals and gene-therapy is still being explored to block myostatin as a treatment for muscle-wasting diseases. Once these treatments are available and spread to the black market, and they will, we may see a whole new crop of impressively-massive bodybuilders.

Basically your body will only allow you to get so big before you just start getting fatter, even though this limit will vary for everyone. Why not get fat and grow as much as you want, then diet down? Because you'll end up turning into a 300 lb tub of lard for a cool 10 lbs of muscle – muscle that you'll lose when you diet all the fat off. The regulation of body mass works both ways, going up and coming down.

When you diet down over the next few years, that muscle's going to go right with it.

What's the solution to this? Steroids. And I say that only half-jokingly.

There's been some attempts to measure just how much muscle a person can add without drugs. One of the most promising studies I've seen examined the ratio of lean body mass to height, a measure called the Fat-Free

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Mass Index (FFMI), to estimate some possible limits. The FFMI is calculated by taking the fat-free body mass (in kilograms) and dividing it by the square of height (in meters).

So the formula is:

$$\text{FFMI} = \text{fat-free mass (kg)} / \text{height (meters)}^2$$

Here's the neat thing about this. The study, by Kouri et al. (1995), looked at the FFMI scores for a rather large sample of guys, some of them on steroids, some of them natural. They examined a total of 157 male athletes, including 83 users of anabolic steroids and 74 non-users. Using some statistical trickery, they normalized the scores to that of a 1.8m (roughly 5'11) man. Once adjusted to the standard height, the normalized FFMI scores for the natural guys all topped out at 'a well-defined limit of 25.0'.

They also ran through a sample of 20 Mr. America winners from the pre-steroid era (1939-1959) and found that their normalized FFMI scores had a mean FFMI of 25.4. Not surprisingly, many of the steroid users 'easily exceeded 25.0', and some even exceeded 30.

So taking a 200 lb, 5'10 man at 10% body fat, we'd come up with the following:

$$\begin{aligned} \text{Weight: } & 90.91 \text{ kg (200 lbs/2.2)} \\ \text{Height: } & 1.78 \text{ meters (5'10 = 70" * 2.54 = 177.8 cm)} \\ \text{Fat Mass: } & 9.09 \text{ kg (10\% body fat)} \\ \text{LBM: } & 81.82 \text{ kg (90.91 - 9.09)} \end{aligned}$$

$$\text{FFMI} = 81.82 \text{ kg} / (1.78\text{m})^2 = 25.82$$

$$\text{Normalized FFMI} = 25.82 + (6.3 * (1.80 - 1.78)) = 25.95$$

Going by the research so far, this guy's probably using chemical assistance. Of course, so close to the mark he could just as easily be a genetic freak. Bodybuilding and strength sports in general have always been in the land of *wink wink, nudge nudge* when it comes to drug use. Natural often means 'natural', and it's just accepted as the rule if you're playing the game.

The point isn't to start throwing out accusations of drug use; that's an ethical matter beyond the scope of this book. The goal is to figure out where you might realistically end up at a given body fat level.

You can use this formula in reverse as well by solving for LBM. You know how tall you are, and 25.0 is going to be your limit for the normalized FFMI score, so we just solve the equation for that.

$$\text{Regular FFMI score} = 25.0 - \text{normalizing factor}$$

$$\text{LBMmax} = \text{Regular FFMI score} * (\text{height in meters})^2$$

If you're 6'2 (1.88m), then your regular FFMI score would be $25.0 - (6.3 * (1.80 - 1.88)) = 25.5$

$$\text{LBMmax} = 25.5 * (1.88)^2 = 90.13 \text{ kg or } \sim 198 \text{ lbs}$$

At 10% body fat, this would yield a maximum body weight of around 100 kg or 220 lbs.

The authors of this study caution that these were preliminary results, but if this holds up to scrutiny, it could be as easy as plugging your height and lean body mass into the formula and seeing where you end up. Sadly, I couldn't find anything more recent along these lines in the journals so it appears we're stuck with this one example for the time being.

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At the same time it's hard to point out any flaws in this. A sample size of 157 is pretty substantial, and further, the measurements and calculations involved are all very straightforward. There's no statistical voodoo or measurement error to potentially confound the results. It's very reasonable to assume that a normalized FFMI score of roughly 25 will roughly correspond to a rough genetic limit for the vast majority of natural bodybuilders. If that's the case, then you can figure out your own limits very easily but starting with your own height and working the formula in reverse.

One obvious implication of this is that it's very easy to figure out who's using drugs just by calculating the FFMI score. Somebody at 26 or so might just be an exception; somebody pushing 30 or more is probably a dead giveaway. I'm not going to suggest that everyone with a score over 25 is a drug user, but when you consider the data sources, it would be extremely likely.

The champion bodybuilders used in the research can be considered the best of the best, those with the genetic talent to excel. If they weren't beating the limit, then it's just a matter of statistics. Some people doubtless can, but they'll be very rare.

If we used that metric in today's terms, it's possible that there would be a strong selection bias. Anybody good enough to be a spectacular bodybuilder would go on drugs to maximize his chances of success. Therefore the naturals that are left over aren't actually representative of the best, because all the real talent is on drugs. That's a legitimate point, perhaps. However the study in question examined bodybuilders that lived before the era of steroids; with that in mind, it's reasonable to assume that any selection bias of that sort is minimal.

In other words, the best bodybuilders in the world at the time, people that we know were drug free, couldn't beat the FFMI cap of 25 by any significant degree. What are the odds that there's been a sudden explosion of genetic talent since the 1960s? What are the odds of this explosion exactly coinciding with the spread of Dianabol use in bodybuilding culture? If you haven't followed along, the answer is 'not very high'.

You could make the argument that the popularity of bodybuilding is at all-time highs, but that still takes a stretch of logic considering the results of the FFMI study directly examined naturals and drug users. While you can't rule out the occasional genetic freak, by and large Occam's razor means that these guys are either mistaken about their measurements, or lying about being on drugs.

Along those lines, Dr. Casey Butt has created his own set of equations which he's published on his website the WeighTrainer (www.weightrainer.net). Dr. Butt used a more complex analysis involving the measurement of wrist and ankle diameter along with height, and his model will also generate expected values for the maximum size of specific body parts at a reasonably low body fat. Interestingly, his results line up almost exactly with the predicted FFMI measurements, which gives them further credence.

Although this isn't published research, his methodology is still sound and thus I consider it to be a valid source. Much like the FFMI research, this suggests that there's a strong correlation between initial body size and the limits of muscle mass.

On the average, people just aren't going to grow all that large without chemical assistance.

Of course, some of these numbers might seem depressingly low, but only because we've been bombarded with the physiques and measurements of drug-using bodybuilders for decades now. If you look back to pre-drug guys, names like Steve Reeves, John Grimek, Reg Park, Tommy Kono, and so on, you'll find bodies that weren't exactly weak and squishy.

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No, they weren't the mass-monsters of today, but if you wanted that look you'd already be on the juice. The point to remember is that you can achieve quite a bit naturally and be quite pleased with it. You just have to shift your point of view. A guy that's 5'7 to 5'10, holding somewhere around 160 and 180 lbs of LBM with a low body fat percentage, is not going to be anything to sneeze at. He won't be winning any IFBB bodybuilding contests, but he's gonna be a jacked dude by any average standard.

Also I'd put it out there that most people just have unreasonable estimations of their own body fat levels. If you think you're 12% and you're really 25%, then your estimate of your muscle mass is going to be off. Most methods of measuring body fat are inherently inaccurate and imprecise. Even the gold-standards such as DEXA scans and the dunk tank are still subject to relatively significant error, to say nothing of calipers or the old mirror. If you think you're holding 200lbs of muscle and you're less than 5'10, you might want to re-evaluate how you're measuring your body fat.

The truth of the matter is that you're not going to know how you respond until you get out there and do it. Use the tools as a guideline, something to keep you grounded in reality when the body-image issues come calling.

Size And Strength Are Complementary

Now that we've gone through all that information, I want to bring the chapter full circle.

Back at the beginning, I talked about how bodybuilders have always felt the need to train differently from those with pure strength goals. Hopefully you can now see why this is, at best, a half-truth.

Bodybuilders do need to train specifically for bodybuilding. At the same time, they aren't exempt from the rules of general preparation that every athlete must follow.

You can think of this as building a house. You wouldn't start building a house from the roof down. If you would, you've got bigger problems than I can fix. No, you start by pouring the foundation. In athletic terms, this is basic strength training – working the big lifts with a focus on getting stronger. This builds up both muscle mass and strength at the same time.

That's the real reason that powerlifting is so useful for bodybuilders. It won't make you a bodybuilder by itself, but it lays an excellent foundation for you to build on. Trying to separate bodybuilding from strength is a pointless exercise. Bodybuilding will always boil down to having improved strength in any particular muscle group.

The real difference between a 'strength' routine and a 'bodybuilding' routine is just the focus of specialization.

A strength routine is specialized to develop strength in specific exercises, where a bodybuilding routine is specialized to develop strength in muscle groups.

There's no reason that a 'strength' routine that fits the requirements for growth can't or won't create hypertrophy. Similarly, a 'bodybuilding' routine can indirectly improve your strength potential in the big exercises.

I mean, ask yourself – do you really think that pro bodybuilders are weak? They may not have the pure 1RM strength of a powerlifter, but they're certainly not *weak*. That's an old myth that needs to die.

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A pro bodybuilder is going to be strong – just that his strength will be measured by different standards. A bodybuilder might find that his 5RM or 10RM is a better gauge than his 1RM. Anecdotally, the best bodybuilders, especially in the natural crowd, also tend to be the strongest bodybuilders.

That's the trick here – while strength in big exercises is a foundation, but it's not the whole picture. After you've got the foundation poured, you can start to diversify a little and use different yardsticks to measure 'strength' progress. That's when the different bodybuilding methods and such will start to become useful.

No matter what you actually do in a workout, it will always come down to increasing tension and playing around with the tension-time integral. Improving tension by piling on weight is the shortest path to that goal, but that won't always be possible. Sometimes you'll have to create overload with different methods.

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KEEP IT SIMPLE, STUPID.

What this all boils down to is translating the theory into practice. We have to take the science and create something useful from it. A novel concept, I realize, but that's the goal here.

I'll tell you up front that nothing here is going to be revolutionary, or even exceptionally different from a lot of the programs you've probably seen or tried before. The difference is that now we have guidelines to go by - there's some established rules that we can use to not only create workouts, but to evaluate the programs created by others. We know *What Works*.

That's the approach I prefer. At the end of the day program design is as much personal preference as it is hard science. Instead of getting hung up on the dogma of One Best Program or some gimmicky method, we can be much more dynamic.

As long as we're working inside the rules, we're OK.

The Program Isn't Fundamental

Ultimately that's why there is no magical program. At the end of the day, it's going to come down to application of these rules, which are derived directly from research into physiology.

Just because someone takes those rules, packages them up in a new and 'revolutionary' way, then slaps a clever name on it doesn't mean it's actually a new program or measurably better than anything else out there using the same rules.

It's not right to say that such a program won't 'work'. If it's designed properly, with the rules in mind, of course it'll 'work'. My beef isn't with that. My problem is when Gurus complain that their approach is better than any other.

Newsflash: everybody thinks his or her way is the best thing since the wheel. That doesn't mean it's true. Unless you present controlled, peer-reviewed evidence, then no one can claim that his/her program is superior to any other. That's not a matter for debate.

Just because I package up a routine, give it a clever name, and then use it to get awesome results with clients does not mean that the program was superior to any other approach.

That's the takeaway here. It's not the program. It's the principles that you follow in the gym. The program is just a means to that end. It's not a discrete 'thing' that is drastically different from every other 'thing' out there. People consider programs like going on a vacation around the world: you could go to Europe, go to Asia, go to Africa, or wherever else, and you could have entirely different experiences on any given trip.

The reality is more like different flavors of Kool-Aid: at the end of the day, you're just drinking sugar water. There's nothing inherently special about any program.

Problem is, a lot of people don't seem to realize this - or they do understand it superficially, but don't realize some of the deeper implications. When you consider the program as being important, you lose some of the really important factors.

You can see all over the place where people get it in their heads that a program will somehow 'stop working' after a month or six weeks or whatever - and when this happens, they somehow need a new program to fill that gap.

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And without that, your ability to actually make improvements goes right out the window.

WORKOUT HOPPING

It's that time again. Your favorite author has just released a new workout routine on your favorite site. There's a new program making waves in the fitness community. For only \$70, you too can purchase this 30-page booklet that will give you the new secrets that everyone needs.

Have you ever noticed that all these workouts look the same? They all follow the same basic themes, just organized in different ways?

No, you haven't? Take a closer look, especially now that you've got a handle on the physiology. The details and the trivia aren't important if you look to the basics.

The fitness industry relies on you not seeing these commonalities. Once you understand that there's only so many ways to go about things, you stop giving them money.

This is a phenomenon I call workout hopping. This is where you stick to a program for maybe a month or two, then consider you 'finished' it and you need something new to keep going. Far too many people operate this way, convinced that they just must have a new routine to do. Sometimes it's marketing hype, sometimes people just get bored and want something different, but it happens. It happens a lot.

What did I tell you earlier? The fundamental element of any strength training program is progressive overload: over time, you need to be adding weight to your working sets. If you're working out with 20 lbs now, and still doing the same thing with 20 lbs in a year, then you haven't gotten stronger, and I can pretty much guarantee that you're no bigger.

It's tempting to go after all these new programs that come out every month. Magazines have been guilty of this for decades, but the recent trend in Internet marketing is jumping on the bandwagon. At any given time, you can see all kinds of programs in vogue, with all kinds of people jumping on the bandwagon.

While it's good to see people motivated, and doing programs that aren't totally stupid, it's my belief that workout hopping is a big disservice in the long term. This is the fitness industry's equivalent of planned obsolescence. When cars last 50 years, people don't buy as many cars. If you've got a productive workout methodology, you don't buy as many products on exercise.

It's well and good to jump between programs every few months, I guess, but hell you'll see guys actually stop an otherwise productive setup and jump ship for something else.

What do you think people gain from that?

What worries me even more than that is how people don't have any concern for continuity.

'Hey, I just finished up MAGIC MASS, I need a new routine now.'

Do you? Why? Did MAGIC MASS stop working?

When you jump from program to program, how are you ensuring progressive overload? Are you writing down goals and making sure to keep consistent over time?

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No? You didn't even think of that? You just do what the program says?

'Just doing what the program says' is why something like 99% of people that start exercising will never see results.

Think about this before you 'finish up' that new program and start searching for the latest thing.

Workout hopping doesn't control for consistency or logical variation in your program. See, people get it in their heads that they need to 'change it up' to 'shock the body'. This old quasi-myth is justification for workout hopping, and in some circles it's used to support completely stupid or dangerous training methods. The need for variety is not carte blanche to do any or every stupid fad you read about. The need for a degree of variety is not justification for constant workout hopping.

Read that again if you need to.

People focus on variety but forget about is the need for consistency. If you're not staying at least a little consistent, how do you know that you're improving? What's your benchmark for improvement? If you're constantly shifting exercises and program ideologies, or buying every new guru's book to jump on the bandwagon, I'll bet my ass that you don't have one.

Look - the program comes out of the basic guidelines. It's about progressive overload and avoiding plateaus. Odds are MAGIC MASS didn't actually stop working. You either hit a peak, or you got bored. There's really no reason that a casual lifter couldn't back off the weights, re-start the training cycle, and make gains all over again.

Now, there is something to be said for the 'avoiding plateaus' part of that, too. Some variety in exercises and rep ranges and whatnot can do you good. I'm not trying to downplay the importance of liking your workout, either – when you like what you're doing, you're more likely to stick to it and put in the required work. What I'm telling you is to keep some sense of continuity when you change your workouts, and that you don't need to change your workouts every 4-6 weeks.

One of two things will come out of this scenario: This guy will switch to something that is at best a re-imagined copy of MAGIC MASS (without realizing it) and maybe keep some progress; or he'll jump ship entirely to something totally different, and basically start himself over. If he's lucky, he'll be the former. When this guy starts program hopping, there's no continuity. There's no thought being put into long-term progress, or any kind of goal-making beyond the scope of what program is being done.

Compare that to the longer-term plans that smart coaches put into place. There's benchmarks set, testing done, and changes made over time with that on-going improvement in mind. The actual content of the program doesn't matter, per se, as long as there's some kind of plan for progression. That's where workout hopping takes you off-course. It distracts you by luring you to one gimmick after another. There comes a point where you have to narrow down what works for your goals and learn how to adjust accordingly.

Again, hey, if you're just after some basic fitness, knock yourself out. But I do find it funny how the guys and girls that do this and claim they just 'want to have fun' by doing different workouts are inevitably the same ones wondering why they're not getting any major results, either.

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There's a line that sums this up nicely: going to the gym and doing a bad program will always give you better results than constantly searching for the perfect program. It's not just good advice. A fancy program isn't a substitute for hard work and consistency.

What Are The Key Guidelines, Anyway?

It'd help if I actually told you what is important, wouldn't it? I can't just be one of those fellas going around making promises and not following through.

I've been making an attempt to bridge the gap between the labcoat science crap and what we actually do in the gym. The physiology, complex as it may be, is easy by comparison. It's just a matter of looking at facts and figuring out patterns.

The strength training, that's trickier part. Research only tells us so much; it's up to us as trainers, coaches, and self-experimenting weirdos to figure out *What Works* within those boundaries. It gets even fuzzier because the guidelines are so damn broad. After all that information I gave you, we still can't say with certainty much besides 'use heavy weights and try to get stronger'.

There's a lot of good bodybuilding programs out there. There's also a lot of bad ones. Whole lot of bad ones. While it's easy to point at something and call it 'bad' or 'good', it's all but impossible to say that protocol A will be more effective than protocol B, assuming A and B both fit under the umbrella. Compounding matters, even the people on the bad ones will be convinced that their pet program is the bomb-ass shizzle.

So what's the litmus test? I mean, it's hard to look at some jacked, shredded dude and tell yourself his program sucks, right? If you are the big, jacked dude, you either think I'm full of it, or just don't care because you're big and jacked. Either way, I'm not really talking to you at this point – I'm talking to Joe and Jane Average, the folks that need to do more than look at weights to see improvements. Where do we start drawing the line between something that gets obvious results, and what will be the best bet for you?

We've looked at the insides, the stuff under the microscope that results in a bigger muscle. We've looked at the research into strength training. From both of these, we drew some conclusions. Having done that, we can lay out some specific guidelines. A good bodybuilding program for gaining muscle mass would have a handful of features:

1) Get Stronger. Put emphasis on building strength and otherwise increasing poundages. This is the core of a bodybuilding routine, point blank. If you're not getting stronger over time, then you're not growing past a certain point.

Note that this does not mean you have to train exactly like a powerlifter. You can borrow from powerlifting, though. It also doesn't mean that you have to blindly add weight to your lifts every time you step in the gym. What it means is that you need to have some kind of plan in mind for progression. If you're still lifting the same thing in a year, I'll give you odds that you're not any bigger, either. Unless you went on the juice.

2) Do Enough Work. Get an adequate total dose of exercise. If you're not getting a proper dose of anything, you can't expect to see the results you want.

The weight is important, and so is getting stronger. But you've got to have enough exposure to that weight for it to matter. This means that both in each workout, and between workouts, you need to be racking up enough

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of a stress to create overload and trigger gains. Whether this means doing a lot in each session and doing fewer sessions, or doing less in each session but more sessions, well, much like everything else, that's something for you to play with.

3) Train for Specific Goals. Use of muscle-specific training methods along with your heavier training. It's well and good to get stronger, but at the same time that strength has to be developed and applied in specific ways.

This is where the old-school bodybuilding stuff can come into play. Once you've got your foundation routine in place and have a plan for getting stronger, then you add in your “high-intensity” techniques and your pump 'n tone fluff. This covers everything from isolation exercises, so you can get your curls and other vanity exercises in there, to, well, pretty much everything bodybuilders have ever done with the goal of fatiguing, pumping, or otherwise working the hell out of a muscle.

Note that this stuff is only conditionally important – if you're not taking care of points one and two, then this stuff is worthless.

4) Control Stress and Recover Properly. Over the long-term you need to have some way of alternating between high and low stress training. Recovery is the number one issue you will face when you start to train for any kind of activity. In fact, recovery is the key determinant of everything we do – if it weren't important, you could just chain yourself to the gym and get as big and strong as you wanted.

Variation becomes more important as you become more advanced, in order to avoid staleness. It's easy for the nervous system to adapt and thus slow down your progress. Adaptation actually decreases the amount of motor units that are recruited when you do an exercise – paradoxically, you actually stimulate less muscle the better you get at any movement. Further, it's easy to literally burn yourself out from trying to get stronger, requiring you to take some sort of a break.

This also encompasses any general or corrective work – joint mobility, flexibility, and conditioning – that's required to keep you healthy and fit.

Possibly even more important is the need to keep fresh mentally, and somewhat regular changes to the routine can help with this too. So we have to vary our stress and our overall stimulus from time to time, in order to avoid burn out and staleness.

...and that's it. Any routine that fits these conditions will be effective as a bodybuilding routine as far as I'm concerned.

Notice there's no harping on exercises, rep ranges, tempo, time under tension, none of that. There's no worry about going to failure or not. Nothing about getting a pump. Nothing about whether you should use high volume or low volume. No magic exercises. No gimmicks, and no hair-splitting.

And that's the entire point.

This is not to say that these micro-level things aren't important. They are, in a way. Just that they aren't fundamentals, and if you don't have them in place, the detail work doesn't really matter. Even then, the detail work will boil down more to individual preference and keeping out of a rut. If you try to put the windows on a house before you've even poured the foundation, you just end up with a pile of crap on the ground.

We've gone over several ways of creating overload in a given workout. You'll be focusing on creating more tension, which means progressively heavier weights, or somewhat lighter weights moved with *oomph*. Or you'll

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be focusing on doing more muscular work with a heavy-enough weight, which we know is a combination of volume and TUT. This may seem simple, but it covers a large amount of training methods – in fact, just about everything ever done by a bodybuilder or strength enthusiast can be classified this way.

Which is what I'm after. I told you way back in the introduction that I'm after a general model, not a specific program. This is our model.

We can nitpick over specific iterations all day long, but once you've whittled it down to the core principles, it all blends together. If you want to show me peer-reviewed evidence that your pet method is superior to anything else, I'll be happy to revise this section. Until then, this is the best we can do and it's not likely to get any better any time soon.

If you sit down and think about it, all successful bodybuilding programs will fit these sets of conditions. They may differ in the weekly split, the rep ranges, or the choice of exercises. They may have some gimmicky method or whatever that's used to set them apart in their own gimmicky way. They may have some egotistical creator that thinks his pet program is the best thing ever, and you can't possibly succeed on any other method. But not even the biggest of Bros can take the complete body of evidence and really challenge those conclusions, no matter how much he flexes.

My entire goal is to distill the process into a handful of key axioms. People get too hung up on crap that just isn't important. I'm sure we can all think of various experts and gym-rats that are just convinced they have 'the secret'. Do they really? It doesn't seem like it. This isn't about secrets, anyway. It's about coming up with the most basic rules we can come up with, then being consistent and busting your ass.

Any type of training you do that follows those basic rules will be effective.

Even though I'm not completely relying on research, the scientific method is still in play. Thanks to Occam's razor, if an idea isn't important, we can safely remove it from the equation. Based on all the data, 99% of crap that people think is important just...isn't.

The final verdict is that lots of things work, and there's plenty of ways to put our basic guidelines into practice. Having narrowed down a general model, we can put together an ungodly number of workout routines, more than you could ever want.

Train to get stronger, and have a method in place for progress. Make sure the muscles are getting some work, one way or another. Try to keep frequency up, and don't go heavy as hell every session; sometimes light sessions and even breaks are good things.

That's it. If you're doing that, the details don't matter. Hell, even so-called 'strength' focused programs can do this. Muscle growth can be a direct goal of training, but it also emerges as a side-effect of any form of resistance work. It's not such a simple thing to pigeonhole.

This is good, because it gives us a lot of flexibility and a lot of options to draw from. When you lay out the different training methods, the idea isn't to fixate on one just because it provides you with results. The different methods are nothing but different ways to put stress on the muscle tissue and the neuromuscular system in general. They'll all give you results. The key is to see them as tools to be used when you need them.

Finally, the most important wisdom: Everything works, but nothing works forever.

Are You A Bodybuilder Or A Powerlifter?

There's an old axiom that says 'a bigger muscle is a stronger muscle'. For reasons I've explained, this is more or less correct. But you might be surprised at how many people get this simple fact confused, or will outright deny it. If you've hung around the Internet, you've certainly heard the old bodybuilders versus powerlifters argument.

The muscles of powerlifters, so they say, aren't nearly as big or developed as bodybuilders, but they can lift more weight. Bodybuilders aren't as strong as powerlifters, but they have bigger and better-developed muscles. Allegedly.

Where to start.

First of all, I didn't know that powerlifters were all one big group that all trained the same way. There's a pretty wide range of guys (and girls) that are competing as powerlifters, and there are as many ways for a them to train as you care to think of. Same goes for bodybuilders. These are different sports with different kinds of training, not Crips and Bloods.

Then there's the matter of specialization for a sport. Powerlifters specialize in three lifts, the squat, bench press, and deadlift, which are tested in competition. Bodybuilders have no contested lifts. Instead, they train specifically for bigger muscles.

The only thing common to all powerlifting training is that they use some combination of really heavy work with the competition lifts and lighter (but still pretty heavy) assistance work with other exercises. Beyond that, it's hard to nail down any universal details.

A powerlifter may or may not give attention to all his muscle groups the way a bodybuilder would. Here's a big clue, though: the ones that do, they tend to look more like bodybuilders. There has been more than one powerlifter that trained with bodybuilding goals in mind, and had the results to show for it. Obviously, there's some overlap in the training methods.

A smart person might come to the conclusion that a powerlifting routine could be adjusted pretty easily for bodybuilding purposes.

We can talk about dietary habits too. The standard argument, which says that powerlifters are fat, always points to the super-heavyweights, who have no restrictions on their weight. Since fat is strong, it makes sense to just get as big as possible in order to lift more. If you check out the top guys in the lighter weight classes, you don't notice this; they have to make weight, and the best way to do this without compromising on strength is to have less fat.

Most bodybuilders will at least attempt to keep lower body fat levels. The good ones will anyway. Body fat levels will impact appearance more than just about anything else. A guy holding 10% body fat is going to look way better than the guy holding 20%, all other factors being equal. This alone could explain the differences between the two groups.

While you can come up with all sorts of hand-waving to make it go away, and believe me they will, the research and the anecdote both line up here: Guys that lift heavy and eat enough will get big. Guys that do this along with work for their individual muscles and some attention to diet will start to look more like bodybuilders. You don't have to be a genius to see that two plus two equals four.

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For all the guys involved in the bodybuilding versus powerlifting argument, you're both right, but you're also both wrong.

Training for best performance in the big three, without any consideration for aesthetics, probably won't make you look like a bodybuilder. But given that powerlifters can end up looking as good or better than a dedicated bodybuilder when they do pay attention to muscle mass and development, it would be pretty stupid to ignore this obvious lesson, too.

A powerlifter is training specifically to get stronger in a few exercises, whereas a bodybuilder needs to get stronger all over in order to get bigger. It's a subtle difference in wording, but it sums things up neatly. A bodybuilder may not absolutely need to improve his bench press or squat, but it would be a good idea. He does need to get stronger on the exercises he does decide to use, in any event.

Note that get stronger does not necessarily imply that you must add weight to your exercises at every single session. Getting stronger means that in a year, you're using weights that are heavier than you use now. How you get there isn't terribly important.

Now, you most certainly can get stronger without getting bigger. Muscle mass is only one piece of the puzzle when talking about getting stronger in specific exercises, and the nervous system plays a large role. This has a lot to do with why the argument exists in the first place. You can see these tiny guys heaving around huge weights; if these guys are so small, then obviously lifting weights doesn't make you bigger, right? If they aren't eating for it and aren't using enough volume to grow, then no, it won't.

Getting stronger in the basic lifts is not sufficient to become a bodybuilder, for most people anyway, but it sure won't hurt the process. The point here is to separate getting stronger in an exercise from making an individual muscle stronger. The powerlifters are getting stronger in an exercise. The bodybuilders need to make the individual muscles stronger. Those two processes overlap a great deal, and even though they aren't the same thing, they're very complementary goals.

The argument would be better phrased as 'getting your muscles stronger is necessary to get bigger', instead of just saying 'you have to get stronger to get bigger'. The latter leaves a lot of room for interpretation, and it's only a matter of time before some good Bro will misinterpret it. This debate is really more an argument of semantics, meaning that the 150 lb kids want to be right and explain why all their cool bodybuilding training hasn't made them into mass monsters.

The answer is simple: if you only pump and tone all day long with no focus on getting stronger, you don't grow. Using heavy weights and making some attempt to use progressively heavier weights is mandatory if you want to get larger.

Is Bodybuilding Useless?

As a strength-type guy, I'm sorely tempted to say that yes, it is. But as much as I hate to admit it, I know better. Useless is a relative term. Before I can give any answer, we really need to define what 'bodybuilding' means.

Bodybuilding, as most see it, is useless for most purposes of power and athletic development. In that sense muscle mass is 'non-functional', being that it doesn't really help athletic qualities in more than the most general manner – meaning, it gets you bigger but it doesn't really help speed, power, flexibility, and that sort of

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thing. In reasonably advanced athletes, adding muscle can actually be counter-productive because it negatively impacts those qualities.

'Bodybuilding' as a way of training is a waste of time for those that think they have to do 100 sets per part, and those that need to justify how bodybuilding is magically different from other forms of strength training. These are the same guys that think powerlifting is totally and absolutely different from bodybuilding without bothering to look past the labels.

Fundamentally there's very little difference, and I've already discussed why. False premises lead to false conclusions. If you're working with the wrong set of assumptions, you're going to do the wrong thing barring that rare occasion when the broken clock is right.

I'd rather talk about bodybuilding in the sense of training specifically for muscle mass and physique development. If we're discussing bodybuilding in terms of a goal to achieve, that I can agree with. I just don't agree that the traditional methods put out there as 'bodybuilding' are always the best way to do that.

I don't care how well you think you know your body, unless you've gone through a controlled, well-designed research study you really can't say what is or isn't effective for people at large. What I like most of all are the people that claim body part splits work best for them when they've never tried an alternative – or at least not tried it in a reasonable way for any length of time. Same goes for pump 'n tone training, high-intensity training, or any other dogmatic belief you care to name.

When the body of knowledge, including science and anecdote, disagrees with you, it's not very likely that you are the sole exemption just because of what you feel is going on. Plenty of you will disagree with this, you unique snowflakes you, and you're free to do so.

To be fair, there are situations when 'classic bodybuilding' can be justified. There are just as many situations when it's inappropriate or even counterproductive. To truly make bodybuilding useful, it has to be updated and has to work within a more solid framework.

We have to be more critical and scientific. Fundamentally, bodybuilding exists as it does because people misunderstand the processes that underly muscle growth.

