NHE Chapter 21

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Hormonally Intelligent Exercise

The best time to begin exercising is sometime between yesterday and tomorrow.
Rob Faigin

Why is it that those people who never have time for exercise always have time to eat?
Unknown

It's better to make time for exercise in your schedule now than to be forced out of your schedule by illness later.
Rob Faigin

Too many people confine their exercise to jumping to conclusions, running up bills, stretching the truth, bending over backwards, sidestepping responsibility, pushing their luck, and ducking questions.
Unknown

The problem with the average self-appointed workout expert is not that he's ignorant, but that he knows so much that isn't true.
Rob Faigin

A vigorous five-mile walk will do more good for an unhappy but otherwise healthy adult than all the medicine and psychology in the world.
Paul Dudley White, M.D.

Popular Exercise Myths

Myth: More is better.
Truth: Better is better.

Myth: The ideal workout lasts more than one hour.
Truth: The ideal workout lasts less than one hour.

Myth: Aerobic exercise is the best form of exercise for burning fat.
Truth: Hormonally correct resistance exercise is the best form of exercise for burning fat.

Myth: It is okay to lift weights every day as long as you allow ample time between training individual bodyparts.
Truth: It is not okay to lift weights every day, regardless of which bodyparts you train.

Myth: The best way to improve muscle definition and burn fat when weight training is to do very high repetitions with very light weight.
Truth: The worst way to improve muscle definition and burn fat when weight training is to do very high repetitions with very light weight.

Myth: To maximize fat loss, aerobic exercise should performed slower and longer.
Truth: To maximize fat loss, aerobic exercise should be performed faster and shorter.

Myth: The key to success from exercise is hard work - the harder you work-out, the better the results.
Truth: No brain, no gain - overtrain, no gain.

Myth: Stretching is a great way to warm-up, and it reduces the likelihood of injury.
Truth: Stretching is a terrible way to warm-up, and it increases the likelihood of injury (never stretch a cold muscle).

Myth: Lifting weights will generally make women bigger.
Truth: Lifting weights will generally make women smaller.

How do you know if you are too old to start exercising?

Perform this test, devised by George Burns.

One, put your hands up over your head. Two, put your hands in front of your chest and push outward as if you were doing a pushup. Are your hands touching anything? No? Then you're not in your coffin, and you're still able to work-out.

Why all the fuss about exercise. . . ?

Hans - How many calories do I burn as a result of jogging three miles?

Frans - It varies with your body weight and intensity level, but probably not more than 300.

Hans - WHAT?! Three miles of hell for a lousy 300 calories. That's about as many calories as I get from a bagel with cream cheese. Why all the fuss about exercise if that's all it's good for? Why can't I just skip the bagel and cream cheese? There's got to be more to this story.

You're right there is. . .

A New Dimension in Exercise

The calories burned while exercising are relatively few in quantity and small in significance. The major benefits of exercise are metabolic and hormonal, and they accrue after the exercise session has ended. For this reason, it is remarkable that so much emphasis is placed on "burning calories." If you surf the TV channels at night you no doubt see good-looking, charismatic actors and actresses promoting the latest newfangled home-workout gismo claiming that it burns more calories than its competitor gismo. They just don't get it (or perhaps they *do* get it but they are hoping *you* don't get it so they can get your money). This quantitative conception of exercise, focusing exclusively on the amount of calories burned while exercising, fails to acknowledge a supremely important fact: **exercise alters your metabolism and profoundly influences your internal hormonal environment**.

Exercise has the ability to unleash powerful hormonal forces, either powerfully beneficial or powerfully detrimental. Exercise can increase insulin sensitivity; or it can decrease insulin sensitivity (by raising cortisol levels). Exercise is potentially the most powerful natural growth hormone stimulator known to science, and, therefore, an unmatched anti-aging force, fat burner, and immune booster; or it can suppress growth hormone levels. Exercise can raise testosterone levels in men, opening the door to all the physiological and psychological qualities of youth; or it can suppress testosterone so low that mating and building muscle are near-impossibilities. Exercise can suppress cortisol; or it can cause a catabolic jailbreak, loosing this hostile hormone to assault your immune system, eat-away at precious muscle tissue, and create generalized havoc within your body.

The reason why most people achieve sub-optimal results from exercise is that their workouts are hormonally incorrect. In terms of results, exercising in a hormonally advantageous manner, as opposed to "flying blind" which is what people are doing who do not understand the impact of exercise on hormones and metabolism, can produce three times the results in half the time. What are the factors that influence fat burning and muscle building hormones? Intensity, volume, duration, frequency, load, and exercise selection. *Coordinating these six variables for optimal hormonal response is the key to achieving great results from exercise.*

First, I will explain how energy is generated during exercise. This brief discussion of "bioenergetic pathways" is helpful to understanding how your body works (and you will see later how bioenergetic pathways relate to hormones). But it is also a bit technical, so if you wish to skip it that's okay.

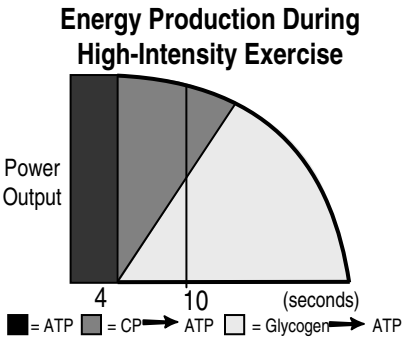
Bioenergetic Pathways

There are two basic families of exercise: aerobic and anaerobic. Each of these two types of exercise entails the use of different bioenergetic pathways to produce energy. To simplify, aerobic exercise primarily taxes the cardiovascular system and utilizes the "with oxygen" pathway. Most of your daily energy needs, including your energy needs right now while reading this book, are fulfilled through the aerobic pathway. The aerobic pathway is the slowest, and thus it is not suited to explosive, high-intensity exercise. This pathway can, however, produce energy indefinitely because 1) it taps into the richest energy source available to the human body, fat, and 2) it does not generate waste byproducts, such as lactic acid, which at high concentrations cause momentary muscle failure.

The other family of exercise, anaerobic, primarily taxes the musculoskeletal system and utilizes the "without oxygen" bioenergetic pathways: ATP/CP and glycolysis. At first blush, it may seem peculiar that muscular work can proceed in the absence of oxygen. But recall from Chapter 18 that ATP is the fundamental energy unit for all living things. The human body has a limited supply of ATP (conveniently located along with glycogen and creatine phosphate in the muscles) on hand for immediate energy needs.[1] You have only enough immediately available stored ATP for one momentary, maximal burst of muscular output.[2] After that, a compound called creatine phosphate (CP) swings into action "donating" phosphate molecules to convert spent adenosine diphosphate (ADP) back into adenosine triphosphate (ATP), thereby regenerating your ATP supply. From the moment readily available ATP becomes depleted, available energy per second declines and so does maximal muscle contraction force, as other fuel sources must be converted to ATP.[3]

In practical terms, if you are straining at maximal effort to lift a weight, and it has not gone up within 4 seconds, it's not going up. During the brief period of time in which high-energy phosphates (ATP/CP) are utilized exclusively, neither protein, nor fat, nor carbohydrate, nor even oxygen is required. Within seconds, the window of wholly anaerobic activity closes, at which point, if maximal effort persists, a different bioenergetic pathway is engaged.

After about 10 seconds of maximal muscular effort, both ATP and CP become depleted, and glycogen becomes the dominant fuel source; this is the *glycolytic* bioenergetic pathway. At this point, with glycogen being used to "phosphorylate" ADP into ATP, muscular power output drops-off further because of the slower rate of energy transfer via glycolysis. When glycolysis is the chief pathway utilized, maximal *effort* produces 45%-70% maximal *output*.[4] This is why in track and field, the 100-meter sprint lasts 10-12 seconds - after that, it is no longer a sprint. Technically, since maximal muscle contraction cannot be maintained beyond 4 or 5 seconds, even the 100-meter sprint is not a maximal output competition (in contrast to powerlifting, the javelin, the shot-put, and the 40-yard dash). Accordingly, the victor in a 100-meter sprint, who typically prevails by a fraction-of-a-second, is often the person who slows down the least from the midway point to the finish line.



One byproduct of glycolysis is lactic acid, which is responsible for the familiar "burn" that accompanies high-intensity exercise and which is a cause of the momentary muscle failure that occurs with this type of exercise.[5,6,7] The accumulation of lactic acid indicates that you are incurring an "oxygen debt."[8] Oxygen debt results from the fact that glycolysis allows for energy formation even though oxygen supply is inadequate relative to the demands of the activity. Heavy breathing following a short burst of intense activity signifies paying off the "oxygen debt" accrued during the anaerobic period.

If you weight train, you know that you can lift more weight if you rest longer between sets. This is because lactic acid is removed and high-energy phosphates are regenerated during these brief mini-recovery periods, commensurately with oxygen uptake.[9,10] Low-intensity exercise, by contrast, uses the "pay-as-you-go" aerobic pathway, in which no oxygen debt is incurred.* Thus, with low-intensity exercise, lactic acid does not accumulate, respiratory rate remains stable, and abrupt muscle failure does not occur.**

* Technically, some degree of oxygen debt is always incurred as a result of exercise, even low-intensity exercise, because during the initial minutes oxygen uptake increases sharply but lags behind energy expenditure. After the first few minutes of exercise, the oxygen uptake curve flattens-out, and, assuming you are working within your aerobic capacity, a "steady state" is achieved in which energy requirements and ATP production via aerobic metabolism are equivalent. In steady state metabolic conditions, lactic acid does not accumulate because it is cleared at the same rate it is produced. Accordingly, steady state exercise can continue indefinitely, until fluid loss, electrolyte depletion, or flagging willpower intervenes. One of the training-induced metabolic advantages enjoyed by endurance athletes is that a steady state is attained sooner and with a correspondingly lesser oxygen debt than in untrained individuals.

** In case you are wondering how our earlier discussion of "metabolic pathways" in connection with diet, and "bioenergetic pathways" relate to each other, it's simple. As noted above, fat can be burned only in the presence of oxygen (i.e., the aerobic bioenergetic pathway, utilized for approximately 95% of daily energy needs). Glucose (sugar) also can be burned in the presence oxygen (although, as I explained above, for brief periods sugar can be burned in the absence of oxygen, as well). The proportion of sugar/fat burned to fulfill roughly 95% of your daily energy needs depends on which metabolic pathway is dominant, the sugar-burning pathway or the fat-burning pathway. And, of course, whether you are a sugar-burner or a fat-burner depends on hormones.

Trained athletes incur less oxygen debt at a given intensity level and have a higher "blood lactate threshold" due to enhanced lactate clearance.[11,12] The difference in lactate threshold between highly trained and untrained individuals is vast; and along with improvements in neuromuscular efficiency, lactate threshold accounts for much of what is commonly termed "strength" and "endurance" (see Appendix B). Heightened lactate threshold is one of the many stress-specific adaptations that occur in response to exercise. Weight training is a classic example of an activity that draws heavily on the ATP/CP and glycolytic pathways and which, thereby, promotes greater efficiency of these pathways. There are hormonal implications, as well, to activating each of these pathways, which we will address shortly.

The Pre-Workout Meal: Priming the Hormonal Environment

Few people fully appreciate the importance of the pre-workout meal. Among those who do, even fewer possess an accurate understanding of its optimal composition. The fact of the matter is that **what you eat or drink prior to beginning your workout strongly influences how much fat you burn during your workout**. Based on what you learned in Chapter 10, about the functions of insulin and glucagon, you are probably a bit perplexed by a contradiction between the facts presented in that chapter and the conventional wisdom on this subject. Specifically, recall that insulin is lipogenic, which means fat-storing, and anti-lipolytic, which means it shifts metabolism away from fat burning toward sugar burning.[13,14,15,16] In view of these fundamental and indisputable facts that can be found in any biochemistry textbook, why are all the "experts" urging us to consume carbohydrate, which stimulates insulin, before exercising? The answer to that question in a moment.

The anti-lipolytic effect of insulin is compounded by the growth-hormone-blocking effect of high blood sugar, which we discussed in Chapter 20 and will return to in a moment. Furthermore, in Chapter 18 I explained how sugar derived from ingested carbohydrate influences the enzymes that regulate sugar-/fat-burning. As you can see, a high-carbohydrate pre-workout meal operates through various physiological mechanisms to shift metabolism away from fat burning toward sugar burning. The practical effect is clear and has been repeatedly demonstrated by clinical studies: *consuming carbohydrate before or during a workout reduces the amount of fat burned during the workout*.[17,18,19,20,21]

More specifically, when carbohydrate is consumed before or during exercise, the magnitude of the inhibitory effect on fat burning directly corresponds with the extent to which blood sugar and insulin levels are raised.[22,23,24] And what determines the blood sugar/insulin response to carbohydrate ingestion? Three factors: insulin sensitivity, total amount of carbohydrate consumed, and the glycemic index of the carbs consumed (Glycemic index is a measure of the blood-sugar-raising potential of a particular type of carbohydrate.)

The NHE Eating Plan eliminates this problem. Carbohydrate intake is limited at all meals except for the carb-load, which, as the last meal(s) of the day, should never be a

pre-workout meal. By eschewing pre-workout carbohydrate in favor of protein/fat, you enable greater use of fat for fuel during exercise.

The Glycemic Index Should Not be Accidentally Overlooked, Rather it Should be Deliberately Disregarded

I am critical of the widely endorsed and increasingly popular glycemic index, because it is misleading and obscures more significant considerations. To illustrate, carrots have a higher glycemic rating than do cookies; however, because the glycemic index is calculated for a given quantity of carbohydrate, it fails to account for the fact that cookies are far more carbohydrate-dense than carrots. In practical terms, because of the vast difference in carbohydrate-density between these two foods, you would have to eat a far greater quantity of carrots to produce a blood sugar response equivalent to that produced by a far lesser quantity of cookies. From a broader perspective, the glycemic index, as it is promoted by many authors, justifies a high-carbohydrate diet by implying that the type of carbohydrate ingested is more important than the amount; this is false. Moreover, to the extent that a useful basis of distinction among different kinds of carbohydrate exists, sugary carbs vs. starchy carbs, not glycemic rating, is it (see Chapter 15). And because glycemic ratings do not always correspond with the sugary/starchy distinction, following the glycemic index is not merely an unnecessary inconvenience but may actually prove counterproductive to fat loss.

For these reasons, the glycemic index should be diligently ignored by adherents of the NHE Eating Plan, despite the enthusiasm this flawed concept is garnering among an American public ever susceptible to a "one-glove-fits-all" approach to diet. Such one-dimensional dietary strategies sell books, but they provide ineffective assistance to readers of such books striving to reduce bodyfat. Instead of the glycemic index, focus on daily and per-meal carb limits during the downcycle and on the starchy-carb/sugary-carb distinction during the upcycle. These considerations are far more important than the glycemic index.

Another benefit of consuming protein, rather than carbohydrate, pre-workout is that it can help preserve muscle protein during exercise.[25] An underappreciated fact is that amino acids supply a small percentage of the energy used during exercise (especially prolonged exercise).[26,27,28] Although the *percentage* is small, the absolute amount of muscle broken down is significant, especially for individuals who are attempting not merely to maintain muscle but to build muscle. *By consuming a protein-based pre-workout meal, you supply amino acids that might otherwise be extracted from working muscles, thereby offsetting the catabolic effects of exercise.* Protein shakes are advantageous in this regard, because they are more easily digested than food and thus can be consumed immediately prior to training.

Recall the growth-hormone-blocking effect of high blood sugar from Chapter 20, where it was discussed in connection with sleep-related growth hormone release. This growth-hormone-blocking effect has been observed by Dr. Douglas Crist, who reported that ingestion of only three ounces of fruit juice immediately prior to a growth-hormone-inducing exercise session negated growth hormone secretion in a person who, weeks earlier, had registered a significant growth hormone elevation in response to an identical exercise session.[29] Dr. Crist's finding is supported by a large body of scientific literature solidly establishing that elevated blood sugar inhibits growth hormone release and showing, specifically, that a carbohydrate-rich pre-workout meal squelches exercise-

induced growth hormone secretion.[30,31,32,33,34] Keep this in mind next time you see someone at the gym sipping one of those "performance drinks" between sets - a mad scientist could not concoct a better potion for stifling growth hormone release. So why are these drinks so popular (to the tune of millions upon millions of dollars in sales)?

Carbohydrate consumed before or during exercise restrains growth hormone release.

The fact is that a highly profitable industry has emerged to sell uninformed people ultra-cheap sugar-water disguised as "performance drinks." The popularity of these products is due in large part to the dominant influence of the major fitness magazines (all of which are owned by, or have close financial ties to, dietary supplement companies) on the public's perception of health and fitness issues. The problem with these magazines is not the clearly identifiable advertisements, but rather the underhanded propaganda masquerading as objective articles. Some publications are worse than others in this regard, but financially inspired bias and back-door salesmanship are pervasive in the fitness industry, and reach a pinnacle in fitness magazines.

WARNING! You Can't Trust What You Read in Fitness Magazines

Most readers take what a fitness magazine writer says at face value, having no idea that the writer is often being either directly or indirectly paid by a supplement manufacturer. This contributes substantially to the "misinformation problem" that I have decried throughout this book. I am not suggesting that all fitness writers are biased - but many are. Nor am I suggesting that all fitness magazines are publishing lies - but some are. What I am saying is that there lurks a hidden commercial agenda, which manifests itself as publication bias. What I mean by publication bias is that if there is one study indicating that "X" helps you burn fat and there are 10 studies indicating that "X" serves no useful purpose whatsoever in the human body; and a particular fitness magazine is owned by the same company that owns ABC supplement company, which sells "X" - *guess which study you are going to read about.*

Collectively, fitness magazines and other media exert a commanding influence over what the public perceives to be truth regarding health and fitness - and this is a major reason why the public guzzles millions of gallons of growth-hormone-suppressing-sugar-water (a.k.a., "energy" or "performance" drinks) per year even though, as you learned in Chapter 18, carbohydrate is neither optimal nor even necessary for energy. Moreover, fluids with a high-sugar concentration empty from the stomach at a slower rate than plain water.[35] With some "performance drinks" containing more than 100 grams of carbohydrate, gastric emptying can be slowed to a snail's pace, forcing the "performance drinker" to compete or train with a distended gut. By hindering fat burning, blocking growth hormone release, and bloating you, these drinks reduce both performance and the beneficial effects of exercise.

Publication bias and "creative interpretation" of scientific studies have contaminated the information pool to such an egregious extent that all magazine articles pertaining to fat loss/bodybuilding supplements must be taken with a grain of salt the size of an ice cube.

Another disadvantage of a pre-workout meal rich in carbohydrate pertains to its effect on brain chemistry, described in Chapters 10 and 11. By elevating serotonin, a neurotransmitter with sedative properties, a carbohydrate-rich meal can adversely affect motivation and energy

levels. A protein-based pre-workout meal has the opposite effect on brain chemistry. (See "Better Living Through Better Brain Chemistry: Using Food to Enhance Mental Performance and Emotional Well-Being," in Chapter 19.) In addition to blunting alertness, serotonin, which increases during exercise, may directly precipitate exercise-related fatigue.[36,37,38] In any event, practical experience counsels that consuming a high quantity of carbohydrate prior to a scheduled workout renders it less likely that you will get off the couch and into the gym.

A concern commonly expressed by individuals who read this book after a lifetime of pro-carb indoctrination is that reducing carbohydrate intake will diminish exercise performance. While it is true that glycogen is the primary energy source utilized during high-intensity exercise and low glycogen levels can limit one's ability to perform this type of exercise,[39,40] it does not follow that reducing carbohydrate intake will diminish glycogen levels/performance. To the contrary, studies show that: 1) an overall reduction in carbohydrate intake, combined with 2) a proportional increase in fat intake, and 3) a cyclical carbohydrate consumption pattern, can enhance both anaerobic and aerobic exercise performance.[41,42,43,44,45,46,47,48,49] (That sounds a lot like the NHE Eating Plan, doesn't it?)

The physiological factors responsible for this performance increment are: 1) a glycogen-sparing effect, and 2) greater access to fat for energy (see "Increasing Energy Levels and Improving Athletic Performance," in Chapter 11). Not only can a higher-fat diet improve fat utilization in general by making free fatty acids more available to working muscles, but it can also increase levels of intramuscular triglyceride.[50]* This is advantageous because, whereas free fatty acids can supply energy only for low-/moderate-intensity exercise, intramuscular triglyceride can be tapped to fuel higher-intensity work.[51,52] Greater triglyceride storage in muscles combined with glycogen-loading, produces a condition optimal for maximizing high-intensity muscular output.

The foregoing research has electrifying implications, because it suggests that world-class athletic performances to date have been limited by diet! Studies ostensibly proving a high-carb/low-fat diet superior to a lower-carb/higher-fat diet, *have uniformly failed to allow for a sufficient period of adaptation.* It takes time to make the transition to a fat-burning state. Accordingly, the immediate consequence of cutting carbohydrate intake is a downturn in exercise performance. But once the metabolic shift is made, exercise performance improves, sometimes dramatically. The *Journal of Sports Science* reports that adaptation to a high-fat diet for a period of four weeks can increase by two-fold, resistance to fatigue during prolonged, low-to-moderate intensity exercise.[53] The *Journal* reports even greater performance enhancement resulting from adaptation to a high-fat diet combined with carb-loading[54] (this sounds a lot like the bodybuilders' NHE Eating Plan, doesn't it?).

I call upon athletes to heed these findings and switch to a higher-fat/lower-carbohydrate/cyclical diet. Whether the general NHE Eating Plan or the bodybuilders'

* Don't confuse intramuscular triglyceride with serum triglyceride. The latter refers to fat in the blood and is a coronary risk factor discussed in Chapters 8 and 18.

version is best for you depends not only upon your performance goals but also upon whether building muscle or reducing bodyfat is your principal objective. By embracing scientific wisdom over conventional wisdom, we can ascend to glorious new heights of athletic achievement.

Although all of your pre-workout-NHE-Eating-Plan meals will be medium-sized or smaller, you should allow at least 75 minutes between eating and exercising. This is a good general rule, but it is especially applicable to a protein-based meal, which takes longer to digest than a carbohydrate-based meal. If your schedule does not permit you to wait that long between eating and exercising (as is often the case if you are working-out in the morning before going to work), you can counter this circumstance by consuming easier-to-digest protein foods. These include: egg, yogurt, tofu, cottage cheese, and the homemade pre-workout drinks described below.

The Post-Workout Meal: More of the Same, Please

Much of the same reasoning that applies to the pre-workout meal applies to the post-workout meal. If you consumed a hormonally correct pre-workout meal and performed your workout in a hormonally intelligent fashion, you boosted your metabolic rate and stimulated a surge of growth hormone that shifted your metabolism into a heightened fat-burning mode. *It is now time to reap the fat-burning/muscle-enhancing benefits of your time and energy investment in the gym.*

All the misinformed "experts" and the ones with hidden commercial agendas would have you drink a "recovery" drink or shake (which is the post-workout version of the pre-workout "performance" drink). The insulin spike produced by these high-carbo concoctions will, literally within seconds of swallowing your first gulp, kick you out of the heightened fat-burning state that you worked so hard during your workout to attain. You will still enjoy the benefit of the post-exercise metabolic elevation, which is independent of hormonal factors, but the percentage of fat burned to fulfill the increased post-exercise energy requirement will be reduced significantly.

By contrast, a medium-sized protein or protein/fat meal will not thwart post-exercise fat burning. Rather, it perpetuates fat-burning momentum generated by your workout. Moreover, post-workout protein consumption is useful in replenishing amino acids in the wake of exercise-induced amino acid oxidation (see p. 240). In addition, by consuming protein immediately after exercise, you capitalize upon a "window of opportunity" in which amino acid transport into muscles and protein synthesis are accelerated.[55,56] *By taking advantage of this metabolic "window of opportunity," you get post-workout recovery off to a strong start by counteracting the catabolic conditions that prevail in the aftermath of an intense training session.* (See also, regarding the post-workout meal, p. 292-293.)

How to Save Tons of Money by Making Your Own Homemade Performance Drink that Blows Away Anything You'll Find in Health Food Stores!

Most commercial performance/recovery drinks are loaded with carbohydrate, often appearing on the label with the impressive-sounding names "glucose polymers" or "maltodextrin." As explained above, these drinks block growth hormone release and impede fat burning. Protein-only drinks are available, but the gastrointestinal distress caused by these pure protein drinks can make you a prisoner in your own bathroom. Adding insult to stomach cramps, the average growth-hormone-suppressing carbohydrate drink or diarrhea-inducing protein drink costs between three and four dollars, a ludicrously high price considering the low-grade ingredients most of them contain.

I recommend making your own pre-workout performance drink or post-workout recovery drink. First, buy high-quality protein powder. (Be careful - the protein supplement industry, like the dietary supplement industry in general, is bursting at the seams with impure, inferior products slickly marketed as the ultimate breakthrough in human nutrition.) The protein powder can be whichever flavor you favor. If it is sweetened, be wary of the carbohydrate content. If it is unsweetened, you can sweeten it yourself with a zero-carb sweetener. Add a few tablespoons of whipping cream and ice and blend for a low-carb, high-protein, moderate-fat, rich, creamy, frosty, shake. You can substitute a tablespoon of olive oil and/or flaxseed oil for a tablespoon of cream to provide even more health and fat loss benefits (see Chapter 18). Using oil will also allow you to use less saturated fat in the form of cream. However, too little cream relative to oil may ruin the taste, so experiment to find a happy medium.

The saturated and monounsaturated fat in this shake supports testosterone production in men (see Chapter 22). Thus, not only will it promote growth hormone release due to the absence of carbohydrate and the presence of protein, but it will also give men a testosterone boost when they need it most, after an intense workout when testosterone levels are depressed.

The caliber of these ingredients - high-quality protein powder, fresh whipping cream, extra virgin olive oil, and/or flaxseed oil - is far superior to the ingredients that comprise most commercial performance/recovery drinks. And while it is never as convenient to make something yourself as it is to buy it, the money savings is considerable. I estimate that the total cost to you, per homemade shake, is about $1.50. This $1.50 is much greater than the per-unit cost to the manufacturer of the ingredients in a typical performance/recovery drink, but much less than the retail cost of the same product.

What Kind of Exercise Should You Do?

This is one of the more basic questions concerning exercise, and yet most people have it wrong. Of the two categories of exercise discussed earlier - aerobic exercise and resistance exercise - which is more effective for reducing bodyfat? If you believe that aerobic exercise is superior in this regard, then you're among 99% of the population - and dead wrong.

Cardiovascular health is a critical component of fitness. However, aerobic exercise ranks second to progressive resistance training as a tool for shedding excess bodyfat and keeping it off permanently.

The notion that treadmills and stairclimbers are the best means of reducing bodyfat and that weight training is beneficial solely toward the objective of building muscle, is a time-honored and unfortunate misconception. At the core of this false belief is the fact that, as explained above, aerobic exercise engages a bioenergetic pathway that is conducive to fat burning; whereas resistance exercise engages the anaerobic pathway, which entails the burning of fuel sources other than fat. In other words, aerobic exercise burns more fat than resistance exercise, *while you are exercising*. But that is not the end of the story - it's the beginning. The greater portion of fat loss benefits accrue *between* not *during* exercise

sessions. The hormonal and metabolic forces set into motion as a result of your motions in the gym can have an effect for many hours after your workout ends.

Both aerobic and resistance exercise raise metabolic rate for a period of time after exercise ceases. But studies show that resistance exercise is substantially more powerful in this regard, with post-exercise metabolic elevation persisting for 15 hours[57,58] and sometimes for as long as 24 or even 48 hours after a resistance training session ends.[59,60] Intensity is the key factor accounting for why weight training outdistances endurance training as a metabolic stimulus. Evidence suggests that duration is linearly,[61] whereas intensity is exponentially,[62] related to post-exercise metabolic elevation. The practical import is that:

1) Higher-intensity/lower-duration exercise will burn more calories *after the workout* than will lower-intensity/higher-duration exercise, even where the amount of calories burned *during the workout* is equivalent.[63,64,65]

2) Two, more intense training sessions of lesser duration will burn more calories overall (during + after) than will one less intense training session of greater duration.[66,67]

NOTE - We are discussing the *metabolic* effects of exercise. Later in this chapter we will discuss the *hormonal* effects of exercise. In this context, metabolic refers to total calories burned; whereas *hormonal* refers to the relative contribution of fat/carbohydrate to fulfilling metabolic demands. As you will see later, the prescription for optimizing the hormonal effects of exercise mirrors the prescription for optimizing the metabolic effects of exercise. This makes it simple, doesn't it? As you might suspect, this happy coincidence is not a product of chance. Rather, it results from the interrelationship between hormones and metabolism.

The extensive post-exercise metabolic elevation that prevails in the wake of an intense resistance training session stems from the fact that if done properly, resistance training initiates a restoration/recovery process in which depleted energy compounds, like glycogen and creatine phosphate, are replenished and muscle tissue is repaired and rebuilt. Anabolic and catabolic hormones orchestrate this energy-intensive recovery process. "Energy-intensive" means requires additional energy (calories) = higher metabolic rate. But resistance training does not stop there.

Not only does resistance training increase your overall metabolic rate, but it can also increase the percentage of fat burned relative to sugar. How can resistance training accomplish this? By prompting the release of growth hormone, which shifts your metabolism into a fat-burning mode. A *well-designed* resistance training program is a potent stimulator of growth hormone (whereas a poorly designed one can suppress growth hormone). In men, resistance training can also increase testosterone levels; and testosterone, like growth hormone, is a lipolytic (fat-mobilizing) hormone. Aerobic exercise, too, can positively influence hormone levels, but not nearly as effectively as resistance training. The post-exercise metabolic increase and the hormonal enhancement effects are the short-term-fat-loss benefits of resistance exercise. The long-term benefits are even more impressive.

In addition to giving your body shape and firmness, and imparting functional ability, muscle is intimately involved in fat burning. At the cellular level, muscle is the locus of fat burning. Specifically, muscle cells contain structures called *mitochondria,* which are tiny organic furnaces that produce energy from fatty acids and glucose. And as you learned in Chapter 4, a direct relationship exists between muscle mass and metabolic rate. Therefore, **the more muscle you have**, **the more calories you burn**, **even at rest**.