'You gotta break down the muscle. When you lift weights, you cause a bunch of tiny tears in your muscle fibers, and those have to heal. After you train with weights, you've got to rest so that the muscles heal up and get bigger.'

That's the approximate summary. Unfortunately, while this is close, it's missing the nuances that make all the difference.

First, it's based on the idea that muscle damage equals growth stimulus. That's only partly true. Second, it's assuming that soreness equals muscle damage. You work the muscle hard, it gets damaged, and it has to heal. We base this on how sore the muscle gets. Obviously if it's still sore, it hasn't healed.

We know that it's not damage that's providing stimulus. Any damage occurs as a secondary consideration – it's not the actual cause of growth. We know that soreness is a function of tissue damage, but not in the muscle fibers, and this isn't affecting the growth processes. Muscle hypertrophy isn't affected by these factors.

From here, two things happen. People start to assume that working the muscle into ground beef is what stimulates growth. Training with excessive volumes, and only once a week, is a sure-fire way to get the muscle

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sore, that's for sure. Soreness is feedback that reinforces the idea that you're working effectively; if you don't know any different (and sometimes, even if you do), it's not an unreasonable assumption. From there people carry the train of thought to its logical conclusion: if the soreness is an indicator of growth and the muscle is healing up, then they have to wait until the soreness is gone before they can train the muscle again.

And thus traditional bodybuilding was born. It's perfectly logical, considering the initial premises. But it's still wrong. Rather, it's not right.

That model is too simple. It leaves out important information, and the resulting training program suffers for it. What about the time course of protein synthesis? MPS rates are back to normal three days post-workout, whether you're healed up or not. What about neuromuscular fatigue effects? High-stress workouts put a hell of a beating on all the neuroendocrine and neuromuscular systems that keep your body working properly, and that beating doesn't always help you along in your goals.

Here's the thing, the most important thing to realize regardless of your goal. This isn't a true or false quiz. You don't have to choose between only two options. *You can incorporate multiple strategies.* Athletes do it all the time; bodybuilders would be advised to keep up.

The Numbers

When talking about a program, the first thing that usually comes to mind is the written-down aspects. This will mainly just boil down to quantitative variables, or simply, 'the numbers'.

These are going to be your volume, intensity, and that sort of thing.

Most of the numbers in exercise are going to be dose-dependent. To bring back my bad analogy, this isn't very different from taking a dose of aspirin. The dose-response relationship can be shown by the inverted-U graph. We can define amounts that are too weak to have an effect, amounts that are harmful, and amounts that tend to be just about right. In the middle, where the graph bulges, the dose is optimal. This is where you'll see the best possible effects.

When it comes to intensity, volume, and frequency, we have dose-response relationships that are surprisingly well-defined. The interesting thing is that they're all conditionally important: the more of one you do, the less of the others you need. Some of this is review, but it won't hurt to look at the information in the context of program design.

INTENSITY

Intensity will determine everything: the rep range, the total volume, and even the rest interval. For purposes of building both strength and mass, your best gains are going to come between 70% and 90% of the 1RM. Beginners may see advantages from sticking to a range of 65%-80%. As you get bigger and stronger, this will edge up gradually. There may come a point where 85-90% is necessary to stimulate gains. Just remember that after a year of lifting, you're not at that point.

The thing is, I don't like percentages. Using percentages requires you to have a fairly reasonable estimation of your 1RM, which isn't always desirable or even possible.

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In that case, the percentages will *roughly* correlate to a range of three to twelve reps per set, assuming each set is reasonably difficult. It doesn't have to be to failure, but you do need to be putting forth some effort for that to hold up.

As a rule of thumb, intensity is going to inversely correlate with volume. The heavier the weight, the less reps you'll get on each set. The more effort you put into each set, the fewer sets you'll be able to do. And vice versa.

The training effect we're after comes from tension-time overload, so there has to be some amount of work done with a 'heavy enough' weight. If you stick to 65-70% as a lower limit for the weight you use, you won't have a problem. Consequently, going above 90% too often will just tend to burn you out unless you have a truly gangsta nervous system. You can make gains under those conditions, but you have to be careful with it.

For most people and most circumstances, 70% to 80%, or a rep range of 5-10, will be about perfect.

VOLUME AND FREQUENCY

Once intensity concerns are met, you still have to do enough work to trigger the best gains. Volume is still conditionally important. A high workload is not sufficient to create gains by itself, but it is necessary if you're working in the proper intensity zone.

For our needs, the best results in a single workout will come from 20-80 total reps per muscle group, spread over 4-8 sets. Workout frequency for a muscle group will be optimal with 2-3 sessions per week. Beginners will tend to have an advantage from the higher frequency, with fewer total reps and fewer sets per session. The prescription would be three weekly sessions and up to four sets per muscle group.

As you get stronger, you'll see the trend move towards less frequency and more sets. In this case, two sessions per week would be plenty, with up to 8-10 sets per part.

I do want to note that the actual number of reps per session may not increase, even if the number of sets goes up. In fact, this might actually drop as you get stronger. On the whole, I think 20-60 reps per muscle group would be about right, regardless of how experienced you are.

There's some evidence that higher frequency, as a measure of total weekly volume, might be advantageous for advanced guys as well, as long as the volume within each session isn't crazy. Given what we see happen in terms of rapid adaptation, it's possible that moving between phases of high-frequency workouts and low-frequency workouts could be a useful approach.

In this case, you'd be exploiting the fitness-fatigue model: rack up gains with hard training, then back off and recover. Train with intensity to create gains, train with volume to stabilize them. Instead of focusing on just the weekly workout, you'd want to spend some time training 'hard' and some time training 'light'. I'll discuss this more shortly.

To recap: if you're new, train each muscle group more often (three times per week, give or take) and stick to fewer sets per muscle (roughly four sets, or a total of 20-40 reps). If you've got more experience (measured in years, not months), then train each muscle a little less frequently (twice a week or thereabouts), but do a little more work within each session (up to eight sets; total reps should probably not go higher than 40-60 in total).

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TEMPO AND TIME UNDER TENSION

You might have come across programs that have three or four numbers after them, something to the effect of 3/0/1/0 or 2/0/1. For most exercises, the first number refers to the eccentric phase, the second is the pause before the concentric phase, the third is the concentric phase, and the fourth is the pause before repeating the rep when it's included.

To get the time under tension (TUT), you'd simply add up the total time per set and then multiply it by the number of reps. So 3/0/1/0 would give you 4 seconds per rep, and 10 reps at that tempo would be a TUT of 40 seconds. Give or take, at least, as this will always be an approximation.

There's many a Guru that's gotten hung up on this TUT number as an absolute thing. It's important in a way, don't get me wrong, but when somebody tells you that a specific tempo is critical, or that you have to get 60 seconds of TUT for a set to be effective, I have to question that.

If it were just about a specific TUT number, you could take a weight and just move it very slowly to rack up a high time. In practice, it doesn't work out so hot. That turns into aerobics.

The flaw is that these guys aren't accounting for weight on the bar and they aren't accounting for total volume. If the tension and the volume aren't there, then the whole equation falls apart. When these conditions *are* present, TUT is little more than an indicator that you're working hard enough.

A 2006 study by Tran et al. compared three different protocols in order to test the effects of manipulating the volume or TUT. The relative weight was held constant at 90% of the 10RM for all three groups. Protocols B and C varied by reducing either the TUT or the volume, respectively, from the A protocol.

The results showed that the decrease in force production (meaning, fatigue) was significantly greater in protocol A than in protocol B, which used a reduced volume. Protocol C, which in contrast reduced the TUT, did not significantly vary from either A or B, although the actual measured value was in between the two. The authors conclude that manipulating either TUT or volume could influence fatigue factors when controlled for equal intensity.

As with the Lawton study comparing constant-reps with intra-set rests, the higher TUT indicated greater fatigue, even with equal volume between the two protocols. Changes in muscle activity implied that greater stresses were being placed on the musculature with higher TUT. *But!* using a higher volume had similar results when TUT was controlled for, which indicates that TUT isn't actually creating the result.

Volume and TUT are both different ways of describing muscular work. That means that both factors should be accounted for. Neglecting one or the other is leaving out a key piece of information. While there's benefits to using a higher TUT with any given volume, you need to account for the actual volume too. It should go without saying by now that the weight/intensity is important.

This is validation of what I've been saying all along: progressively higher volume and higher fatigue with heavy weights tends to result in greater effects. The specifics of your workout just don't matter as long as that's happening.

With all things being equal, the greater the effort, the greater the gains.

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The lesson here is that TUT is not the goal of your workout. TUT describes a level of effort and a level of muscular fatigue that you should be working with to see the best results. The TUT recommendation of 60-90 seconds per set came about because training with that kind of TUT is a *consequence* of an optimal set.

Those recommendations should be an indicator of hard work, not a goal. Read that again, to make sure you got it. Just doing 60 seconds of work doesn't guarantee you get bigger.

Now – what about the tempo suggestions? Different tempos do have different effects on the body, as I've already pointed out. Moving explosively creates higher tension with a given weight - but you can do that without a strict time count.

I know for a fact that trying to count out a strict tempo while I'm fighting a weight or grinding through a set isn't going to work out too well.

It's well and good if you have a partner working with you to time things, but for most people it's just not worth the loss in focus. You don't need that kind of distraction when you're in the middle of a set. Honestly, the data just isn't worth that much. I'd rather be able to put my mind into my lifting.

I just use a more general recommendation, like fast, controlled, slow, or whatever else, and still get the effect without the annoyance of counting a strict tempo. You can tell the difference between moving a weight quickly and moving it slowly.

So let's expand on the idea of rep speed and how it relates to muscular work. Simply speaking, time under tension is how long your muscle has to handle a given weight. For any given weight and volume, a higher TUT means your muscle did more work and experienced greater fatigue. Both volume and TUT are attempts to describe the amount of work that your muscles have done; we're using those numbers as a proxy for the real figure.

Any calculation of volume only gives us an idea of weight lifted. But that doesn't tell us how much work the muscle did - there's still some information missing. In order to understand the volume of work, we have to know the tension.

Well that's easy, right? It's just the weight on the bar!

Not so fast. Force is mass times acceleration. *If we're only looking at the mass of the bar and not how fast it moves, we don't actually know the tension created.*

The weight on the bar is a stand-in for the actual tension created. It's easy to know that 200 lbs requires more force to move than 100 lbs, all things being equal. The problem is that things aren't always equal. Volume calculations assume that 200 lbs took 200 lbs of force to move. If you're moving faster, then your volume number will be skewed.

Knowing the tempo can help with that. Then we know how much weight was moved around and how fast it was moved around. When we have both of those numbers, we have a better idea of what actually went on.

A faster movement will create more force (and more muscular tension) than a slower movement with the same weight. Take the following example. We'll look at two scenarios, both using an exercise for 5 sets of 5 with 205 lbs as the load:

Scenario A – Each rep is performed in 0.5 seconds

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Scenario B – Each rep is performed in 3 seconds

In both instances, the volume and weight are the same. Number of lifts is 25, total tonnage is 5125 lbs, and weight lifted is 205 lbs. Going by simply those two factors, it might seem that the work done is identical.

But hold on. Is 205 lbs moved in half a second *really* the same force as 205 lbs moved in three seconds? I wouldn't bet money on that if I were you.

If we assume that both of these guys are lifting the weight as quickly as they can, then scenario A is significantly stronger. Even though they're using the same weight, A's creating far more force.

You can bet that this will make a difference in the work that your muscles are doing. The net outcome is that we can't just multiply the total reps times weight and assume we know how much muscular work was done.

It's obvious that A and B are creating dramatically different amounts of force, so even though the volume and weight are identical, the actual force created and the work done won't be.

Looking at the TUT between the two is one way to see this. Just doing the math, B will have a significantly higher TUT than A. This still doesn't tell us how much work was done, but it gives us a better idea - we now know that B worked way harder than A did in this example.

Scenario A was doing speed work, while B was grinding his way through with a higher percentage of his 1RM. Long story short, you can't just assume the weight on the bar directly equals the amount of tension placed on the muscle. You can't assume that the tonnage, by itself, represents the actual stress placed on your muscles.

The running assumption is that B is going to benefit more in terms of strength and muscle mass. Given equal volume I'd be inclined to agree, at least at first glance. Scenario B is using a higher relative intensity, has a higher TUT, and the implication is that it was just a much tougher session for him than it was for A.

What we haven't looked at yet is what happens if A were to do a lot more sets, or keep his rest times very short. As with the earlier study on fatiguing sets vs. intra-set rests, volume can represent its own stress.

These conclusions are made with the assumption that both cases are pushing as hard as they can on each rep. If B is really as strong as A, but he's slowing his sets down on purpose because he thinks he needs to hit a certain TUT, the equations change a bit. In that case, B is actually creating *less* tension in his muscles – without that acceleration of the weight, there's actually less tension being created. He's extending the TUT, but at the cost of tension.

If that's the case, A and B might be using equal intensity and moving equal tonnage, but B's not creating as much tension as A. The TUT alone doesn't change things in this case because it doesn't represent fatigue. He's not grinding through a heavy weight – and weight and tension are still the most important.

Scenario B either needs to add more weight or speed things up if he wants the best stimulus. There's a huge difference in weights moved slowly because you have no choice, and weights intentionally slowed down. This is the fallacy of slow and controlled tempos that's often promoted – that only works if the weight is so heavy you *can't* move it any faster, not just because it's slow. Slowing down the movement voluntarily doesn't cut it.

It's pretty much accepted that fast and explosive movements are the best bet for improving size and strength, but this is with a few caveats added. Fast and explosive doesn't mean jerking, bouncing, or otherwise looking

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like a complete tool. There's a difference between being a tool and lifting explosively, a subtle distinction that seems lost on many people.

Walk into any gym on Monday, International Bench Press Night, and you'll see this rule in effect. The bench press is the worst offender in most commercial gyms, and that's only because nobody ever does squats. Barbell curls, better known as reverse-grip hang cleans, would have to be a close second. Guys are using weight that's far too heavy, and as a result form goes right down the toilet. That's not explosive lifting, that's just asking to get hurt.

Truly explosive lifts will be under your control the entire time. The weight might be challenging, but it won't ever slow down. You won't be fighting the weight. It can be heavy, but it will move smoothly. Most importantly, your form won't fall apart. If you can't keep tight and move the weight properly, then you're doing it wrong.

A controlled tempo means that the motion isn't as fast as you can go, but it isn't intentionally slowed down either. This is more of a moderate pace, and it can be a good idea in cases where moving explosively is a bad idea – like single-joint exercises or if you're tending to an injury.

Slow means it's moving slow because the weight is too heavy to move any faster. Obviously I don't see much benefit from intentionally slowing down your exercises, but if you're knocking off sets at 90% or heavier, then you're not expected to be lightning-quick.

The only possible benefit to intentionally slow movement might be the occlusion/ischemic training where you're intentionally trying to cut blood flow from the muscle. If that's what you're after, then very slow movement might be helpful.

In all cases involving a big compound lift, I'd suggest that you push as hard as you can regardless of the weight. There's some exceptions to this, but if it's strength or muscle you're after, you want to push as hard as you can. This means that heavy weights will move slowly and light weights will move fast — but you should be giving your best effort regardless.

Smaller fluff exercises can break this rule. They don't always have to be explosive because they aren't so much for a 'neural' effect. Since you're probably trying to get a 'muscle' effect with these movements, and it can be somewhat dangerous to accelerate single-joint exercises, it's OK to move a little slower here.

With heavier weights, speed will probably not be there. Closer to 70% you'll probably be able to move weights reasonably fast. However you can still accelerate a heavy load; it is the *intent* of speed, not the actual speed, that creates the required effects in the nervous system.

We always have to remember that the weight on the bar is the primary consideration, even with dynamic/explosive training. Tension is maximized when you let the weight determine the tempo. The only reason to slow it down on purpose is when there's a safety concern.

We know that heavy, explosive-type training should be a foundation, but even the slower tempo work traditionally done by bodybuilders can be useful if you put it in the right places. It's not excluded because of that tension-time graph, but you should know that intentionally slowing yourself down produces less tension in the muscles.

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Prescribing a tempo is going about things backwards, basically. When you have a target intensity zone and a target volume goal, the tempo should click into place on its own. In effect, the tempo can be thought of as another indicator of intensity – moving faster is harder and more stressful (physiologically) than moving slower.

REST INTERVALS AND WORKOUT DENSITY

Another mostly-trivial issue is the rest intervals between sets. Along with the tempo, the rest interval will contribute to the overall fatigue created by a workout.

Continuing with scenario A from earlier, say he's resting two minutes between sets. If he shortens the rest between sets from two minutes to 60 seconds, he doesn't give the muscles time to fully recover.

Suddenly those 'speed' reps become a lot harder. Even though the weight is still light, and they're still moving smoothly, the fatigue effect in the muscles is more noticeable. When you train like this, you'll start to notice that fatigue builds up with each set. You might even feel the beloved 'burn'.

Training with a time-based goal like this can increase the amount of work your muscles do, and serve as a kind of overload of its own.

Here's a more extreme example to drive home the point. Say you're doing an exercise with 200 lbs. One day you go in and do 25 singles, taking one hour to finish. That's 25 total reps, a tonnage of 5000 lbs, and one rep every 2.4 minutes.

Say you come back next week and do that same workout, 200 lbs and 25 total reps. This time you shorten the rest periods and finish in 15 minutes. Tonnage is still 5000 lbs, but you did it a lot faster – one rep every 36 seconds, give or take.

It's the exact same amount of weight moved, on paper, but even intuitively it should be obvious which one is more difficult. If you're normal, you're a lot more beat up from the 15 minute workout. The fatigue factor, which is directly related to how fast you do work, is important too. This is called *workout density*.

As you see, shorter rest periods increase the amount of fatigue you generate. The same weight and same volume can have a different effect depending on how long you rest (Willardson 2006).

Rest intervals can also influence strength levels (Willardson and Burkett 2006), which should be pretty obvious. If you're tired out from a previous set, you won't be doing your best. If you need high-quality of work, allowing for long rest intervals is a good idea.

To see any major differences requires you to use fairly short rests, though. For example, the differences between two minutes and five minutes seems to be pretty minimal when it comes to fatigue (Ahtiainen et al. 2005). This makes sense, as a lot of the issue between sets isn't really neuromuscular, but cardiovascular. If you're not in shape, it'll take your heart rate time to drop.

Athletes do seem to adapt to shorter rest periods with time (Willardson and Burkett 2008). This would be the concept of 'getting in shape'. It seems that when you have a higher work capacity, you can tolerate more without turning into a sweaty puddle on the floor.

Moving the rest period to something shorter than two minutes would be one way to improve stress (Willardson and Burkett 2006). When you shorten the rest periods to something like 30-90 seconds, you're

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doing basically the same thing as all the other intensive fatiguing methods I've discussed so far. You're exhausting the muscle, and then having to push through that fatigue.

In this regard, the goal is to both increase the amount of work and decrease the time it takes to get that work done. Much like the tempo variable, manipulating the rest interval and workout density is another way to affect intensity – both the subjective 'effort' definition and the percentage of 1RM definition.

Think about it. You're not going to pull off six sets with a 30 second rest interval unless you're working with a weight that's relatively light for you. By definition, you're doing that workout with a light percentage. What happens if you go from having to rest 2 minutes to resting only 30 seconds between the same number of sets? There's some specificity effects in terms of muscle endurance, yes, but in effect doing the same volume with less rest actually does represent a strength gain. The workout density is also another measure of intensity.

The higher the density, the more demand you put on the muscle. Also this is closely tied together with the tempo, as density accounts for both moving faster and resting less – you're eating up energy at a higher rate and limiting the body's ability to replace that energy. It's counterintuitive if you're used to thinking of things in terms of 'how many reps per set', but the stimulus is still there. You just have to look at how things add up over the course of a workout, not just as a result of each set.

Tension comes from the high accelerations you put on the barbell (or whatever you're moving around). The fatigue or 'hard work' elements comes from playing with the rest times. When you're not recovering completely between sets, fatigue accumulates over each set.

We're still attacking the problem from different points on the tension-time graph, too. Instead of relying on simple progressive overload to increase the intensity, we're using the measure of density – moving the weight faster and using shorter rest times. In this case, the accumulated work over a session is subbing in for the fatigue created in each individual set.

In the Lawton study (2004) I referenced earlier, comparing continuous reps and intra-set rests with regards to bench press strength, the continuous rep group improved the most because they worked the hardest and created the most fatigue with the given volume of work. However what we've seen is that the advantage to dynamic lifting is not economy, but rather the ability to do much more work without being limited by fatigue.

Dynamic/explosive lifting is a prime example of density-based training at work. You keep the rest intervals brief while focusing on the quality of each rep. In the course of even 20-30 minutes, you can potentially rack up some large volumes even using heavy weights. This will still create the tension-time overload we're after – and it'll wear you out in a way that might surprise you.

The Intangibles

Having some estimates for intensity, volume, and the other numbers is where most people draw the line in program design. What else is there to do?

If only it were that simple. A big part of a workout routine revolves around stuff you can't write down on the page. What's written down on that sheet of paper you take to the gym is not necessarily going to reflect what actually happens at the gym.

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Let me explain what I mean. As I said before, intensity is usually given as a percentage of your 1RM, or barring that, a rep-maximum. Here's a question for you: at any time, how confident are you of those numbers? Say you rest up for a few days, eat well, and then go lift. Now think about what happens after a back-breaking week of work, getting almost no sleep the night before, and heading off to the gym.

Do you think your 1RM will be the same? Do you think that the percentage of your 1RM will be the same? Of course not. We can invoke chaos theory here or whatever buzz-word you like, but the gist of it is that a variety of factors can influence your overall condition at any given time, and this will trickle down to affect your lifting too.

Even in a situation where you're training separate and seemingly unrelated muscles, there can be problems. While it's true that different muscle groups are usually not affected directly by other recovering muscle groups, this isn't the whole picture. Stress is a systemic response, not just a local thing. Yeah, all those sets of bench press you did yesterday might have worn out your chest and triceps - but they also release all those chemical messengers that tell your brain that you've put those muscles through the ringer. Your brain doesn't care that it was just the chest and triceps that got worked.

Were you on fire yesterday, knocking out PRs left and right? You've also taxed the brain itself by sapping your neural drive with the heavy weights. Chances are that even if you want to go in and do your legs or back, your body as a whole may not be up to it.

Systemic fatigue can originate from doing too much work, and it can originate from too much mental exertion. Too much of either, or both, is going to wear your body down. Over a short period of time, this isn't that big a deal. It's when it keeps up for weeks or months at a time with no breaks that you run into problems. The muscles might be fine. It's your whole body you have to be concerned about.

Make no mistake though, if you're trying to lift or do some kind of strenuous activity every single day, as some are wont to do, you're not doing yourself a service. Overreaching can be fun and productive if used properly for short periods of time, but how many people are doing this? I'll answer for you: nobody at your gym. People are over-working themselves alright, but it's not with a larger goal in mind. They just don't know better.

At first overreaching is just annoying. You'll lose motivation to lift, you'll probably have trouble falling asleep and waking up, you might develop a twitch somewhere, you might feel hot, soreness takes several days to go away, and so on. It's almost like you're coming down with the flu or something like that.

This is a direct result of the body's stress response, your body's way of giving you a very clear message to sit down, get some rest, and go eat some cookies. A rational person would listen to this message and stop going to the gym. But I'm writing this for bodybuilders and their relatives, so I can't assume that.

Ranting about OCD appearance-obsessed people aside, even otherwise 'well-designed' programs don't take any of this into account. The stress response, one of the most fundamental and critical factors involved in any exercise program, is entirely glossed over beyond simple concerns for immediate recovery of muscle groups. How novel.

You can put together what you think is the best program in the universe, but if it doesn't take into account the daily variation in your individual ability and your overall systemic recovery, it's not worth a damn.

This is the big reason I shy away from strict adherence to percentages or any kind of static suggestions like that in a program - you just don't know from day to day what you'll be able to do.

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CYBERNETIC PERIODIZATION

What you need is some way of gaging your daily ability alongside those calculated numbers. For example, the Bulgarian weightlifting team has been reputed to use the concept of the daily max. To give a little background, back in the old Soviet era sport coaches in that part of the world were known to recognize two kinds of maxes. One of these was the competition max. As you'd guess, this was the athlete's best effort in a competition. Then we had the training (or daily) max, which was what you could hit under gym conditions.

What's the difference? The big thing is the rush of competition day. If you've ever done any kind of competition, you know what I'm talking about. If not, well, it's some blend of excitement, arousal, and adrenaline that comes from having to put it on the line and compete in front of a crowd. Imagine being six years old on the night before Christmas, combined with nerves about having to give a speech, and then having a zombie jump out at you in a dark alley.

OK, I'm embellishing a bit, but those examples give you the idea - on contest day, you're all wound up, and it's been proven that what most people can performance-wise under those conditions is substantially different from gym ability. I want to say up to 10% difference, but I could just be making that up. Note that this doesn't always hold true, as some people will choke on the platform, but in general it applies.

The training max is done without any kind of psyche up or adrenaline. You just walk up to the bar and knock it out. Some sources suggest that the Soviets measured this by heart rate; since elevated HR corresponds to excitement, the athlete was tested and not allowed to make an attempt if he was too worked up.

The Bulgarian weightlifting team under coach Abadjiev was reputed to use daily training maxes as the cornerstone of their programming. They'd go in, work up to a comfortably heavy daily max, then base the rest of the workout on percentages of that number. After reaching a max, they'd back off the weight, then build back up over 2-3 sets with the hope of breaking that daily max. By doing this, both the intensity and volume of the session can be manipulated based on the lifter's ability. This technique has become the basis of so-called wave-loading programs that have become popular lately.

An example closer to home comes from Louie Simmons of Westside Barbell and the training system name after the eponymous powerlifting gym. One of the days is given over to testing a new max with a special exercise, and in some iterations, back-off sets at a percentage of that max are used afterwards. This isn't quite the same as the Bulgarian approach since Westside guys are known to get really worked up and push to break PRs on these heavy days, but I like to think of it as similar in spirit if not in practice: you're still testing out daily capability instead of relying on a written plan.

It's a clean an approach as any, relying on daily ability rather than a preselected number that may not be accurate. However, this isn't practical for a lot of exercises, nor do you have the time to do this on every single lift if you have a life outside the gym. The daily max might be useful for an exercise or two, but for other things we'll need another option.

Enter the Rating of Perceived Exertion (RPE) and Rating of Technique (RT). These are two components of what's called *cybernetic periodization*, the use of your own feedback to adjust and regulate a training program.

The RPE is a sliding scale that you use to grade exertion. The RPE scale originates from a fellow named Borg that came up with the concept to gauge the difficulty of aerobic exercise. For some odd reason, Borg's scale starts at 6 and goes up to 20. There really is no set scale beyond, however, so I suggest using something

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practical. I've always liked the basic 1-10 scale, but you could also get away with 1-5, or even something non-numerical like 'light', 'heavy but smooth', or 'how the hell did I get that rep?'.

The scale isn't important. Being consistent is. Pick one scale and stick with it.

Mike Tuchscherer, an IPF powerlifting wonder, has written a book called *The Reactive Training Manual*, where he lays out his own system of auto-regulation for powerlifting with RPE numbers as the centerpiece. This book has a lot of gems in it, but arguably the best thing there is the RPE scale Mike's come up with, along with the chart that compares RPE numbers to (roughly) estimated percentages of your 1RM.

The gist of it is that a '10' would represent your absolute maximum for a lift. A 10 will be very slow, very challenging, and a textbook definition of a 'grinding' set. Remember that the weight doesn't matter; it's how the weight feels at the end of the set. A 10 will always represent your best effort, regardless of the rep range, or the duration if you're doing endurance training.

Also note that a maximum effort does not imply going to failure; failure means that you can't complete the rep. A maximum effort is different; subtly different, but still different.

As you work down the scale, you might find that a 9 is a very heavy and hard set, but you could still knock out one more if you pushed. An 8 would be difficult but still leave you with another 2-4 reps in the tank. And so on down the line. Again, the point is not to copy the scale, but to have an idea of your relative effort for each set.

Bodybuilding culture tends to emphasize the 'go hard or go home' mentality, which puts a premium on 'intensity'. When you hear that kind of gym-talk, your bodybuilder friend is really talking about the RPE when he says 'intensity'. In this case, an 'intense' workout would have you working in the 9-10 range on the RPE scale. I don't think that's the smartest way to go about things, as I've discussed, but it can be useful to have some context.

The RPE indicator can give us two key pieces of information depending on how it's used: firstly, we can use it to determine a working weight, and secondly, it can help to figure out a stopping point.

The easiest way to select your working weights is to have a starting point in mind for your main exercises, the lifts where you know or can reasonably guess a 1RM. For growth purposes you know that 70-80% is pretty close to optimal, so you can pick values in that range. From that starting point, you can use RPE feedback to adjust things up or down from set to set.

Say your max is 100, and your goal starting weight for the day is 70 (70%). Once you get to your work sets, 70 turns out to be too easy for your work sets, so you can bump up the weight a little. Or if 70 is too heavy, you can notch it down. Use the RPE feedback to adjust the weights until they feel right.

Another alternative would be to simply suggest a rep range and let you figure out the right weights based on the relative difficulty. Instead of going by a percentage, you'd just figure on a rep range from say 5-10 reps. Your first week might be a testing or introduction week to get a handle on where you stand in terms of strength. From there, you'll have a reasonable idea of what to expect – and can use the RPE scale to adjust things as needed. This would be a better approach for more experienced lifters, who will have a better idea of their capabilities.

In either case, your program is more dynamic. If you're stronger on any given day, you can take advantage of that. If you're having a bad day, you can adjust that accordingly. The good news is that there's fairly substantial

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research support for this concept, too. Even beginners can get reliable feedback from the RPE scale, provided they've been introduced to it. It appears that both men and women can estimate the relative difficulty of a working weight and any given set with a good degree of accuracy – which means that the score you assign to a set can be considered reliable (Focht , Gearhart, Lagally , O'Connor, Sweet).

When you use these ratings to adjust your training, we call this *auto-regulation*. The program adjusts itself based on your ability, instead of you adjusting to the program.

Pavel Tsatsouline suggested a routine, called the Russian Bear, based off these principles in his book *Power to the People!* You start out by working up to a 5RM set, which is your heavy lift for the day (daily maximum, if you prefer). The second set is 90% of that heaviest weight, and the third set is 80%, both done for five reps. From here on, you stick to 80% and do sets of five until you tire out. As you can see, you have control over both the heaviest weight of the day and the total number of sets done.

Looking back even further, we can see elements of auto-regulation in the routines of the old-time lifters. The strength routines of Doug Hepburn are one classic example, which I'll go over in more detail later on.

In addition to determining a working weight for the exercise, we're also trying to figure out how much volume to do – or more accurately, when we've reached the desired level of ass-kicking for the session. For a high-quality session devoted to speed or power, you'll probably want to keep the volume low, and thus stop at the first signs of fatigue. Likewise for any light or recovery sessions.