Muscle is vital, dynamic tissue churning with busy activity: protein synthesis, glycolysis, ATP regeneration, and fatty acid oxidation are just a few of the activities that regularly go on inside muscle cells. Fat, on the other hand, is basically inert - it just sits there. Per ounce, muscle takes-up less space and uses-up more calories. Muscle enhances the functional ability of the body; fat diminishes the functional ability of the body by saddling it with dead weight. Muscle tissue possesses an extensive capillary network allowing the heart to pump blood through the muscles with relative ease; adipose tissue is much less vascular and thus taxes the heart.

As you can see, muscle is "high-maintenance tissue," requiring a steady supply of energy (calories) and oxygenated blood. By contrast, fat is "low-maintenance tissue," requiring less energy and less blood. Not only does muscle "cost" more energy to maintain than fat, but also muscle contributes less energy to your survival. In other words, whereas fat is an excellent energy source, muscle is a poor energy source. Muscle must be broken down to its constituent amino acids, and the amino acids must be converted to glucose - and after all that work, glucose yields less than half as much energy as does fat. This explains why, when under duress, the body readily jettisons muscle. Faced with the potentially life-threatening specter of calorie restriction (which is how your body perceives it), the body eagerly unloads "energy-costly" muscle.[68,69,70]

As fasting progresses to bona fide starvation and after “unnecessary muscle” (that which helps you excel athletically and look good in a swimsuit) has been unloaded, counterregulatory adaptive mechanisms, including thyroid downregulation and ketosis, come into play to conserve remaining “necessary muscle” (the heart, other organs, and a minimal amount of skeletal muscle requisite for basic movement).[71,72,73,74] At this point, even if adequate caloric intake is restored, a severe metabolic disadvantage has been incurred. And while lost fat is never far from home, a portion of lost muscle often proves irretrievable, especially among females, the aged, and the sedentary.

In light of the foregoing discussion, it is clear that, whether male or female, **building a calorically "high-maintenance" body is the best strategy for achieving maximum *permanent* fat loss** - and that means a high muscle/fat ratio. Women are limited in this regard, due to their relative lack of testosterone. Nevertheless, within this narrow window of muscle growth potential, building muscle will greatly assist a woman in her effort to lose fat permanently, while giving her a firm, toned, shapely look to go along with low bodyfat.

Relying solely on aerobic exercise to reduce bodyfat, which many people (especially women) do, can actually have a *negative* long-term effect, by reducing muscle mass. Prolonged, high-volume aerobic exercise is catabolic, raising cortisol levels and causing

muscle loss in both men and women.[75,76,77,78,79,80] * And it appears that women, who can less afford to lose muscle than men (see Appendix A), are more susceptible to the catabolic effects of endurance training.[81,82] *Even the loss of one ounce of muscle reduces your metabolic rate and your ability to burn fat.* Hence, those highly motivated men and women who spend hours laboring-away on the treadmill or stairclimber, rather than allocating an appropriate proportional amount of energy to this mode of exercise, are committing a costly error.

Take a look at the body of a world class long-distance runner: do you see a shapely, lean body with impressive muscle tone and fullness? No, in most cases you see a stick-figure physique, emaciated and weak. "Some runners are so weak they can't carry their own luggage," comments Dr. William Evans of the USDA Human Nutrition Center on Aging.[83] Dr. Michael Colgan of the Colgan Institute concurs, observing that "30 push-ups are beyond many of the elite runners that we test."[84]

Even if, like those individuals whose mindset has been distorted by the popular media and the fashion industry's obsession with rail-thinness, you aspire to the skeleton look rather than the lean and sculpted look, a skinny, muscleless** body does not age well. By burning-off muscle tissue, you accelerate the physical degeneration associated with aging and the age-related metabolic slowdown. Conversely, by building muscle you counteract these adverse physiological trends. In this connection, a study published in the *Journal of Applied Physiology* reported an 8% increase in resting metabolic rate in 50- to 65-year-old men after 16 weeks of weight training.[85] Another study, published in the *American Journal of Clinical Nutrition*, found a similar metabolic increase in men and women, aged 56-80, after 12 weeks of resistance training.[86] Moreover, researchers find that in addition to producing strength gains, progressive resistance training consistently improves body composition in both men and women by increasing lean mass and decreasing bodyfat[87,88,89,90,91] - even when subjects trained only twice a week.[92]

The point is not that you should dispense with aerobic exercise - quite the contrary. Cardiovascular fitness is essential to good health, and aerobic exercise promotes cardiovascular fitness. Furthermore, endurance training enhances the body's capacity to use fat for fuel[93,94,95,96,97] by positively altering fat-burning enzymes, called *lipases*.[98,99,100,101,102] Thus, aerobic training and resistance training work together synergistically. **By combining aerobic training with resistance training, you multiply the benefits of each, while avoiding the muscle loss associated with high-volume aerobic-only exercise**. And, by applying the principles of hormonally intelligent exercise, you can achieve optimal results from only 2-4 hours total, per week. Is a couple of hours a week - out of 119 waking hours - too much to ask when the rewards are a stronger, sexier, healthier, more energized, better functioning body? It sounds like the bargain of the century to me.

* It is true that *any* type of exercise, including resistance training, can have a net catabolic effect if frequency, intensity, duration, and load are not properly modulated. However, resistance training, if done properly, generates a compensatory anabolic response that outweighs the catabolic response. By contrast, with aerobic exercise, the catabolic effects are unopposed by a countervailing anabolic stimulus.

** I know this word looks strange - it's my humble contribution to the English language.

The lack of appreciation of the remarkable anti-aging, health, and fat loss benefits of resistance training is due, in large part, to the tardiness of health authorities in endorsing resistance training (there are still many benighted health authorities and doctors who have yet to awaken to its many benefits). Among its benefits, resistance training not only builds muscle, but bone too. The importance of weight-bearing exercise for the skeletal system became evident when America sent men into space. Without gravity, astronauts rapidly lost bone mass.[103] Efforts to prevent bone loss by having astronauts pedal exercycles while in orbit met with failure; despite being young and exceptionally healthy, the astronauts' bones disintegrated.[104] This illustrated the need for weight stress in maintaining skeletal health. Unfortunately, aerobic exercise performed on Earth also fails to maintain bone mass.[105,106,107]

Resistance Training as a Means of Warding-Off the Deadly Crippler

In the face of aging and the attendant drop-off in anabolic hormones, gravity alone is not enough to maintain bone mass, as evidenced by the prevalence of osteoporosis - the deadly crippler of older men and women. Millions of older men and women are afflicted with this merciless disease, which breaks approximately 1.5 million bones per year in the U.S.[108] The million-and-a-half fractures of the spine, hip, and forearm attributable to osteoporosis account for an estimated $13 billion in medical costs.[109] Demographic changes in the U.S. toward an older population herald an enormous public health burden in coming decades, with the cost of osteoporosis-related morbidity projected to exceed $60 billion by the year 2020. [110]

Women are disproportionately affected by osteoporosis due to menopausal loss of estrogen, smaller bones than men, greater propensity to engage in restrictive dieting throughout life, and lesser propensity to lift weights. For many elderly people, the trauma of a hip fracture and the consequent stay at that extremely dangerous place called the hospital proves fatal.[111] Even when elderly hip-fracture-victims survive, protracted agony and disability often mar the rest of their days.[112] Once the crippler strikes, it's too late. The only cure is prevention.

While gravity alone is not sufficient to maintain bone mass in the face of aging, neither is the popular medical recommendation of calcium supplementation. True, calcium (and many other nutrients) is vital to bone health. But the ultimate issue is not how much calcium you ingest, but how much calcium is retained and incorporated into your bone structure. This is why calcium supplements, alone, fail to maintain bone.

Weight stress, which can be effectively applied by resistance exercise, influences calcium metabolism by promoting retention and incorporation of minerals into bone.[113] This mineral synthesis process is analogous to protein synthesis, in which amino acids are retained and incorporated into muscle. Both of these processes are mediated by hormones, particularly growth hormone,[114,115,116] which can be stimulated by resistance training. And just as resistance training can reverse muscle loss, it can also reverse bone loss.[117,118,119]

Although osteoporosis is a life-threatening and debilitating disease that affects millions of Americans, the good news is - it is almost completely preventable. Like most chronic conditions that become manifest later in life, the crippler does not go in for the kill until after decades of stalking. Osteoporosis is a creeping degenerative process, which can be arrested or reversed at any point along the way. The current medical approach of calcium supplements and estrogen replacement is woefully inadequate, a fact to which the statistics readily attest.

The widespread prevalence of the human tragedy known as osteoporosis despite the existence of effective means of prevention, represents yet another piteous failing on the part of a medical establishment focused on treating rather than preventing disease. To prevent osteoporosis, employ resistance exercise and appropriate nutritional supplementation.

The Times, They are A-Changin'

For the last decade, I have been advocating resistance training for fat loss, health, and as an anti-aging strategy. I became convinced, early on, of the efficacy of resistance training as a hormonal enhancement vehicle. For much of that period, I was a lone voice in the wilderness. In support of my recommendation of resistance training, I could not cite the American College of Sports Medicine, nor the National Academy of Sciences, nor famous exercise authorities like Dr. Kenneth Cooper, the man who coined the term "aerobics." The prevailing view of resistance training ranged from unnecessary to inadvisable.

The times, they are a-changin.' Both the National Academy of Sciences and the American College of Sports Medicine have revised their positions and now recommend resistance training. Dr. Kenneth Cooper, as well, after seeing too many people with great cardiovascular systems and crumpling bones, has recanted his longstanding denunciation of resistance training and has redesigned his facilities at the Cooper Clinic to accommodate this form of exercise. With new discoveries being made almost daily concerning the impact of hormones on body composition, health, aging, and mental well-being, resistance training will only grow in popularity. I recommend you start now, if you have not already.

Having discussed exercise on a general level, it is time to focus on how to structure your workouts for optimal hormonal response. A large percentage of people who exercise, and many trainers, have not the faintest inkling of the hormonal effects of exercise or how to modulate exercise variables to optimize these effects. Most exercise practices are the product of tradition, convention, and imitation - not science. Personal trainers can be of some benefit, especially in the areas of motivation and proper exercise execution. But for your cash per hour, you are unlikely to learn much about using exercise as a means of hormonal enhancement - this technology is the razor-sharp-cutting-edge of exercise science.

A Quick Word about Personal Trainers

The substantive material that must be mastered in order to become a "certified" personal trainer is largely theoretical and makes only passing reference to hormones. Furthermore, there exists an alphabet soup of certifying organizations with widely varying legitimacy (including nil). Certification emerged for insurance purposes to ensure an irreducible minimum of knowledge among personal trainers. From this standpoint, the emphasis on certification has been a positive development: on a random basis, it is less likely that a "certified" personal trainer will commit malpractice than an uncertified trainer because the certified trainer at least knows *something* about which he or she is instructing.

I raise the issue of trainers by way of disclaimer: there is a limit to how much can be taught via the written word, and there is no substitute for a wise mentor/coach.

The Six Exercise Variables

The following factors determine the hormonal response to exercise: frequency, intensity, duration, load, volume, and exercise selection. Hormonally intelligent exercise entails strategically manipulating these variables for optimal hormonal response.

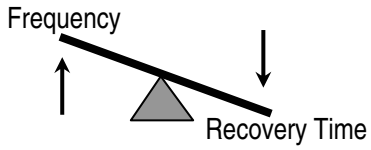
EXERCISE SELECTION

We have already discussed exercise selection in broad terms, comparing aerobic exercise with resistance exercise. To review: whereas resistance exercise is superior for achieving permanent fat loss and is a more effective means of hormonal enhancement, aerobic exercise promotes cardiovascular health. As well, aerobic exercise can significantly increase the rate of fat loss when properly integrated into a resistance-training-based exercise program.

On a more specific level, the issue is exactly which exercises to do. Free weights or machines? Compound exercises or isolation exercises? Jogging or jumping? Dumbells or barbells? Sit-ups or crunches? Pulldown or pullup? This is a vast topic that could easily occupy a book of its own – and does. All exercises are not created equal.

FREQUENCY

This variable refers to how often you exercise and relates to recovery in the following way: the more frequently you work-out, the shorter will be recovery periods between workouts.



(If recovery is insufficient, cortisol levels rise.)

As you know by now, exercise sets into motion powerful hormonal forces. By stimulating secretion of anabolic (muscle-building) and lipolytic (fat-burning) hormones, vigorous exercise creates a *potential* for favorable body composition changes. If you train too frequently, however, this potential cannot be realized. What is worse, under these circumstances catabolic hormone levels escalate, overwhelming "good" hormones and assaulting your physique and health. Specifically, "king catabolic" - the hormone cortisol - eats-away at muscle, reduces insulin sensitivity, and impairs immune function (see p. 92). Chronic overstimulation of cortisol leads to adrenal insufficiency, a condition in which the endocrine system cannot respond properly to stress.[120,121]

In addition, overtraining dramatically increases the likelihood of injury, especially connective-tissue injuries, the kind that can keep you out of the gym for months.[122] And, as many athletes can attest, inability to train heralds the unraveling of hard-earned

progress. In the words of Olympian long-distance runner Jeff Galloway, "the single greatest cause of improvement is remaining injury-free to train."

The obvious question is how frequently is too frequently. Unfortunately, the answer is not as obvious as the question. It depends on the other variables: exercise selection, intensity, duration, and load.

You can perform a given volume of aerobic exercise (like jogging) more frequently than weight lifting because aerobic exercise is less intense. Therefore, the greater the resistance training component of your workout regimen relative to the aerobic training component, the less frequently you should work-out and vice versa.

EXAMPLE: It is okay to jog for 30 minutes every day. But it is *not* okay to weight train for 30 minutes every day. Resistance training, when performed properly, is, by its nature, much more intense than jogging. This illustrates the interplay between exercise selection, intensity, and frequency. Every day is not too frequent for lower-intensity exercise (jogging); but it is too frequent for higher-intensity exercise (resistance training).

NOTE - I am employing a convenient distinction between low-/moderate-intensity cardiovascular exercise and resistance exercise. What about high-intensity cardiovascular exercise, like interval training (e.g., wind sprints, discussed later)? Interval training is a hybrid, and should be accounted as such in determining frequency. Like resistance training, interval training entails high effort intensity. But like jogging, interval training does not involve added load and it chiefly engages the cardiovascular system, as opposed to the musculoskeletal system. In terms of bioenergetic pathways, interval training is more-aerobic/less-anaerobic than resistance training and less-aerobic/more-anaerobic than continuous, moderate-intensity cardiovascular exercise.

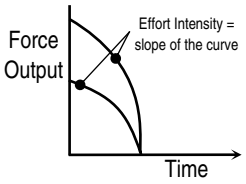
LOAD

This variable refers to amount of weight or resistance against which force is applied. Weight lifting, by definition, involves added load. Pull-ups, push-ups, and sit-ups, like jogging, entail moving a fixed load (your body) through space against gravity. The primary significance of load is that it provides a means of *quantitative*

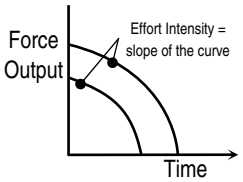
progression. At a given level of strength, more effort is required to lift 300 pounds than to lift 150 pounds, *per time*.

Why isn't it accurate to simply say "more effort is required to lift 300 pounds than to lift 150 pounds"? Because the relationship between load and effort intensity is modified by time (duration) such that effort intensity is greater when lifting 50 pounds 3 times successively (i.e., 1 set of 3 reps with 50 lbs. = 150 lbs.) than when lifting 50 pounds 2 times successively then resting 2 minutes then lifting 50 pounds 2 times again then resting again then lifting 50 pounds 2 times again (i.e., 3 sets of 2 reps with 50 lbs. = 300 lbs.). And *the hormonal implications of each of these workouts are markedly different.* Similarly, it is not accurate to say more effort is required to roll a 16-pound bowling ball than to roll a 12-pound bowling ball. Why? Because more effort is required to roll a 12-pound bowling ball at 40 mph than to roll a 16-pound bowling ball at 4 mph. (When rolling a 12-pound bowling ball at 40 mph, the duration from when the arm holding the ball begins moving forward to when the ball is released is less than when rolling a 16-pound bowling ball at 4 mph.)

Hence, at a given duration and level of strength, load is directly correlated with effort intensity. (You must exert more effort to carry fifty 2-pound bricks a given distance in 10 minutes than to carry fifty 1-pound bricks the same distance in 10 minutes.)



And, at a given level of effort intensity and strength, load is directly correlated with duration. (If you do not increase effort to match the greater load, then it will take you longer to carry fifty 2-pound bricks a given distance than to carry fifty 1-pound bricks the same distance.)



INTENSITY

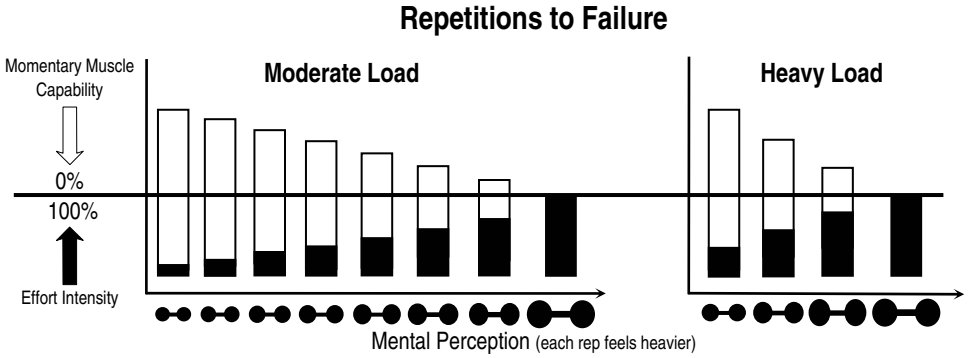
There are two basic types of intensity - effort intensity and relative intensity - and a third that encompasses both - anabolic intensity. At a given level of fitness, an increase in effort intensity increases relative intensity. But relative intensity can increase absent a change in effort intensity. I will define each of the different types of intensity and explain the hormonal significance of each.

Effort Intensity (e-intensity)

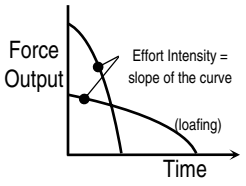
Effort intensity is a measure of the quantum of effort exerted while performing an exercise. More precisely, e-intensity is *the percentage of momentary muscular capability exerted at a given moment*. During the course of taxing physical activity, absolute muscular capability diminishes and thus a correspondingly greater *percentage* of momentary muscular capability (effort) is required in order to perform the activity. Ultimately, 99% momentary muscular capability is required, and a moment later, 100% is insufficient - this terminal moment is called "point of failure."

Increasing e-intensity, like increasing load, constitutes quantitative progression.

EXAMPLE: If you can lift 100 pounds twice, and you hit the "point of failure" while attempting the 2nd repetition with that load, you are, at the point of failure, exercising at 100% e-intensity. If you are lifting only 50 pounds, a much lesser load, your e-intensity level will be much lower during the 2nd repetition, as compared with the 2nd repetition with the greater load. With the lesser load, you may hit the point of failure on the 8th repetition; at that moment, you are exercising at 100% e-intensity (a greater load causes you to become fatigued – lose muscular capability - at a more rapid rate).



EXAMPLE: As you can see from the previous example, there is an inverse relationship between duration and e-intensity such that at a given volume more of one means less of the other. To illustrate, if you are told that Bullet Bob ran 100 meters in 15 seconds you know that he was "loafing" (running at low e-intensity); but if you are told that Slo Mo ran it in 15 seconds you can conclude that Slo Mo was putting forth mo' effort (higher e-intensity) than Bullet Bob.



NOTE - You have greater control over e-intensity than over load (load progression is largely constrained by strength gains, whereas e-intensity is chiefly a function of the will). Therefore, your ability to err in modulating e-intensity is greater. When beginning an exercise regimen, or resuming exercise following a layoff, you must *gradually*, over a period of weeks (and sometimes months depending on biological age and fitness level), work up to the point where the last repetition of each set (except for warm-up sets) is performed at 100% e-intensity. Failure to increase e-intensity inevitably results in stagnation (due to a drop in *relative intensity*, discussed below), whereas a too rapid rise in e-intensity is counterproductive and potentially injurious (see below).

Hormonal Significance: Effort intensity determines the *anabolic potential* of exercise. "Anabolic potential" can be defined as the extent to which the anabolic impetus created by a particular exercise outweighs the catabolic impetus created by that exercise. "Potential" denotes the fact that the anabolic period follows the catabolic period and is contingent upon adequate nutrition and recovery time. For example, weight lifting (high e-intensity) has greater anabolic potential than jogging (low e-intensity). Very low e-intensity exercise

has zero anabolic potential – meaning it can have either a net catabolic effect, or a net effect that is neither catabolic nor anabolic, but it cannot have a net anabolic effect.

Activity	Anabolic Potential
Weight Lifting (least likely to have net catabolic effect and capable of having substantial net anabolic effect)	high
Vigorous Running	moderate
Slow Jogging (most likely to have net catabolic effect and incapable of having net anabolic effect)	zero

Relative Intensity (r-intensity)

Relative intensity is a measure of physical stress. Relative intensity is "relative" because stress is relative. For example, delivering a speech to an audience of 500 people is likely to be very stressful to someone unaccustomed to public speaking, but it would tend to be much less stressful to someone who delivers speeches to large audiences every day. We can generalize about the "stressfulness" of an activity like giving a speech, skydiving, or sprinting 100 yards. But it is impossible to assess the quantum of stress imposed by a particular activity on a particular person unless we know specific facts about that person (like that person's fitness level in the case of sprinting 100 yards). Once you appreciate that stress is relative, you see why relative intensity tends to fall: because a given stressor (e.g., lifting 100 pounds 10 times successively or running a mile in 9 minutes) becomes less stressful each time one encounters it.

By increasing e-intensity and load, you can maintain a high level of r-intensity. But e-intensity and load (quantitative progression) cannot increase indefinitely. As quantitative progression slows then ceases, r-intensity accelerates downward because the stress of exercise slackens (see diagram, p. 277). Falling r-intensity translates to diminished hormonal response and, consequently, diminished results from exercise. This is why most people who work-out enjoy positive results initially, then stagnate. Can the downward trend in r-intensity/hormonal response/results be countered? Yes.

Hormonal Significance: Relative intensity determines the relative (relative to other occasions) hormonal response (catabolic and anabolic) to exercise. Where hormonal response is equal to or greater than on previous occasions, the body will change (either for the better or worse). Where hormonal response is lesser than on previous occasions, the body will either remain the same or will change in the opposite direction to the direction it changed on previous occasions, depending on the magnitude of the reduction in hormonal response (the "detraining effect" discussed on p. 260 is an example of an "opposite direction" change). Hence, r-intensity determines whether A) physical change will occur B) physical change will not occur C) previous physical change will be undone.

Anabolic Intensity (a-intensity)

Anabolic intensity encompasses both e-intensity and r-intensity.

$$AI = RI \times EI^{n} *$$

Hormonal Significance: Anabolic intensity describes the relative (relative to other occasions) anabolic potential of exercise, and it determines the *actual amount* of anabolic hormones secreted in response to exercise. Therefore, a-intensity determines whether (assuming adequate nutrition and rest) you will A) gain muscle mass, or in the case of women, "muscle tone" B) neither gain nor lose muscle mass/tone C) lose previously gained muscle mass/tone.

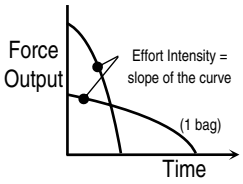
DURATION

Generally, this variable refers to time spent exercising; but there are two distinct usages.

1) When used to discuss how long a workout session should last (which I will do later in this chapter), duration refers to the interval from when exercise begins to when it ends.

2) When used in the volume equation, duration refers to actual time spent performing exercise, as opposed to resting. According to this definition, there is a significant difference between 40 minutes engaged in continuous exercise (like jogging), and 40 minutes engaged in intermittent exercise (like weight lifting) in which bouts of muscular output are interspersed with rest periods.

When the total amount of work (volume) is the same, duration and load are inversely related. (When transporting bags of groceries from your car into your house you can either carry two bags at a time and be finished in 2 minutes, or carry one bag at a time and be finished in 4 minutes.)



VOLUME

At a given level of fitness, volume is the product of frequency, duration, and load. In essence, volume is a measure of how much exercise you are doing per unit of time.

* If you are wondering what “n” is, I am too quite frankly. Someone with mathematical skills superior to mine will crack this mystery someday. How do I know that e-intensity is exponentially related to anabolic hormonal response? Because if one switched from a high e-intensity weight-lifting regimen (to which one were accustomed, thus low relative intensity) to a low e-intensity jogging regimen (to which one were unaccustomed, thus high relative intensity) anabolic hormonal response would drop. In other words, a decrease in e-intensity will more effectively blunt anabolic hormonal response than a corresponding increase in r-intensity will enhance it. If you figure-out the quantity of the unknown anabolic exponent, please let me know, I’ve been pondering this for quite some time.

Volume = Load x Frequency x Duration / Fitness

For example, at a given level of fitness. . .

(Frequency = 3 days per week) x (Duration = 40 min.) (Load = 500 lbs.)

is equal in volume to:

(Frequency = 4 days per week) x (Duration = 30 min.) x (Load = 500 lbs.)

is equal in volume to:

(Frequency = 2 days per week) x (Duration = 40 min.) x (Load = 750 lbs.)

equal volume does not mean equal results.

As a person becomes fitter, the volume of a given workout decreases. . .

less volume = less exercise

less exercise = lower relative intensity (assuming all other variables are constant)

lower relative intensity = less hormonal release

When discussing the volume *of a workout*, as opposed to a period of time encompassing more than one workout, delete frequency.

Volume of a Workout = Load x Duration / Fitness

Excess Volume Impacts Sex Hormones

Where volume is excessive, exercise wreaks havoc on sexual and reproductive function in both sexes.[123] In men, overtraining can depress testosterone levels and reduce sperm count and quality[124,125,126,127,128] with both of these problems more prevalent in endurance athletes than in weight lifters.[129,130,131] In women, overtraining disrupts menstrual cycles, causing irregularity or cessation; and it suppresses production of hormones that regulate ovarian function and fertility.[132,133,134,135,136] Moreover, overtraining-induced alterations in the female reproductive hormones, estrogen, follicle-stimulating hormone, progesterone, and luteinizing hormone,[137,138,139,140,141] and resulting menstrual dysfunction is associated with an increased risk of musculoskeletal injury during exercise[142,143] and accelerated bone loss[144,145,146] (by contrast, properly modulated exercise helps preserve bone, see p. 248). As in men, sex hormone suppression in women is largely caused by excess cortisol.[147]

Excess Volume Reduces Thyroid Output

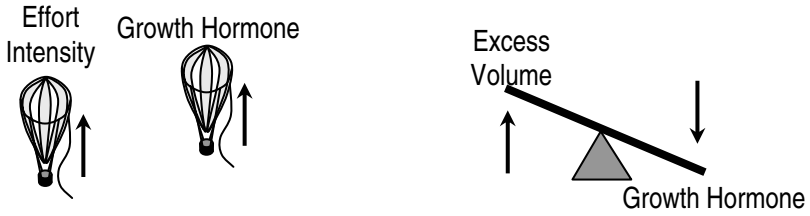
In Chapter 9, we discussed thyroid hormones in connection with diet, and you learned that thyroid hormone "T3" plays a key role in regulating metabolic rate. Just as calorie restriction and carbohydrate restriction each can lower T3 levels, so can overtraining.[148,149,150] The reduction of T3 in response to excessive exercise is the body's

desperate attempt to quell the catabolic uprising instigated by such exercise. Once again, we see the body's innate survival-driven intelligence working at cross-purposes with the body owner's efforts to lose fat. Unfortunately, while T3 reduction slows fat loss, its insufficient to arrest the catabolic action of elevated cortisol. Hence, the restrictive dieter and the excessive exerciser continue to lose muscle even as fat loss slows to a creep. If you are wondering why the body, in its supreme wisdom born of eons of evolutionary experience, would opt to ditch muscle while clinging to fat, see p. 245-246.

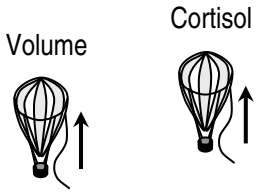
The Relationship between Exercise Variables and Hormonal Responses

All Hormones are directly correlated with relative intensity.

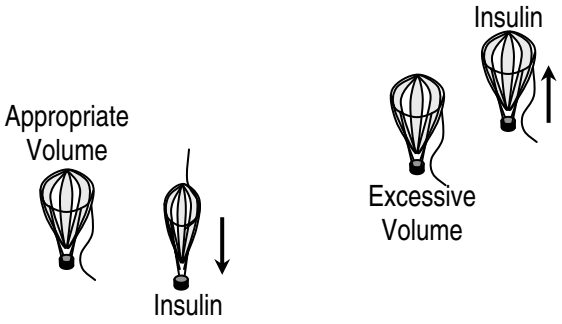
Growth Hormone is directly correlated with effort intensity and inversely correlated with excess volume.



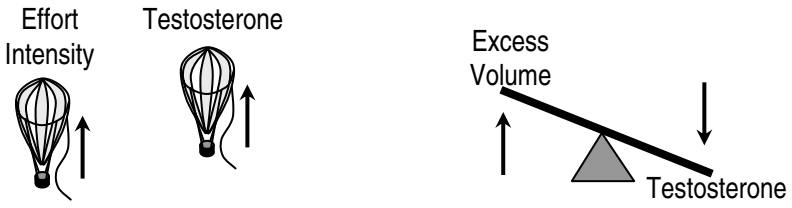
Cortisol is directly correlated with volume.



Insulin sensitivity is generally enhanced by exercise (resulting in lower insulin levels). However, insulin sensitivity is reduced (resulting in higher insulin levels) where volume is too high, because excessive volume raises cortisol levels and at high levels cortisol impairs insulin function.



Testosterone is directly correlated with effort intensity and is inversely correlated with excess volume.