If you're after size, you may want to do a higher workload. Instead of stopping when fatigue kicks in, you can use that as a sign to reduce the weight and keep training. In the *Reactive Training Manual*, this is referred to as a Fatigue Stop – meaning you use the increase in difficulty as a sign of when to stop your sets.

In both of these cases, we can use the RPE to track when sets slow down and start to grind. In the previous example, if you're doing sets of eight with 70 and they've all been around an 8, you'd want to call it quits when the RPE hits 9 – which effectively means the set slows down and 'feels harder'. If you're being a hardass and having a monster of a session, it may even be acceptable to work until you hit a 10, or to reduce the weight by 10-20% and keep working until you hit a fatigue stop there.

It's useful and practically necessary to apply time limits and/or strict rest intervals for this kind of thing as well. I can see right now that there are people out there that would take 10 minute rests between each set and be in the gym literally all day long. So keep the rests maybe in the 2-5 minute range (shorter for lighter weights, longer for heavier) and perhaps a total cap of 15-25 minutes (briefer for low volume, longer for higher).

While the RPE scale is meant to apply to individual sets, I'd take it a step further and also rate how you feel overall. For example, the workout that happens after you've slept for two hours and worked 60 hours in the last week is going to be different from the workout that happens while you're on vacation and sleeping nine hours a night. This can be a critical piece of information, especially if you have an exceptionally good or bad performance.

To distinguish this from the RPE score, you can just call this the Rating of Fatigue (RF). You might want to record this as you come into the session, and then again after the workout's over, so you can gauge how you felt and how hard the workout was on you. It could also be useful to record if any given exercise or even a single set wipes you out in an unusual way.

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We can't forget about the Rating of Technique (RT) either. Like the RPE scale, RT is a subjective rating that measures your form in an exercise. This is best done by having a qualified coach watch you lift and giving feedback, but in broad terms you can tell if a rep was ugly or not. You won't catch all the fine details, but that's not important for most average lifters, either.

The RT is important to measure because a 1RM attempt that's ugly and really, really hard is different from an attempt that's flawless and just slightly hard. If you hit a heavy set and wrote it up in a journal without any extra information, you'd just see '100x1' or whatever it was you hit.

Depending on the circumstances, 100x1 might have been cake or it might have been the worst lift you've ever done. You don't know unless you record it.

Remember: either volume or intensity can wipe you out if you're getting too much in a given time frame. You can use RPE to judge the difficulty of an individual set and of the entire workout. One '10' might not be a big deal. Knock out eight sets that are '10' and you might have a problem.

Likewise, you should have a system in place to control the total volume of work; it won't do to come in and grind yourself to a pulp on a light session, while you don't want to short-change your heavy sessions.

TRAIN STRONG, TRAIN WEAK

The normal advice given when you do an exercise is to use a full range of motion. This is how the body's supposed to move – in a complex pattern of muscle activation that will hopefully create the motion you want. Usually this is a good idea.

You'll notice that all exercises will have weak points, places where the leverages go bad and make the exercise harder. This is especially noticeable in larger lifts, like the squat and bench press, but all exercises have this to some degree or another. Pulling exercises, like deadlifts, chinups, and barbell rows have sticking points at the 'bottom' of the exercise, because you have to overcome resistance from a full stop.

There's two strategies you can take to get around this, if 'just doing the lift' doesn't work so well. You can do the exercise in a way that's mechanically weaker, in order to build up the part that is limiting; or you can train it with a mechanical advantage, to overload certain parts of the lift and adjust the body to heavier weights.

For an example of 'training weak' let's look at squatting. There's actually several different types of squat that you can do, depending on how wide your stance is (close, moderate, wide) and where the bar sits (high on the back, low on the back, on the collarbone/shoulders, etc.). Most people tend to be stronger with a wider stance, lower bar position, and shorter range of motion (ROM); this is where the leverages seem to add up in the right way.

To 'train weak', you'd train in the opposite way: close stance, bar high on the back – or even better, with the bar on the shoulders (a front squat). Using full depth, instead of what most people like to call parallel, is a good idea if you don't already. What you'll tend to notice is that spending time getting strong with the 'weaker' stance will tend to improve the 'stronger' stance.

Of course you can come at it from the other angle, too. Train with mechanical advantage: partial-ROM exercises, training with supportive equipment, things like that which will specifically allow you to handle weights that are heavier than normal. Where training weaker tends to 'push' your strength up, training with an advantage 'pulls' it up by forcing you to handle heavier than usual weights.

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You may not think this applies to bodybuilding in quite the same way. After all, I'm discussing pure-strength training. Consider this, though. What kind of weight can you use for a dumbbell concentration curl, as compared to a chin-up? Even if you just use bodyweight, odds are you can move a lot more weight with the chin-up.

That's an example of 'training strong' – yes, you're using more muscle groups to move the weight, but that's also putting a greater overload on the related muscles. The concentration curl is training weak; you're working the muscle in question more directly, but the sacrifice is that you can't create as much total overload.

Partial-ROM exercises, where you only work a portion of the lift, can be useful for the same reason. This method allows you to move significant amounts of weight, exposing the muscles to overload. Examples would be half-squats, board presses, and various kinds of lockouts. The old bodybuilder concept of '21s' fits this as well.

You can also go with the progressive ROM idea. You stick with a very heavy weight, which you may only be able to move a few inches, and gradually progress through a larger range as your strength improves. You have to be careful with this kind of thing, though – limiting the ROM tends to have a limited strength carryover, too. We've seen this with studies into isometric exercise – they'll build strength in the range that's trained, but the other joint angles tend to suffer. The progressive ROM method may or may not work for you, depending on how patient you are – and whether you have access to a good power rack, for that matter.

Remember that much of this is dedicated to overloading specific weak points; if you don't have any defined weak points – or rather, if your weak point is just being small and weak – you don't have much business playing around with this kind of training. For beginners, I feel that the basics are generally sufficient to build strength without problems. It's only when those lifts are done poorly or the routine itself is imbalanced that problems will arise. There really shouldn't be a need for any weak-point training with special exercises or special methods.

It's when you start getting stronger that you might notice problems coming up. I've heard the idea put forth that your individual levers and mechanics will determine how much weak-point training you'll have to do (thanks to Steve Shafley for that nugget). If you're built for an exercise, you can benefit from just doing that exercise. If you're not, you'll tend to benefit from doing more diverse training for that particular lift, in order to train up the weak points.

An example would be someone built to deadlift. This is usually a taller, narrower build with longer arms – great for moving a weight off the floor, but horrible for benching. This guy might never have to do anything but pull to get a good deadlift, while at the same time he might find that he never makes any progress on the bench without using special exercises to train different parts of the lift. A short, thick guy with T-rex arms might be able to bench all day and thrive on it, while his deadlift never budes without a lot of specialized work.

I'd also suggest that we extend this argument beyond mechanical strengths and weaknesses. For example, if you spend all your time doing sets of 1-3 reps, then doing a workout with sets of 10-12 reps is going to be painful – during the session and after the fact. In this case, your ability to do sets of 10-12 reps represent a weakness, in the sense of 'something you aren't good at'.

That represents a weak point in your body. If you've spent years training with triples, spending a month or so getting adjusted to higher-rep sets can pay off with extra growth. Now I will add the caveat – for most of us strength/power types, switching to higher reps also represents an unloading or rest phase from our usual high-

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stress training, so that can contribute as well. That said, there's some reason to believe that the use of varied rep ranges (and thus higher/lower volume and intensity) can be a positive thing for the purposes of bodybuilding.

You want well-rounded, overall development if you want maximum size. This developing strength in different exercises and muscle groups, but it also means development of your ability to handle work-induced stress. Heavy training is the foundation, pump is the paint on the walls.

Training in a way that is deliberately less than optimal can lead to greater long-term results. Likewise, training with an intentional advantage, allowing you to apply greater overload, can also trigger progress by exposing you to heavier weights. These ideas are complementary, not two competing strategies – you just have to use them accordingly.

Size And Symmetry: Training Muscle Groups

Here's something I haven't really talked about yet, but it definitely needs some treatment: picking exercises.

When you put together a bodybuilding routine, it's a given that you'll want to train your muscles. Beyond size, the goal of the bodybuilder is also to develop a symmetrical physique – in other words, you want the body to develop in proportion, with no parts lagging or over-developed.

The traditional way of doing this with a split routine, giving each muscle group its own workout day and then picking exercises to work those muscles. However this may not always be the best approach. I want to look at some of the factors that can influence your program schedule and exercise selection.

The exercises you pick out are obviously going to be important, yet most people just go to the gym and pick out some movements that they think will work their chosen body part of the day.

I'd make it a point to put more thought into it than that. Your exercises determine what muscle groups are being worked. We can broadly define two different kinds of exercises, depending on their importance in the program.

Your *main exercises* are big lifts that you train for the sake of getting stronger. These are almost always going to be compound exercises, the exercises that involve multiple joints and tend to impact a lot of muscle mass.

With the main exercises, the effects on the individual muscles aren't important – you're not benching to work the pecs, or deadlifting to work the back. Well, you are, but it's more of an indirect action. The bench press isn't a 'chest' exercise, and the deadlift isn't a 'back' exercise.

In these lifts, the goal is lifting more weight. Your muscles are trained by the exercise as an afterthought, not as a goal.

Assistance exercises are the movements that you train specifically to work a muscle group. In this case, the exercise itself doesn't really matter as long as the muscles are being stimulated. This might be equated with the so-called isolation or single-joint exercises.

Yeah, they're 'not functional' or whatever. So what? For bodybuilding purposes, they work. All you're after is overload on the targeted muscle, and an isolation exercise can do that just as easily.

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It might seem like a no-brainer that you'd want to pick an exercise for each part of the body. In some cases, this is a good idea. In others, it's not.

I want you to think about overlapping muscle groups. Think of a squat and a deadlift, for example. While the details can vary depending on the form used, in general these exercises overlap a lot. Both work the quads, hamstrings, glutes, and midsection extensively. Same applies for the bench press and the overhead press, which both train the shoulders and triceps. Or any kind of rowing or pullup exercise, which will work the back and arm-flexor muscles.

This isn't to say you can't or shouldn't train overlapping exercises together, but you do need to keep in mind the fact that there's a lot of redundancy.

If you just blindly pick exercises to work a muscle group and don't take this into consideration, you could end up over-working some muscles and joints, while under-working others. Over time this can lead to lagging development and injuries – destroying the very symmetry you set out to create.

This is the number one complaint that can be made about the traditional bodybuilding split programs – they don't take into account movements and balance across the body. This isn't always the case, but in a lot of instances, it is.

One matter I need to touch on is the systemic stress caused by some exercises. Big lifts like squats and deadlifts are very taxing on recovery, especially if you're training them heavy and have gotten strong on them. The negative effects of these lifts can take quite awhile to recover from, sometimes longer than the usual 3-5 day window.

These lifts aren't just training 'legs' or 'back' or whatever neat category you might be expecting. They work a lot of tissue, and can have a powerful impact on the nervous system. Some exercises transcend any pigeonholing.

It could be a good idea to limit the use of exercises like that to just once a week, and use less taxing movements on any subsequent workouts. Some people can handle it, some can't, and it can change depending on the circumstances. If you're eating for size gains and getting a lot of sleep you'll find it a lot easier than someone dieting with a 60-hour work week.

Just be smart about it; you don't have to squat and deadlift every single week without fail.

The number of exercises you do will depend on your goals. If you're trying to get good at a lift, you'll want to spend a lot of time with just that lift. If you do any assistance work, it'll be specifically to address weak points in your main lift.

For muscle mass, the rule of thumb has always been to use a greater number of exercises. While it might seem like there's something to this, all practical evidence suggests that it's not the case – instead, it's a matter of making sure you work each muscle and get enough volume.

In any event, just for the sake of not boring yourself, you might want to pick a handful of exercises and rotate through them. Whatever you do, you have to balance diversity with consistency. If you're not consistent, you can't measure improvements.

My preferred approach here is to find some big lifts that you can keep more or less stable and hammer away at, and then play around with your smaller assistance work as you see fit. Just remember: balance variety with consistency.

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The actual number of exercises you do will depend entirely on the muscle group in question. Too many people fall into the trap of over-generalizing body parts that are actually many separate muscles.

Take the back for instance. Most bodybuilders would just call it 'back' and leave it at that. But if you look at it, the 'back' has quite a few functions around the shoulder joint, scapula (shoulder blades), and spine. For that one body part, there's quite a few anatomical movements involved. In reality, that's because you can identify at least four separate areas in the back that all perform different movements, and those areas themselves are made up of even smaller individual muscles. To train your back you need a lot of exercises to hit all those areas and develop it fully.

That may be part of where the mythology comes from. 'Back' day takes a lot of exercises because there's a lot of separate muscles to train. But there's no reason that a less complicated muscle group would call for this. Let's take the exact opposite, the biceps. Everybody knows the biceps: the relatively simple muscles connecting the shoulder and elbow. For some reason they seem to get something like 99% of the attention in most guys' workouts. Apparently you need to hit the biceps with no less than five different exercises – even though they perform what is effectively a single function.

Actually that's not true - the bicep does have two functions. Besides flexing the elbow, which brings your wrist up to your shoulder, it's also responsible for the rotation of the wrist (called pronation). You can actually toy around with the position of the shoulder and the position of the wrist to change the stress on the different arm flexors. What, you thought the bicep was the only one? No, there's another muscle in the upper arm (the brachialis) and another in the forearm (the brachioradialis) that help with this as well. You can alter how much these muscles contribute (or don't) by rotating your wrist. The bicep itself has a slight role in flexing the shoulder – moving the arm up and over your head. You can change the degree of involvement by changing where your elbow is in relation to the body.

But most folks don't even consider this. It's standing barbell curls, standing dumbbell curls, curls with the EZ bar, cable curls...and all of them for 5 sets of 10. I'm not sure what this is supposed to accomplish, really, but I can't see it doing much besides giving you very stiff arms the next day. If you really wanted to do different exercises for those muscles, you'd want to exploit different shoulder and wrist positions. While I don't think the shaping effect exists, if you're convinced it does, that's how you'd want to go about it - by actually working muscles in different anatomical positions.

Unlike the 'back', the 'biceps' can be trained very effectively with a single exercise. Because they're being worked in rowing and pullup exercises, some people opt not to train them at all, or only occasionally. At best, if you're really convinced you need several exercises for your biceps, you could get away with a battery of maybe 4-5 exercises – and no more than two in a workout. Even that's pushing it, in my opinion. Seriously, they're not a huge muscle and they don't do much. They don't need that much hammering.

MUSCLE SHAPING AND SCULPTING

A lot of you have certainly come into lifting at one time or another thinking that you could shape your muscles. You've almost certainly heard of (or done) programs with exercises for the outer and inner chest, exercises for different parts of the quads, the biceps, and whatever else you care to name.

This is based on some half-truths. Some muscles are actually grouped into different structures, called heads, that attach to different spots on the skeleton. Each head has a different function. The shoulder for example is actually three heads that do different things: we call it 'the shoulder' even though it's actually made of several

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smaller muscles. Part of this is due to neurological wiring, part due to function, and mostly because of convenience.

Most of the larger muscle groups in the body are like this, made up of several smaller muscles. 'Back' and 'legs' would be two examples. For all that bodybuilders like to label these as a single muscle group, they're actually composed of multiple smaller muscles. Again there is some convenience involved, since those muscles tend to have similar functions. There is some logic involved in training them together.

With regards to the shaping argument, it seems that people are making a case for two different types of shaping. The first and probably the most common is the idea that you can change the shape of a single muscle - for example, the bicep or the chest. The second idea is that you can change the relative proportion or visual shape of a muscle, which isn't really shaping as much as it would be developing certain muscles over others in order to create an overall customized aesthetic.

To some degree or another, changing the way you do an exercise can change the way muscles are recruited. But does it really make a difference? Not just guys swearing up and down that it works - I mean does it actually work? There's arguments that can go either way, although what you'll see is that it's not very likely in either case.

The big finding for the first pro-shaping viewpoint is the way that motor units are arranged into functional compartments. Without getting into extreme detail, these compartments are groupings of motor units inside a single muscle that are activated under similar conditions. An exercise, weight, or rep range that activates one motor unit may not activate another that is immediately next to it, and vice versa. But that same exercise might consistently activate the same bundle of motor units; change the exercise and another group might be activated preferentially instead.

Unfortunately this isn't terribly well studied. Differences in motor unit activation have been observed in a number of muscles, depending on the type of activity. It's like having a muscle in a muscle; moving one way might activate this group, while moving another way might activate that group. Going by this logic, different lines of pull through the muscle and different groups of MUs being given consistent stimulation, over time, might add up to a difference. It's at least plausible.

There's still some major obstacles to overcome, though.

For one, force is force. When the fibers in a muscle contract, they have to transmit that force to the skeleton. This means that the entire length of the muscle shortens, and within an individual muscle it would be very unlikely to notice any variation in tension. Once the muscle contracts with enough tension to create any growth, it's tight all over so no particular point would get more stimulus than another. Think about what happens if you stretch a sheet of rubber. Either the whole thing stretches, or it tears. Muscle isn't really different. Now, the force through that sheet of rubber won't be uniform, and that can apply to the muscle as well; the question is, can that difference in force add up to a real change in growth with time?

There's also the matter of maximal motor recruitment, where all available motor units become active. Thing is, most of the compartment studies aren't really working with reasonable loads; most of them are working with substantially less than would be practical for any bodybuilder. If the compartmentalization effect doesn't keep up under those conditions, then the effect is going to be pretty much non-existent. As it stands, there's no real reason to think that we'd observe this under conditions that bodybuilders would experience.

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But, there's another potential but with regards to maximum training effect and fatigue. Remember earlier where I stated the point about fatigue leading to ischemia and then subsequent damage to the fiber. If that does hold up as a way to maximally stimulate a muscle fiber, then there's another possible avenue here.

When training at or past the point of maximum MU recruitment, the weak link in the chain is going to terminate the set. The highest threshold MUs, the heavy hitters that produce the most force, are also the ones with the lowest fatigue times. They don't have the ability to stay active for very long. Once they fatigue and give out, you lose the ability to move the weight.

Here's the thing - if we're going by maximal stimulation as the guideline, then the fast-fatigue MUs were stimulated, and nothing else was. How do you train the other MUs? Simple. You reduce the weight on the bar so that you're under the threshold of maximum MU recruitment. When you do this set, you'll be training with higher reps. When you create fatigue in this set, you're targeting the MUs that have higher fatigue times and exhausting them, too.

Now this is where the logic has to get really shaky. If the idea about maximal stimulation from ischemia and fatigue holds up, and if the idea about training specific groups of MUs holds up, then you *might* have a case for training different components of the muscle. The argument would be that training with a weight light enough to allow higher reps wouldn't necessarily involve all the available MUs; this would allow you to preferentially train some parts of the muscle over others.

As much as I think it'd be neat if this held up, I don't think it stands up to scrutiny. For one, it doesn't address the line of pull and force transmission through the muscle. While I can't rule shaping out on that alone, it is a big glaring hole in the idea.

Two, I just can't point to anybody that would benefit from it as compared to sticking to a handful of exercises and focusing on progressively getting stronger. I have a hard time seeing how a guy who's built a nice physique with the same 10 exercises is going to magically get bigger because he started working things from different angles.

Finally, I'm not completely convinced that the ischemia/fatigue factor is that relevant; active motor units are still going to be exposed to tension just for the sake of being active. While there may be something to maximal stimulation from fatigue, I think it's incorrect to say that fibers that aren't fatigued get *no* stimulus at all – remember, this is a sliding-scale effect, not an on/off switch.

While I do want to argue for this point, I just don't think I can. If there is anything to this at all, it's restricted to the most elite of the advanced, and it's only making sure that they're not leaving anything out of their overall development - if any kind of shaping effect even exists in practical terms, then it's utterly useless to anyone that isn't a high-level bodybuilder.

Now anecdotally, I have seen it pointed out that powerlifters and strength athletes that diversify their exercises tend to be bigger and more bodybuilder-ish than the guys that stick to only their competition lifts. Of course, this could just be a side-effect of extra volume and actually doing muscle-specific exercises, much more than the simple fact that the exercises were varied. If you look at the discussion on bodybuilding vs. powerlifting, I made this exact point – oftentimes the reason that a powerlifter doesn't look as muscular will be because he isn't training some muscle groups with the same volume. In that case, it's just a matter of exercise selection favoring total symmetry and development, rather than some magical shaping effect.

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For my money, I'll let Occam's razor get rid of the middle man. As far as I'm concerned, while there is some evidence that might support the idea, there's just not enough to support the idea that shaping, or even any sort of 'complete development', actually happens. Even if it does, the majority of the evidence doesn't support it as useful for most people.

What about the other concept, the idea of muscle proportion and shaping the body from an aesthetic standpoint? This one is a big harder to disprove on scientific grounds, but there's arguably even less rationale for it.

The concept is simple here - the muscles that you want to develop, you train and train hard. The muscles that you don't want to get 'big and bulky' are either not trained at all, or trained very lightly with higher reps. This is supposed to emphasize some muscles and de-emphasize others, creating an overall aesthetic shape.

When I read that, the first thing I think about are the 'light bulbs'. You know exactly what I'm talking about - the guys at the gym that train nothing but bench press and bicep curls. Every so often one of these guys will actually see gains from that kind of training, getting a barrel chest and big arms. With no leg or back development. For his efforts, this guy takes a lot of crap and is prone as hell to injury because he's so imbalanced. Everybody loves to make fun of the light bulb guy.

My question is, with that being the case, what makes you think you can do the exact same thing and come out looking good because of it? Make no mistake, the analogy is identical.

Most of this kind of 'shaping' and 'sculpting' stuff is targeted to female insecurities, promising the body of whatever celebrity is popular at the moment. Various special exercises are promoted to build some muscles and break down others and make you look all slim and toned and lean and yay!

For my two cents, it doesn't work that way. Your body is going to grow how it wants to grow. You're either training a muscle or you aren't. If you're training it, it's going to develop. It doesn't have to grow to massive proportions, but by and large that's up to your genes. If you're not training it, you're asking to look as ridiculous as light bulb guy.

For all that people swear you can do this kind of thing, nobody has actually been able to point out to me a person, male or female, that has changed his or her aesthetic appearance with these magical body-shaping routines. And it's not that I haven't been asking, either. Everyone I've seen used as an example just got bigger muscles or leaned out.

There is absolutely nothing out there that would suggest you can substantially change your overall body shape by selectively training and neglecting individual muscle groups.

Now if you want to talk about degree of muscle development and body fat levels, then I'm willing to listen. But that's become a matter of body composition, and by extension, your diet and total activity level. It's not something you can just wish into being with Pilates and high reps.

What bothers me even more is when you see some trainers trying to intentionally overwork or neglect parts that are 'too big' on women. This usually comes about in women's bodybuilding and figure competitions, but you'll see it in general fitness too. The problem is that aesthetic gets wrapped up in physiology. It's not a matter of just training a muscle to make it leaner; it's a function of body composition.

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If a part is genuinely too big, well – you're just stuck with it. If you stop training it, it will be less muscular alright. In physique training, less muscular also means 'soft'. If you're OK trading muscularity for less definition, then have at it. Realistically, this ends up in the same fantasy land as muscle shaping. Everybody talks about it, but I've never actually seen somebody do it successfully. The people that try it end up looking worse for their trouble.

To make the point again: train everything. If you don't, you're going to look worse and you're going to increase the chances of getting injured. Training everything makes sure that there's no weak links and no muscles being neglected.

A bigger and more complicated muscle group can justify – if not require – more exercises to work it completely.

In general, your back and legs will have the most need for exercise diversity simply because of the amount of muscle involved. Some people would include the 'chest' or upper-body pressing muscles here, too. Taken together, the big exercises for squatting, pulling, and pushing will work nearly every muscle in your body. The detail work comes in when you're built in such a way that these basics don't target everything in an ideal sense.

Anything involving single-joint training just won't need more than one, at most two, exercises, and even in that case it would be your preference - not because of any physiological reason. There's just nothing there to train and shape. Pick an exercise, get your work done, and call it a day. Bro-science has a knack for generalizing when generalizations need not apply, though. Because you can somewhat emphasize different areas of *some* large muscle groups, due to those groups actually being made of several individual muscles, that must apply to all your muscles. You have to take it on a case-by-case basis.

As a rule of thumb, if you're wanting to get bigger and stronger all over, you'd want to focus on a handful of big exercises. You can get away with as few as three – a lower-body exercise, an upper body pressing exercise, and an upper body pulling exercise. Hit those hard and work to get good at them. The more you focus on them, the stronger you can get.

If you're interested in developing smaller, individual muscle groups, that's where the bodybuilding diversity comes into play. You'd use a greater diversity of exercises to work the specific areas you want to develop. If you're more advanced, you'll probably want to pick one or two muscles to specialize when you train this way.

Women, this applies to you and all your attempts to shape, sculpt, and tone, too. As much as we may not like it, you're just not going to change the shape your body wants to be. You may be able to influence it subtly, but even that is a big maybe. For whatever my opinion is worth, I've never seen anybody actually create this ideal aesthetic illusion. People either have it or they don't. Nobody trains themselves into it.

There's just no such thing as toning. There is no body shaping or body sculpting. There is no such thing as training in order to get long, tight, lean muscles. Women constantly have this crap rammed down their throats, from aerobic workout DVDs and step classes to rubber tubing and chrome-plated 3-lb dumbbells that seem to pass for weight training.

Let's look at this rationally - all you're going to accomplish here is improvements in cardiovascular fitness, possibly some muscular effects if you've never set foot in a weight room. And that's the best case scenario. 'Toning' is not some different style of training, and it's not an alternative goal. All of these sculpting, shaping, and toning workouts are nothing more than aerobics and resistance exercise without much emphasis on the resistance.

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My personal belief is that 'toning' does actually have an effect, though - just not what people make it out to be.

What you get is people that are getting in shape, aerobically speaking, and developing a small amount of muscle. Without progressive overload and with only tiny weights to begin with, 'toning' won't really build any muscle in anyone that isn't a total beginner; but it will maintain muscle mass in someone that isn't already carrying a decent amount. Combine a lot of aerobic exercise with enough resistance exercise to maintain muscle, and guess what you get? You get a small girl with just a little bit of muscle and below-normal levels of body fat, or 'definition' as most would call it.

I'll add a caveat, though: this is not a powerful training method. A girl that's already of average build and that isn't terribly out of shape can probably end up looking anywhere from decent to really amazing, depending on how things come together. I'd suggest that diet and genetic tendencies would contribute far more than any workout, though.

The problem isn't with them; the problem is with women that either won't respond as well, women that are built differently, or women that are more than a little out of shape. Toning and sculpting are the female versions of bro workouts; everybody supposedly trains this way, but the people actually getting results from it are a very small percentage of that number.

Honestly, can anyone actually show me a woman that has truly changed her body shape with this methodology? I see a lot of girls that look pretty good that swear by 'toning', but despite that I've never actually seen a woman significantly change her shape with that kind of exercise. I've seen plenty of women lose a lot of body fat and end up looking amazing, but that's not remotely the same thing. I'm talking about actually changing the relative proportion of muscle, or affecting the shape of a muscle, not going from overweight to in shape.

It seems more like cause and effect are getting confused again – just because these girls look good doesn't mean that their workouts are useful to girls that don't look that way.

The fact that nobody can even name an example kinda makes me scratch my head. Combine that with the low numbers of people getting any sort of results despite the popularity of 'toning' workouts, and that would suggest that more productive ways could be found. As I've said, I think most of this just boils down to body composition factors - muscle mass and body fat.

You'll hear all kinds of people asking how to make X part look better. My butt looks bad, how do I make it look better? My arms jiggle, how do I tighten them up? See, this is one of those context-less questions.

Maybe it sounds reasonable to the people asking it; but from where I'm sitting it's the equivalent of asking how to make water dry. If a body part is a trouble area, let's think about it logically. Is any one exercise or workout likely to change that, based on what you've read here so far? Do you think you can just magically work this part and 'make it look better' without even defining what that means? For that matter, can you even translate 'make it look better' into a realistic goal?

Note that 'realistic' does not mean that you just do a lot of reps and watch it magically tone up. I mean speaking in terms of physiology or exercise science. The only things you can realistically do are build up the muscle or drop body fat. And this is where folks get confused. The toning/shaping/sculpting culture has melded these two goals together, making it sound like you can go in and pick out some magic exercises that will 'make your butt look better'.

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Realistically, you train the muscle and drop some fat. It'll look better - in fact, it'll look as good as your body will allow it to look. And ladies? You don't get 'too bulky'. You don't wake up one day looking like She-Hulk. Believe me, some of us men have been chasing the big, ripped look for years and still haven't gotten there. The odds of you doing it are not good, to put it mildly.

My pet belief on that: when you first start to lift weights, it's normal to see some mild weight gain. Further, because you're adding a little bit of muscle, everything gets 'bigger'. These are not bad things - these are normal, expected responses to exercise. What happens, though, is that you put on your favorite jeans and notice they're tight. Then you go step on the scale and holy crap you've put on three pounds!

What the hell is going on here? Isn't exercise supposed to make you look better? Now you've got to go buy new clothes and go eat a tub of ice cream because you're depressed about your huge butt. Okay, I'm poking a little fun here, but there is some reality to that story. For some reason, too many people get really attached to very simple, and ultimately meaningless, numbers; the big ones being scale weight and clothing sizes.

The funny thing about body composition: muscle has a higher density than fat. For any given amount of space that your body takes up, you'll be heavier if you have more muscle. In other words, you can actually get heavier, going by the scale, and have your clothes fit better than when you were lighter. The mirror will tend to agree with this too; a big reason I always suggest that women not bother with the scale when starting out on an exercise program.

And all of this is compounded by the fact that the average woman - and man, for that matter - will have some really messed up ideas on what's actually an ideal or pleasing shape for a female body. This can be anything from 'I don't want big bulky muscles' to 'if my ribs aren't poking out I'm fat' to anything in between. This makes it even more difficult to deal with the situation objectively. One girl can come in complaining about how her legs are way too big and she wants to shrink them, while another girl built the exact same way can come in complaining they aren't big enough.

That's the nature of the subjective game - you can't just listen to what somebody thinks and assume what they want from it. Seriously, I've seen some really, really odd ideas on how physique should be trained. I've been told that 100 lb women are 'too muscular'. I've seen girls with a visible six-pack say they're too fat. I'm not just picking on the girls here, either. Men do the same thing, in different ways. I'm bringing this up in particular because women do seem more susceptible to it. Part of it is social and cultural factors, and part of it is the fact that the fitness industry in America is full of uneducated people passing themselves off as experts so that the thought process is constantly reinforced.

Ultimately I'm not here to tell you what looks good. That's your call. The take home message: you're not going to shape your body in any appreciable way, outside the gain of muscle mass and the loss of body fat. As far as shape, your body is going to end up looking the way it wants to look. When you lift weights and diet, you either accept this or you quit. And ultimately, aesthetics do come down to a matter of personal choice. If you're enamored of the skinny waif look, or if you think that your 12 inch legs are too bulky, far be it from me to stop you from achieving your best body. Just realize that you're doing it wrong.