As you can see, the e-intensity/volume ratio influences both growth hormone to cortisol and the ratio of testosterone to cortisol.

$$\frac{\text{E-Intensity}}{\text{Volume}} \xrightarrow{\textit{influences}} \frac{\text{Growth Hormone \& Testosterone}}{\text{Cortisol}}$$

(If you don't like mathematical formulas, here's the English language version: What percentage of the exercise "work" you do is "hard work"?)

A workout that involves a lot of low-intensity/high-duration exercise, like long-distance running, has a low intensity/volume ratio. This type of workout tends to increase cortisol relative to both growth hormone and, in men, testosterone. The superiority of a high-intensity/volume-ratio training regimen is subject to the following qualification: higher intensity corresponds with higher risk of injury.

You can contain the risk of injury (but you can never eliminate it) by *gradually* increasing intensity. In so doing, you allow fitness/recovery ability to increase in lockstep with intensity, which minimizes risk of injury. Conversely, where intensity is increased too rapidly during the first few weeks after beginning an exercise program (or when resuming an exercise program after a layoff), such that intensity outstrips fitness/recovery ability, the risk of injury increases exponentially.

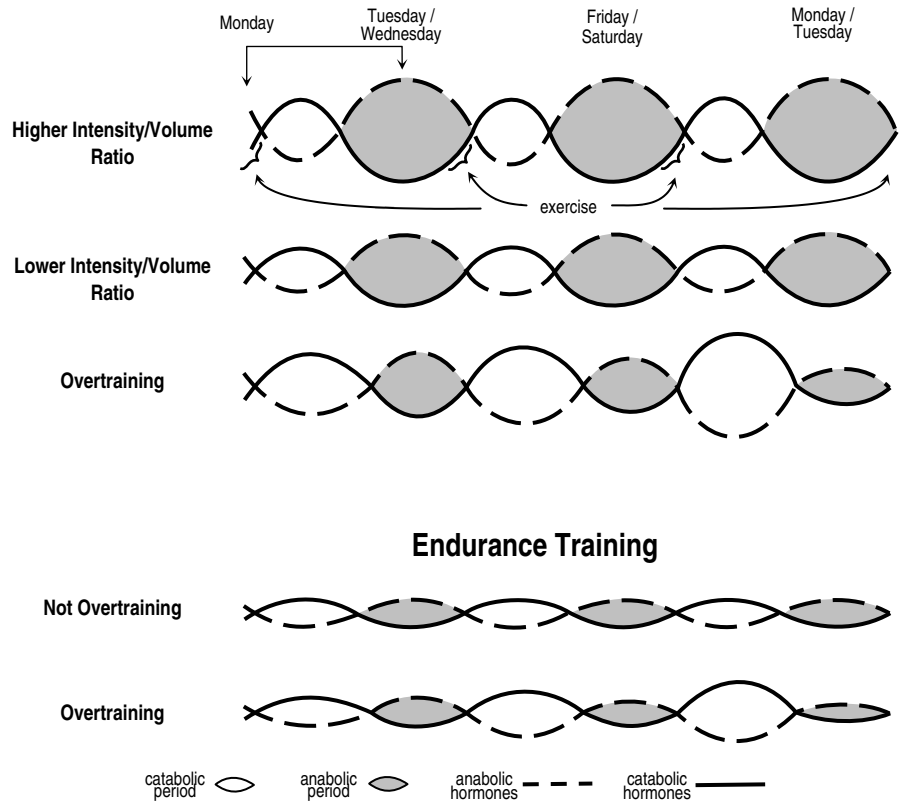
To optimize the hormonal response to exercise, gradually increase e-intensity from low to high and keep the e-intensity/volume ratio high thereafter.

While the intensity/volume ratio is a useful predictive indicator of hormonal response, it applies only *at a given level of volume* – it does not indicate whether volume is excessive or insufficient. To illustrate, a workout consisting of lifting as much

weight as possible one time would maximize the intensity/volume ratio; but it would be relatively ineffective because volume is too low (see below). Conversely, overtraining (excess volume) reduces the pituitary output of growth hormone,[161,162,163] in addition to adversely affecting testosterone, insulin, and cortisol levels.

Studies of runners, comparing the effects of increasing mileage while keeping speed constant versus increasing speed while keeping mileage constant, find that the former is more apt to lead to overtraining than the latter.[164,165,166] The former increases volume, whereas the latter keeps volume constant and increases e-intensity. Given that volume is directly correlated with cortisol, whereas e-intensity is directly correlated with growth hormone and, in men, testosterone, the outcome of these experiments was easy to predict.

The following factors determine the volume of exercise that will spark adverse hormonal changes: **nutrition**, **sleep**, **fitness level**, and **emotional stress**. The better your nutrition, the more and sounder your sleep, the fitter you are, and the lower your emotional stress level - the greater volume of exercise you can tolerate without falling prey to overtraining syndrome. Stated differently, the ratio of anabolism to catabolism will be higher over a given period of time when these factors are optimal than when they are sub-optimal.



Modulating Intensity for Maximum Growth Hormone Release

Maximum e-intensity occurs when exerting 100% of momentary muscular capability. As intuition would suggest, there is also a minimum for e-intensity. In fact, it is e-intensity of physical activity that defines exercise. What is the difference between sleeping and running? Why is one considered a form of exercise while the other is not? Because sleeping is non-intense; whereas running has an e-intensity rating greater than zero (it requires an output of force sufficient to prevent it from being performed indefinitely).

The exercise threshold rises commensurately with fitness increments. In other words, whether or not a given activity constitutes exercise for a particular person depends on that person's fitness level. This should also make sense intuitively: whereas brisk walking constitutes exercise for most people, it may not constitute exercise for a world-class runner.

EXAMPLE: Whereas a couch potato who has not exercised in years would experience positive physiological changes (a "training effect") from brisk walking, a world-class endurance athlete, if he or she relied solely on this form of "exercise," would experience negative physiological changes (a "detraining effect"). In this scenario, the world-class athlete would continue to *lose* cardiovascular fitness all the way down to the level at which brisk walking constituted exercise! This illustrates that the exercise threshold moves up or down with fitness level.

Likewise, whether a given activity constitutes “intense exercise” depends on the fitness level of the person doing the activity.

EXAMPLE: In order for "Weak Willy" to bench press 100 pounds, he must exert great effort (high e-intensity); but "Buff Daddy" can manage the lift while exerting minimal effort (low e-intensity).

However, even where e-intensity is high, r-intensity may not be.

EXAMPLE: A highly fit athlete might train at a high level of e-intensity every workout. This person has a high exercise tolerance due to his/her high level of fitness. In other words, his/her body is efficient at managing the stress of high-intensity exercise. For this person, high e-intensity represents moderate r-intensity. For an untrained person, by contrast, exercising at high e-intensity would be traumatic - heightening the risk of injury, causing severe muscle soreness that could last for days, and generating an excessive surge of catabolic hormones. For the untrained person, high e-intensity represents extremely high r-intensity.

Growth hormone release is positively correlated with both effort intensity and relative intensity.

Growth hormone output increases as effort intensity increases.[151,152,153,154,155] (In other words, the higher the e-intensity level of exercise, the greater the growth hormone response; the lower the e-intensity level of exercise, the lesser the growth hormone response.)

AND

Training diminishes the growth hormone response to exercise.[156,157,158,159,160] (In other words, the fitter one becomes relative to a given form of physical stress, the lesser the growth hormone response to that form of physical stress.)

Because growth hormone release is positively correlated with both effort intensity (e-intensity) and relative intensity (r-intensity), anabolic intensity (a-intensity, which encompasses both e- and r-intensity, see above) is the most complete and accurate way to depict the basis for physical-activity-related growth hormone output.

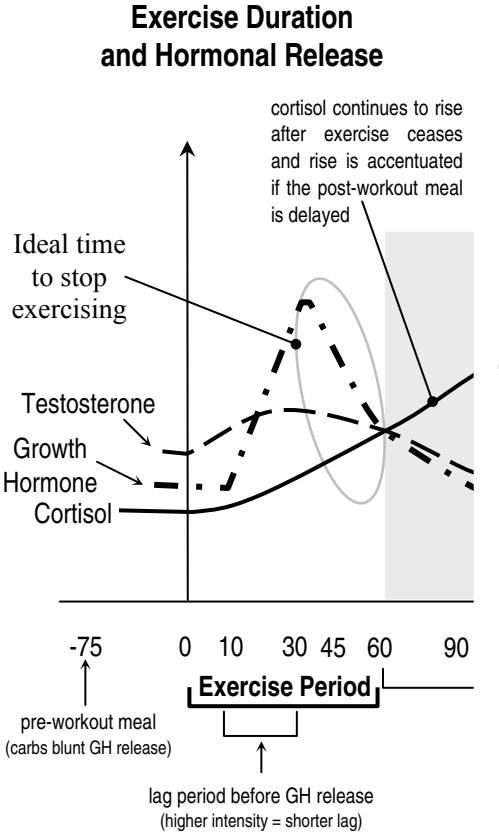
Synchronizing the Duration of Your Workouts to Hormonal Responses

Just as there is a minimum for intensity, there is also a minimum for duration. As a practical matter, a workout must be sufficiently lengthy to allow you to complete your exercises, including warm-ups, with the proper form and technique. In addition, there is a lag period from the onset of exercise to the rise in growth hormone (assuming sufficient intensity to stimulate growth hormone in the first place). One brief bout of peak effort exercise can stimulate growth hormone release, but several brief bouts of peak effort exercise performed repetitively generally produces a superior growth hormone response.[167] One reason for this is that certain metabolic byproducts of exercise, like lactic acid[168,169] and/or endorphins,[170,171] catalyze the release of growth hormone. A workout that is too brief limits the build-up of these GH-signaling factors, and does not impart sufficient physical stress to provoke a maximal growth hormone response. Therefore, a training session must go beyond a single exertion of peak effort, and the exerciser must accumulate a significant volume of exercise (which takes some time, but less than commonly believed) in order to achieve an optimal hormonal outcome.

The greater the a-intensity, the lesser the duration of exercise need be for growth hormone to be released.[172,173] Generally, the requisite duration ranges from 10 minutes for more intense exercise to 30 minutes for less intense exercise. [174,175] But this period may be considerably shorter in some instances, as demonstrated by a study published in the *European Journal of Applied Physiology.* The researchers found that after a 30-second sprint, growth hormone levels rose rapidly in both men and women subjects and peaked at approximately 10 minutes post-exercise. [176] This finding, while impressive, is not unprecedented. Similarly robust growth hormone responses to very brief, very intense bouts of exercise have been reported.[177,178,179] While the timing of the growth hormone response to exercise is variable and individualized, the following proposition is firmly supported: where a-intensity is high, it does not take long to stimulate growth hormone release. Therefore, **in terms of growth hormone release**, **there is no justification for a long workout**.

In most cases, peak growth hormone levels occur 20-50 minutes after the onset of sufficiently intense exercise;[180] after which growth hormone declines, *but cortisol continues to climb*.[181,182,183] **When falling growth hormone intersects with rising cortisol, your workout becomes hormonally incorrect**. And from that point on, your workout becomes progressively more hormonally incorrect with each passing minute that it persists. A-intensity determines when the intersection of growth hormone and cortisol will occur. The less intense the exercise, the slower the rate of increase of both cortisol and growth hormone. Accordingly, where a-intensity is low, an exercise session can run longer before it turns hormonally incorrect; however, less growth hormone is released under these circumstances. And if a-intensity is too low, growth hormone will not be released. Where a-intensity is high, 40-60 minutes after beginning a workout is approximately when growth hormone

levels and cortisol levels will begin moving in opposite directions (signifying the impending onset of "hormonal incorrectness").



Even where little or no growth hormone is stimulated (because a-intensity is too low), cortisol will gradually rise and can reach excessive levels if the exercise session is prolonged. This is why I recommend against a workout program that primarily consists of high-duration, low-intensity exercise. This is also why long-distance runners tend to be weak and skinny - their "muscle axis," see Chapter 4, is skewed toward catabolism (promoted by cortisol) as opposed to anabolism (promoted by growth hormone and testosterone); whereas sprinters, *who often have the same bodyfat percentage*, tend to be strong and shapely. (Note the vast difference in the intensity/volume ratio between sprinting and long-distance running. Are you beginning to see how exercise variables affect hormones, which, in turn, affect the shape and composition of the body?)

The bottom line is that to obtain optimal hormonal response, a workout should: 1) be sufficiently intense to prompt growth hormone release, and 2) not last longer than one hour. Remember this: "He who trains then walks away, within one hour, is

able to train again another day - sooner, stronger, and more fully recovered." **The goal is to exhaust *the muscles* without excessively exhausting *the body***. As elaborated below, this is one of the training secrets of the Eastern European athletes who dominated world strength competition years ago, before the fall of communism. *A workout that is both intense and long-lasting makes severe inroads into your body's recovery ability by sharply skewing your hormonal profile toward catabolism and depleting energy resources*. Thus, you should train at a high level of a-intensity and limit your training sessions to no longer than one hour.

RULE - Regardless of whether the session is completed in terms of the number of sets or exercises to be performed, THE TRAINING SESSION SHALL TERMINATE WITHIN ONE HOUR AFTER IT BEGINS. But remember: one hour is the durational limit, not necessarily the optimal duration. If you are training at a high level of a-intensity, your workout can turn hormonally incorrect earlier than one hour (see above). Hence, *40 minutes is generally closer to the optimal workout duration than one hour*.

From a psychological standpoint, as well, a shorter workout is advantageous. The specter of a long, grueling workout can be very discouraging, especially where motivation is a problem to begin with (as it is for many people). You are more likely to find a reason to skip a workout if you know that you have a long workout ahead of you. On the other hand, knowing that your workout will be over in 30-45 minutes is a heartening thought - the light at the end of the tunnel is clearly visible from the time you set foot in the gym. Short workouts also negate the ever-popular "I don't have time to work-out" excuse.

For the average person, one exercise session per day is sufficient. Athletes, however, may require additional training time. What is the most effective way to increase volume? Answer: increase frequency and decrease duration of each workout. This facilitates greater per-workout e-intensity, which increases the per-workout intensity/volume ratio. In addition to a higher per-workout intensity/volume ratio (which translates to higher net anabolic potential per workout), chopping-up workouts into smaller pieces provides more occasions for stimulating growth hormone release. Hence, **two shorter more intense workouts**, **separated in time**, **are superior to one longer workout**, both in terms of fat loss (see p. 244) and anabolism/catabolism. When training twice in one day, refrain from directly working the same muscles on both occasions. Doing so leads to *localized overtraining*, discussed later.

Training Secrets from Across the Iron Curtain

The strategy of substituting more frequent, briefer training sessions for less frequent, longer ones was practiced secretly, behind the Iron Curtain, by Eastern Bloc athletes and, particularly, the Bulgarians. If you are not up on international weightlifting history, for years the Bulgarians dominated. Rumors swirled that the Bulgarians had developed an advanced anabolic

drug. While there is evidence that Eastern Bloc athletes were subjected to systematic state-sponsored steroid administration, there is also evidence that Eastern training methods were more advanced, from a hormonal standpoint, than Western methods during the period of Eastern domination of Olympic strength competition. (Communism was ideal for keeping secrets because of strict travel restrictions and the absence of a free press.)