STRUCTURAL BALANCE AND FUNCTIONAL TRAINING

One big issue that comes up with arbitrary exercise choices and muscle group workout routines has to do with the overall balance of strength across your body.

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The body is designed to move as a system. When you start doing a lot of curls and leg extensions and dumbbell flyes and things like that, you're working the muscles to the exclusion of movements. Over time, you tend to build up movement imbalances as some muscles get stronger than others. You can point to many cases where people even do this intentionally – guys like to train the chest and biceps, girls like to do weird shaping stuff to build that beautiful body that they'll never get.

That's great and all, but if you push that kind of imbalanced training too far, you're just asking for problems.

Even with compound lifts and a balanced routine, this problem can come up. Compound lifts are all about movement efficiency, and over time it's certainly possible to develop movement patterns that can neglect or under-work some muscles.

The big trouble spots to be aware of are the shoulders (which is really the 'shoulder girdle', including the shoulder blades/scapulae and thoracic spine) and the hips. It's very easy for some of the tiny muscles in these areas to get tight or neglected by just relying on the big lifts. This is a problem because these neglected muscles are responsible for keeping other stuff where it's supposed to be, which in turn keeps the shoulder and hip joints working properly.

How many guys do you see walking around with hunched shoulders because they bench all the time and never do any upper back work? The pressing muscles are developed all out of proportion to the muscles of the mid-back and rear delt. How many of these guys currently have shoulder problems?

In this case, it's about balance. The pressing isn't balanced with pulling, and there's no attention being given to the actual muscles that are important.

How many people are walking around with lower back pain? How many with knee problems?

Watch these guys lift and you'll see a combination of issues. Leg workouts will consist purely of leg extensions and leg presses with a two-inch ROM and way too many plates. If they squat at all, it's the little dippity-doo knee-bends that look like a curtsy. Squatting with a full ROM and deadlifting is 'dangerous', of course, despite there being no actual peer-reviewed evidence to support that belief. Then these same people will go run on the treadmill for an hour.

I'm not going to moan about the leg extensions or leg press, as some are prone to doing; they can be useful when used properly. My complaint here is that people are using them to the exclusion of other, better means – not as accessory work, where these things are ideal. If you're not getting full-ROM work around the knees and hips, along with some single-leg training and mobility work to keep the hips happy, then you can expect problems.

Of course balance can also be a function of program design. Think about how some bodybuilding routines are set up. They'll have a chest day, a shoulder day, a back day, and an arm day that involves heavy pressing work. That's four days a week that the shoulders are getting hit, even though there's only one 'shoulder' day. That's a ton of work for a little damage-prone joint, and further, there's no concern for balance across it.

I've already discussed what the normal 'leg day' can do for the lower body. When you only consider what muscles are being trained on a given day, you tend to lose sight of other considerations like this.

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That said I do think that there's a huge difference in the needs of a bodybuilder as compared to any kind of performance athlete. Bodybuilders need to stay healthy, sure, but they also aren't going to be out on a field running around and getting hit, either.

I'm also not a fan of the current trend of relying solely on physiotherapy trends and research to dictate how athletes should train. Physiotherapists do great things for people that have undergone injuries and need to regain basic mobility. When it comes to training athletes (or even otherwise healthy recreational lifters), I've seen some exceptionally unintelligent suggestions come from that field.

Because of that, I take their advice with a grain of salt. It's one thing to rehab injured people; it's another thing entirely to put together a program for a performance athlete. No harm in listening to some suggestions regarding good practices, mind you, but you have to balance that with pragmatism.

The point here is not to nag you about corrective work – though it's a good idea. Rather, I want to drive home the point about having a balanced routine, and not neglecting parts to chase some impossible goal.

It's just not a smart idea. Split training and 'shaping' won't actually change your shape, the benefits to your muscle mass are questionable, and you're dramatically increasing your injury risk on top of that.

What about 'functional training'? 'Functional training' is all the rage these days. This ranges from the physiotherapy-inspired workouts that treat athletes like fragile children right on down to the massively-parallel 'functional' workouts that involve a lot of kettlebells and poorly-executed power cleans.

Nothing against these schools of thought, except where they stray into dangerous territory, but let's be clear on something. Functional, in the context of athletic development, means one thing: improving the body's function for a specific activity. By that definition, functional training is simply training for a particular goal using the exercises and methods that help you reach that goal.

These days you'll hear people talk about 'functional training' like it's some discrete way of training. It seems to have caught on like wild-fire the last few years.

Powerlifting isn't functional. Olympic weightlifting isn't functional. Bodybuilding damn sure isn't functional, they say. Mixing and matching strength and endurance and whatever else is supposedly functional. Doing all your exercises on a Swiss ball is functional. Allegedly.

When someone says that something is 'functional', your first question should be 'functional for what?' Functionality is entirely based on context.

Earlier when I was bitching about the comparisons between bodybuilders and powerlifters, I touched on the ideas of general and specific training methods. A general training method improves your body's overall capabilities, but doesn't always have to apply to your particular sport. In contrast, a specific training method is one that directly benefits your sport. This is the same idea.

Functional training for a bodybuilder encompasses a lot of methods that are usually thought of as nonfunctional by the 'functional training' crowd. I'll let the irony of that sink in for a moment.

Athletes have concerns for movement specificity because of their sport. They have specific performance-based goals that have to be met. Bodybuilders, in contrast, don't have that problem. For the purposes of muscular hypertrophy, resistance is resistance. For fat loss, calorie burn is calorie burn.

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Bodybuilders should still work on general needs – the stuff that is usually trotted out as 'functional exercise' – but only to a point. General fitness, which includes conditioning and flexibility, shouldn't be neglected by anyone.

While I don't see a problem in taking inspiration from physiotherapy, I have the same reservations about building a program around rehab methods as I would building a program around any unrelated activity. There's certainly no impetus to refer to this as 'functional training'.

Proponents of 'functional training' point out that bodybuilding is not functional for athletes most of the time. In response, I say 'so what?' Why should you care about that if bodybuilding is your goal? If you're not an athlete and are mainly worried about being pretty, then who cares if your training isn't functional for athletic needs? In this case, *'functional exercise' is nonfunctional for bodybuilding.*

Don't mistake what I'm saying. Free weight strength exercises with barbells and dumbbells should always be a foundation of training. Bodybuilders always need to concern themselves with conditioning, mobility and flexibility, and pure strength/power work. They need to make sure they're moving properly and using a balanced program, just like anybody else. The basics of athletic development don't change, no matter what the goal is.

What I am saying is that ruling out the use of cables, various machines, bands, kegs, barrels, and any other form of resistance is short-sighted if muscle mass is your goal. Leg extensions aren't functional? They build muscle mass in the thighs; that's the definition of functional for the person that wants bigger legs.

I like use the analogy of a building a house. Most bodybuilding routines you see in the magazines are painting the walls. And that's fine, houses need paint on the walls.

But that's not the first step in building a house. You start by pouring a solid concrete slab for the foundation. The foundation is your basic training with the barbell lifts and training to improve your overall fitness level – any kind of conditioning work and corrective/preventative work falls here. After that's handled you can start to frame the house. The frame determines how big the house is and what it's going to look like. This is where you'll start to throw in specific exercises and training methods for different muscle groups.

Only once you've got a foundation and a well-framed house do you need to start worrying about the nitpicking details. Yeah it's a pretty cheesy analogy, but it gets the point across. There's a priority of exercises which is important to obey. You always need to make sure you're moving right, that you're flexible, not out of shape, and strong.

But none of that means you can't add in more traditional bodybuilding stuff on top of that foundation.

This problem has too simple a solution for people to argue so much over it. For whatever reason, it's hard for people to understand that you can bring in 'nonfunctional' exercises without problems if you're still working on the basics. This isn't some black or white issue.

You should include both general and specific training in any program, regardless of goals.

Recovery And Regeneration

As I've been stressing for most of the book, recovery from training is at least as important as the training itself. The trick is to manage stress with a well-designed program.

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I want to make sure the point is clear – some degree of fatigue can be good in a single workout. Going to a point of fatigue on a single set, or getting a little tired from a thorough workout, can be a good thing. In fact, I've argued that a bodybuilder's workout needs fatigue from one avenue or another to truly be effective.

But fatigue is bad in another sense. If you accumulate too much tissue damage and create a lot of inflammation on a regular basis, you're going to pay for it. Same for doing too much mentally-taxing work.

We can differentiate between fatigue in a tissue and fatigue across the whole body. We can also distinguish between residual fatigue from a workout and a true stress response that results from accumulated fatigue. Overreaching, as the latter is called, follows directly from having too many heavy workouts and not allowing enough recovery time between them.

The first step in managing recovery is a smart program design that accounts for this. You don't have to blast yourself to hell at every opportunity. While you can benefit from having *some* workouts like this, they don't all need to be that way.

I feel the need to reiterate this point, because lots of people go by what they feel after a workout. The assumption is that you should be carried out of the gym on a stretcher in order for a workout to be effective, and that you should be too sore to move the day after a workout.

You know what I mean here - all that hardcore/macho crap you hear people going on about. I hope I've explained sufficiently by now as to why this isn't necessary, and it can actually be counterproductive.

A workout done with the goal of muscle growth doesn't require that you utterly exhaust yourself and 'blast the muscle'. This is true even of your hard workouts, let alone the lighter ones. The pump and a feeling of pure exhaustion in a muscle is not a requirement. What matters is that you lifted heavy enough with enough effort and enough total reps to trigger a response. Whether or not you feel it is beside the point.

Same goes for any cardio or endurance training you choose to do; this isn't just limited to strength training by any means. Exhausting yourself can end up hurting your gains. Everything you do in the gym is one more pebble in the bucket of stress on your body.

To summarize: work hard, but don't grind your muscles into powder. At least not at every session. It's better to lay out hard training and save space for some lighter training in between.

I realize some people don't have it in them to scale back the effort, and it's counterintuitive to not give it your best. I also know that some people swear by the exhausted feeling and being sore. But I'm telling you, yet again, it doesn't work that way when it comes to long term results.

Don't be dumb about it and assume that your desire to be all hardcore is doing you any favors. You'll feel better and see better results by exploiting your body's responses, not trying to brute-force them into cooperating.

The leads me into what I want to talk about, namely the different methods of recovery and regeneration work. As I said, the first step is prevention: don't wear yourself out in the first place and you won't have a problem. Since I know you won't listen to me, I want to discuss some other potential options.

Diet would be the big recovery issue. You can't be in a calorie deficit and expect to recovery optimally.

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This goes for all you girls out there that want to eat 800 calories a day while spending three hours on the treadmill, and then wonder why you feel like crap and don't lose any weight. Well no wonder: you're doing too much exercise and allowing too little recovery. You simply don't have the resources to recover, which puts you in a state of chronic stress. Keep that up too long and the specter of Han Selye's ghost will come to visit you as your body exhausts itself. Your body will effectively give up and do what little it can to make sure you don't end up dead.

You need amino acids from protein and you need some carbohydrates in order to maximize recovery from taxing exercise. You need to be in a calorie surplus so that you've got the spare energy to fuel all these metabolic functions. If you're not getting these things, then it's no wonder your recovery time isn't what it could be. You're fueling physical changes to your body, which requires both nutrients and energy. If you don't have those resources and still expect adaptations to happen, you're asking for trouble.

Having a solid program strategy and a solid diet are simply the best things you can do from a recovery standpoint. There are a lot of other things touted as being useful, which you may or may not find to be effective. These would be the so-called restoration or regeneration methods.

Manual tissue work such as deep-tissue massage, Active Release Techniques (ART), and myo-fascial self-release (aka foam rolling) can all help to loosen up adhesions and break up scar tissue in the muscle complex. Even plain-old stretching after a workout can give you some of these benefits.

Myo-fascial release in particular, better known as foam rolling, is a cheap and easy way of getting some soft tissue work. You just put the foam roller (a cylinder of hard foam) on the ground, lay on top of it with the target muscle positioned correctly, and slowly roll back and forth to loosen up the muscle. You can do something very similar with a tennis ball to target the hard-to-reach areas. Be warned that this can be very painful. It gets better with time as you loosen up, but it's always going to suck.

Soft tissue work will loosen up the muscle, which can help improve blood flow (and thus recovery) and improve neurological tone (so that you're not so tense all the time).

Alternate use of cold and heat is another recovery option often suggested. Cryotherapy, or treatment with ice and other cold objects, can be used after very hard workouts. This can help to reduce swelling and to improve blood flow once the cold is removed. Cold therapy can be as simple as rubbing an ice cube (under a rag) over the affected muscle all the way up to an ice bath (which will suck, and probably isn't necessary unless you've just utterly trashed yourself).

On the opposite end of the temperature spectrum you'll hear of people taking saunas or hot soaks in the tub with epsom salts. This, too, is a fairly effective way to relax after a session. The hot and cold methods can be combined in contrast showers, which alternate hot and cold water on the targeted muscles. This is supposed to be done with a professional piece of equipment, mind you, so I'm not sure how effective it is to just stand in the shower flipping the water from hot to cold.

Some will use so-called feeder workouts to work the muscle with high reps and very light weights, or just use very low-intensity cardio to achieve the same effect. This will also force blood back into the muscles without overworking them. This is something I've found to be very effective, at least for controlling extreme soreness. Of course, this assumes you aren't already working yourself into paste 10 days a week.

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The thing all these methods have in common is that they work to get blood into the muscle, and they prevent said muscles from shortening and becoming less pliable. That seems to be the real trick here, just doing something to keep the muscles mobile and active in between strength training sessions.

As far as dietary supplements, a lot of people will rely on aspirin or ibuprofen to reduce pain. However, I've already gone over that; while I don't think you'll have an issue in moderate doses, I would try to limit my intake of NSAIDs if the goal is increased muscle mass.

Antioxidants, like vitamins C and E, can be helpful to some people, but you run into a similar problem. There's some evidence that antioxidants can interfere with the adaptation process as well.

The thing that bugs me is that anything that actually works to enhance recovery also seems to impair muscle growth and other related adaptations. You might actually 'heal up' faster, but the trade-off is that you aren't going to see the degree of gains you might have otherwise. It seems that the inflammation signals are an unavoidable part of the process.

Think about it like brewing up a cup of tea. You need the water to be really hot so the tea can steep properly, but it's also too hot to drink for a few minutes. You can cool it down by dumping ice in the cup – but if you do that, the tea won't brew properly.

You're kinda in a catch-22 here. If you use the restoration methods, you could be compromising gains. On the other hand, if you don't use them, you might not be able to sustain your training. In the scheme of things you have to look at it from a cost-benefit standpoint. Ask yourself what's more important: gains, or recovery? That's going to be your determinant, and there really is no one right answer. You could be in a situation where you need to maximize recovery and it's worth whatever small cost in gains there may be.

Restoration methods are almost mandatory for serious performance athletes. These individuals may have to handle a substantial amount of exercise and practice sessions, and they'll need to be recovered for those sessions (or for the game). However, to point out the obvious yet again, bodybuilders don't have that kind of pressure – and even competitors can afford easier training schedules most of the time.

I also have to address the Big Pink Elephant again. Anabolic steroids, even mild doses, are very effective at increasing recovery ability. The positive effects they have on protein synthesis and tissue regeneration can dramatically shorten the recovery time, even from sessions that would otherwise be crippling. Not only can the athlete simply tolerate higher workloads, but he can actually adapt to them and thrive from the stimulus. Further, these 'regenerative doses' won't necessarily build crazy amounts of muscle, either, so it may not be as obvious that the person's using them.

This is one big reason why high-level athletes in any sport can get away with crazy amounts of training and still improve. It's also why natural bodybuilders should be wary of copying the elite.

Ultimately, I feel that prevention is the best cure. There's nothing wrong with using restoration techniques from time to time, say if you're in the middle of a difficult training cycle. I just don't think you should rely on them in the course of regular training. Having a well-designed program is the best way to handle recovery issues – by not having them in the first place.

Toolbox Of Training Methods

With all the theory stuff out of the way, we've got a good understanding of what's going to make you bigger and stronger. We need to overload the muscles using a combination of heavy (and progressively heavier) weights and sufficient muscular work (by manipulating volume and density). The trick now is translating those general concepts into specific (and practical) methods.

ORGANIZING SETS AND REPS

The first thing we need to do is break down how we're going to organize our session. When you go into a workout, you should have an idea of the theme for that day – are you going to use very heavy weights and work on a few exercises? Are you going to come in and exhaust your whole body? Maybe do a really heavy session that combines some of both?

Whatever your goal, you're going to have some idea of the target intensity zones and the target volume for the day. The most common way this is proscribed is to give a working weight and then a set/rep scheme, which may look like 4x6, 3x10, or what have you. That's read '4 sets of 6 reps' or '3 sets of 10 reps' in the notation I use (others may write it differently, so be aware of that).

Now, when I say 4x6, what does that mean to you? Am I telling you to do all four sets with the same weight? Or do you add weight each set? Maybe you're supposed to build up to a heavy weight, then back off once you get tired? Depending on the program, any or all of these could be valid ways to do things. This brings me to the three main ways of actually doing your sets.

The way most people do things is called the pyramid. With a pyramid, you add weight each set until you reach the heaviest set of the day. You can either stop here, or you can do a double pyramid which basically reverses the process – so you work back down to lighter weights.

The pyramid has problems. The way most bodybuilders suggest pyramiding is to work each set to exhaustion on the way 'up'. You'd do 60% x10, 70% x8, 80% x6, and maybe 85% x4. Doesn't look so bad? The problem is, those sets at 60% and 70% are going to wear you out before you even get to the heavier, more productive sets. The pyramid isn't totally useless, but when we're after quality of work – say for strength training or if we just want to use higher weights – there are better ways to do it.

The flat pyramid, or 'sets across', has you stick to one working weight for all your sets. You can do a few warm-ups, but these are kept short instead of tiring you out. So you might do something like 60% x6, 70% x3, 80% x2. With sets across, the two warm-up sets are just enough to get blood moving; the actual work is done with the heavy, productive weight.

Then we have the reverse pyramid. With this method, you ramp up to your heaviest weight after your warm-up sets, just like the flat pyramid. The difference is that after your heavy work, you decrease the weight to do *back-off sets*. The reverse pyramid can be combined with the 'sets across' scheme by adding back-off sets after your heavy work.

Note also that you don't have to stick to any single approach in a given workout. Your main lifts might use a heavy protocol (like 4x6, 5x5, 6x3, etc.), while your assistance exercises use something lighter (3x10, 4x12, etc.).

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There's a couple of other ways to manipulate the set/rep scheme besides these main three, which I'll mention below. The rest of the methods in this section are just different combinations of intensities and set/rep schemes which can be useful.

MAXIMAL EFFORT – SINGLES

This particular method is an old stand-by which involves doing sets of one rep (singles) with pretty substantial weights. Depending on the strategy, you can use anywhere from 85% right on up to 100%.

There's two options with this method: pick a weight and stick to it for all your sets (sets across), or pyramid up to a heavy single. Note that when you pyramid up in this case, you'd want to stick to singles so you don't wear yourself out. Pyramiding up is a good way to test a new max or break a PR, while sets across is a good way to rack up volume.

Rule of thumb is to get anywhere from three to 10 total reps. You can use either a predetermined goal or use the RPE scale to do sets until fatigue starts to set in.

ACCENTUATED ECCENTRICS AND NEGATIVES

Negatives are an old bodybuilder technique that involves taking a heavy weight, lowering it, then having a partner raise it back. I'm listing this for completeness, as I don't really like partner-assisted methods, but it's an alternative if you like that kind of thing.

The literature likes to remind us that eccentric strength is technically up to 120-140% of 1RM strength, but in practice I don't think this is ideal. Using even 1RM weights would be sufficient for negatives, and I'd probably not go more than 5%, at most 10%, above your best. The risk of injury and cheating is too high.

Negatives should be used sparingly and with very low volume – I'd say that three sets of 1-2 reps would be plenty. The dose-response effect means that very heavy weights like this can stimulate gains with relatively low volume.

Accentuated eccentrics are another way of training eccentric strength without being quite as taxing. This method doesn't use the super-heavy weights of negatives; instead, you just control your tempo when lowering the bar. You might do the concentric (lifting) portion explosively, then use a very slow tempo as you lower the bar.

There's some research suggesting that a faster eccentric creates greater forces, which is probably true. If you're trying to develop speed or power, that's probably the way to go about it. That said, extending the eccentric TUT by resisting the load actually seems to be more productive if your goal is muscle mass. Your mileage may vary.

Another option is to use elastic bands (like those offered by Jump Stretch and Iron Woody) to increase the eccentric overload. The bands pull against the bar and create some weird voodoo effects. They've become very common in powerlifting circles for dynamic-effort training, as bands do seem to have substantial effects on strength and power development.

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Where they'll interest the bodybuilder is the fact that they aggressively pull the bar down. When you resist this pull as you lower the bar, you get a greater eccentric overload without having to use the weight. Bands can be attached to the barbell, dumbbells, and even machines, so they can be used for all kinds of things.

CLUSTER SETS

A cluster set is when you use the intra-set rest method to break up a longer set. Instead of just doing one set of 10 continuous reps, you'd do one or two reps, rack the bar to rest briefly (say 10-20 seconds), then do more reps until you hit the goal. This may also be called the rest-pause method by some, but I consider that to be a little different.

Didn't the research show us that this method was inferior, though? For equal volume and equal intensity, yes. When you do cluster sets, the idea is that you can handle heavier weights or do more total reps than you otherwise could. This is a fatigue-managing method, which allows you to do much more work with a given weight – and you need to take advantage of that for this to be effective.

With a cluster set, you can control volume by either having a target goal, say 10-12 reps, or by using the RPE scale to just do reps until fatigue sets in. For example, if you start out at an RPE of 7-8, you'd work until you hit a 9 or so – the bar would significantly slow down and you'd know you're tired.

REST-PAUSE SETS

Rest-pause sets are similar to cluster sets, only you're not focusing on the quality of each rep. With a rest-pause set, you'd work to failure or very close to it, then rack the bar when you hit your last rep. Then you'd rest 10-30 seconds, give or take.

From here, you've got options. You can either do 1-2 more 'mini-sets' to a point of fatigue, or you can switch to a cluster-style where you just do singles or doubles with brief rest intervals (10-20 seconds). The former will tend to stress you a lot harder, while the latter allows for higher volumes and higher quality of work. Same rules apply as the cluster set.

WAVE LOADING

Wave loading is when you change the weight up and down from set to set, like a wave. The idea is to exploit neurological potentiation, where the nervous system is temporarily 'spiked' after you handle a heavy weight. The idea is to hit a heavy, but not super-stressful, set, then reduce the weight. Since your nervous system now expects that heavy weight, the lighter set should be easier. With this scheme, you'd do a heavy set, then a lighter set, and so on.

Note that wave loading with heavier or maximal weights is a different matter from using moderate weights and higher reps. You need to figure out what your goal is before haphazardly doing a 'wave loading program'.

If you want to handle heavy weights, I'd suggest that you stick to low reps – no more than 1-3 per set. Doing higher-rep sets in between the heavy sets is only going to tire you out, instead of refreshing you – as the lighter set is supposed to do.

If you're after 'muscle' training or higher volume, then the situation is reversed. You'd want to take a token heavy set – heavy, but not an all-out effort. Then you'd focus on your higher-rep sets, which are your target.

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A strength-based wave might be something like 1x85%, 1x95%, 1x75%, etc. A muscle-based wave might go 2x85%, 6x75%, 1x90%, 5x80%, and so on. There's no reason you couldn't just stick to the same rep range, say fives (because fives rule), and just vary the weight from set to set.

Wave loading is one of those methods that's conducive to auto-regulation since there are both 'intensity' and 'volume' variables that you can manipulate. Just remember to pick a single goal and adjust things accordingly.

LADDERS

The ladder method is similar to wave-loading; however, instead of changing the weight from set to set, you change the number of reps while leaving the weight the same.

For example, you might start with 85% for a single. Then you'd do a double, then a triple, and so on. When you reach a point of fatigue, you start the ladder over again.

There's all kinds of ways to do ladders. You can vary the reps (1/5/10), you can work 'up' and 'down' the ladder (1/2/3/2/1), and any number of other variations.

You can use ladders as a method of progressive overload. Start with a series of 1/2/3 reps with a 5RM weight. When you can get three series of 1/2/3, you move to 1/2/3/4 and work up to three series of that. The goal might be three series of 1/2/3/4/5, or a total of 45 reps. If you only started out with 18 total reps at a 5RM weight, that represents a substantial improvement in strength.

DYNAMIC/SPEED SETS

This is well-suited for 'technique' training on your bigger lifts. You'd take a bar weight of 60-70% and just move it as fast as you can for sets of 3-6 reps. If you're stronger, you may benefit from 50-60% or even lower.

If we go by the Westside suggestions, you'd want to rest only 30-60 seconds between each set. Total sets should be in the 8-12 range. However, Louie Simmons has commented that sets of 70% x6 and 80% x4 might be more bodybuilding-specific. Your mileage may vary. You can also use bands for your dynamic sets if you want, in order to increase the eccentric overload.

In a similar vein you can use the dynamic method with a 'do as much as possible' goal. The idea is to work with sub-maximal sets, but do a lot of them and with the shortest rest periods you can handle.

For example, using the same weight and rep-range suggestions, you'd do sets of 4-6 reps, only resting 30-60 seconds. You've got two options to control volume: either use the RPE scale to do sets with strict rest periods until fatigue sets in, or set a block of say 15-20 minutes and do as many sets as you can in that time.

In this case, the rep range and the weight are fixed; the rest interval and total number of sets is what varies and controls your progress.

INTENSIVE BODYBUILDING

Intensive bodybuilding is just regular continuous sets done with very high exertion. You may or may not reach failure, though you'll be grinding out each rep. The target rep range here will be 4-8, which is going to be fairly heavy if you're really putting effort into it. The RPE will obviously be in the 9-10 range.

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TRIPLE-DROP SETS

The concept of a drop set is simple. You do a work set to a point of fatigue, then drop the weight by maybe 10-20 lbs (5-10 kg) and keep going, only resting long enough to change the weight.

As with all the so-called 'intensity methods' that bodybuilders love, the drop set is a way to prolong your ability to work once fatigue sets in, which puts it in the same category as rest-pause and cluster sets.

The triple-drop set is self-explanatory: you do three total mini-sets. Do 5-8 reps, drop the weight, 5-8 reps, drop the weight, 5-8 reps. Alternatively, you can take the last mini-set to a point of exhaustion.

EXTENSIVE BODYBUILDING (PUMP TRAINING)

This is the old standby bodybuilder method. Pick a weight that lets you get 10-15 reps and then do 4-5 sets. If you want to get really extreme, do this for 5-6 exercises per part (*Note: This is a joke. Do not do this*).

The extensive method is fine during lighter phases of training, for recovery purposes, and even for the purposes of fat loss when used to deplete muscle glycogen. You almost always want to combine this method with some kind of heavier training, though; the weights generally won't be heavy enough to maintain muscle mass or strength.

CONSTANT TENSION SETS

Constant tension sets will take advantage of the vascular occlusion concept. Instead of actually counting off reps, the easiest way to do this is to just get a watch or somebody to count the time for you and just go for 60-90 seconds worth of reps.

They don't have to be full range of motion reps, either. Smaller 'mini-reps' would be fine, as long as the muscles aren't relaxed. In fact, I can't think of any reason why you couldn't just do an extended isometric set. Load up the barbell or machine or whatever with a weight that's on the light side and just hold it for the time goal. The working weights here are going to be somewhere in the 30-50% range for most instances.

Constant tension stuff would make a good complement to heavier strength work, if you're so inclined to add it in. I should note that either of these methods will be very painful if you're not used to them, so be aware of this.

LOADED STRETCHING

This method would have you using body weight or some other external resistance to stretch the targeted muscle. At first glance you might think this was just for purposes of flexibility, but there's more to it than that. Loaded stretching has been suggested by John Parillo as far back as the 1980s, and it's a cornerstone of the 'DC Training' system.

Despite some of the questionable explanations offered for stretching your muscles, there is some research support for the concept.

The easiest way to look at it is as a form of eccentric overload. Strictly this would be called eccentric quasi-isometric (EQI) stretching. The idea is to use relatively heavy weights to (very slowly) put the joint through a

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range of motion. As you'd imagine, the result of this is eccentric stress not unlike the lowering phase of any regular exercise.

The rationale usually offered up for loaded stretching is questionable. The original idea came about due to the supposed need to stretch the fascia – the fascia being the connective tissue 'sheath' surrounding the muscle. The idea was that the fascia would become too tight and thus restrict muscle growth. The thing is, the fascia actually grows with the muscle, like all connective tissues.

The other thing is the studies done back in the 90s showing that loaded stretching caused muscle growth and hyperplasia (formation of new muscle fibers) in birds. Only problem is, birds aren't human – and even then, the studies were using a constant stretch for *several days*. Obviously this isn't practical.

That said, if we look at the EQI concept and consider this to be another form of overload, then it fits into the overall model quite well. I'd also suggest there may be something to it from the standpoint of tissue quality and recovery after a difficult training session, which alone can make this method worth doing.

There's not a lot of data to draw on as far as volume suggestions, but the anecdotal rule is 30 to 120 seconds of stretch per muscle group. Grab a dumbbell or position yourself accordingly and stretch away. I should note that this, too, is going to be very painful, so be aware. You'll probably have a very low tolerance to this method at first, so start easy and build up. After a few weeks, it gets a bit easier. Mostly you just have to grin and bear it.

You didn't mention...

Yeah, this isn't a complete list, because I'm shooting for broad classifications and because I think some methods just aren't that useful. Some things (like pre-exhaustion or giant sets) just aren't that valuable, in my opinion. I'm not a fan of methods that require tons of equipment, such as giant sets of three different exercises, or rely on having partner assistance, such as forced reps. Don't let me stop you from using them, not by any means – I just don't see the utility given the options that are available.

Further, some of those methods can be a pain in the ass if you train in a busy commercial gym. Supersetting is one glaring example, which is alternating between exercises from set to set. I have nothing against supersets, and I think they're useful in getting out of the gym faster, which is always a bonus. If you're in an uncrowded facility and can make use of that approach, by all means do so. I just won't ever write a program that makes it mandatory; not everyone can make it happen, for one, and a lot of suggested supersets are thoughtless (Squats supersetted with deadlifts? Seriously?).

The Workout Session

Putting together an actual workout session is pretty straightforward, but there are some things I want to talk about. Might be common sense, might not.

The beginning of the workout should always be some kind of warm-up. I'm not going to tell you to spend 20 minutes on a bike or what have you, but I will say that some kind of activity before I get to it seems to help out. Truth told, I don't bother with this unless I'm feeling really beat up, or if I have no choice but to walk to the gym.

There's one thing to remember about the warm-up: it's not about wearing yourself out. This means don't go in and do 45 minutes on the stairmaster before trying to squat. Prioritize.

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Don't be an idiot about warm-up sets, either. Yeah, doing a few (2-4) sets is a good idea before hitting your real work sets, just to get blood moving and to get the nervous system revved up a little, but a lot of people overdo it.

It shouldn't be complicated. Do a light set and add some weight. The stronger you are, the more jumps you might want to take. You might find that you can make big jumps in weight without a problem. Again, this is a matter of personal preference and a little trial and error. As long as you aren't exhausting yourself before the show starts, you're fine.

As for the meat of the session, there's a few simple guidelines to follow. You always want to hit the heavy stuff before the lighter stuff. Fatigued and exhausted muscles are going to impact your strength. Imagine trying to hit a new 1RM squat after running 30 miles. That won't be fun, right?

Lifting heavy stuff doesn't have the same effect on endurance when you do it first. Strength and power work is always done before endurance work unless you're an endurance athlete. Hint: you're a bodybuilder. Put your heavier work first, and any muscle-exhausting stuff afterwards. Prioritize.

What if you're only doing a bodybuilding workout or only a strength workout? Usual wisdom there is to go from big exercises to small – you don't want to do cable crossovers before bench press, for example. However, I could see the utility of doing say arms or calves before something like squats. Why, you ask? Because a good hard squat workout is a kick in the gut. You may wuss out and go home after a hard workout like that. If you've done your little stuff beforehand, then you don't have to feel bad about doing that. Further, arm work isn't going to affect your ability to squat.

Just remember that as a rule, you want to prioritize the big stuff, which means doing it first.

At the end of the session you'd throw in whatever it is you do for cooling down. Really-high-rep stuff can go here if you're into that, and I'd even include things like cycling and rowing as falling under that heading. Yes, cardio can indeed serve as an accessory to a workout if you set it up right. The idea here would be to gorge the muscle with blood more than anything else.

Stretching would probably be a good idea for both the tissue and for neurological reasons (so the muscle doesn't stay tight). If you're into the loaded or 'extreme' stretching, this would be a good place to put it. Foam rolling and related soft tissue work can go well here for the same reasons. If it was an ass-kicker of a workout, you might want to hit the sauna or hot tub. Some guys will go as far as jumping in a tub of ice. If that's your thing, have fun.

Chapter 5: Program Strategies

IT'S NOT PERIODIZATION. REALLY.

We're winding it down now. What I want to discuss in this section is how you're putting together a workout and how you're going to change things over time to prevent stagnation.

Consider this the 'periodization' section if you must, though I'm doing my best to stay away from a lot of theory-wanking. It's unavoidable to some degree, though I'm doing my best to keep it light.

I'm not going to get into a lot of the history and deep nuances of the subject. Even the name 'periodization' is up for debate, depending on who you ask. To avoid all that discussion, let's assume that I mean 'programming and organization of the training process'. Or, for the laymen, we're talking about putting together a workout and then planning progress over time.

While we can go back and forth about the naming, the application, and all that crap, there's really only a handful of generalized ways to set things up. I'm gonna look at the big ones.

We already know that progressive overload is the fundamental principle, as I've stressed on virtually every page up to now. That's not going to change. However, that simple linear progression can't last forever – so we have to switch to the idea of fluctuating overload. The trend line over time still moves upwards, even though any given point on the line (like a workout) might be flat or even negative (indicating maintenance or even reduction in the weights you're using). Yada yada.

This isn't a bad thing. It's just how the body works, with cyclic variations in your fitness and your body's physical state. Periods of high stress require periods of low stress. Organizing your training over any sufficiently long period of time requires that you take this into account. That's where all of the periodization models come into the picture.

The big problem is that most people don't bank on this. Some people will instinctively understand that they need to get stronger – even if this just means piling on more weight at every opportunity. That's well and good, but without some mechanism to control that increase in weight, you're going to hit a brick wall. Most people's workouts are spent in a hole that they don't realize they're in – and have no idea how to get out of.

Some ideologies, such as the HIT guys I've mentioned before, would suggest that you must add strength at every session. Without fail you must add weight to the bar, or at least do more reps with a given weight. A workout without improvement is a workout without utility, so they say.

If you're doing nothing but toiling away with challenging workouts and stuck in a rut, then you're at the wall. You can use the analogy of racing down a highway. If you put the pedal to the floor, you'll hit every light. If you use a moderate pace, you can time it to hit all the lights. Progressive overload races you right up to the light. Fluctuating overload accelerates at the right times, then throttles back to keep you moving along.

What you're going to see here, and what is far more important than the actual periodization model, is that workout stress and your actual gains are going to move like a wave – just like going down the highway.

You'll have high points and you'll have low points. The message is that you can't really be at your best all the time. You'll have times when you can go all out and break records like crazy. You'll have other times where you'll have to stick to light weights and boring stuff – which will set you up for later progress.

The thing to remember is that the low points are important – they allow your body to rest and to build up without a lot of stress. When you get back to hammering yourself, you'll be better for it. The trick to periodization is just figuring out how and when you hit the highs and lows.

Periodization Wanking

In this section I'm going to cover the basic theoretical models of programming and organization. This is may be rehash for some of you, and it may even be a little boring. However, I'm not going to dwell on much of this as it's just not important.

TRADITIONAL 'LINEAR' PERIODIZATION

Ah linear periodization. Hated, feared, misunderstood. The linear model is the granddaddy of them all, originating over in Russia many years ago. It's a very simple approach, starting with high reps and low weight, then adding weight on a weekly basis while dropping the reps.

Linear periodization is considered synonymous with progressive resistance training and simple progressive overload. You simply add weight to the bar each week, reducing your rep range as you go. However they aren't exactly the same thing, so the first thing we have to do here is distinguish 'linear periodization' from simple progressive overload.

Traditional linear periodization blocks off separate phases of training, or if you prefer, periods of training (hence the name). Each of these training blocks is given over to a particular goal, such as muscle hypertrophy or pure strength development. The linear nature of this approach comes from the fact that progressive overload is applied literally – the weights increase while the rep range decreases.

You might start out with sets of 12-15 reps to condition the body, then move on to 8-10, then 4-6, then the so-called 'power' range of 1-3 reps. Volume drops as intensity increases. Over the course of a training cycle, traditionally a single year of training, the athlete will reach a peak – the heaviest weight and lowest reps.

The standard linear training cycle is broken down into four phases: anatomical adaptation, hypertrophy, strength, and conversion (or power). This happens as the reps drop and the weight increases. Since low-weight/high-volume is associated with muscle growth, we consider this 'hypertrophy'. The same goes for low reps and 'strength' or 'power' training.

Table 4.1 - Example of traditional linear periodization

Weeks	1-4	5-8	9-12	13-16
Reps	10	5	3	2
Sets	5	3	3	3
Intensity	75%	85%	90%	95%
Volume (Reps)	50	15	9	6

In the orthodoxy, the linear model is usually not suggested for people that aren't beginners. Why?

It has a few potential problems. Firstly, a beginner will get stronger from almost anything. When you start out, the higher reps will build a foundation, and over the cycle you build up to heavier weights. No problems so far.

What happens when you get stronger, though? We know that the stronger you get, the more overload it takes to tax the body and create improvement.

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Now what happens if you're spending four weeks working with high reps? You're ignoring the heavier weights that you need to make improvements. Advanced athletes will often drop the anatomical adaptation and hypertrophy phases entirely, in favor of sticking to heavier weights and lower reps throughout the year.

What happens two months down the road when you're working on power? Since you've dropped the volume of work, you're going to lose all that hypertrophy you developed earlier on. There's no continuity between the different things being trained.

Linear periodization is synonymous with slow, gradual, and steady changes in your working weights. Since part of stimulating the body is introducing unfamiliar things, there's really nothing to shake up the monotony. That by itself can cause you to get stale and stagnate.

Now, that said, I do think some these criticisms – no continuity and no novel stimulus – are overblown and very easily avoided. The crux of the matter is that the needs of a bodybuilder, or any strength athlete for that matter, are pretty simple: it's all about getting stronger.

Much of the criticisms of the linear model deal with the original year-long cycle, as well as the fact that it doesn't account for any consistency over the long run. Updated variations of the traditional model which use two, three, or even more 'peaks' each year are far more common, and far more useful.

Despite all the flak it gets, plain old linear periodization works. The drawbacks have more to do with implementation than any real flaw in the concept. Sticking blindly to 16 week cycles probably isn't smart, but there's no reason that a form of linear periodization can't work over the short term.

Powerlifting legend Ed Coan used linear periodization to set more than a few world records in several weight classes. That may not be the best example considering it's freakin' Ed Coan, but the point stands – when you can be a long-standing world champion using a basic linear plan, it throws out the idea that it's 'ineffective' for high-level athletes. In this context, it obviously can work.

To me, the big issue for a strength athlete is the lack of any sharp changes in stress and the time frames involved. To really be effective, I'm of the mindset that a routine does need some kind of variation in the workouts. Sticking to just one approach may not be optimal for a lot of people.

Periodization is fundamentally about hitting highs and lows. The orthodox linear model still does this, just in a way that may not be compatible with the needs of some people. However, I can see no real reason why even a relatively strong person couldn't benefit from a 6-8 week linear periodization approach. If you use a reasonable time frame, a lot of the issues vanish. If you're building up to a peak roughly every two months, you're still accomplishing the goal: spend some time training easy, spend some time training hard. A training cycle using linear periodization over 6-8 weeks is still making that happen.

NONLINEAR PERIODIZATION

So you've decided that linear periodization isn't for you. That's fair enough. While I think the criticisms of linear periodization aren't valid for a lot of strength athletes, there's still reasons to explore other options. In recent years this linear model has been superseded by the so-called nonlinear (or undulating) methods.

Remember that our goal isn't necessarily progressive overload, but *fluctuating* overload. Meaning, the progress from workout to workout isn't as important as the progress over longer time frames. The term in

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vogue these days is *nonlinear or undulating periodization*. When something undulates, it moves like a pendulum swinging back and forth. High to low, low to high. Repeat.

The nonlinear methods simply alternate heavy, medium, and light training over some period of time; the workouts can alternate from session to session (daily undulating periodization), from week to week (weekly undulating periodization), or from month to month (block periodization).

Where the linear model moves gradually between hypertrophy, strength, and power phases over a series of weeks (thus making it linear), undulating models, well, they undulate between those over the short term – within a week or over several weeks.

You'd spend time on hypertrophy, then a little time on strength, then on power, and so on. Instead of having these huge cycles that go on forever and only gradually shift between these factors, you frequently change the stress over shorter time frames, training everything at once in alternating workouts.

Charles Poliquin was one of the first to discuss the idea in Western circles, so far as I can tell. In his article *Football: Five steps to increasing the effectiveness of your strength training program* from the NSCA Journal (1988), Poliquin discusses the key flaws in old-school single progression and outlines his solution.

When you simply add weight on a regular basis, you don't impose any real demands on the neuromuscular system. The body will adapt, of course, but it's a weaker stimulus since the body gets used to it. In effect, you run into a wall; trying to push further just results in stagnation. Further, there's no real continuity between the different phases. The hypertrophy you develop in the early phases won't be maintained later on because the volume drops so much. Poliquin claimed that the body would rapidly adapt to different training loads, so regular variation was necessary. The same criticisms of linear periodization as everyone else, basically.

His solution was to alternate between high-volume and high-intensity phases, along with periods of unloading to allow for recovery. Basically you'd spend some time training with high volume and moderate weights, and some time training with low volume and heavy weights. Poliquin's original article suggests that waving between these *accumulation* and *intensification* methods can be done across a week or over the span of several weeks.

Following along with Poliquin's thoughts, many Eastern European and Russian/former Soviet coaches were supposedly fans of this type of undulating training, which is where a lot of the mystique comes from. It's all Russian secrets or whatever.

This strategy of short-term changes is nothing more than daily and weekly undulation, which have been explored in more recent research. Daily undulating periodization (DUP) in particular has been a topic of interest recently. A 2007 book by Fleck and Kraemer titled *Optimizing Strength Training: Designing Nonlinear Workouts* investigated the topic and found that on the whole, daily undulation improved performance in athletes more than the simple linear model. Several papers have tackled the subject (Rhea et al. 2004), showing a significant advantage with the DUP model over linear models.

Mark Rippetoe and Lon Kilgore discuss the idea of weekly-level manipulation in *Practical Programming* (2006), arguing that daily undulation is more effective than the linear method for intermediate-level athletes – which is going to be almost everyone. They make the point that there's no reason to make your training more complicated, as this will potentially cost you progress; yet you're at a stage where simple progressive overload isn't sufficient.

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Table 4.2 - Example of daily undulating periodization

Workout	1	2	3	4
Reps	12-15	8-10	6-8	3-5
Sets	5	3	3	3
Intensity	68-70%	72-74%	84-86%	88-90%
Total Reps	60-75	24-30	18-24	9-15

When you vary things from workout to workout, you minimize fatigue and maximize adaptation. You don't focus on anything long enough to stagnate, but you repeat workouts often enough to make consistent gains.

Table 4.3 - Example of weekly undulation

Weeks	1-2	3-4	5-6	7-8	9-10	11-12
Reps	10-12	4-6	8-10	3-5	5-7	2-3
Sets	3	5	4	5	4	6
Intensity	70-75%	82-88%	75-78%	85-90%	80-85%	90-95%
Total Reps	30-36	20-30	32-40	15-25	20-28	12-18

Rippetoe and Kilgore suggest that much of the advantages of this method come from the time course of adaptation. Accumulation training exposes the body to a high-stress event, which dips into your adaptation reserves and forces changes in the body's tissues. After a few days of recovery, the intensification workout capitalizes on these changes, allowing you to exploit the overload. The process of stress and recovery has become stretched out.

Most of these undulating models in the literature rely on simply changing the rep range. This is the most convenient way to shift the stress – low reps will tend to imply heavier weights and lower volumes, while high reps imply the opposite. I just want to point out that it's not the only way to do things. The intermediate-level 5x5 routine would be one example of this in practice; the rep range is largely fixed at five reps. What changes is the number of sets and the weight used.

As a rule, the stronger you become and more specialized you get, the harder and more concentrated your training cycles will have to become. Accumulation lets you prepare the body and create stress, while intensification lets you train hard to 'bring out' the changes. Throw in your unloading weeks to rest and recover, and you've got a winning formula.

Virtually all programs that aren't bog-standard linear periodization follow this undulating pattern one way or another. It's important to note that the progression between *the same type of workout* is still linear – you just add weight each session. Instead of having a rest of 3-5 days between a workout, you might end up with 10-14 days between the same kind of session. This spreads out your progress on each kind of workout, while still exposing you to different stimulus in the mean time.

DO IT ALL AT ONCE: 'CONJUGATE' PERIODIZATION

There's a third option that sits somewhere in between the linear and nonlinear setups. For reasons beyond the scope of this book (meaning, I don't want to get into it), there's some question about how and when to train different skills and physical abilities.

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That is to say, if you want to improve your bench press and get bigger legs and run a half-marathon, how would you go about training for those goals?

The bench press goal and your leg-mass goal wouldn't necessarily be in conflict, but training for that half-marathon is going to be a problem. Endurance training and strength/power training don't tend to mix well when you train them together. Which means you're going to have to make a decision: are you interested in strength and size, or are you interested in endurance training?

This issue comes from the observation that mixing strength training and aerobic training within the same week tends to create negative adaptations for both. This is the so-called 'concurrent training effect' (concurrent because strength and endurance are trained concurrently, within the same week). This simple fact, combined with some translated Russian materials, has led to all kinds of crap with regards to program design.

Cross-training, which mixes both, is typically not advised barring a few sports. The suggestion is to prioritize either strength/power or endurance, which is *sequential organization* (concurrent training or cross-training would be parallel organization). If an athlete needs both strength and endurance, he'd train to emphasize strength for some period of time, then shift gears to work on endurance.

In essence, this sequential organization is the foundation of periodization models. The concurrent/cross-training approach is considered sub-par for high-level athletes.

So far, it's straightforward. Don't mix strength/power work with endurance work. All this is telling us is that if you want to hit your best squat in six weeks' time, you've got no business running 10 miles a day. If you want to run a marathon, you've got no business racking out singles at 90% twice a week. It really is that simple.

The problem is that people want to overgeneralize.

There's a lot of argument about whether or not you should 'mix up' different rep ranges in the same workouts or even in the same week. For example, if you're doing sets of three, you'd want to avoid sets of 10 – or vice versa. The idea is that there's some neurological voodoo going on so that your body will respond 'best' to one particular range at any given time.

Make no mistake: the comments regarding the interference of concurrent training apply to extremes on either end of the strength-endurance continuum. They don't say anything about the organization of strength training.

While there may be some basis for splitting up rep ranges, I think any benefits would have more to do with your ability to focus and devote effort to the things you're training than anything else. There is something to be said for specialization, after all.

Where I see it getting ridiculous is when people start talking about how mixing rep ranges will compromise your gains. From a neurological standpoint, for strength development, there may be a case for that. If we're just talking pure muscle mass, no way.

What most of us strength and bodybuilding types are doing is actually mixing complementary types of neural and muscular training. If you look at the different types of strength training, especially pure strength and intensive bodybuilding, there's not a lot of difference there. So how are we justifying the need to separate rep ranges?

There's actually research done showing that mixing different kinds of strength training is beneficial. Goto et al. (2004) showed that a high-rep set following heavier low-rep work produced greater strength gains than just

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heavy work, as just one example. While it's pretty clear that different rep ranges do have mildly different effects, this is a matter of degree; in the scheme of things it's all just strength training.

Even more than that, it just follows logically given the facts. The adaptations to 'strength' and 'muscle mass' are not going to destructively interfere. I'll agree that it's hard to specialize on one or the other at the same time, but that's mainly because of limits on your time and your recovery ability - to get good at something, you need to do that thing and do it regularly. There's no underlying physiological reason, as far as I can see, that mixing strength methods would cause any sort of interference.

I'd caution not to extend this past strength training, though. If you start getting out into things like sprinting, jumping, various kinds of plyometric training, and so on, you're dealing with entirely different physical demands. There's a very real case for separating out that kind of work – but that's also beyond the scope of this discussion.

Based on that information, I'm willing to pretty much toss out the idea. For the purposes of programming, strength training is strength training. And that, finally, brings me to the point.

The core of this debate is the never-ending Internet argument over 'what kind' of periodization the Westside powerlifting workouts actually are. Westside, for those unaware, is a popular powerlifting system that was developed by Louie Simmons from Columbus, Ohio, based on some older Russian/Soviet ideas on strength training.

Unfortunately a lot of the nuances of the Russian language can get lost in the translation to English, which creates some interesting wording at times. Louie originally, and some say erroneously, described his approach as the *conjugate method*, a name that has stuck. Based on this Westside is now commonly known as *conjugate periodization*.

And oh boy do the people on the Internet like to argue over this. According to some translations, the sequential organization I discussed before is referred to as 'conjugate'. Because of that little bit of language, we've got a lot of people that like to raise their hands and sit up straight in their desks to point out that this is actually a *concurrent* approach, since it trains 'separate qualities' in the same week.

Now, we can hair-split this all day long, and believe me plenty have done just that, but because of what I've already gone over, I don't actually consider this to be concurrent training. Westside brings in some heavy stuff (max effort workouts), some heavy-fast stuff (dynamic effort workouts), and then rounds out the rest with what's basically just bodybuilding for assistance work. None of those methods interfere with the net training effect; if anything they're all complementary methods of training.

That's the big thing in my mind - concurrent training is almost always discussing the parallel (simultaneous, in the same week) development of *conflicting* training goals, like aerobic work with strength work. In that case, you can look at the research and see that it cancels out. But max strength work and hypertrophy work?

I could even see the point being made about speed training on dynamic days. Speed work can be affected by heavy, slow training, so it can be a good idea to separate these methods if speed is important to you. The thing about Westside dynamic days is that 'speed training' is a bit of a misnomer. While they're training fast in comparison to max efforts, that's not saying a whole lot - short of the Olympic lifts, you're just not going to find a barbell exercise that comes even remotely close to the speeds or power involved in actual speed training.

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It'd be better to describe these as explosive training days, but 'explosive bench' doesn't roll off the tongue quite the same way.

When I say that speed work should be separated from strength work, I'm talking about like sprinters and jumpers, people involved in a sport that requires explosiveness and power. Powerlifters and certainly bodybuilders don't have any significant requirement for that. The explosive work that's actually done by these guys isn't going to interfere (or be interfered) with maximal and bodybuilding training.

So what do we call this?

I don't see a problem with just sticking to conjugate periodization, just to distinguish the setup from other models. Another idea would be to just not worry about what the damn thing is called and treat it according to what it does.

Since I'm here to split hairs, though, it's just a form of undulating periodization specialized for powerlifting. In effect, you're taking the linear model and 'turning it sideways' so that it fits in your training week. In practice, this works out to be little different from undulating periodization. The big difference is that you're mixing Different Stuff in each workout session, instead of dividing things up into '10 rep day' and '5 rep day' or what have you. Which is just daily undulation.

We can argue over the definitions of 'conjugate' and 'concurrent' and all that crap all day long; go find a forum to post on and you can do it til you're sick. I'm going to call it 'conjugate periodization' because that's how it's widely used. If you don't like it, well, that's how language works.

To sum it all up: mixing rep ranges isn't a big deal. Trying to mix a ton of cardio or sports technique or what have you along with a robust strength-training plan can cause issues – but lifting weights is just lifting weights.

With conjugate periodization, you 'train everything' within a single week. For example, you might have a 'heavy' workout, using a combination of maximum strength and intensive methods, then a 'light' workout focusing on dynamic/power training and extended sets.

Instead of going about those phases in successive order, one after the other, you'd just stack them all up and do some of each at the same time. On paper, you're supposed to vary the proportion of each method. You might emphasize one method for a few weeks, then another method, and so on. Each method would follow its own little mini-organization. Some are being prioritized while others are set on the back burner.

In practice, most people following this approach just go in and do what they feel like. Truth is, that works as well as anything. This 'freestyle' kind of organization works very well with the concepts of cybernetic periodization and auto-regulation.

You might come in with a rough idea of what to do on any given day. You come in knowing that it's squat day, or deadlift day, or whatever, and have an idea of how you want to train that exercise. Once that's done, you figure out some other exercises that fit the theme of the day.

Note that this works just as well for 'muscle group' workouts; if you had a deadlift day, you might round it out with work for your upper back and just call it 'back day'. Or what have you.

Training For Bodybuilding

That's about as in-depth into the theory-wanking as I want to go. You've got an idea of the basic arrangements, anyway.

When we talk about organizing our training, we have to understand that training is a goal-directed process. The goal is supreme. It dictates everything: how often we train, what exercises we use, the intensity zones, the volume of training, how many workouts. When I say everything, I mean everything.

All sports and activities have specific physical requirements, and bodybuilding is no different. In order to make that work, we need to understand our goal in the first place.

The goals of bodybuilding (casual or otherwise) can be summed up as follows:

1. Build (and/or maintain) muscle mass in proportion across the body
2. Reduce body fat so that said muscle mass is visible

This book has mainly focused on Goal #1. Don't get me wrong, the matter of reducing body fat is also important; it's a necessity if you want to compete as a bodybuilder or even just look good for the beach. However fat loss, especially getting bodybuilder-lean, is a different animal from getting bigger.

The two do overlap somewhat, in that you have to stimulate your muscle mass to some degree, but getting shredded requires a discussion of diet, different forms of cardiovascular and metabolic training, and managing stress, so I'm really not going to get into all that.

We can divide the muscle-building aspect of bodybuilding into two distinct needs: progressive tension overload (getting stronger to handle heavier weights) and local muscular endurance (doing more work with those heavier weights). You can call that last bit 'pump' or 'exhaustion' or 'intensity' or whatever else you want, but it's got to be there to some degree.

There are also secondary goals that are required to allow this to happen. First, if your joints and connective tissues aren't up to snuff, and you aren't moving correctly, then you're not going to get very far. Secondly, some degree of 'neural' or pure strength training is useful for both variety and to create greater stimulus over the long run. Strength yields size.

It's important to realize that these secondary goals can and do overlap with specific muscle-building training. For example, a low-intensity 'pump' training relies on high rep, short rest weight training, which can help prepare joints for heavier weights. This can also stimulate growth, especially if you don't regularly use that kind of training. Likewise, the very heavy weights used during a neural/strength phase can trigger their own growth.

Bodybuilding bro-lore has come up with its own list of goals over the years. You'll hear about training for definition or 'cuts'. You'll hear about building symmetry and balance. The debate will rage over lean quality mass or just building size. Things like that.

As I said back in chapter one, I'm willing to listen to that kind of talk insofar as I can parse it into legitimate terms. No matter how well-intended, if you're chasing your goals with the wrong map, you're just going to get lost.

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The good news is that based on the information I've provided so far, it's not too difficult to rephrase some of that into useful (and more realistic) terms.

Muscle definition is purely a function of leanness, so to make this happen you want to drop body fat while maintaining muscle mass. How you look after that happens largely depends on how much muscle mass you started out with – and how much you held on to during the diet.

Symmetry and balance is a matter of choosing your exercises properly and not doing what 99% of people in the gym do, which is 10 exercises for chest, 10 for the biceps, and 1-2 exercises for every other part of your body. If you're doing a balanced routine, instead of orienting your workout around International Chest Night before showing back up to pump your guns on Friday night before you hit the club, then symmetry will take care of itself.

What about lean bulking for 'quality mass', as opposed to just getting freaky big? Same idea. The former involves getting larger while keeping body fat in check, while the latter is just eating yourself huge no matter how much fat comes with it. Again, we're just looking at building/retaining muscle mass, and then working for leanness. When bodybuilders talk about 'quality lean mass', they're really just saying 'don't get fat when you bulk up'.

THE ROLE OF ACCUMULATION AND INTENSIFICATION TRAINING

Instead of going through the hassle of the traditional periodization phases, which are at best indirectly related to our goals, we can make that overall theme a little more specific to bodybuilding. Remember that hypertrophy can almost be thought of as a side-effect of progressive resistance exercise, rather than a deliberate goal in and of itself. With this in mind, training for muscle mass is as much a function of varied stimulus and on-going overload as it is any single training method. The goal is to get a healthy exposure to each 'flavor' of stimulus, then change it as your body adjusts, while continuing to get stronger over time.

Most sport-specific programs, rightly, rely on very specific training methods. Since hypertrophy is a general effect, not a specific effect, there's no need to follow the specific training programs of other sports. Instead, hypertrophy relies on mechanical overload combined with total workload. The actual source doesn't matter.

Now, what do I mean when I say 'flavor' of stimulus? And more importantly, why does that matter in the face of progressive overload?

As I've stated before, we're after a long-term *net* overload. How we come about that doesn't seem to particularly matter in the scheme of things. If we look at our options with that general long-term overload in mind, we see two distinct styles, methods – or 'flavors' – of training emerge.

Accumulation training will focus on higher volume, higher frequency, and relatively low intensity approaches to weight training. Higher reps, short rest intervals, and lots of sets will be the name of the game here. You'll want to do a lot of volume per session, and lots of sessions to build up a high weekly volume.

Intensification will do the exact opposite. The emphasis here is on pushing up the intensity – both the classical definition (percentage of your max) and the bodybuilder definition, which is the subjective effort of your workouts (measured by the RPE scale). You'll do fewer sets and less volume overall, in exchange for using heavier weights and creating more exhaustion in the muscles. Of course the other methods of increasing intensity, things like rest-pause sets and drop sets, will come into play here.

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Accumulation focuses on quantity, while intensification focuses on quality.

Along these lines we have to consider that the stress of individual workouts and the frequency of training are inversely related. The higher the stress, the less often you'll be able to do it. The more frequently you train, the less stressful each session can be.

High frequency training has the benefit of developing strength through practice and keeping the growth chemistry humming along. The drawback is that it's easier to overwork yourself, and it can leave you in a nearly constant state of fatigue and inflammation.

High stress training is almost exactly the opposite. While it presents a greater one-time stress to the body, you also get more time to recover from it. The higher impact is enough to trigger gains, but the trade-off is that the growth process won't be stimulated as frequently as possible.

The general rule of thumb is that high-frequency accumulation training tends to create smaller, but longer lasting gains, while high-stress intensification training tends to create larger, short-lived gains. We can chalk this up to changes in the tissue (a result of volume) versus changes in neuromuscular factors (a result of intensity).

There seems to be an individual response to the different approaches, too, at least anecdotally. Some people seem to respond better to a higher-volume, higher-frequency approach, while others respond to higher stress and longer recovery times. Depending on who you are, a high stress workout may not be sufficient to off-set the lack of frequent training; then again, frequent stimulus may not allow you to train hard enough to stimulate gains.

My belief is that there is a trend from higher frequency towards higher stress as you become more advanced, though even this isn't absolute. By all accounts it seems that some people are just built, mentally or otherwise, to lean towards one or the other - with that occasional rare genetic freak that can respond to both.

This makes sense if you consider that the tissue changes (including muscle growth) caused by years of training will add up. Changes in the body's structure tend to be very long-lasting, which we see in the behavior of satellite cells right on up to the anecdotes of 'muscle memory'. Someone that's spent years forcing his body to adapt will have the foundation required to benefit from high-stress methods.

I've also got a hunch that productive long-term training for most people will rely on alternating between the two approaches. There's too many advantages to each strategy to rely exclusively on one or the other, and the fact that we repeatedly see positive effects from sharp changes in stress reinforces this idea. It comes back to the notions of both variety of stimulus and shoring up weak points.

We can see this argument in the conflict between the High Intensity Training (HIT) of Mentzer, Jones, and Darden, as compared to the more 'traditional' high-volume, high-rep training promoted by Joe Weider and pretty much every pro bodybuilder since Arnold.

My thoughts on the magic of HIT, as I've said, is that it simply provides a change in stress from what most people are used to doing. It's not actually magic in and of itself. All it does is take people away from excessive volume and then focus them on getting stronger with brief workouts.

At the same time, I think it's a bit futile to say it's an either/or scenario. My premise, to make sure I'm clear, is that there will be occasions where volume is good, and occasions where intensity is good. Similarly, training

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frequently will be good, while other times high-stress, lower frequency training will be good. While some may prefer one over the other, or even have better responses, I don't think we can assume that either approach is 'better'.

The trick now is how and when to put accumulation training and intensification training into your routine – along with proper rest.

BEGINNER, INTERMEDIATE, AND ADVANCED LIFTERS

Your muscles and your body require progressively larger stimulus in order to throw things off balance and force them to adapt. We see this in everything from the hormone response to exercise right down to the repeated bout effect that desensitizes the muscle to the stress of weight training.

A beginner can do just about anything and grow from it. The beginner is a blank slate, and as a consequence most any activity that involves getting off the couch will count as a 'novel stimulus' and serve as overload.

As mentioned, this is why I feel that people often believe they're bulking up too quickly. They see these initial changes and just assume that it's going to continue like that forever. Fortunately for them, adaptation is a process of diminishing returns.

I said in an earlier section that one of my pet hypotheses is that as you become more advanced, your physiological needs will shift. The beginner can train often, exploiting that to keep MPS rates high. The beginner still responds strongly to a weight training session, but in absolute terms, he's not capable of creating that much stress. Because of this, he can just go in and hit the muscles three times a week and still grow.