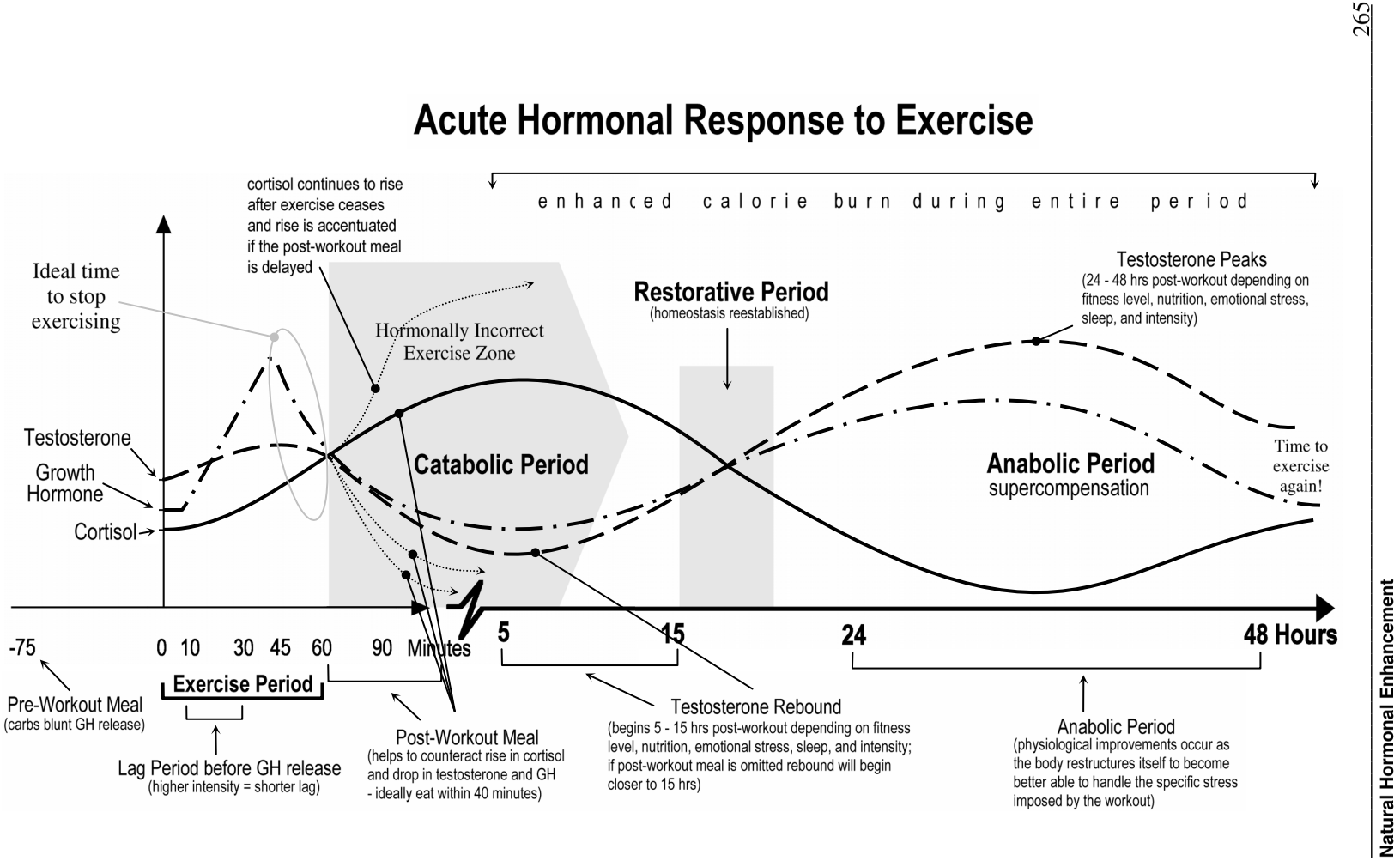
In contrast to the prevailing wisdom in the West, the Bulgarians and other Eastern Bloc athletes limited their workouts to 35-45 minutes. A workout of this duration promotes maximum intensity, allows for more frequent training, coincides with growth hormone peaks, and ends on a physical and psychological high rather than with the athlete emotionally drained and physically depleted of critical recovery resources. (Bear in mind that if you are training for a particular sport, like long-distance running for instance, this training methodology may not be appropriate due to the need to conform your training to the demands of the sport.)

The Effect of Recovery Periods on Hormone Levels

When you train at a level of a-intensity sufficient to stimulate growth hormone secretion, the muscle-enhancing and fat-burning effects of such a workout take time to work their magic. (Remember, as explained earlier, the lion's share of benefits accrues *after* the workout ends.) Immediately after such a workout, your internal hormonal environment is catabolic due to exercise-induced cortisol release. This catabolic period, marked by net protein breakdown, gives way to an anabolic period, marked by net protein synthesis.[184,185]

Hormones conduct the transition from catabolism to anabolism. Specifically, cortisol, after being elevated by the workout, falls and ultimately drops below initial levels hours later. Concurrently with cortisol decline, testosterone, in men, after being suppressed by the workout, rebounds, and ultimately rises above initial levels. Growth hormone, meanwhile, trends upward during the recovery period, which is what one would expect given that cortisol is antagonistic (suppressive) to growth hormone and testosterone is complementary (supportive) to growth hormone. Thus, the recovery period begins with catabolism, which yields to anabolism.

It is between workouts, particularly during the anabolic period, that the physical improvements wrought by exercise occur. From a fat-burning standpoint, recall from p. 244-245 that the restoration and rebuilding of the body requires additional energy and thus additional calories are burned for many hours, and sometimes days, after an intense workout. It is crucial that you not short-circuit this physique-renovation process by working the same muscles again too soon or by working different muscles but going overboard with volume such that cortisol remains elevated and energy resources needed for recovery become depleted. Under these circumstances, recovery is derailed. If recovery is chronically impeded, you begin a downward slide leading to


Acute Hormonal Response to Exercise
enhanced calorie burn during entire period
cortisol continues to rise after exercise ceases and rise is accentuated if the post-workout meal is delayed
Ideal time to stop exercising
Hormonally Incorrect Exercise Zone
Restorative Period
(homeostasis reestablished)
Testosterone Peaks
(24 - 48 hrs post-workout depending on fitness level, nutrition, emotional stress, sleep, and intensity)
Testosterone
Growth Hormone
Cortisol
Catabolic Period
Anabolic Period
supercompensation
Time to exercise again!
-75
0 10 30 45 60 90 Minutes
5
15
24
48 Hours
Exercise Period
Pre-Workout Meal
(carbs blunt GH release)
Lag Period before GH release
(higher intensity = shorter lag)
Post-Workout Meal
(helps to counteract rise in cortisol and drop in testosterone and GH - ideally eat within 40 minutes)
Testosterone Rebound
(begins 5 - 15 hrs post-workout depending on fitness level, nutrition, emotional stress, sleep, and intensity; if post-workout meal is omitted rebound will begin closer to 15 hrs)
Anabolic Period
(physiological improvements occur as the body restructures itself to become better able to handle the specific stress imposed by the workout)

overtraining syndrome, and all the hormonal derangements and health problems that define it.*

As you can see, in order for recovery to reach fruition, you must allow sufficient time between workouts. If you do, the anabolic periods will be greater than the catabolic periods and you will advance. Accordingly, more workouts is better than less workouts provided that full recovery occurs after each and every workout. The full-recovery provision is the kicker - without it, you would be left with "more workouts is better than less workouts." This "more is better" mentality is widely prevalent among avid exercisers, and it ensures that they will never achieve the results from exercise they seek. If, conversely, full recovery occurs and you continue not to exercise, you are forgoing the benefits of another workout and eventually you would experience a "detraining effect." This is called undertraining, the opposite of overtraining. Whereas overtraining occurs when volume is too high, undertraining occurs when volume is too low.

The optimal amount of time between workouts is the minimum necessary to allow for maximum recovery.

Earlier, I noted that trained athletes can tolerate higher volume and higher e-intensity. Does this mean that as you become fitter you require less time to recover from your workouts? Yes and no. The fact is that recovery ability increases substantially in response to training, *but the proportional improvement in strength is generally greater than the proportional improvement in recovery ability*. The upshot is that. . .

Contrary to popular belief, **the risk of overtraining increases as you become fitter and stronger**.

If you were to keep e-intensity and load constant as you became fitter and stronger (which would cause relative intensity to decline), then yes, less recovery time would be needed and you could train more frequently. But the goal is to keep r-intensity high by steadily increasing e-intensity and load. Therefore, since e-intensity and load do not remain constant in a hormonally intelligent exercise program but rather increase; and can increase - along with strength - faster and further than recovery ability, a reduction in frequency, rather than an increase, is often warranted as you become fitter and stronger. Stated differently, your ability to inflict trauma on your body via exercise increases sharply as you become fitter and stronger, and it can outstrip your recovery ability.

In contrast to resistance exercise or intense cardiovascular exercise, low-intensity aerobic exercise can be performed without concern for the recovery process, because

* Bear in mind that the definition of volume (see p. 255) includes a time element. There is no such thing as too much exercise in an abstract sense. Running 1000 miles is not necessarily excessive if performed over a period of a year; but running 10 miles can be excessive (depending on fitness level) if performed in one day. But as you will see later, short-term volume excess, which occurs when you weight train intensely two days in a row (because 24 hrs. is not enough time to allow for full recovery) is not necessarily a problem. In fact, short-term volume excess, called *overreaching*, can be beneficial provided that extra recovery time follows. Therefore, "short-term overtraining" is a contradiction in terms. Overtraining describes a condition caused by chronically excessive volume.

with such exercise there is no recovery process. Hence, a given duration of weight training is more likely to induce an overtrained state than walking. But just as a given duration of low-intensity exercise is less likely to produce adverse hormonal changes, so it also has much lesser potential to produce positive changes. Furthermore, low- intensity exercise *can* produce adverse hormonal changes if volume is high. In this scenario (low intensity/volume ratio combined with high volume), cortisol levels rise and growth hormone and testosterone levels fall. You can lose some fat when your hormones are arrayed in this unpropitious configuration, but you cannot build the lean, sculpted physique that defines a sexy, fit, strong, healthy body.

We have been talking a lot about resistance training, because it is the centerpiece of a hormonally intelligent training regimen. But as emphasized earlier, cardiovascular exercise is a vital component of any fitness program. Accordingly, let's discuss how the principles of hormonally intelligent exercise can be applied to cardiovascular exercise.

Interval Training for Hormonal and Cardiovascular Enhancement

Although resistance exercise is the ultimate form of exercise for reshaping the contours of your physique, cardiovascular exercise, when done properly, works synergistically with resistance exercise to accelerate fat loss while improving health. As to the issue of "how to," we see that, once again, conventional wisdom is wrong.

The prevailing belief is that to reduce bodyfat you should perform cardiovascular exercise at a low level of intensity in a steady, rhythmic fashion for an extensive duration. However, as discussed above, this lowers the intensity/volume ratio, which, in turn, increases cortisol relative to growth hormone and testosterone - definitely not the hormonal profile you want. Conventional wisdom on this subject reflects the truth in reverse: higher-intensity, lower-duration exercise is superior to lower-intensity, higher-duration exercise for reducing bodyfat[186] (see related discussion on p. 244).

Examining the Conventional Wisdom on How to Exercise for Maximum Fat Loss

The notion that you should trade intensity for duration is based on two premises, both of which are invalid.

1) Higher duration is necessary in order to phase into a fat-burning mode.

2) Lower intensity will keep you in an aerobic rather than anaerobic state, and more fat is burned during aerobic respiration than during anaerobic respiration.

Premise 1 is flawed because it assumes that everyone is in a sugar-burning mode to begin with, and, therefore must exercise continuously for some period of time before fat becomes a significant fuel source. To the extent this is true, it is true only because of misguided dietary practices. Sugar-burners are not born, they are made – self-made. The purpose of the NHE Eating Plan is to put you, and keep you, in a fat-burning mode by activating lipolytic hormones and suppressing lipogenic hormones.

Premise 2 is also faulty. You learned earlier in this chapter that the fat you burn while exercising pales in comparison with the enhanced post-exercise fat-burn that follows a hormonally correct workout and the long-term metabolic advantage of added muscle. Thus, the focus on fat burned during exercise is misplaced.

Furthermore, percentage of fat burned for energy should not be confused with amount of fat burned for energy. A higher-intensity workout uses a lower *percentage* of fat for energy. The real issue, though, is not the proportion of fat burned but rather the amount of fat burned. If you were concerned only with the percentage of fat burned, your best bet would be not to do *any* exercise since the percentage of fat burned is higher when intensity is lower. Does this mean you burn a higher percentage of fat when you are snoozing on the couch than when you are sprinting? Yes. Does it mean you burn more fat? Of course not.

You are probably pleased to learn that, contrary to what you have been told, you need not spend a long time in the gym doing continuous, monotonous exercise in order to burn fat. To the contrary, you should exchange duration for intensity and your cardiovascular training sessions should be composed of short, intermittent bursts of activity interspersed with rest periods. This methodology of brief bouts of high-intensity exercise juxtaposed with pre-established recovery periods is called "interval training"; and it is more effective at stimulating growth hormone release than continuous, lower-intensity exercise.[187,188] In one head-to-head comparison, interval training induced a three-fold greater growth hormone response than an equivalent amount of moderate-intensity continuous exercise.[189] I believe that, while impressive, this study understates the superiority of interval training because in many instances conventional low-/moderate-intensity aerobic exercise produces no growth hormone response at all.

Interval training illustrates the direct relationship between the intensity/volume ratio and growth hormone release. Duration of actual exercise is less for a 30-minute session of interval training (due to the intermittent rest periods) than for a 30-minute session of continuous exercise; therefore, e-intensity is higher. Where volume is equal, higher e-intensity translates to greater growth hormone secretion.

The following dramatizes how interval training increases e-intensity, and demonstrates how interspersing work with rest influences the amount of work that can be performed. Relatively few people can run at a 4-minute per mile pace for longer than 1 minute, much less complete a mile within 4 minutes. However, with correct spacing of running and resting periods, it would not be very difficult to complete a mile in 4 minutes of actual running. In a classic study on this subject, it was found that, when running speed was controlled, a subject who could run for only .8 miles when the run was performed continuously could cover 4 miles when 10 seconds of running was interspersed with 5 seconds of recovery.[190]

In addition to the hormonal advantages of interval training, there are cardiovascular benefits as well. One study that compared improvements in aerobic capacity (as measured by Vo_2max) achieved through interval training to improvements achieved through continuous training, found that interval training resulted in a two-fold greater increment in Vo_2max.[191] Another study comparing these two types of exercise found that

while both training modalities improved aerobic capacity to the same degree, interval training increased anaerobic capacity by 28% while continuous exercise failed to improve anaerobic capacity.[192] Furthermore, once aerobic improvements are attained through exercise, interval training is the most effective means of maintaining such improvements. Specifically, studies show that substantial reductions in either frequency (with duration and intensity held constant)[193] or duration (with frequency and intensity held constant)[194] do not result in a loss of aerobic capacity. Remarkably, aerobic improvements were maintained even when frequency alone or duration alone was reduced by two-thirds. But when intensity was reduced by only one-third, and frequency and duration were held constant, Vo_2max declined.[195] Collectively, these studies demonstrate that intensity is the key factor relative to both increasing and maintaining cardiovascular fitness. Interval training accentuates intensity; hence, it affords considerable cardiovascular benefits in addition to hormonal benefits.