As you get stronger, the body becomes more and more resistant to the stimulus of exercise. The more advanced guys need to think a little differently, both in the short-term and in terms of planning things out. This is actually where some of the bodybuilding gym-lore can start to come in handy.

The advanced guy has a blunted response overall - he doesn't really get the same hormone spikes and his muscles are highly adapted to weight training. Even his nervous system doesn't respond as strongly, since it's optimized itself too. The advanced guy has also grown his muscles significantly. In fact, he's probably very close to genetically-defined limits. Regulating factors like myostatin are working against further growth; the chemistry in his muscle fibers is struggling to support the protein that's already there, let alone adding any more. In order to overcome all that, this fellow is going to have to stimulate the hell out of his muscles to force an adaptation.

Anecdotally, I've noticed that guys past the beginner stage tend to gravitate towards 'heavier' workouts – not just in terms of weight, but in terms of volume and overall hit to the body. The trade-off is that they do them less frequently. Your bog-standard muscle group split, in other words.

Muscle mass is inertial. It builds up slowly and it goes away slowly. It's also much easier to maintain muscle than it is to build it in the first place. It seems that the more advanced you become, the less the 'rules' apply. At that point, what was once intuitive is just, well, not.

This could just be psychology at work - you've learned the fundamentals of progressive overload, gotten decently strong in the basic lifts to lay down a solid foundation, and developed a good work ethic and nutrition practices. It's like sculpting; you have to have a block of stone to chisel.

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But there's also some potential physiological reasons. We know that satellite cell activity is very important to the hypertrophy process in muscles, and I think that has a lot to do with it. It takes a greater and greater hit to the system to make any progress.

Some have suggested that this is due to muscle hyperplasia, or the development of new muscle fibers. I'm not really a fan of the hyperplasia idea, I have to say.

The human neuromuscular system just isn't designed to add new muscle fibers in the same way that some animals are. Yet this doesn't rule out some kind of fiber-splitting; it just won't work in the way most people think.

More advanced bodybuilders might actually need more of a 'shock to the muscles', as much as that phrase makes me want to stab myself in the face. Just increasing MPS rates won't cut it. They have to really work the muscle to trigger that whole inflammatory and prostaglandin response that brings in the satellite cells.

In other words, satellite cell fusion and nuclear donation may well be more important to advanced lifters than beginners - and they have to train accordingly. This may be one reason why more specialized work for specific muscle groups (the body-part splits); each muscle group gets a bigger 'hit' and more time to recover from it. It's not optimal from the standpoint of MPS rates, but it may be necessary for an advanced guy because he won't grow with a lighter stimulus.

This is where the change in physiological needs comes in. The beginner can get by with 'just' increasing MPS rates. The advanced guy can't forget about MPS rates, but it may well be that he's got to start focusing on things to get the satellite cells working. Thus explaining the heavier and less frequent workouts.

The typical muscle-group training in a body-part split is based around doing multiple exercises and, depending on who you ask, either a small number of very hard sets, or a relatively large number of lighter sets. This creates a lot of stress on the muscle, a lot of eccentric overload, and a lot of fatigue - conditions that may very well trigger a more profound satellite cell response, based on what we know.

In all actuality, it's probably a combination of factors - muscular resistance to exercise, changes in the requirements of protein metabolism, neuromuscular adaptations, and whatever else you care to list. The point is that regardless of the actual cause(s), the advanced guy needing more muscle seems to respond favorably to larger acute stresses. I'm not here to suggest that the once-a-week routines are optimal or anything like that, but rather to explain the possible mechanism - and why a lot of people swear by them.

To make it even more confusing, large stresses can still be generated by high-frequency training. You just have to adjust the volume and intensity of each session. The problem is, this can (will) burn you out in a hurry unless you've got a crazy ability to handle stress, so it has to be matched up with regular down-time.

The net result is still the same in either case - whether using high-stress/low frequency or the opposite. The greater the stress required to create gains, the more time you're going to spend waiting to recover from it.

Of course, I do have to point out that this is simply guesswork - I could easily be wrong. This idea just happens to fit both the data and the anecdotal trends I've observed. Take it with a grain of salt.

That said, I think there is a very solid case to be made for playing around with different variables in terms of 'workout stress' and training frequency, in order to exploit some of this. I also think there's something to be said for using planned overreaching to trigger gains, in the right context.

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Ideally you'd want to spend some time with some with each, using them as another variable to manipulate as you plan out your highs and your lows.

IF YOU'RE A BEGINNER: ADD WEIGHT TO THE BAR

If you're just starting out, just go lift weights. Seriously. What you need more than anything is consistency and effort. You need to build good form with the basic exercises and really just get into the habit of getting to the gym on a regular basis.

There's plenty of solid approaches to get you started; frankly it's too easy to get caught up in the mania and lose track of your goal.

There are basic progressive-overload methods like Mark Rippetoe's beginner-level 5x5 routine, and there are more structured methods like Ed Coan's linear periodization workouts. You might find something like Stuart McRobert's Brawn workouts to be useful.

The thing that all those approaches have in common is that they involve simple, well-rounded workouts and they put an emphasis on progressive overloading.

The main thing you need to worry about at this point is getting to the gym, making sure your form is good, and adding weight to the bar. Beyond that the details are largely superfluous.

IF YOU'RE INTERMEDIATE: VARY THE STRESS

At the intermediate level, you're kind of caught between the needs of short-term progressive overload and more complicated training cycles.

If you're at a stage where the simple progressive overload approach isn't cutting it, then something like the daily undulating method might work well for you. If even that isn't working so well, one of the shorter methods of weekly undulation might be up your alley.

Periodization at this stage is going to be more about fluctuating the difficulty of your workouts than it is about planning out training cycles. In short, as long as you're varying the stress with some kind of methodical approach, you'll be fine. No need for the massive training cycles just yet.

The hardest part about this phase is realizing that you can't just add weight to your exercises each and every session. You can try, but don't expect it to last long. It can be frustrating if you're used to straight progressive overload, but you have to be patient and realize that your gains are going to be cyclical from here on.

IF YOU'RE ADVANCED: PLAN YOUR GAINS

After a point you're probably going to need some kind of long-term structure to your training if you want to keep improving. Please, please, please realize that you're not advanced because you've been in the gym three months. Don't even consider it unless you've been working out consistently for at least five years, and have the gains to show for it.

Seriously.

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Back to the point, what does this entail exactly? More frequent shifts in stimulus, mainly. And those shifts will have to be more extreme. Intensity, volume, and workout frequency are all going to have to fluctuate sharply from week to week.

You're probably going to find that the traditional methods of high reps with moderate weights isn't going to be so productive, at least not by itself. Instead, you're going to have to handle heavy weights, use some occasionally extreme workloads, and crucially, alternate this hard training with somewhat frequent light weeks.

And of course you'll probably find it easier to manage your training in short blocks of time, which will be about a month long (give or take). Whereas before you could have hit weekly PR lifts, you may only have one week a month for going all-out.

This is where a strategy of frequent alternation between accumulation and intensification blocks, with well-placed transition/recovery blocks, can start to pay off dividends. There's also no reason you can't incorporate the conjugate-periodization strategy, combining some of each in every block.

Which Method Is Best?

For most people, I'd think that some version of the linear model or daily undulating model would be ideal. At the early and middle stages of 'getting strong', all it takes is consistency and steady progress. Muscle mass will come along with it.

It's when you get past a certain threshold that the more complex crap will become useful. The stronger you become, the more you'll benefit from frequent changes in workout stress – and the more abrupt those changes should become. This is one place where the muscle-group split routines might become handy (even if it's for relatively brief blocks of time).

So beginners and intermediates would stick with simpler workout routines, while more advanced folks could opt for more complex weekly splits. I think there's some degree of goal-dependency here, too. Once you're past the beginner stage, it becomes a matter of specializing towards your goals instead of just 'general strength training'. In my mind, that's the real determinant of your program. The stronger you are, the more specific your goals will become, and the more you'll benefit from a planned training cycle.

Keep in mind also that you're never training exclusively for either size or strength. Bodybuilders need strength work, and strength athletes can benefit from muscle-mass training, so in the overall scheme of things you can benefit from both 'styles'. You might find that three blocks out of four should focus on strength, but you'll still need that one block to work on everything else.

Realistically there is no one superior method for anyone or any goal. You may find that a degree of 'meta-periodization' comes into effect, where you cycle through different approaches depending on your goals at the moment. Even the poor old linear model can be useful if you do it right.

Don't get caught up in the belief that complex is somehow better, either. If it helps, think of it like this: the advanced guys are doing these programs as a necessary compromise *because they can't handle linear progress anymore*. The more advanced you become, the more your program has to intentionally throttle back your rate of progress just so that you don't hurt yourself or wear yourself out.

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They're doing this because they have no choice, not because it's the best approach. Linear progressive overload is the fastest and most direct way to make gains. The advanced guys might only set PRs once a month, where a linear program would have you setting records weekly or even daily.

So why would you want to actually reduce your potential progress by copying what an advanced lifter is doing?

That said, fluctuating overload is going to apply to most people. You'll have peaks and troughs as you look at your overall progress. Even linear programs are only linear in the short-term.

Expect and plan for highs and lows. As long as you're doing that, I don't think the detail work matters all that much.

When you're building your workout strategy, try not to think in terms of all the details and numbers, but rather 'how hard' you're training and what you're training for. Both total volume and the intensity of a workout (meaning, weight on the bar) can wear you down if you do too much for too long. Remember that, somewhere in the process, there needs to be high points and there needs to be low points. If you do that, the rest tends to fall into place.

This is where the RPE scale will come in handy. If you get the chance, picking up Mike Tuchscherer's *Reactive Training Manual* can give you an example of this put into practice.

You'll have to adjust things slightly to apply to physique goals, but ultimately I think that keeping track of RPE numbers and using them to manage your progress is probably the best way to go about it – provided you've got the ability to be honest with yourself about your workouts. If you're accurately tracking how much each workout beats you up, it's child's play to create heavy, medium, and light sessions based on that.

If a workout is supposed to be 'hard', then plan to go in and hit some very hard sets, and probably do more sets than normal. A light workout would be easy sets and fewer of them. A hard week would have more hard and harder sessions; a light week would have less. You get the idea – it's not rocket surgery.

If you can do that, reliably, then you don't really need any kind of 'periodization'. Just go in and hit hard workouts when you can, and when you feel beat up, hit light workouts. This is cybernetic periodization, and I think it's as good an approach as any *provided you can be honest with yourself*.

Most people will like things to be a little more concrete than that, though – and I can certainly understand why. If you really want to pin me down to some general guidelines on periodization, well, what the hell? Bear in mind that these are based on my personal opinions and experiences as much as they are on science, so your mileage may vary. The following assumes you're past the beginner stage and shooting for some degree of specialized training.

FOR MUSCLE MASS AND PHYSIQUE GOALS

Remember that muscle mass gains are slow and very gradual. I'd likely design my routine to reflect that – longer phases, less frequent changes in exercises (but possibly a greater number of exercises), a greater emphasis on volume, and more diverse rep ranges.

Since there's a lag-time between your training and the actual effect, I'd suggest that slower, gradual progress would be the theme, and you'd want your program to reflect this most of the time. This means less of an emphasis on rapid strength gains, and more focus on consistent, steady overload.

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The important thing here is to not get carried away with variety. For all that the workout stress – sets, reps, intensity/bar weight, and so on – may need to be change, the actual exercises you do should be fairly consistent and you should map out some kind of plan for steady gains over blocks of 4-8 weeks. Whether you do a linear plan, an undulating plan, or use some kind of more complex strategy isn't terribly important in the scheme of things, though you should keep it as simple as you can get away with.

Consider the idea of 'consistent variety'. Every 4-8 weeks you might change your goal or your exercises to something different. For example, if you're emphasizing your lats and quads in one cycle, you may change that to triceps and hamstrings for the next. Within that block, you stay consistent. Between blocks, you keep as consistent as possible – say changing a back squat to a front squat, or a bench press to a 2-board press. That won't always be possible if you're specializing on different muscles, but you get the idea. I'd also suggest that this is much more important for your big exercises than it is for the smaller assistance movements.

You might also benefit from alternating between 'size' training and 'strength' training as part of your strategy, say every 2-4 weeks. This fits in with the idea of spending most of your time with slow, gradual progress, then dropping in some heavier work and rapid progress to balance it out.

I've also heard it suggested that you could just train 'for strength' most of the time, only switching to 'bodybuilding' for brief periods when you want to develop particular muscle groups. This may be due to the anecdotal observation that 'bodybuilding' only seems to work for about a month or so – you start training with the higher rep ranges and you see an immediate size-gain, but further growth seems stunted.

This initial growth spurt is just a short-term 'bloating' effect due to both the pump and inflammation of the tissue; while the visual changes are definitely compelling, they're also relatively transient. If you want to add size that will actually last, you'll need to put in the time and effort – which is where the heavy strength stuff is working for you.

For the purposes of growing, we can identify roughly four distinct training methods that will be useful:

- 1) Maximum strength training
- 2) Intensive bodybuilding with heavy weights and high fatigue
- 3) Dynamic/power training focusing on short rest periods
- 4) Extensive bodybuilding with continuous tension

The possibilities for combining these are numerous. A daily undulating routine could move between them from session to session, training the whole body; or you could use the 'conjugate' approach to combine them in a weekly split routine. You might combine max strength with intensive training for a 'heavy' day, leaving dynamic training and extensive training for a 'light' day. Or you could do a 'strength/power' day with maximum and dynamic training, along with a 'bodybuilding' day for intensive and extensive methods. It's really up to you.

Also remember that your diet will play into this too. How much mass you add is determined by your diet as much as, if not more than, it is by your workout. If you take the GFH approach, living at McDonald's and knocking down a few 5000 calorie shakes every day, then you're going to pile on a lot more weight than the guy shooting for a 500 calorie surplus with a disciplined diet.

The GFH guy may have more obvious results, if only because he's adding fat with the muscle. Bulk is bulk, especially if you're one of those chronically skinny types. The clean dieting approach is a bit better for those

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that have already added some size, or for those 'endomorphs' that tend to add fat easily. You may not get the mental benefit of quick gains, but you're still adding muscle. Before you jump in and start force-feeding yourself, just remember that you've got to diet off the fat you gain at some point – and dieting sucks.

Due to the quirks of the body's mass-regulating chemistry, you're just as likely to lose any muscle you gain when you GFH bulk, so do keep that in mind (especially if you're a natural bodybuilder). In other words, getting fat while you bulk may net you more total muscle, but you're also more likely to lose it as you diet back down. Taking the slow and steady approach won't give you the same total muscle, but you also don't have to worry about dieting it off and potentially losing it either. Unless you're just finding it impossible to grow, leave the GFH eating for the powerlifters and sumo wrestlers.

Some have suggested the idea of very high calorie intakes matched with very high activity levels. The net calorie balance would only end up in a slight surplus, though the total input and output would be high. This is something I'm on the fence about. Some guys swear by it. It would follow logically that you'd be optimizing your physiology for muscle gain without fat accumulation; the problem is that logic alone isn't a sufficient argument. While there may be something to this due to something called *calorie partitioning*, I've not seen enough concrete evidence to make a decision either way.

There's also the fact that you've only got so many hours in a week to train, if you have a job or a social life. To rack up a thousand calories from activity each day takes a lot of time – and frankly unless you're a competing athlete with few other concerns, I don't see the point. It's easier just to eat less food. From the standpoint of energy balance, it works out the same. You might be missing out on some of the partitioning benefits (nutrients sent to muscle instead of fat), but I doubt it will add up to that much importance for you recreational types.

Somebody that's trying to diet for a bodybuilding show would have different needs yet. You need some heavy work in the mix, but for the most part the goal here is wasting calories. Depending on strength levels, I could see the case made for rolling in pure strength work, bodybuilder split-training, and conditioning exercise either across a week or across several weeks. But that's a topic for another book, I think.

FOR STRENGTH DEVELOPMENT GOALS

Strength emphasis would be opposite of muscle-mass training in some regards. You might only have a handful of exercises to work on, but frequent changes in the intensity and volume would be called for to avoid stagnation.

As opposed to muscle-mass, the gains from training are much faster (which means you'll also stall out faster), so you have to plan with that in mind. Your highs and lows are going to be more frequent, and you might well benefit from more intricate planning than bodybuilding.

Thing to remember is that strength isn't trained in a vacuum. You can benefit from some occasional bodybuilding, too.

While you'd still want to keep your big lifts consistent, you'd potentially do a lot fewer total exercises. The key here is to regularly change the stress – intensity, volume, and frequency – more than the lifts themselves. Which is why I'm suggesting cycles that involve a lot of short-term variation.

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Shifting between muscle-mass training and strength training can be a stimulus in itself, so we can't rule that out. As muscle mass is a gradual change, the key thing is simply to keep tension high without burning out – and to allow for recovery times with occasional low points in your training.

A note on recovery times: while I can't lay out precise needs for rest, I do want to stress that it's very important to take rest weeks and occasional rest months. Don't underestimate the importance of resting.

If you want to press me for a quick rule of thumb, then I'd say that a rest week, or at least a very light week, would be important every 4-6 weeks, and you'd want to take an light training block for every 2-4 blocks of training (assuming a block is 4-6 weeks). So that works out to be a week of rest for every block, and an easy recovery block every 2-4 blocks.

Note that an unloading block doesn't mean you sit at home. It means light work – do some easy cardio, go for walks, play some sports, and generally try to relax. You can work on any muscle imbalances or movement problems that may have cropped up, or do some harder conditioning work to get in shape. If you hit the weights, cut the frequency way back and cut the volume way back – maybe keep the weights around 80-85% of your previous bests, just to maintain strength, but definitely keep the volume low.

Note that this doesn't mean you should be trying to push out any new records – unloading means maintaining, not gaining. Yes, you may feel really good and motivated to hit a new best. That's normal; it also doesn't mean you don't need the rest time anyway.

To recap the whole section: Sometimes you'll have hard workouts. Sometimes you'll have easy workouts. Whether this happens within a week or over several weeks doesn't really matter, as long as it happens and it allows you to make progress.

The trick here is not to get overwhelmed by the options. Pick something that will lead you toward your goals and then stick with it. Keep things simple and keep things consistent.

FOR TONING AND SHAPING

No, I'm not kidding. This is something people want to know about so I'm going to lay out guidelines. Following along with my methodology, what I'm going to do is distill this into realistic goals and then tell you how to proceed.

I've largely gone over this already. When people say they want to 'tone', they really mean that they want to build just a tiny amount of muscle mass, and more importantly, they want to see it – meaning, they want to see *some* of the cuts and striations, which in turn means low body fat ('some' will of course vary from person to person).

'Shaping' on the other hand is just a function of developing some muscle groups and downplaying others. I've already gone over why I think this is crap. If your body wants to grow a muscle, there's not a damn thing you can do about it. You can shape your body in the sense of building an overall aesthetic, but you absolutely cannot change your body's genetic preferences.

While a bodybuilder can shape his or her body *to a degree*, by emphasizing or de-emphasizing some muscle groups, bodybuilders also hold above-average amounts of muscle mass. If you're untrained and tiny, then you don't have anything to work with. You can't shape bone and skin, sadly. Your options here are pretty well

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limited: you can build up an overall pleasing physique with a balanced routine, and you can drop body fat from areas that might be 'too big'.

Remember that size is built by progressive tension-time overload: heavy weights, high workloads, and a net increase of both over time. If you want to minimize 'bulk', then you have to minimize those factors. That brings me to two suggestions, depending on your inclinations and available equipment.

Option 1: A strength/power oriented routine, keeping the volume very low and incorporating lots of athletic-type conditioning work.

Option 2: A more traditional 'fitness' routine, using the bare minimum of resistance training and incorporating more general activity.

Option 1 still has you in the weight room and doing more 'hardcore' stuff, so you don't have to feel like a pansy, while option 2 could potentially be done at home and with minimal equipment.

In this case, option 1 would just be a generic full-body routine, done once or twice a week. You'd want to keep a bare minimum of big exercises – probably no more than a squat, a press, and a rowing movement. Reps should be kept low, in the 1-3 range, with relatively heavy (but *not* maximum) weights. A total of 2-4 sets would be plenty, for a total of 2-12 reps per exercise.

The key thing here, which I must stress, is *not* to make any attempt to get stronger. Yes, you read me right. Getting stronger *will* build size, even with 1-3 reps. If you don't want that, the only recourse is to maintain where you are.

After that, you could follow up with higher-rep assistance work, such as bodyweight exercises or work with resistance bands. Whatever you pick, the theme is high reps, low resistance. You'd want to throw in specific conditioning work as well, which could be anything from occasional sprint/interval training to longer distance runs.

Option 2 would be the same thing in effect, only you wouldn't bother with the big exercises. This may be the only option for those of you that really don't want any sort of muscular development, because like it or not even Option 1 is going to build some muscle. There's just no way around it.

For this approach, just do some of light resistance training 2-3 times a week (you can do it more often since it's lighter) and fit in conditioning work several times a week. This might be better for those of you without gyms and only minimum equipment; you really don't need more than your bodyweight or some cheap dumbbells.

Note that neither of these approaches is going to make particularly drastic changes to your body; these would be good maintenance programs or if you're already somewhat close to how you want to look. Option 1 might even be acceptable for dieting. If you're really looking to get big and strong, you need to look elsewhere.

Planning Things Out In Three Easy Steps

So now we're at the meat of it. We've got the ideology, we've got the game plan. All we need now is something to actually go and do in the gym. I'm going to lay this out as a step-by-step process to make it as easy as possible.

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STEP ONE: ARRANGE YOUR WEEK

The arrangement of your training week is the first step to take. How you set this up is going to depend on your goals and realistically, your personal preferences. We've only got a few facts to constrain us here: muscle groups will need fairly regular training (2-3 times per week on average), and anyone that isn't a raw beginner will need to manipulate the difficulty of each session.

'Go heavy or go home' sounds like a great macho mantra, but it's flawed in execution. A productive workout should be difficult, but a productive workout is also going to wear you out. We have to balance the heavy with the light.

There's lots of ways to make this happen. In other words, this is where we argue over whether or not full-body routines are better than split routines. Some parties feel that full-body is the way to go, and split training is stupid. Others feel exactly the opposite. You know by now how this is going to go.

Barring a few very advanced and very competitive individuals, I think splits based around muscle groups or body parts aren't going to be the ideal. When I say muscle-group splits, I'm talking about the routines that have days for *everything*, down to the last detail. Hint: You don't need a day for shoulders. You don't need a day for arms. Just no.

Splitting things up along the lines of say pushing, pulling, and legs isn't a horrible way to go about things, though once we go down that road we're getting away from the muscle group splits anyway.

You're probably going to find the muscle group splits most effective if you're using chemical methods, to be blunt. Which is to say, drug users can get away with it and thrive, even if it's not the optimal arrangement – which is a big part of why everybody does the part-splits. And I'm not exaggerating. Go into any commercial gym, ask any layman. Chest is Monday, back and/or shoulders Tuesday, and Friday is for pumping the guns before hitting the club.

Needless to say, the vast majority of people are doing part-splits, and these are the people least likely to benefit from them. What's that? You've been doing a part-split and you put on 30 pounds? Of course beginners will grow off anything, so that's not even supportive of the argument. Grow, get big without drugs, and you'll have support for your argument.

Remember: 'everybody does it' is not a valid defense. Results are.

However I'm not quite ready to throw the split idea out. You can still separate the body into functional groups and train those muscles accordingly. I've already mentioned the push/pull/legs setup, which isn't half bad. There's also the two-way splits; the most popular (and effective, in my mind) is splitting the upper body and lower body into separate workouts.

That isn't the only way, though. You can split according to push/pull, or torso/limbs, or even integrate several different splits into your week. For example, you might split upper/lower early in the week, then push/pull later. It's really up to you, and I'm not going to cover every permutation.

Full-body workouts are another approach, one that's come into vogue again in recent years. Once upon a time, everybody trained this way. The splits didn't really start becoming popular until the 1970s and 80s.

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Training your whole body at each session makes a lot of sense. It maximizes frequency, so that no parts get left behind; this can be a good thing or a bad thing depending on the circumstances.

We can loosely divide full-body workouts into a 'bodybuilding' style and a 'strength' style, depending on the emphasis.

The 'bodybuilding' style would have you doing a lot of exercises, with lots of detail work. The goal is to hit pretty much all the muscle groups, and this is doable with a reasonable number of exercises. Since full-body sessions are meant to be frequent, you can get away with using a lower volume (maybe 2-3 sets per part), which will also save you time.

Please don't be one of those that thinks you have to use the same volume as a split routine. If you do that, not only will you be in the gym for hours, you're defeating the whole purpose. The idea is to provide a stimulus, then go home. Frequency makes up for the lack of volume.

The 'strength' style may not even be considered a full-body workout, depending on your outlook. Ideally you'd pick a handful of exercises to work on, keeping the volume minimal for other work. You'd pick your big lifts like the squat and bench press for this sort of thing, so that most of the body is trained. Assistance work should be very limited, mainly to any corrective exercises or weak points in the big lifts.

Which do you use? Beginners tend to do well with full-body training, as they benefit from frequent training. I'm a fan of the full-body 'strength' approach for getting stronger; having only a few exercises to worry about makes it easy to focus and drive up your weights. The 'bodybuilding' approach may or may not be useful to you once you're past the beginner stage. The more experienced you become, the more you're going to get out of split routines. The basic upper-lower split is great for most people when they outgrow the full-body sessions, as are the other variations.

I do want to suggest that you don't get caught up in the 'must do this!' dogma. Even if you're fairly big and strong, there's no reason you couldn't benefit from a few weeks with a higher-frequency/lower-volume workout routine – even if it's just something strength-focused.

STEP TWO: PICK YOUR EXERCISES

Picking exercises is another over-thought issue that's really pretty simple. All you have to do is set a goal for the day – whether it's bench press training or leg training – and go from there.

I'd suggest having a main lift for the day, then adding in accessory moves after the fact. The only exception would be for light sessions, where you may not want the stress of a big barbell exercise. Your main lift should get most of the attention; the accessory work should be just that – accessory.

You might have a day where you want to train the overhead press as your main lift. The overhead press is an upper-body pressing exercise, so we might consider training those related muscles, like the triceps, delts, and chest, with accessory exercises. The muscles of the upper back and the biceps work to stabilize and balance those pressing muscles, so you could train those as well.

Before you hit the gym, you might only know that you're going to press. You'll have an idea that you need to work the pressing and upper-back muscles, but you may just figure those exercises out once you get there. Of course there's nothing stopping you from planning things out in advance, if that's how you like to do things. Just realize that there doesn't seem to be any real advantage to planning versus figuring it out on the fly.

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To recap: pick a main lift for the day, work on it, and then follow up with whatever else as accessory work. When I say accessory work, it means 'something lighter and easier than the main lift'.

In other words, if you just knocked out five sets of five on the squat, you've got no reason to go do five sets of five on a lunge and then on a step-up. Put your effort and concentration into your big lift, and use your accessory exercises for lighter stuff.

STEP THREE: PLAN FOR PROGRESS

Once you've got those things ironed out, you'll need a way to monitor and regulate your progress over time. You raw newbies and intermediate-level people won't have much need to worry about this. Once you've got your basic strategy in place, your goal is to put more weight on the bar. It's the guys that have several years' experience, minimum, that are going to need to worry about having a plan.

The undulating program style is good in a lot of ways. Mainly, it removes the need to do any real long-term planning, which is huge a bonus. The downside is that you'll probably have to rely on full-body workouts for the best effect; there's only so many days in the week, and daily undulation relies on maximizing recovery between your heavy sessions. That's not to say it can't be done, mind you, just that it takes a little maneuvering.

I think that recreational strength athletes, meaning your competitive powerlifters and yes, even bodybuilders that focus on strength, will get to the point of needing weekly-level planning after a few years of hammering. Unlike competitive athletes in other sports, who have to balance weight training with other activities, weight training is the main activity for these guys. If you're doing things right, you're going to start hitting that wall after a few years, which will require you to start planning more thoroughly.

In this case you'll need to plan out heavy and light training cycles, which may be as short as a week or as long as a month.

THE TRAINING BLOCK: A MONTH

When you string together a couple of related training weeks, you get a training block. You'll hear this go by several names, too. Block, phase, mesocycle, whatever. It's all the same thing: a collection of weeks. We also call that a month.

Going by the literature, a training block can range from 2-6 weeks. As usual, practical matters are going to take over, meaning that the typical four-week, one-month block is going to be the easiest to deal with. The block gets you away from progressive overload by giving you a more structured plan from week to week.

At this stage of the game, it's understood that you're going to be using heavy weights, so when I say 'heavy' or 'light' in the following bits, what I'm talking about is *total stress*. Since the weights are going to be relatively heavy, what we're going to manipulate is the volume (rep range, the number of sets and exercises in a workout, and the number of training sessions) and the perceived effort of your sessions.

A heavy (high-stress) week would involve lower reps on average, more workouts, more sets in each workout, and a higher degree of fatigue, represented by your RPE scores. If you want to hit any PRs, this is the time to do it.

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A light (low-stress) week is the opposite: higher reps on average, fewer workouts, fewer sets, and more moderate efforts. You're going to be doing less work, and the work you do is going to be less stressful. This kind of training may actually be harder for some people to deal with, as it involves scaling back your effort and doing less than you might want.

When I say 'lower/higher reps on average' I don't mean you'll be doing exclusively one or the other. I mean that your workouts will trend towards one or the other – or the rep range may not change at all. People seem to grasp rep ranges more intuitively than percentages of max when talking intensity.

Perceived effort is going to rely on the RPE score. The higher the RPE of a set, the higher the stress it generates. As discussed, RPE gives us a way to manage total volume and control the desired amount of fatigue.

To make this easy, a high-stress/heavy week does 'more': more weight, more effort, more sets, more workout sessions. Low-stress/light weeks do 'less'. When in doubt, remember that guideline.

In all these cases, you're going to need some idea of your 1RM for the lifts you choose, and you'll need to be familiar with the RPE scale and how you respond under various conditions. In other words, this style of training is not for beginners – though it's highly suited for more advanced lifters.

The Informal Mesocycle

I think of this as a bridge between daily undulation and monthly training blocks. The idea is that you let feedback from your workouts tell you when to deload and when to restart a cycle. In effect you do have a training cycle, but it's not strictly planned out. For that reason I call it the *informal mesocycle*.

It's not as hard as it might sound. It just means that you allow yourself to progress, week by week, until you stall out. There's no fixed time frame. If you're humming along nicely and still making progress, then you keep milking it. Only when you stall do you consider messing with the program.

Basically what you'll do here is monitor your RPE numbers. If you're still sitting around 8-9, then you're OK. After a week or two up in the 9-10 range, it's probably time to allow for a little rest. The generic suggestion is to shoot for PR weights from 3-4 weeks into the cycle, and no more than 1-2 weeks with very taxing workouts. The idea is that the time spent in the 'grinding' range will net you a PR or two before you back off to recover.

To do that, you simply reduce the weights by 10-15% and then start the cycle over – which is called back-cycling. Depending on the workout, you might benefit from reducing the volume as well. In any event, you want to build up a little momentum behind you, by training with easier weights, before heading back into high RPE numbers.

While the generic suggestion is to shoot for 2-3 weeks of lighter training and 1-2 weeks of heavier training, if you're coming at it from a mass-gain perspective, you might benefit from a longer block – perhaps as long as 6-8 weeks, and with more of a focus on using slower progression methods. Meaning, you'd focus on increasing the volume with a given weight until it becomes comfortable, before working to increase weights. It may seem counter to everything I've said about getting stronger, but we can use the RPE of a workout to determine increases in strength as well. It's not just about piling on more weight.

Step Loading

Step loading is quite possibly the most widely-known kind of training block, where the intensity and total training stress will change from week to week. In the orthodox setup, the first week is light, the second week

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medium, and the third week is heavy. The fourth week is a low intensity unloading week used to recover. Each week (or step) encompasses several workouts, all done with the target percentage. You work up to peak stress for the cycle during the heavy week, which can mean both heavy weights and high workloads then reduce the workload to recover.

Wave-like Loading

There are other approaches used which will get away from that 'step-like' structure but still involve week-to-week changes. These methods are referred to as 'wave-like' or 'pyramid' methods, as this is how they appear when you plot the intensity on a graph.

In a wave cycle, you change the stress every week in a repeating pattern. Hence the name 'wave-like'. This would be the most literal interpretation of the 'highs and lows' concept I spoke of. Because you're making more frequent weekly changes, you alternation in the kind of workout can keep you fresh; this would be better for someone stronger, as compared to a relative beginner.

A wave cycle could shift between neural/strength and muscle or bodybuilding training as the volume changes. The first week would be higher reps and more sets, the second week would be lower reps and higher weight, while the third week would be pure strength work. This would be about the simplest way to do it.

Another approach would be to make the wave into a shortened version of a linear cycle. The first week would be 10 reps, second week 8 reps, and third week 6 reps. Remember that these changes in the rep range are just a proxy for the idea of changing workout stress – and you can play with that however you please.

The wave can last 3-6 weeks give or take and form any 'shape' you want. It can build up to a pyramid and then back down, it can zig-zag, whatever you want as long as the weekly stress changes.

Instead of the light, medium, heavy, unload sequence of the step method, you'll see something like heavy, medium, very heavy, unload as one example of a wave-like approach. A simpler sequence could be as easy as light, medium, heavy. The pyramid method might use a 5-6 week block, moving through a sequence like medium, heavy, very heavy, medium, light. The list goes on.

Light

Medium

Heavy

Medium

Heavy

Light

Really Heavy

Medium

Light

Heavy

Light

Pendulum Cycle

Continuing the theme of regular variation, the pendulum cycle makes variations in training on a more irregular basis. Instead of changing every week like, the pendulum makes regular periodic changes every 2-3 weeks –

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exactly like the motion of a pendulum. You'd spend some time working neural-dominant stuff, then some time working muscle-dominant stuff. Strength, then size. Repeat. What distinguishes the pendulum arrangement is that you'll spend 2-4 weeks training one way, then switch to something else.

Notice also that each phase is including daily undulation as well. There's absolutely no reason why you can't use different workouts in the same week, as long as they work towards the goal.

Strength Phase

The strength phase is going to focus on, you guessed it, strength. The goal here is going to be the exact opposite of what you'd want in the muscle-specific phase – high frequency, only a handful of exercises, and lots of sets. heavy weights and low reps, lighter and faster exercises for explosiveness.

Weeks 1-3 - Strength

Day	Monday (Upper)	Tuesday (Lower)	Thursday (Upper)	Friday (Lower)
Intensity	70%	70%	85%	85%
Rep Range	3	2	1-3	1-3
Sets	8-10	8-10	5-8	5-8
Volume	24-30	16-20	5-24	5-24

You'll spend a few weeks working on strength, then shift to the muscle mass phase.

Muscle Mass Phase

In contrast, the size phase is going to be more traditional bodybuilding, using an upper body/lower body split or something similar. Frequency will be lower, rep ranges will be higher and more varied, more exercises will be used, and fatigue per set will be higher with fewer total sets done.

Weeks 4-6 – Hypertrophy

Day	Monday (Upper)	Tuesday (Lower)	Thursday (Upper)	Friday (Lower)
Intensity	70%	70%	80%	80%
Rep Range	8-10	8-10	4-6	4-6
Sets	3-4	3-4	4-5	4-5
Volume	24-40	24-40	16-30	16-30

Keep in mind that these are just examples. What you need to understand is the underlying rationale, why these are structured the way they're structured. Each example I give you is just derived from the underlying rationale.

Beyond this, there are other kinds of blocks available, most of which are designed for specific goals like recovery or tapering for a contest. One worth mentioning is the *concentration block*, which is a little different take on this concept.

Instead of fluctuating the intensity and volume weekly, you'll keep them high and do several more taxing weeks. This is called a concentration block for a reason, as it's very stressful on the body. In fact, that's the goal: to dig down into your recovery reserves and wear yourself down a little, making use of functional overreaching

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like I discussed before. This can be necessary for some advanced athletes in order to push them out of a rut and stimulate gains.

You can accumulate stress gradually, with a 3-4 week block of high-volume training, or you can take the shortcut approach and obliterate yourself in one week.

The gradual accumulation approach is seen in the so-called 'accumulation/intensification' cycle that Poliquin talks about. In the book *Practical Programming*, Rippetoe and Kilgore mention a 'pyramid cycle' that is basically the same thing. I think everyone's heard of the Smolov squat cycle, which is the same idea as well – a block of ridiculous volume with frequent workouts. It's hell to go through, but once you make it out the other side and rest enough, you'll reap the gains. The gist of it is that you train often, do a lot of volume in each session, and do all of this while you keep the weights moderately heavy.

The latter approach of short-term obliteration was known to the Russians as a *shock microcycle*. You'd ramp up the volume and frequency to truly insane levels, while keeping the intensity pretty high. One hard week may not sound like a lot, but by the time you're heading back to the gym for your eighth workout of the week – and it's only Thursday - you may think differently. Most people will notice marked overreaching symptoms by the end of the week if they're doing it correctly.

This is done on purpose, though. We actually trick the body into overreacting. You stress it out with a really hard phase, and then when it's gearing up to respond, you remove the stress. It's like what happens in tug of war when you're pulling as hard as you can and the other guy just lets go.

We're artificially triggering a massive neuro-endocrine response from the body – which has been shown to create real training effects in people that otherwise find it hard to improve.

If you're past a threshold of size, strength, and overall development, I'd suggest that this may be the only way you can trigger any kind of improvements. Note that this for people that are *really* advanced, not just 'lol advanced'. Using this kind of planning requires that you not only be strong, but fit and conditioning in a more general sense. If you can't tolerate the workloads involved, you won't get very far.

Concentrated loading is best used as part of a long-term strategy, though, not the least of which because it can require substantial recovery. A concentration block makes little sense without the context of a larger plan.

I want to stress that there is no right answer here. What you need to see is that in all of these cases, the goal is to have a peak week where you hit the heaviest weights and create high stress. The rest of the block is either building up to or recovering from that peak.

You may find one method works better than another, or you may find no real difference between them. It could well be that you find one approach you like and just stick to it. In all of these cases, you're simply manipulating the intensity and workload from week to week so that you aren't stuck in the monotony of progressive overload. As long as you're manipulating the stress from week to week, the details aren't terribly important.

I'll remind you one more time that it's not just intensity, but total stress and workload that changes each week. In most models this means just increasing the percentage of your maximum, or whatever approach you're using to measure intensity. However, it can also mean doing more sets to increase volume, or using 'intensity methods' to increase your subjective effort.

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While four weeks is the standard, there is a time and a place for shorter training blocks. Blocks of three weeks can be used to emphasize hypertrophy, pure strength, or even endurance work. The pendulum method makes use of these short 1-3 week cycles by frequently alternating between two goals. For example, you might choose to alternate between bodybuilding training and maximum strength training every two or three weeks so that you don't stagnate.

Now, in practical terms – I don't think most of you will need to bother with anything crazy here. You might find that a four-week cycle is right for you; it could just as easily be 5-6 weeks, or even longer. The idea is not to lock yourself into any defined length of time; why would you stop a productive training cycle, when you're still setting new records, just because you've planned to stop? That doesn't make any sense.

That variability is the big reason why you shouldn't rely on this kind of complexity unless you really need it. Progressive overload has you hitting PR weights every workout – a training block like this has you hitting them once a month. Which do you think is more productive? You use this complexity because you have to, not because it's better.

THE TRAINING CYCLE

A training cycle is just a collection of monthly blocks that come together for a specific goal. This is very useful for those with concrete deadlines, say a competition or the beginning of a season. You put all your preparation training in the earlier stages so that you're ready for go-time.

Now, I'm going to go ahead and say right out that you casual-types, the gym-rats and weekend warriors amongst you, are just not going to have any need for the monolithic year-long plans. You can follow such a strategy, don't get me wrong – just realize that sports training tends to be divided into the preparatory (off-season) and competitive (in-season) phases for a reason. If you don't have a competitive season, then you're missing out on potentially valuable training time when you pretend you do.

In this regard, I agree with Rippetoe and Kilgore – there's just no need for the complexity of long-term planning, and further, you can actually slow down your progress by getting too hung up on a complicated plan. All you need is a well-designed weekly routine – undulating periodization, if you prefer – and a strategy for troubleshooting.

Of course if you're a competing bodybuilder with a defined season, then you could make use of preparatory and competitive cycles. Use the off-season to get bigger and stronger, then switch to training for fat loss and fine-tuning muscle development during the competitive phase.

Where this type of longer cycle may come in handy is for planning together a series of blocks and making sure you don't wreck yourself. As a rule of thumb, you might consider having an easy block for every 2-3 heavy blocks, the same way you generally want an easy week after 3-4 heavy weeks. Rules are made to be broken, of course, so this doesn't have to apply to every situation.

As I've said, I don't think bodybuilders need to mimic the structure of sports training plans, at least not exactly. There are some takeaway points of course, but there's no need to copy the specialized programming when bodybuilding is a more general goal. Bodybuilding would probably be better served by looking at things from the stance of high-volume (accumulation) training and high-intensity (intensive) training. You're going to want to cycle through some degree of bodybuilding training and some degree of heavy strength training, and the fine details don't really matter that much. And of course we can't forget about rest.

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That's how long-term planning should affect you; otherwise you're just over-complicating things.

When shifting between blocks with different goals, you'll want to allow for the difference in exercise selection and your weekly routine. A muscle-training phase would have you using a wider variety of exercises and a possibly a form of a split routine, while a strength-training phase would use a minimum number of core exercises and a more appropriate weekly routine. As long as it's specific to your goal of getting jacked, you're OK.

We also need to keep in mind the need for transition phases, or short rest phases between harder training blocks; it doesn't have to last longer than 1-2 weeks. If you're using the standard training block with one unloading week each month, then that counts as your transition.

These lighter blocks are important, though, so don't drop them. Even though the high rep pump 'n tone stuff can be dropped if you're more advanced, you still shouldn't completely drop the general work. Your basic stuff like corrective exercises and cardio, the stuff that keeps you moving right and keeps you in some kind of shape, should stay in your routine even if it's only in small amounts.

Some people suggest keeping this in year-round, just in smaller amounts, say during warm-ups or cool-downs around the main session. Others suggest devoting short periods of 1-2 weeks between training blocks. Either method (or both) is fine – just gauge it according to your needs.

Solid Programs To Think About

And what would a workout book be without some examples?

I'm gonna go a little different here yet again. By now you should see that my thought process doesn't really put much importance on the exact program you do. My preference is to have an overall system of training, basically just a set of solid practices, and then fill in the blanks as you need them.

With that in mind, I tend to use a lot of very basic templates, usually pre-existing programs, and just fill in the blanks as needed. Realistically, there's only so many ways you can organize things across a week.

So what I'm going to do here is lay out some of the programs I like and give a little blurb about how they fit into the process. I think this will also help you better understand what I'm talking about, when you look at these seemingly different programs and see how they can fit into a greater ideology.

Some routines are geared towards getting stronger, others are geared towards building muscle. Some don't really fit either bill at first glance. As I've already said, no program is going really build strength without making you bigger, and no program is going to really make you bigger without getting you stronger in the process. It comes down to proportions.

The strength routines have the stated purpose of building up strength in a limited number of exercises. While you most certainly can grow on these routines, the goal is neuromuscular strength training. You might only emphasize 2-4 specific lifts in one of these routines, with the theme being relatively frequent sessions, low to moderate volumes in each session, low reps, and relatively many sets.

Strength routines will always boil down to training lifts as a skill – which means practicing as often as you can and emphasizing the quality of performance. In other words, lots of sets and limited fatigue.

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Bodybuilding routines are explicitly for training and developing muscle tissue. While these routines can make you stronger and do have a progressive-overload component, the goal is to overload the muscle groups in a variety of ways.

Bodybuilding in a general sense will be the opposite arrangement from a strength-specialized routine: fewer sessions, but greater volume per session. There may be fewer total sets done, but reps will generally be higher and more diverse in range. Instead of focusing on just a few exercises, more total work will be done to ensure each muscle group is trained optimally.

When you look at these programs, some of them are simply weekly workout routines. They're a plan for organizing your week. Unless it states otherwise, you can fit these approaches together with the previously-mentioned periodization models.

On the other hand, some of these will already have their own preferred progression methods, which is fine too. I'm giving you options here, not locking you into specific and mostly arbitrary 'workouts'.

ARE YOU STRONG ENOUGH TO LIFT?

This is something I haven't really touched on yet, but when it comes to strength training, I'm not sure some people realize how to connect it with their goals.

The mantra is lift, lift, lift. Get strong and grow. The thing is, I don't necessarily think this is appropriate for everyone.

I think that at a bare minimum, you should be able to do the following without any major problems:

Bodyweight squat to acceptable depth
Bodyweight lunge with each leg
Pushup with bodyweight
Inverted (or supine) row with bodyweight

If you can't do at least one clean rep with those exercises, I'd strongly advise that you take steps to get to that point. If you can't do these basics, then you're not going to do any better trying the barbell or dumbbell equivalents.

The question is, why can't you do them? Sometimes it's a matter of weakness, and sometimes there's a deeper movement problem at work. Movement issues are often a result of muscles shortening and becoming tight, which makes a joint less mobile than it needs to be. Ankles and hips in particular have a habit of getting overly tight, so they may need to be loosened up. This can be one limiting factor in both squatting and lunging motions.

On the converse, it can sometimes be a matter of *too much* mobility and not enough strength in the muscles that keep things stable. If that's the case, it's often just a matter of strengthening the relevant muscle groups. You see this in play with the shoulder blades (scapulae). If these muscles are weak, the scapula won't be positioned properly – which can lead to shoulder issues. Doing exercises to strengthen this area is important for shoulder health.

I'm not going to say much more than that; this isn't really my area of expertise. I'll just say that it's something you should keep in mind, and leave it at that.

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Now, assuming you can actually do those exercises, mechanically speaking, you're still not out of the woods. How many can you get before you tucker out? I still question how useful weights are going to be when you can't handle your own body weight.

If you get down and can only do five pushups, or two lunges, I don't think you have much business on the bench press or doing barbell squats.

Now there might be a case for light barbell, dumbbell, or even machine work (yeah, I said it) if you can't do these. The reason is that they'd work to strengthen the muscles in a non-specific manner. You'd still have to work towards the goal of moving your bodyweight, but the resistance exercises would help you build up the muscles.

I'm really hesitant to put out any specific numbers, because it would vary from person to person due to a lot of variables. Off the cuff, I'd throw out at least 10 pushups and bodyweight rows, 20 bodyweight squats, and 10 lunges per leg. But as I said, that's not even close to a hard and fast rule, so don't start quoting me on that.

Finally, you have to think about what you want out of it. I've spoken of how some women like a smaller, sleeker look. While I don't think you're going to radically shape your body, if you're not after high levels of strength and what little muscle mass will come from that, I don't see much rationale for going into a full-bore progressive strength routine, either.

You may well see all the results you care to see from bodyweight exercises and some additional strength work thrown in to round things out. Remember that muscle mass is a product of *change* in tension overload – if you're not adding resistance to your lifts, then you've put a cap on how much muscle you can develop. Don't want to grow? Stop getting stronger.

This doesn't change my viewpoint on the frequency or volume suggestions, mind you. In terms of workout routine, exercise choices, and all that stuff, I'd not do a thing different. The change would come from intensity. If you want to be tiny and 'in shape', then stick to lighter weights and don't make any attempt to get stronger.

If you are looking to get big 'n jacked or as strong as possible, then you're fine just going the traditional strength-program route.

THE 5x5 ROUTINE

The 5x5 is one of those timeless classics that's hard to narrow down. On the one hand, it's a well-developed system of strength training; on the other hand, the routine itself is so old and fundamental that it's hard to narrow down where it came from.

The system is named for the set/rep scheme for which it's associated – 5 sets of 5 reps. Five by five. Although admittedly I have little data on this, the concept dates back to at least Reg Park, a bodybuilder from the 1950s. It might well be older than that, as some of the even older-timers were known for doing lots of sets in the 3-5 rep range.

In any event, the current iteration of the program that we all know and love can be traced back to Bill Starr's book on football training *The Strongest Shall Survive*, released way back in 1976.

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Starr laid out a simple, but remarkably effective plan: train on a Monday – Wednesday – Friday schedule, stick to the basic barbell lifts, and vary your stress across the week. In that regard Starr's 5x5 can be thought of as an early example of what we now call daily undulating periodization. So much for the Russian secrets, huh?

Starr's favored exercises were the back squat, power clean, and bench press. The story goes that he would have preferred the incline bench to the normal bench press, but due to the needs of football he was kinda stuck with it.

Over a week, Starr had heavy, medium, and light workouts. Unlike most of the periodized and cycled routines you see, this wasn't based around rep ranges. Instead, you just stick to sets of five but change the number of sets and the goal weight.

A heavy day might have you working with a fairly heavy weight and doing five sets (as per the '5x5'). Medium day would have you working up to your best set of five reps (or even three reps), but doing less sets to get there. It's still stressful, but not in the same way. The light day would have you doing multiple sets, but with a weight that's only mildly challenging.

Besides Starr's version, I've seen several variations floating around on the 'net over the years. One that sticks out in particular is a version promoted by the late JV Askem, who was an early influence of mine. JV's version of the 5x5 wasn't terribly different from Starr's, and he had several iterations depending on whether your goal was Olympic weightlifting or more powerlifting/strength emphasis. Sadly JV passed away back in 2003, but his original web site containing his writings can still be found online.

Of course the version that everybody knows these days is associated with Mark Rippetoe and Glenn Pendlay. In many ways they're Starr's successors, having taken the older program and refined it into a full-on training system that's remarkably flexible.

Based on research into strength training adaptations (going back to Hans Selye's GAS model from chapter 2), they've identified roughly three stages of development: beginner, intermediate, and advanced. Each stage is based around the response to training; a beginner will benefit from frequent workouts and rapid progress, while an advanced lifter will have to plan for monthly-level progress. Intermediates lie in between, making use of variations across a weekly cycle.

The main differences in the three stages are how and when you do the heavy, medium, and light training. For beginners it all blurs together, and progressive overload is perfectly fine; they just have to pile on more weight each session. Intermediates will spread these different workouts across a week, per the Bill Starr version. The really advanced guys devote entire weeks or even months to heavy, medium, and light training. The beginner phase is basic linear progression, the intermediate phase is a daily undulating model, while the advanced level is where you'd see the big monthly periodization stuff come into the picture.

In their comments, Rippetoe and Pendlay have described what I guess you could call an 'informal training cycle'. You progress through the workouts from week to week by adding weight, just a basic linear progression.

After a few weeks of training with light-moderate type weights, easy to respectable on the RPE scale, you'll hit a point where the weights get tough and the RPE gets high. At this point, you just reduce the weights – the standard number is 10-15% off your best weights of that cycle - and start the cycle over. You get your highs and you get your lows.

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If you want to get fancy, you can start specializing on the high-volume 5x5 day, or on the high-intensity day that works up to a heavy set of 5. When you do this, you'd put the other on maintenance. You'd still do the workout, but you'd just make a token attempt instead of trying to push the weights up. Focus on one day for a cycle, then focus on the other day.

Glenn Pendlay has said that one method they use for very strong guys is to use the 5x5 workouts in an accumulation style – squatting 5 sets of 5, three days a week, working to set a PR by the end of week three or four – then switch to a Westside template, which is much lower volume and much heavier. This resembles the 'pyramid method' outlined in *Practical Programming*, with a high-volume loading phase followed by a high-intensity peaking phase.

Even the 5x5 arrangement is up for debate. There's no reason you couldn't use triples, doubles, singles, or even sets of 8-10. Just use the same methodology of heavy, medium, and light days.

I'm not going to go through every single permutation, of course, but it doesn't take much imagination to see how the idea can be used in other ways.

UNDULATING FULL-BODY ROUTINES

While I don't see any real reason to diverge from the beginner-level 5x5 routine, as it will work just fine, if you're dead-set on more variety and muscle-mass specialization, this is how I'd suggest you go about it.

This is a basic daily undulating program, three full-body sessions per week, and rotating through three different kinds of workout. You have some heavy sets of 5-6, some lighter sets of 10 for a good pump, and then the lighter day focused on just getting to the gym and getting the blood going with some easy triples.

Day 1 – 3x5-6 (Strength)	Day 3 – 5x3 (Light)	Day 5 – 4-5x10 (Muscle)
Back Squat	Front Squat	Back Squat (or Leg Press)
Bench Press	Overhead Press	Incline Bench
Barbell Row	Chinup (or Pulldown)	Seated Cable Row
(Assistance)	(Assistance)	(Assistance)

The (Assistance) just means smaller isolation exercises. Most people are going to go straight for Da Gunz and shoulders here, but I'd also make the suggestion to not ignore corrective work for the upper back/scapula, and single-leg work for the hips.

If you're doing the vanity stuff for arms/shoulders/calves or what have you, 1-3 sets of 8-10 would be plenty. For corrective work, that's largely individual but I prefer to keep that stuff to higher volumes and less fatigue (meaning, don't train to failure).

Another option would be to throw in a fourth type of session to cover all the bases. You'd still keep the M-W-F scheduling, but rotate through the workouts.

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Session 1 3-5x3	Session 2 3-4x5-6	Session 3 3-4x8-10	Session 4 2-3x12-15
Front Squat Overhead Press Chinup (or Pulldown) (Assistance)	Back Squat Bench Press Barbell Row (Assistance)	Back Squat (or Leg Press) Incline Bench Seated Cable Row (Assistance)	Circuit – pick 1-2 exercises for each part and go through them in a circuit style

A variation on that theme would have you using the four methods I outlined earlier: max strength, intensive and extensive bodybuilding, and dynamic/power training. This, or something like it, might be ideal for muscle mass.

With that in mind, you could go full-bore, with four training days per week and do a mixture of strength work and hypertrophy work.

Monday 4-5x5-6	Wednesday Bodybuilding	Thursday Bodybuilding	Saturday 2-4x5 (Light)
Back Squat Bench Press Chinups	Pulldown Bench Press Seated Row Overhead Press Arms	Squat Romanian DL Split Squat Leg Curl Calves	Front Squat Overhead Press Pullups

In this case, Monday is the moderate-stress 'strength' day, Wednesday and Thursday split the high-stress 'bodybuilding' days between upper and lower body, and Saturday is your light recovery session.

Regardless of the workout, your goal will be to get stronger on each of these workouts from week to week. Add weight in a reasonable manner session to session, and don't be afraid to use a double progression on the hypertrophy days – making sure you get all the reps before adding weight, in other words.

When you get to a point that the weights are really heavy and grinding, that means you're near a peak. At this point, drop the weights back a little, maybe 10-15%, and start the cycle over if you want.

Or do what most people do and start asking for an entirely new workout because you've 'completed' this one (*Note: Don't actually do that. It's a joke*).

BASIC FOUR-DAY ROUTINE

This workout style splits the body into upper body and lower body halves, emphasizing slightly different muscle groups each session. This is more of a flexible template than it is a pure workout, since it's really customizable for various goals.

I could call this 'my routine' I guess, but this thing is really old as dirt. The only thing 'mine' about it is what I chose to call the days and the details of the exercises I slotted in. None of that especially demands that this be considered 'my routine'.

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As per SOP, consider this a useful template that can be adjusted as required – not some unchanging 'program'. If you don't like the exercises, change them. It's OK to make changes as long as those changes make sense and are consistent with your goals. If not, that's fine too – you can do it as-written and it won't kill you.

Basic Four-day Routine

Upper (Bench Press/Chest)	Lower (Squat/Legs)	Upper (Shoulders/Triceps)	Lower (Deadlift/Back)
Bench Press	Squat	Overhead Press	Deadlift
Dumbbell Flye	Single-leg Exercise	Triceps (heavy)	Weighted Chinup
Triceps (high volume)	Glute-ham Raise	Shoulder side raises	Barbell Row
(Upper back corrective work)	Leg Extension	(Upper back corrective work)	Curly
	Leg Curl		
	Calves		

Depending on your preference, you can split this up several ways.

Day 1 – Upper (Strength/Power)

Day 2 – Lower (Strength/Power)

Day 4 – Upper (Hypertrophy)

Day 5 – Lower (Hypertrophy)

As per the earlier comments, strength/power would be few exercises, low reps, and either heavy/slow or heavy/fast as the case may be. Hypertrophy would be several exercises and higher reps with an emphasis on creating fatigue. Another variation would be to split into 'heavy' and 'light' days, to separate the high and low stress methods.

If you've got the time and a pretty good recovery ability, you can also split the upper-body hypertrophy day into a push session and a pull session. That particular variant is credited to Layne Norton. I don't know if it's really his, but I really like the setup so I wanted to include it.

Day 1 - Upper (Strength/Power)

Day 2 - Lower (Strength/Power)

Day 4 - Upper (Hypertrophy: Chest/Shoulders/Triceps)

Day 5 - Upper (Hypertrophy: Back/Traps/Biceps)

Day 6 - Lower (Hypertrophy: Legs/Calves/Abs)

Of course you're not limited to the upper/lower split. You can do something like push/pull instead, putting squatting and pressing exercises on the push day, with any back and pulling exercises done on the pull day. It's all up to you.

The same rules with regards to periodization applies here as well. There's nothing wrong with using a somewhat higher volume than normal, or trying to push out strength gains, for 3-6 weeks at a time. Just pay

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attention to your body's responses, and if you start to reach a plateau, there's no harm at all in backing off the volume and dropping your weights back 10-15% to allow a little recovery.

HYPERTROPHY-SPECIFIC TRAINING

Hypertrophy-Specific Training (HST) is a perfect example of the linear model applied over the short-term, in a way that's oriented towards bodybuilding. Thus the 'hypertrophy-specific' title.

It's about as basic an arrangement as you can think of. The base routine is three full-body workouts on non-consecutive days, like the 5x5 and undulating routines I've mentioned. You choose exercises for each body part, instead of just a handful of lifts to improve.

The periodization method is an eight-week linear cycle. You start with 15 reps, then 10, then 5, and then eccentric-only training, with each phase lasting two weeks. During each phase, you start with light weights and add 5-10 lbs per session until you're at maximums by the last workout of the cycle. So if you know that your 15RM is 100 lbs and you want to make 5 lb jumps each workout, you'd subtract 25 lbs ($5 \text{ lbs} * 5 \text{ jumps}$) to start out with 75 lbs.

In practice, HST can be hit or miss. When done to the letter, a lot of people report getting stronger, but they don't necessarily get larger.

However I do see HST as being useful, even in principle, as an accumulation phase. The trick would be to stay with 15s and 10s for 4-6 weeks, then switch into a heavier strength phase. Instead of focusing on blind progression, you could use a wave-like progression – add weight for 3-4 workouts, then drop the weights back and start over.

I will say that a few years back, I did exactly that using 10 reps per session. I wasn't using the linear progression approach, however; I just waved the weights up and down every few workouts. After about four weeks, I switched into a Westside-type routine and managed to net quite a bit of size. Yes, that's pure anecdote and there could well be other variables involved, but it does at least follow.

In any event, the linear version could be useful for beginners or those otherwise in a situation that would call for a relatively easy linear program. The accumulation version is an option as well. The basic principles of HST are sound in any event: frequent training, adequate stimulus, and progressive overload.

DC TRAINING

DC Training has an interesting history. It's the brainchild of a fellow named Dante Trudel, who made waves on the 'net a few years back under the rather unfortunate screen name 'DoggCrapp'. Dante said it was a joke, but sadly it stuck. This particular program is commonly known as 'DC Training' because of this.

Dante's focus is on strength development. He's one of the bodybuilders that realizes the value of strength, and has put it into practice. It's a deceptively simple system, but that's arguably the strength – it's packaged up in such a way that it's hard for people to fail.

At first glance, DC resembles a HIT program. Normally I don't like HIT, but that has nothing to do with the actual programming, per se; it has more to do with the dogma. Some HIT-type programs I've seen have been quite good, and I include this as one of them.

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Dante's basic routine separates the body into two workouts, an A session and a B session. You alternate these two on a M-W-F schedule.

Session A	Session B
Chest	Biceps
Shoulders	Forearms
Triceps	Calves
Back Width	Hamstrings
Back Thickness	Quads

What's this? Body parts? Yep. I don't agree with some of the naming, but I can look past that; the actual meaning is what's important. Back width is just a chinup, pulldown, or related type of motion. Back thickness is a row or deadlift. We can argue with the concept of 'width' and 'thickness', but 1) there's some rationale behind it and 2) it's solid exercise selection so who cares?

I also like how the B workout puts the smaller groups first, so you don't do your leg work and go home before you do the biceps and calves.

In more advanced settings, I've seen DC adapted into a push workout, a pull workout, and a leg workout, then rotated over four workout days each week. You'd need good work capacity to pull that off, though, just be warned. It would make a good concentrated loading strategy if used in the short term – just make sure you actually taper afterwards.

DC Training has two other features that you don't tend to see in other programs. Dante's big on the idea of rest-pause sets. You start with a normal set of 5-8 reps, and go until you can't get another rep. Then you rack the bar and rest. The orthodoxy is '10-15 deep breaths', which probably works out to 15-30 seconds depending on how fast you breath. At any rate, you do another mini-set. Expectation might be 3-5 more reps. Then you repeat this one more time. The goal is to hit from 11 to 20 total reps in each session.

If you've kept up, you see why this is effective. You only do that one 'set' for each part, but you're racking up a ton of volume and fatigue in the process. It's one set on paper, but in practice it's equivalent to more. Remember that fatigue and effort can skew the volume equation. Dante suggests anywhere from 11-20 total reps for each part, and damned if that doesn't just fit the bill for total volume. Combine this with a drive to increase either weight or total reps, and you've got a winner.

The program suggests picking three exercises for each part; on the A-B schedule, you'd end up repeating each sequence every two weeks. Consistent enough to make progress, but spread out enough to not break you.