"Wind sprints," which involves jogging punctuated by intermittent sprinting, is a popular form of interval training. Because interval training is a high-intensity mode of exercise, I should reemphasize that intensity must be *gradually* increased over time commensurately with fitness increments. A modified version of wind sprints, tailored to the less fit, consists of walking interspersed with jogging. Most cardiovascular training devices, like step machines and stationary bicycles, allow for adjustments in intensity level and therefore are suitable for interval training.

While a full physical examination is an important prelude to any exercise program, it is absolutely imperative where one is beginning a training regimen designed to maximize intensity and thereby maximize demands on the cardiovascular and respiratory systems. The time to discover an undetected cardiac condition or latent defect or irregularity in cardiorespiratory function is in a doctor's office through testing and examination, not in the gym through shooting pain or sudden horror. Having made this clear, I would also make clear that where a doctor's clearance is obtained after a full examination, and where intensity is increased commensurately with fitness increments, no person, no matter how old or unfit, should feel incapable of, or unequal to, interval training, weight training, or any other kind of exercise described in this book.

In support of the foregoing statement, studies show that even elderly people can successfully undertake resistance training.[196,197,198,199,200] In a study published in the *New England Journal of Medicine* an average strength increase of 113% was registered by 100 nursing-home residents (63 women and 37 men, average age = 87 years) after a 10-week program of high-intensity weight training.[201] In another study, published in the *Journal of the American Medical Association*, 8 weeks of resistance training produced a 174% increase in strength in nursing-home residents up to 96 years of age.[202] In yet another study, published in the *Journal of Applied Physiology*, focusing on body composition changes in 76- to 78-year-old women resulting from either weight training or endurance training, the weight-training-women gained muscle and lost fat whereas the endurance-training-women experienced negligible improvement in body composition.[203]

In addition to strengthening their skeletal muscles, elders can strengthen their heart muscle, too, by means of exercise. In fact, older people can increase their aerobic capacity to the same relative degree as younger people.[204] Similarly, cardiac patients, once considered among the permanently disabled, are increasingly using appropriately formulated high-intensity training programs to walk, jog, participate in, and even complete, marathons![205,206,207] The bottom line is that it does not matter whether you are a frail, institutionalized centenarian or someone who has undergone open-heart surgery; you are not foreclosed from the promise of a better, healthier life that hormonally intelligent exercise offers.

Even should you choose not to employ the interval format that I am recommending, you can enjoy a portion of the same benefits by ending your cardiovascular workout with a peak of intensity (your "cool-down" would come after this). For example, if you jog, you can sprint for the last 60 yards. Even a few seconds of high-intensity output added to your aerobic workout can substantially magnify growth hormone release.

The Interval Paradigm Applied to Resistance Training

Resistance exercise is, by its nature, a form of interval training. The vocabulary of resistance exercise is sets, repetitions (reps), and inter-set rest periods. "Reps" refers to how many times in succession you perform a particular lift. After completing your last rep, you rest, then do another set of reps. How many sets and how many reps to do is a time-honored question; it is addressed in broad terms in this book and treated more fully in *Hormonally Intelligent Exercise*. The point here is to show how resistance exercise – bouts of intense muscular work preceded and followed by momentary episodes of recuperative inactivity - is a form of interval training. If your resistance workouts do not conform to this format, you are doing something wrong.

The most common way that people run afoul of the interval framework when weight training is to do ultra-high repetitions with very light weight and very brief rest periods between sets. The belief underlying this wrong-headed practice is that ultra-high repetitions will burn more fat. In fact, *growth hormone* will "burn more fat"; and any load that is so light that you can do 20+ reps with ease is generally too light to generate the intensity requisite to growth hormone release. In addition, excessively light weight results in sub-optimal muscle fiber recruitment, activating only Type I not Type II fibers[208,209] (more about this later). **Don't "make light" of the importance of resistance when doing resistance exercise**.

Adaptation to Stress

In Chapter 9, we discussed the body's adaptive responses to changes in food supply, and I explained the relevance of those responses to your efforts to improve your physique. Now, I will do the same with respect to exercise.

Principles of Stress Adaptation

Principle 1 The ability to adapt to stress is the key to survival both from a lifetime and an evolutionary perspective.

Principle 2 The human body responds to stress by restructuring itself to become more capable of handling the particular imposed stress.

Principle 3 The human body is highly efficient at adapting to stress and thus adaptations are narrowly tailored to the specific stress encountered.

Consider a person who, accustomed to working behind a desk, gets a job doing manual construction work. He is likely to develop blisters from the friction on his hands. The damage to his body - signified by inflammation - results from his being unaccustomed to this particular form of stress (i.e., abrasive contact against the skin). His body will repair the damage.

A certain amount of this particular stress, say two weeks at the new job, will induce his body to go beyond merely repairing the damage to taking affirmative measures to "defend" against further stress of this kind. The defense in this instance would be a callus. Hence, the body restructures itself in such a way that further stress of the *same* nature and magnitude will cause *less* harm. By manipulating physical stress factors, we can restructure our bodies in other ways, as well. **This is how you should view exercise - *as the strategic manipulation of physical stress factors designed to induce a beneficial restructuring of the body* - not merely as a means of burning calories**.

The above example illustrates two additional points about how the body adapts to stress, both of which are germane to exercise. For one, stress need not be life-threatening to trigger an adaptive response. Rather, the adaptive response to stress is aimed at offsetting discomfort, promoting efficiency, and averting injury. Exercise is self-imposed, non-life-threatening, physical stress. The other point illustrated by the construction-worker example is that adaptations are stress specific.

Adaptations are Stress Specific

The body responds specifically to each imposed stress. In the example above, the calluses formed only at the contact points; the skin on the entire hand did not thicken. The stress-specificity principle bears important implications for exercise. For example, we discussed earlier how aerobic exercise, while it strengthens the heart and lungs, is ineffective at preserving bone and muscle in the face of aging. This demonstrates that the body does not respond to aerobic exercise by becoming stronger and healthier throughout its entire physiology. Rather, only those systems adapt that are specifically stressed.

The same applies to resistance training. Although resistance training, when done properly, contributes modestly to cardiovascular fitness, aerobic exercise is superior in

this regard. The disparity stems from the fact that resistance exercise primarily stresses the skeletal muscles, not the heart and lungs. Accordingly, the adaptive response to resistance training primarily affects the skeletal muscles, not the heart and lungs. This is why, as emphasized earlier, an exercise program should include both of these two different kinds of physical stress - aerobic/cardiovascular and anaerobic/musculoskeletal. In terms of our present discussion, the aim of this two-pronged approach is to trigger two beneficial, but different, adaptations.

The stress-specificity principle transcends the strength/endurance distinction; it applies not only between, but also within, each of these two contexts. For example, recall from earlier in this chapter that both cardiovascular exercise and resistance exercise engage various bioenergetic pathways, depending on intensity and duration. Adaptations are specific to the bioenergetic pathway trained such that an endurance athlete whose training consists of running single miles as fast as possible (thereby engaging the ATP/CP and glycolytic bioenergetic pathways) will enjoy minimal "carry-over benefit" if he/she competes in a 10K run or a marathon (both of which chiefly engage the aerobic bioenergetic pathway), and vice versa. The same limited interchange of benefits occurs in the context of resistance exercise, between higher-rep/lower-load training and lower-rep/higher-load training.

The stress-specificity principle applies to an almost counter-intuitive degree, with limited transfer of benefits occurring among different forms of aerobic exercise. One might reasonably assume the opposite: that there would be complete crossover applicability of fitness increments attained through swimming, running, and bicycling given that all of these modes of exercise impose demands on the cardiovascular system and chiefly engage the aerobic bioenergetic pathway. To the contrary, studies show limited improvement in aerobic capacity when measured during a different mode of aerobic exercise from that which was used to achieve the improvement.[210,211,212,213,214] For example, in the most dramatic finding on this subject, a 10-week swim training program produced significant improvements in Vo_2max among 15 subjects when measured during swimming, but virtually zero improvement was observed when Vo_2max was evaluated during treadmill running![215]

Likewise, when trained male rowers were tested on a cycle ergometer, cardiorespiratory parameters were similar to untrained subjects. But when tested on a rowing ergometer, the same subjects registered readings superior to untrained subjects.[216] Similarly, triathletes (superbly conditioned athletes who compete in an event that includes cycling, running, and swimming) exhibited cardiorespiratory readings inferior to athletes who train and compete only as runners or cyclers, when tested during cycle ergometry and treadmill running.[217] Finally, the stress-specificity principle even applies to the time of day one trains: studies find superior cardiorespiratory performance when the time of day of testing coincides with the time of day of training.[218,219] For the competitive athlete, these findings are of great practical significance; see Appendix B for a discussion of the applicability of stress specificity to sports training. For the average person, the take-home message is: vary your training regimen. (As you will see when we discuss "qualitative progression," there are hormonal advantages, as well, to varying your training regimen.)

Exercise Selection and All-in-One Home Fitness Devices

Because it is ideal to vary your mode of cardiovascular training, the concept pushed by the late-night fitness infomercial folks, that there exists one supreme form of cardiovascular exercise (the one they're selling) is inherently false.

Variation is even more important relative to resistance training. The skeletal muscles are many and varied, and they function in intricate patterns of cooperation and opposition. To make matters more complex, there are different muscle fiber types within the muscle which have different firing thresholds such that working a muscle does not necessarily mean working all the fiber types that comprise the muscle. Later, I will discuss how to maximize muscle fiber recruitment. For now, the point to remember is that you should stress each and every muscle to an approximately equal degree. Otherwise, some muscles are forced to adapt while others are not, and this produces a functionally and aesthetically unbalanced body.

The sale of home exercise devices that "work every muscle in the body," while simultaneously providing a cardiovascular workout has become a huge industry, owing to the informercial revolution and public receptiveness to all-in-one panaceas for getting in shape. Infomercial sales patter notwithstanding, these devices are limited in terms of quality, versatility, and effectiveness. Accordingly, I have a low estimation of the value of most of these contraptions, though I admire the engineering ingenuity they embody.

Unless you are unwilling or unable to exercise away from home, your money would be better spent buying a gym membership. While it may cost more, especially in the long run, there is simply no comparison between one fitness apparatus designed with minimizing production costs a major objective, and a building filled with tens- or hundreds-of-thousands of dollars worth of work-out equipment. Moreover, if you have ever purchased one of these products, upon receiving it you probably acquired a heightened appreciation for the power of lighting, camera angles, music, and an attractive actor/salesperson to make a product look better than it really is. Many people find themselves disappointed in the quality of these products and wind-up using them to hang clothes on - a function for which they often prove more suitable.

Having said all that, applying the principles and techniques of Natural Hormonal Enhancement is much more important than the quality or extent of equipment used. There are millions of people who work-out in exquisitely well-equipped gyms but who, nevertheless, progress at a snail's pace, or not at all, because they are ignorant of the hormonal dynamics of exercise. In the final analysis, tangible tools are of little value if one lacks the intangible tools necessary to apply them properly - specifically, knowledge and commitment.

Strategic Stress

Exercise can be viewed as the strategic application of physical stress as a means of generating desired adaptations. Hormones and their subordinates, enzymes, conduct the remodeling process by which these adaptations are etched into your physique. For example, exercise activates hormones and enzymes that increase fat burning. Not only does this serve to fuel your exercise endeavors, but it also causes a restructuring of your body into a configuration more conducive to physical activity. Earlier, I stated that "the adaptive response to stress is aimed at offsetting discomfort, promoting efficiency, and averting injury" (p. 271). It is discomforting, inefficient, and potentially injurious to carry excess bodyfat with you on a 5-mile run; and the faster you try to run the 5 miles, the more of an encumbrance the excess bodyfat represents.

Just as a construction worker develops calluses on his hands to protect against the stress of abrasive friction, a runner sheds excess bodyfat not only for present fueling purposes but also to protect against the future stress of carrying dead weight (fat) while

running.* For the active person, excess fat translates to excess stress. For the sedentary person, this is not the case. Thus, a heightened activity level is a strategically imposed stress designed to make it “impractical” (inefficient) for your body to maintain its current configuration.

The nature and extent of the stress imposed upon the body dictates the nature and extent of changes in body composition and shape. This is why marathon runners tend to be skinny and weak. For their bodies, imposed upon by the extreme stress of running very long distances, not only does bodyfat represent an encumbrance, or stressor, but so does muscle. The point to remember is that exercise-induced adaptations are not necessarily positive, either in terms of health or appearance. Therefore, you must make sure that the nature and extent of the stress you impose upon your body is strategically calculated to produce desired adaptations.

The Principle of Progressivity

You are probably familiar with term "progressive resistance training." Earlier, I defined “training” (demarcated by the “exercise threshold,” which varies with fitness level) and I emphasized the importance of resistance (which serves as a vehicle for generating intensity, the key variable in growth hormone release). The “progressive” element is commonly overlooked, but indispensable, to actualizing your physical potential.

Most people who complain about a reduction in their rate of progress or a cessation of progress (known as "plateauing") are training in a manner inconsistent with the principle of progressivity. Simply put, **if you do not exercise progressively**, **you will not progress**. There are two types of progressivity, *quantitative* and *qualitative*, which we will discuss later.

Progressivity is the practical application of what you learned from "Adaptation to Stress," (above); specifically, that the body responds to each imposed stress, and that adaptations are narrowly tailored. Returning to the previous examples, friction against the skin from construction work causes the skin to toughen at the contact points. Toughness of the skin is an adaptive response, serving as an "antidote" to the stress of abrasive friction. Similarly, long-distance running causes the body to become lighter. Lightweightedness is an "antidote" to the stress of long-distance running. Just as the *kind* of stress dictates the adaptation, so too does the *extent* of stress: the body responds almost exactly to the extent of the stress

* There is a subtle and tricky implication of this that holds back many people from achieving continued positive results from cardiovascular training: the adaptations to aerobic exercise, whereby dead weight decreases and metabolic efficiency increases, reduces the stressfulness (i.e., makes easier) a given quantity of aerobic exercise. In other words, running a 10-minute mile might be a good workout for you in January when you begin your exercise program. But in May, when your body has adapted by dropping dead weight in the form of bodyfat, the intensity level (effort intensity and relative intensity) of running the same 10-minute mile will be lower because body weight will be less and metabolic efficiency will be greater. The practical effect is that if you do not increase duration, frequency, or intensity of your cardiovascular workouts, weight loss coupled with heightened metabolic efficiency will spell diminishing returns and eventually no returns. In other words, you will stop progressing or "plateau". Thus, if you are one of those people who, despite making some progress initially, "just can't lose those few extra pounds of fat," your progress and associated adaptations may, ironically, be responsible for the cessation of progress. This illustrates the critical importance of progressivity to achieving positive results from exercise.

encountered (i.e., adaptations are "narrowly tailored"). Once the body has effectively responded to a stressor, by becoming stronger, tougher, lighter, etc., it will respond no further to that stressor.