The other oddity is what Dante calls 'extreme stretching'. As you might guess this is involves stretching the muscles that were trained. After doing your rest-pause set, just stretch the hell out of the part for 30-60 seconds. Only it's not the usual stretch – this is done with resistance.

This loaded stretching was supposedly based on studies that show passive stretch can cause fiber hyperplasia. Only problem is, these were done in birds and the birds were stretched for several days. So, uh...yeah. Another theory trotted out is that this stretches the fascia, connective tissue that surrounds the whole muscle. Bro-theory would have it that the fascia can constrict the muscle and prevent it from growing, but that doesn't make sense – fascia grows with the muscle.

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Nevertheless, we know that stretching a muscle while it's under tension is one way that fibers are overloaded. In that regard, this extreme loaded stretching isn't terribly different from an overloaded eccentric movement. You're still placing that tension-induced stretch on the tissue. In practical terms, you can look at this as additional growth stimulus.

Lest you think that's all, DC even throws in a periodization scheme. This is referred to as 'blasting' and 'cruising' phases. Blasting would be your high, where you go all out and really try to ramp up strength on the lifts. Cruising is your low, where you still train but throttle back on the gains for a few weeks instead of trying to push out progress.

All in all, I like DC Training. It's a solidly-designed program, and I really can't pick out any major flaws to the design.

There may be some individual concerns, though. The program is very "intensity" driven, so it works best for the people that can go in there and give it all they have on each set. Since you only get the one attempt, you have to give it everything. This doesn't jive with some people, although I don't see this as a weakness. Some people are going to respond better to volume-based approaches, while others will respond better to intensity- and effort-based workouts such as this.

Still, it's worth a shot if you're interested in growing, or if you're coming off some higher-volume training. You won't know until you try it.

THE WESTSIDE BARBELL SYSTEM

I might not even have to put this in here, because I think everybody in the world knows what Westside is. It's certainly argued enough on the Internet.

Westside is one of my favorites because it demonstrates some very smart methodology. The workouts are based on the three methods I mentioned before: max effort, dynamic effort, and repeated effort (or bodybuilding).

The bench press gets a maximal (heavy) and dynamic (light/speed) day. So does the lower body, which trains the squat and deadlift. Both days are followed up with assistance exercises to work the involved muscles – bodybuilding, in other words.

Although it's a bit more complex in practice than the boring old workouts in the research, Westside is just a version of daily undulation specialized for powerlifting.

Keep in mind that everybody and his daddy has a version of this setup, as the goal is to prioritize according to your own weaknesses, so there really is no set in stone 'program'. As we're so often reminded, nobody but Louie and the guys at Westside are actually doing Westside. Everything else is just an adaptation of the concepts, so there's about as many ways to go about it as you'd care to mention.

Lest you think this is useless for bodybuilding, I'd argue otherwise. Even in the unaltered form, the Westside template is a powerful stress. I'd suggest making sure to use a form of periodization with it, but there's no reason you can't get considerably larger with the setup.

Yes, Westside can actually be tweaked for the purposes of bodybuilding. I already touched on the concept earlier, but it's mostly a matter of tweaking the ME and DE days and then picking the right assistance exercises.

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The Westside Template (more or less)

Day 1 (Sunday) DE Bench	Day 2 (Monday) DE Squat/Deadlift	Day 4 (Wednesday) ME Bench	Day 6 (Friday) ME Squat/Deadlift
Speed Bench - 8-10x3 Triceps (Heavy) Shoulders Upper Back	Box Squats - 8-12x2 (Speed Deadlift - 8-15x1) Hamstrings Lats	ME Bench Exercise Triceps (Volume) Upper Back	ME SQ/DL Exercise (Secondary Exercise) Lower Back Lats

Louie Simmons and Dave Tate have both made comments in various places regarding how they'd modify the program for that goal. In fact, Louie's trained at least one IFBB bodybuilder, Mike Francois, using a variation on the system.

That particular workout was outlined in an article in the defunct *Peak Training Journal* back in the 1990s. It's the same basic principles and weekly routine of a standard Westside setup – focus on the big lifts, using special exercises and assistance exercises to bring up the weak points. In this case, the weak points are body parts.

Otherwise the weekly schedule is pretty much the same: two upper-body workouts, two lower-body workouts. There's some nods to muscle building, such as using slightly higher reps on the dynamic-effort work, and using higher reps on the max-effort exercise.

Mike Francois trained eight times a week, according to the article. He'd come in and do the heavy strength work in the morning, then come back for a later session to do higher-volume muscle-group training. You wouldn't necessarily have to do this, but if you had the time it couldn't hurt.

In an audio interview from a few years ago, Louie basically stated that he'd train at 80% for sets of four on one day, and then at 70% for sets of six on the other day. Additionally, he suggested adding bands to exercises, which I think is an interesting idea in itself.

To recap, you use sets of 4-6 on max-effort work, sets of 4-6 for dynamic-effort work, and then do a ton of bodybuilding work afterwards, or in a separate session. You can add bands to your exercises to increase the eccentric overload.

TRADITIONAL MUSCLE-GROUP SPLITS

What the? Didn't I just make a strong case for this being ineffective? Yeah, I did. But I'm also following along with my theme of fitting all the pieces into the puzzle.

If designed properly, I think that bodybuilding split training can work just fine provided you're out of the beginner phase. By 'designed properly' I mean that it accounts for movement issues, it accounts for frequency needs, and it uses sane volumes of work. Most of the routines people follow, straight out of the mags, don't do any of this.

Believe it or not, you can actually make this work with a few tweaks, and that's why I won't totally throw out the idea.

Movement problems can largely be solved by having an intelligent workout structure and picking exercises carefully. For example, let's say you do 'chest', 'legs', 'shoulders/arms', and 'back'. With the magic label-maker,

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that split has just become Upper, Lower, Upper, Lower. Now it's not a muscle-group split anymore! Or is it? As you see, the label is just a name. What matters is what you do inside the routine.

Frequency issues can be solved by using some kind of rotating schedule, so that you can train each muscle group more than once a week. One of the first books I ever read on bodybuilding was *Bodybuilding: A Scientific Approach* by Fred "Dr. Squat" Hatfield. In that book, he discusses the idea of variable split routines, where you set up a split based on recovery times between muscles and between different degrees of workouts. A hard leg workout might require a week's rest, while a light bicep workout might let you train them again two days later, as some examples.

The easy way to do this is to first pick how many days you want to train each week – lift three days (Monday, Wednesday, Friday), four days (M-T-Th-F), five days (M through F), or whatever. Then figure out how often to train things. A big muscle group like the legs might get away with one heavy workout or two lighter sessions; the big upper-body muscles (chest and back) can probably handle 2-3 sessions; the smaller detail-stuff (shoulders, arms, calves) could likely go 2-5 depending on how hard you train them and what your priorities are.

So you just fill in the details from there. This way, you can scale recovery time to the difficulty of the workouts – and you don't get caught in the once-a-week mindset. A small part might get hit several times a week, while a bigger one might only get 1-2 workouts each week. Average time between each part getting some work will likewise be 3-7 days, depending on how hard it was worked.

It's a neat concept that I think a lot of people would do well to remember, especially if you're just dead-set on doing the muscle-group split methods. This doesn't have to be hard, either; you just have to think of things on a schedule besides the usual seven-day week.

Even something as simple as rotating a push workout, pull workout, and leg workout over a 4-5 day cycle would suffice – with four training days per week (M-T-Th-F), each of those workouts would repeat roughly every five days. In other words, this is a variation on the daily undulation concept.

There's other more exotic arrangements that you could come up with, depending on how much spare time you have and how detailed you want to get. Just remember that if you want to train this way, you can't just throw it together without some forethought. You're stuck with the same rules as everyone else, even if you do want to be a bodybuilder.

THE HORMONAL FLUCTUATION MODEL

This would be a prime example of the shock microcycle in action; as such, it's an advanced method that is most certainly not for beginners. The HFM is a cycle that has you spending a little time with 'average' stress before ramping the workload up to super-insane levels. Fortunately this extreme loading then backs off sharply for several weeks to taper and allow you to recover.

Although you can make the wave as long as you'd like, the ideal seems to be 5-8 weeks, give or take. There's only going to be one shock week, and once you get to it you'll be very glad for that. This is not something for the weak-hearted (or people with jobs) to try.

According to Mark Rippetoe and Lon Kilgore, the basic five-week structure is like so:

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Week 1 – Light

Week 2 – Medium

Week 3 – Holy Crap

Week 4 – Medium

Week 5 – Light

The six-week variation would add an extra shock-loading ('holy crap') week, while the eight-week variant extends the lighter tapering phase to four weeks instead of two.

The light and medium weeks are normal-ish training as you'd expect from the names, using average frequency, heavy-ish weights, and reasonable volume.

Then comes week three. You don't necessarily have to increase the weights here, as you'll already be using fairly high intensity, but you'll want to add a lot more sets with those weights. You can keep the effort and RPE high here, so there's no worries about going to failure and making repeated PR attempts.

While you're at it go ahead and double the number of workouts. If you were training with four sessions, go ahead and jump it up to eight. You'll probably have to train in the morning and evening for this, but that's what it's all about. It's only one week, you'll live.

If done correctly, this is going to be like fun, except completely opposite. The good news is that the next two weeks are light tapering in order to reset all the hormone stuff you knocked out of whack. The taper is just your recovery time; you don't really reduce your working weights, but you sharply drop the workout frequency and the volume within each session. This is mandatory if you want to actually recover properly. You might back the weights down to 80-85% of your best, but the real change will be volume.

You might want no more than two total sessions each week, and maybe just 1-2 sets within each session. Not a lot of work, and you don't want it to be. You're just greasing the wheels to keep some stimulus going while the body's recuperating. If you pull it off, you'll see some rebound gains even during the tapering weeks. You might even have the motivation to do more than the piddling amount of training you're doing, but you have to hold back. After you're all recovered, you should notice some interesting improvements.

This is one of those things that's very counterintuitive if you're used to the basic bodybuilding style of training, but you have to trust the idea. It works if you let it. To make this work right for bodybuilding, you'll want to adjust the rep ranges and the exercise selections accordingly. This model was tested for Olympic weightlifters, and as far as I know nobody's really put out a bodybuilding version.

It's not hard to brainstorm a little and think of what you'd want, though. The light and medium weeks wouldn't have to differ too much from your normal training, although you'd want to make sure they fit the overall theme of the cycle. The maximal-stress week would have to fit a few criteria: more sets for each muscle group, heavier and harder weights, higher exertion (maximum RPE numbers) and higher fatigue, and more total sessions.

The taper weeks would follow suit by reducing the workloads. If you were training six days a week during the maximal week, you'd want to drop that to 2-3 sessions on the medium week and two sessions on the light week. Limit your volume to 2-3 sets in each workout, and keep the RPE in the 'easy' range. You can keep the actual weight fairly heavy, though.

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SPECIALIZATION ROUTINES

Specialization routines are done to, well, specialize. To run with the theme, you can classify these as either strength-focused or muscle-focused. Same rules apply: strength development will focus on a limited number of exercises, high frequency, lots of sets, low reps. Muscle development will focus on more exercises, slightly lower frequency, fewer sets, and diverse rep ranges.

Strength Specialization Template

Day 1 – Heavy
Day 2 – Medium
Day 4 – Heavy
Day 5 – Light

At first glance this isn't unlike the 5x5, barring the extra day. The difference is that you're only focusing on one exercise (or two, if you pick one for upper body and one for lower) instead of doing a more balanced program. This lets you get away with a little more. Even though there's two heavy days, you wouldn't necessarily want them to be identical workouts. One might be 5x5, the other might be a max triple, for example. Try not to repeat yourself if possible.

As with the other undulating periodization routines, you'll want to vary the stress and type of workout, instead of just repeating the same kind of work over and over. Even 'heavy' may not mean the same thing every time you do it. Changing the intensity zone and rep range each session is critical, as is varying the number of sets.

The thing about the strength template is that it's modular. You can add in more sessions when and where you see fit, up to a point. This template has you training four days, but there's no real reason why you couldn't train up to six days per week, and even multiple sessions if you had the time and recovery ability.

This kind of thing would fit really well with the planned overreaching concept, too. You can progressively add sessions until you start to push the limit, then back down to more normal volumes. This approach wouldn't be as extreme as the hormonal fluctuation model, but the same principles apply.

Muscle Specialization Template

The muscle specialization routine has a different philosophy. Since you're training the muscles more than the neurological stuff, you'll benefit from a little less frequency and a little more volume. Even so, there's no reason you can't get 2-3 solid sessions in each week.

The rest of the body is trained in maintenance workouts, which are just light, economical workouts to stimulate everything that you're ignoring.

Two Sessions	Three Sessions
Day 1 – Specialize	Day 1 – Specialize
Day 2 – Maintain	Day 3 – Specialize
Day 4 – Specialize	Day 5 – Specialize
Day 5 - Maintain	Day 6 – Maintain

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Here we have the block specialization workout. This one is credited to Lyle McDonald since I haven't seen anybody else suggest this. A word of caution, this is going to be one of those things you need to be really conditioned to pull off.

Block Specialization Template

Day 1/2/3 - Specialization Training

Day 4 - Maintenance Training

Day 5 - Specialization Training

Day 6 - Maintenance Training

The 'block' part comes in when you train your chosen parts on two or even three consecutive days. You can also add a third (or fourth, as the case may be) day later on in the week.

Be warned, this is basically the definition of concentrated loading. You might get 3-4 weeks out of it before you need to either take a rest, or at least switch to new parts.

AUTO-REGULATING ROUTINES

Of everything listed here, the auto-regulating routines are probably going to be my favorite. There's just something alluring about not having to rely on any written, preset workout – instead, you just go in and do what you can do.

I'm only going to list a few of the more practical versions; you can apply some of the methods listed herein, and methods I listed earlier such as ladders and wave-loading, to the various routines and splits I've already mentioned.

Doug Hepburn's Routines

Doug Hepburn, one of the now-legendary old-time lifters, used a variety of programs with double and triple progressions. Originally, he was a fan of 'power' and 'pump' training in the same session. You'd do some heavy singles or triples, then move on to sets of 5-6 reps.

The story goes that in his later years, he realized that doing lots of singles followed by multiple sets of higher reps was probably a bit much, so he adjusted the programs into what are now labeled 'A', 'B', and 'C'. Not very imaginative, but the old-school guys were actually interested in lifting more than marketing.

The 'A' program took a heavy, but not maximum, weight and had you start with four singles. Progress came by adding singles, up to a maximum of 10. That was your benchmark to add weight.

The 'B' program started with six sets of three, progressing to 10 sets of three.

The 'C' program, which was the original 'pump' routine, was considered lighter and more for recovery purposes after the 'A' and 'B' training. You started with six sets of three and progressed to six sets of five.

If you want to try and combine the 'power' (A) and 'pump' (C) routines, you're more than welcome to do so. Just be aware that it's probably too much to do on more than one lift, or for too long at a stretch.

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Doug Hepburn's A, B, and C programs

Program	A	B	C
Start with	Four singles	5-6x3	5-6x3
Work up to	Ten singles	10x3	6x5

Although the actual split used varies depending on who you ask, it seems Doug was a fan of frequent training. Most sources I've seen suggest training every other day, alternating between upper body and lower body sessions and doing no more than two exercises each session. He'd train with basics, your overhead press, bench, squat, power clean, barbell curl, and things of that nature. Yes, I said barbell curl – you can train that as a strength-type lift if you're smart about it and use decent form.

Hepburn's three programs all have their own method of progression as you see in the table. You'd start with the low-end, then add sets and/or reps from workout to workout. Once you reach the goal, you bump the poundages and start over. This is called auto-regulation, where your own ability dictates the progress of the training cycle. In this regard, you don't need any actual periodization plan beyond changing between the three workouts.

Do one until you stagnate, then move to another one. Hepburn suggested moving between the A and B workouts, switching when 'staleness' set in – burn-out, or a plateau in other words. After a few rounds with A and B, you'd do the C routine for some lighter recovery work.

Each workout is done based on your ability, and with gradual increases in the amount of work you do with a weight. This kind of 'unplanned plan' is a hallmark of the old-school lifters, and it's something to pay attention to before you get all wound up on fancy planning.

The 50-20 'Have It All' Routine

This is a routine attributed to Bryce Lane. Why 50-20? Because the goal is to reach 50 reps in 20 minutes. It doesn't matter how many sets you do, or how many reps at a time, as long as you reach 50 one way or another within the time limit.

This may sound easy on paper, but don't be fooled. If you're using any kind of reasonable weight, you're going to hurt from this.

The standard suggestions I've seen are to split into four workouts, focusing on two big lifts each session. Things like squats, deadlifts, power cleans, rows, overhead press, all the usual suspects. Two lifts per session will give you a 40 minute workout, and you probably won't care to do much accessory work.

You can get more details as well as more gems from Bryce at his website, www.ironsports.tv

The Russian Bear

The Russian Bear is a routine outlined by Pavel Tsatsouline. This routine was allegedly used by certain units in the Soviet special forces, the so-called 'Hollywood units' that had to be big and muscly to impress the brass.

The Bear has you build up to a best set of 5 reps; this may or may not be a PR set. After that, you take 90% of that weight and do 5 reps, then take 80% and do 5 reps. From here, you just do sets of 5 reps with 80%, keeping the rest times brief, until you're too fatigued to continue.

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Keeping with the theme, the idea is that you'll have several benchmarks of performance to break, in terms of weight, in terms of total workload, and in terms of the total time to complete the workout. You can try to break any or all of these.

Pavel's suggestion is to stick to two lifts, the overhead press and the deadlift. This may or may not be enough for you. Each lift is done twice per week, as the lower frequency takes into account the higher volumes and greater fatigue that will be created. In any event, it doesn't take much imagination to see how you could apply something like this to another weekly routine.

You can read more at Pavel's site, www.dragondoor.com

Max-Stimulation and Myo-Reps

I'm listing these under the same heading due to their similarity, though they're different routines. Both of these approaches use frequent full-body training sessions similar to Hypertrophy-Specific Training.

Max-Stimulation (Max-Stim) was developed by Dan Moore based on the research into muscle growth. Dan decided that fatigue was compromising performance and thus limiting the exposure to growth stimulus in each workout. With that in mind, Max-Stim uses cluster sets based around 'M-time' or the rest interval between each rep, which will vary from 10 to 20 seconds. The idea is to rack up a substantial workload with heavy weights, more than you'd be able to accomplish with the regular sets-to-fatigue approach.

Dan's website can be found at www.hypertrophy-research.com

Myo-Reps is a variation on the same concept, incorporating elements of both the rest-pause set and the cluster set methods, suggested by the Nordic beauty Borge Fagerli. Where Max-Stim avoids fatigue entirely, Myo-Reps makes use of it. You'd start out with an 'activation set', which is just your standard set to failure-or-high-exertion with a target of maybe 8-12 reps. As with the rest-pause method, you'd rack the bar and take a few breaths.

The set now becomes a cluster. You'd knock off sets of maybe 3-4 reps, keeping the rest intervals brief – around 10 seconds or so at first. Once those start to grind, you'd drop the reps to 2-3 and extend the rest period to 20 seconds. When you fatigue here, you're done.

Fatigue here is defined by the RPE score and rep speed. Smooth reps are the goal. Once a set starts to grind – and the RPE goes up – fatigue has set in and it's time to stop.

If you're feeling frisky, you can add weight drops as you start to fatigue. Say you do your activation set of 6 reps, then knock off say 5 singles before the reps start to grind. At that point you can knock the weight down say 10kg (or 20 lbs) and keep the cluster set going with higher reps.

The beauty of this system, like the other auto-regulating approaches, is that it combines both high-load and high-volume training into one method by using fatigue management principles. You get some of the fatigue/exhaustion effect while simultaneously racking up a large workload.

That's the gist of it, anyway. You can read more on Borge's website at www.myrevolution.no (it's mostly in Norwegian, but Google translator makes it reasonably readable in English).

It doesn't take much creativity to adjust this approach to make it applicable for either high intensity or high volume phases. By varying the starting weight (you'll get more total reps with 75% than with 85%), and by

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toying with both the rest interval (10 second rests will fatigue you faster than 20 second rests) and the number weight drops, you can customize this method for pretty much anything.

Really High Frequency Routines

By 'really high frequency' I mean routines that have you training 5-7 days per week or more. I'd not expect to gain much muscle mass while on this kind of routine, but it can set you up for later gains if you keep in mind the 'highs and lows' concept.

This has fallen out of vogue in recent decades, but a lot of the old-time lifters trained this way. If you think of strength as a skill to be trained, then think of this as 'practice'. With 5-6 workouts a week, you get a lot of exposure to your chosen exercises.

The trick is to make sure you aren't doing too much at each session, either using weights that are too heavy or doing too much volume. It doesn't take much.

Steve Justa, a strength enthusiast and all around awesome dude, has written about quite a bit of this in his book *Rock, Iron, Steel* (available from the excellent www.ironmind.com). I have to confess I like this book a lot, simply because it's stuff you don't hear about – and stuff that could be very effective if used properly.

For example, one of his routines suggests bench pressing and squatting one day, then bench pressing and deadlifting the next. You'd do 12 singles on the bench, and 25 singles on the squat or deadlift. The weight starts at 70%, and you add 5 lbs to the bench each week; 10 lbs to the squat and deadlift. Once a month, you test maxes and reset your weights to 70%

It sounds like a lot of work, and it is. But it also works, very well. Justa lists a lot of variants on the theme, but that's the gist of it: lots of practice, lots of reps, weights in the 70-80% range, and progressive overload.

Turns out if you stick to the basics and work hard, you get stronger. Who knew? The moral of the story is that you can train very frequently, but only if the other variables are adjusted accordingly.

VARIATIONS ON A THEME

I really hope you could see the recurring themes in all of these seemingly different workouts. They all seem different, but it always boils down to a set of principles that come together to meet the goals that the science laid out for us.

Regardless of the program, the basis is always heavy weights and a trend towards higher intensity. After that, they all have some method of increasing the volume of work and the degree of fatigue created in the target muscles.

Sometimes they accumulate, using more exercises, more sets, and keeping the total reps a little higher. Some of them intensify, keeping the weights heavy and focusing on getting stronger. But none of them are avoiding the basics.

Conclusions & Final Thoughts

So you made it through. Either that, or you're a big dirty cheater that wants to cut to the end.

I threw a lot of facts at you over the last 200-odd pages, I realize that. The irony is that most of those facts aren't really important – but you have to discuss them in order to see why.

That's the conundrum we face here, as I said way back in chapter one. The problem is not information. The problem is how we look at information: who we trust as sources, and how we choose to interpret it once we have it.

The simple fact is that some people – a lot of people – are much more likely to think in terms of faith. To these folks, ideas are shaped by emotion and by desire. Their outlook towards the world is constructed from the ideas that they *want* to be true. People *want* homeopathic medicine to be real. People *want* the other political party to be wrong. People *want* to do a pro bodybuilder's workout from the magazine and end up shredded at 250 pounds. You can see how quickly this mindset falls apart when put under scrutiny.

It's an unfortunate fact of reality that faith can only do so much when it comes to describing the physical universe. I won't tell you that there's no room for faith in your life; that's a discussion far beyond this book, and one that is frankly personal in nature. What I am telling you is that when it comes to matters of objective reality, we have to rely on science – and I don't just mean science in the lab.

If you really want to understand how the universe works, you need to think like a scientist even if you're not in the lab – you need to be skeptical and approach information with a critical eye. As you may be aware, your body is part of the universe. It's not an exception to the rules. Approaching bodybuilding with a scientific mindset is something that's long overdue.

When you read through this, the implicit assumption is that, while I tried to be as science-oriented and as logical as I could be, I'm still human. I have my own biases and likes and dislikes. You may or may not agree with the conclusions I've drawn; and that's OK. There's as much art to this process as science. My goal here was to present the facts as objectively as I could present them, and to have you understand *why* I drew the conclusions I drew.

What I really hope you took away from this is a better understanding of the entire process: why you weight train, what to expect from it, and some good starting points that most everyone can benefit from. Maybe you picked up enough that you can start to see through some of the misinformation out there.

Anybody can write a program down and give it to you. Anybody can take some studies, pick out some good quotes, and use that to support their viewpoint. That's never been my goal here. Yes, I want you to go to the gym and lift weights – but to me, it's far more important that you don't fall for every gimmick strung in front of you and promising results.

This is important to me because I've been there. I've been the confused newbie that didn't know where to start. I've been the guy that was so overwhelmed that I didn't even know what questions to ask, let alone where to ask them. This is my way of giving something back.

When I boil it down, that's all I want – for people to learn and to improve themselves. I guess there is something to the old phrase 'those that can't do, teach'. That sounds like it's meant to be a put-down, but to me there's more than a little truth there. Even at my best, I've never been a great lifter and I hate dieting too much to ever be a good bodybuilder. Yet I seem to have a knack for taking this labcoating and translating it into results. From that standpoint, I'm fine with not being able to do. Teaching is rewarding enough.

Conclusions & Final Thoughts

Of course I want to be right too, but more than that, I want people to understand. I want people to realize why I drew my conclusions. As I said way back in the first chapter, it's as much about the journey as it is the destination. The process is at least as important as the goal.

If I've opened your eyes, even a little, and made you think about your workouts, or your diet, or your goals, or anything else in a new way, then I've done my job. That's all I've ever asked.

Just remember that this process is easy. When somebody tells you 'eat more and lift heavy things', well, he's right. It doesn't tell you much as a raw newbie, but that is the right answer. It really is that easy. The devil is in the details.

Most people tend to go through phases that mirror their training. The newbie knows nothing and just goes to the gym. He'll look around and watch what others do, usually try to copy it, and will generally do anything he's told will get results.

Then comes the know-it-all. This is when you know just enough to get you in trouble. You can quote facts and data and experts all day long. You might even have some results to show for your efforts. The thing that distinguishes this phase the most is that, despite knowing just the barest amount of trivia, the know-it-all thinks he has all the answers. At this stage, the details are the most important, and you could never possibly improve yourself with the basics.

Whereas a newbie will go buy expensive protein powder because it had a flashy ad with a great-looking model, the know-it-all will not only buy it, but suggest that you buy it while justifying it with quotes cherry-picked from some research paper. The know-it-all will buy each and every 'new workout' offered, because he knows what's up and wants to keep on top of his knowledge.

If you survived knowing everything, you might end up at the experienced level. This is, funny enough, more like the newbie stage – you just aren't worried about much of anything except the few things that really are important. While the experienced lifter won't be clueless, he's certainly not going to be over-complicating everything. The truth is, the more you know about the field, the more you realize that the trivia just isn't important. At this stage, you realize that all that stuff you were worrying about before is useless. It's detail-work that may sound impressive, but won't actually net you any real improvements.

The know-it-all wants a cutting-edge workout with all the latest buzzwords, designed by a Fitness Expert. The experienced lifter just wants to go to the gym, move some iron around, and not get hurt in the process. Being an experienced lifter is when 'go lift heavy things' makes sense. You don't need more context than that; you've been through your lumps, made your mistakes, and figured out what works.

That's why, for all you can repeat the mantra to the beginners, I don't think anyone can truly understand the simplicity unless he or she has been there.

This ties in with one of my key themes: for all you can pull out the magnifying glass and look at things down to the fine details, there's only so much you can actually do at the gym or in the kitchen. I know it's hard to believe that there's only a few relevant principles from all that mess I threw at you. That's the whole point, though – simplicity emerges from complexity. The science is only working to solidify and reinforce the basics that have been known since even the old-time strongmen. The implementations are different, sure, but the biggest difference is that there's now more raw data for the Labcoats to obsess over.

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For all that new and emerging science, there's going to be nothing new. There is nothing revolutionary in exercise science, and there's not likely to ever be again. Again I can point to the theory of gravity as an analogy. For all we understand gravity, we still don't truly *understand* it. We don't have the complete picture.

Yet I can tell you with nearly 100% certainty that if you walk off the top of a building, you're going to fall. Astronomers can predict with near 100% accuracy how planets and stars even very far away from us are going to behave. That's because the fine details aren't necessary to have predictive power. We don't understand everything about gravity, but what we do understand is more than enough to make extremely accurate predictions of behavior.

You don't need to have all the pieces of a puzzle to tell what the picture's going to be.

That's where exercise physiology stands right now when it comes to designing programs. We don't know everything and we'll certainly keep discovering details for quite awhile yet. The fundamentals, the stuff we do know, the stuff that lets us make predictions – that's not going away, and it's not going to change. From here on out it's going to be a matter of refinement, not revolution. Anybody promising a revolution is either incompetent or selling something.

People can and do come up with novel, occasionally even interesting, training systems – but that's an entirely different matter. That's just creating a new protocol based on the rules of the game; the rules themselves haven't changed. A new workout protocol doesn't re-invent the wheel by any stretch (woe be it to the would-be gurus that build themselves up around their pet programs).

You have to be careful even with that, though. It's often the simplest, most straightforward programs that will net you the best results – mainly because they do the things that are effective, and because it's much easier to stick with them. Don't fall for every new fad out there on the Internet. If you can do this, you'll be rewarded.

If not, you'll end up in the permanent know-it-all phase. You'll know so much that you'll never spend more than two weeks on any of the new programs you go pay for. Those of you reading this, you know exactly who you are. Remember that results are based on what *actually* happens – not what *should* happen because you keep dropping \$70 for a re-packaged version of the same workout you bought two months ago.

What I've tended to notice, anecdotally, is that results tend to correlate more to hard work and consistency than anything else. The best, most perfectly-crafted program you can find simply cannot make up for this. The guy with the unstoppable work ethic, the guy that always works his ass off, always rests out of the gym, and always sticks to his diet is likely going to succeed even if his program 'sucks'.

That's food for thought for all you know-it-all types. Odds are that your lack of success has more to do with your own efforts than anything else. Of course, it won't hurt to have a well-designed program, but as I've so nicely outlined for you, there's not a whole lot that goes into 'well-designed'. Could it be that the bodybuilder's 'stupid' program isn't that stupid after all? Could it be that a lot of the things you've convinced yourself are important really...aren't?

Bodybuilders, you're not off the hook. Could it be that you're not growing because you're doing a stupid program? Do you stop and think that maybe you could re-evaluate your results every few months? That if your approach isn't working, you should do something else? It's not a contest to be right, you know. It's about getting the results you're after. If your program isn't doing that – or it's getting you hurt – it might just be worth it to think it over. It's not the end of the world just because your program is dumb.

Conclusions & Final Thoughts

There's a balancing point here between the Bro 'go lift something' and the Labcoat desire for ultimate perfection down to the last detail. 'Stupid' programs can work wonders, and 'just lifting' can, at best, keep you spinning your wheels. You need an intelligent game-plan; at the same time, once that plan's in place, you need to stop worrying over it and get your ass in the gym.

For those of you that are so inclined, and assuming you haven't found it already, you can find my website at <http://www.ampedtraining.com>. I've got a sporadically-updated blog, a collection of related articles, and a discussion forum where you can come hound me about the parts of the book you didn't understand.

So if you have a minute, come on by.

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