> **EXAMPLE**: The stress of attempting to lift 100 pounds will trigger a "remodeling" of the muscles and an increase in strength, which (assuming adequate nutrition and recovery time) will make the person undergoing this stress ("Stressee") more nearly able to lift 100 pounds. Eventually, if this stress is repeated and nutrition and recovery are adequate, Stressee will be able to lift 100 pounds. However, this particular stressor will not, no matter how many times Stressee is exposed to it, enable Stressee to lift 120 pounds or 150 pounds.

> **ANALOGY**: Think of a restaurant patron who never leaves more than a 15% tip, regardless of the quality of the service. This person pays the necessary amount, the bill, plus the minimum consistent with the mores of society - it's called stingy, and it also describes the way in which the human body adapts to stress. Whereas the stingy restaurant patron strives to conserve money, the body strives to conserve something much more valuable - energy.

Energy is necessary for survival, and all living things conserve energy. Every activity undertaken and everything that goes on inside the body - circulation, digestion, getting out of bed in the morning, brushing your teeth, thinking, breathing, sex, *adaptive responses*, etc. - requires energy. Because the physical restructuring process consumes energy (calories), the body "wants" to do as little restructuring as possible. Not only would a beyond-minimal-adaptation be a waste of energy, but it would also render the body *less*-well-adapted to its environment because the body and the external stressors it encounters would not match as closely as possible. The practical implication of this is that **you must continually increase or vary the stress of exercise in order to continue to progress**. The reluctance of the body to change its shape and composition (a fact all-too-apparent to those who have tried to effect such changes) must be overcome by the insistent prodding of new and/or greater stress.

Qualitative Progression = Introduction of a new stressor

Quantitative Progression = Increase in magnitude of an existing stressor

General Hormonal Response to Exercise

Although adaptations are narrowly tailored to each stressor, exercise also generates overall or systemic improvements. For one, a properly designed exercise program improves endocrine function.

Hormonal output is limited by the functional capacity of the secreting glands. As explained in Chapter 4, absent proper intervention, the entire body, inside and out, deteriorates with advancing age. The deterioration of the glands is part of a self-perpetuating cycle in which weaker glands yield less hormonal output, and less hormonal output results in deterioration of the entire body - including the glands that secrete hormones.

In view of the "use it or lose it" axiom, it is reasonable to posit that exercise, which causes a storm of hormonal activity, would be able to revive a flagging endocrine system. In fact, there is considerable evidence to support this hypothesis. During the 1930's, a series of studies using rats, published in the *American Journal of Anatomy,* found pronounced changes in the weight of glands after a training period lasting 90 days.[220,221,222] Specifically, significant increases in mass were found in the adrenals, pituitary, thyroid, thymus, and gonads as a result of the 90-day exercise program. Exercise was then discontinued, and after 125 days of detraining, the weight of the glands was back to initial levels. Further studies since then have confirmed the revitalizing effect of exercise on the endocrine system.[223,224]

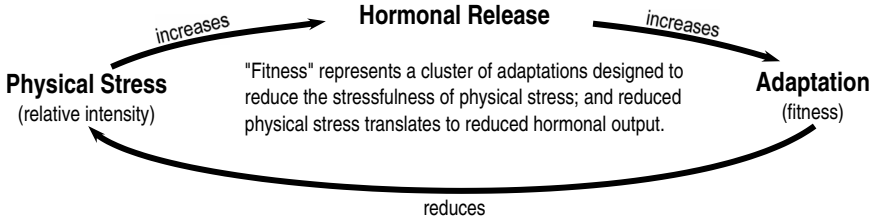
As well, exercise increases blood supply to the glands, and improved blood supply enhances endocrine function.[225] Studies show, moreover, that people who exercise regularly have higher levels of growth hormone;[226] lower levels of insulin (resulting from higher insulin sensitivity);[227] and in men, higher levels of testosterone;[228] than do their sedentary counterparts. Furthermore, it is not uncommon for older, fit individuals to have better hormonal profiles than younger, unfit individuals.[229]

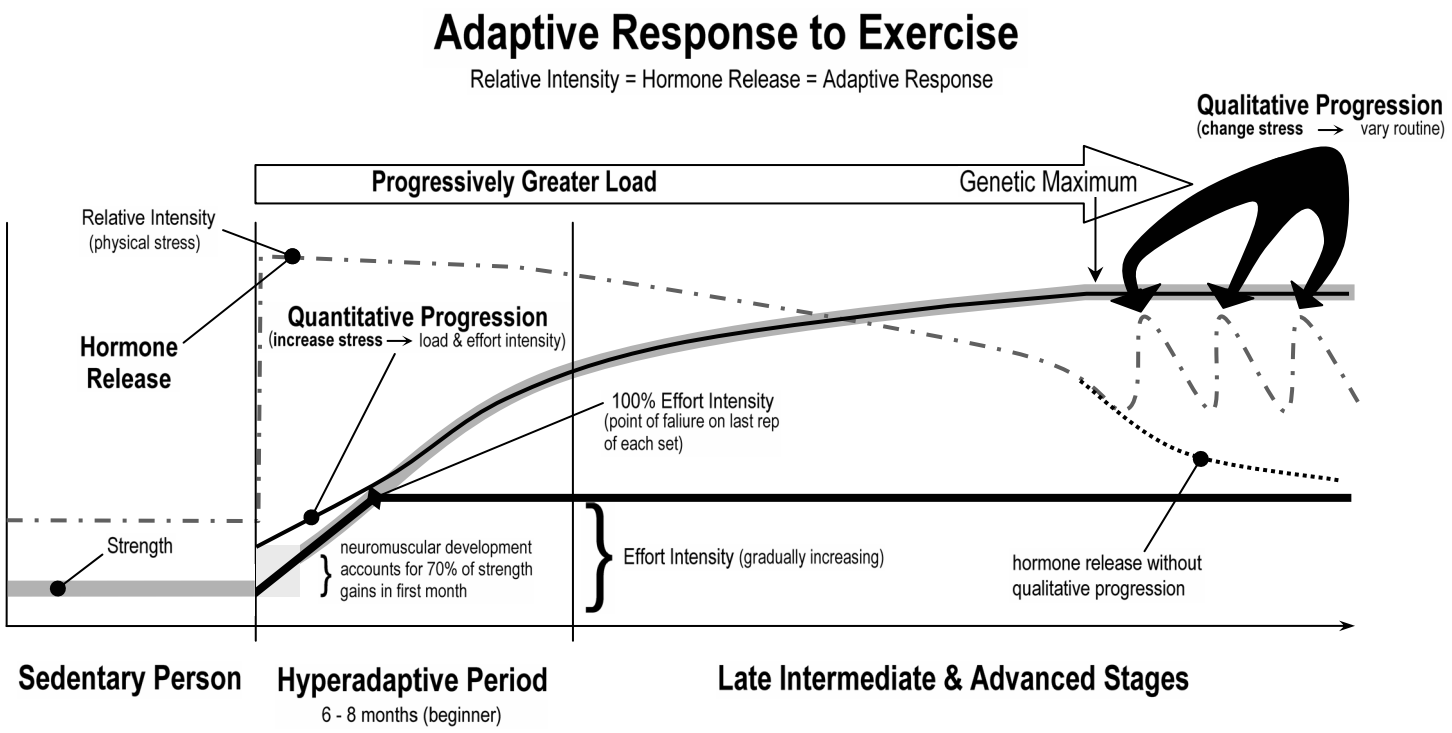
Bringing it all Together: "How Adaptation to Stress" and "Progressivity" Relate to Hormones

As you can see, the "use it or lose it" axiom applies to the endocrine system. However, simply "using it," while sufficient to enhance endocrine function, is not sufficient to elicit continued hormonal response to exercise. Additional hormonal output (i.e., hormonal enhancement) occurs only when an adaptation is *needed*. (Remember: adaptations consume energy and the human body conserves energy; thus, adaptations occur grudgingly not gratuitously.) The only time when an adaptation is needed is when the body encounters stress that it is ill-suited to handle. What kind of stressor is the body ill-suited to handle? New stress.

Progressivity refers to the continuous imposition of new stress on the body. Training progressively means continually increasing and/or continually changing the stress imposed on the body, thereby continually creating new stress. (The astute linguist will note that an “increase” in stress is a “change” in stress; bear with this artificial distinction for now, it will become more meaningful when we discuss quantitative and qualitative progression.)

Absent new stress, the hormonal response to exercise declines.[230,231,232,233] This is because a given stressor becomes decreasingly stressful as the body adapts to it (translating to a fall in relative intensity, which is defined on p. 253 as “a measure of physical stress”). Ultimately, the absence of new stress = no stress = no adaptive stimulus = no hormonal response. Got it?




Adaptive Response to Exercise
Relative Intensity = Hormone Release = Adaptive Response
Qualitative Progression
(change stress → vary routine)
Progressively Greater Load
Genetic Maximum
Relative Intensity
(physical stress)
Hormone
Release
Quantitative Progression
(increase stress → load & effort intensity)
100% Effort Intensity
(point of faliure on last rep
of each set)
Strength
neuromuscular development
accounts for 70% of strength
gains in first month
Effort Intensity (gradually increasing)
hormone release without
qualitative progression
Sedentary Person
Hyperadaptive Period
6 - 8 months (beginner)
Late Intermediate & Advanced Stages

Does Increased Exercise Tolerance Mean You Should Weight Train More Frequently?

As discussed earlier, the answer to this question is no. Although the cortisol response to a given stressor diminishes with repeated exposure and recovery ability increases, it is also true, as discussed above, that as a general rule strength gains exceed improvements in recovery ability. And as strength increases, so does the ability to impose stress on one's own body through exercise. For this reason, if you are increasing e-intensity and load appropriately, frequency of exercise generally does not increase. Remember, too, that the imperative to increase e-intensity must be tempered by prudence. If you increase intensity too rapidly, the increased stress will outpace the increase in recovery ability. Consequently, cortisol levels escalate, and you experience negative results including muscle loss, immune suppression, or injury.

The temptation to overtrain increases as recovery ability increases. One of the features of improved recovery ability is reduced post-workout muscle discomfort and pain, even as e-intensity increases. This can be deceptive because the absence of soreness leads people to believe, erroneously, that recovery is complete. Don't make this mistake; **muscle soreness is not an accurate index of recovery**.

Growth Hormone Response to Exercise: Critiquing Training Routines

Now that we have explored some major concepts relating to the hormonal response to exercise, we can return to the question of how to structure your workouts to enhance growth hormone levels. First, let's review what you have learned so far about the growth hormone response to exercise.

- Growth hormone release is determined by anabolic intensity. Specifically, growth hormone release is related to effort intensity (e-intensity), which refers to how much effort you exert while exercising, and relative intensity (r-intensity), which refers to the quantum of physical stress imposed by your workout. (Remember that stress can only be quantified with reference to the person undergoing it - a workout that is stressful to you may not be stressful to a fitter person.)

- R-intensity is related to progressivity in the following way: if you do not progressively *increase* e-intensity and/or load (or *change* your workout in other ways), r-intensity will decline and, consequently, so will growth hormone output.

Now let's see how this operates in real life. . .

HYPOTHETICAL #1

Joe is a 25-year-old couch potato who is embarking upon a resistance training program for the first time, in compliance with his New Year's resolution to get in shape. The heaviest things Joe has lifted during the preceding year are a telephone receiver and a TV remote control. On his first day in the gym, Joe, following the instructions of his $100-per-hour personal trainer, takes it easy: after an extensive warm-up on the treadmill, he begins his weight training session, performing repetitions until the set becomes difficult, at about 10 reps, then he stops, not approaching the point of failure. A

few minutes later, he does another set of the same exercise and then moves on to another exercise. After a total of 10 sets of 10 reps, all performed up to the same e-intensity level, he goes home.

Let's analyze Joe's workout:

Effort Intensity: Moderate. E-intensity is moderate because Joe did not even approach the point of failure on his final repetition of any of his sets - a wise decision in view of his beginner status. However, Joe did proceed to the point at which each set became "difficult"; and since each set became difficult at about 10 reps, Joe was using a significant load. (Even though Joe is young, his previously sedentary lifestyle and his unfamiliarity with weight training would counsel a lower e-intensity level and lesser load on his first day in the gym, with emphasis on proper exercise execution.)

Relative Intensity: High. Compared with a telephone receiver and a TV remote control, the weights Joe lifted at the gym were very heavy. Furthermore, the muscular effort required to lift the weight repetitively to the point at which it became difficult constituted a substantially greater output of muscular effort than Joe is accustomed to as a couch potato who has not exercised at all during the last year.

Growth Hormone/Adaptive Response: Yes. Joe's body will perceive his experience in the gym as a threat and will "defend" against a recurrence of that stressful episode by adapting. The adaptation will be aimed at making sure that if a stressor of a similar nature and extent were to emerge in the future, it would be less stressful. Growth hormone will be released in response to the stress of Joe's workout to orchestrate the adaptive process by shifting metabolism into a fat-burning mode, which will simultaneously preserve glycogen and will make extra fuel available (from bodyfat) to fulfill the heightened energy demands of the recovery/restructuring process. Additionally, growth hormone spurs protein synthesis, the process by which distressed muscles, bones, and connective tissues are strengthened (i.e., made better able to withstand the stress imposed by a similar workout in the future). Remember, *the body hates stress* - it views it as a threat to its survival - and it will go to extraordinary lengths (including dramatically changing shape and composition) to neutralize stress.

If these workouts continue, and if Joe progressively increases e-intensity and load, Joe's body will be forced to change its shape and composition to better deal with the physical stress of lifting weights. Specifically, Joe's fat/muscle ratio will drop. This will cause a redistribution of tissue (since muscle and fat are each concentrated in different areas), accounting for a transformation in the shape of Joe's body.

HYPOTHETICAL #2

Jessica is a 22-year-old healthy woman. She has been exercising regularly for one year. She jogs two miles each day, and she trains with weights. She performs each set to the point at which it becomes difficult, at about 25 reps. She scrupulously avoids the point of failure based on advice from a friend to the effect that if she works-out too

intensely she'll "get big." Fearing for her femininity, and just interested in "toning-up," Jessica adheres to her friend's advice.

First, let's analyze the weight training component of Jessica's regimen:

Effort Intensity: Moderate (same as Joe, above).

Relative Intensity: Low (very different from Joe).

Growth Hormone/Adaptive Response: No. Jessica is being led astray by her misinformed friend. A healthy 22-year-old woman who has been weight training regularly for one year is well-suited to higher intensity exercise than what she is doing. Because Jessica's workout routine has changed neither quantitatively nor qualitatively since she began working-out a year ago, neither will the shape and composition of her body change. Stated differently, Jessica is not applying challenging stress to her body; hence, growth hormone will not be released, and adaptation will not occur. Because her weight- training routine is fundamentally flawed, Jessica is deriving little benefit from her time spent lifting weights.

While Jessica's resistance training routine will not produce positive results, the minimal stress it imposes will maintain previously achieved fitness increments (as opposed to quitting training, which would cause r-intensity to plummet resulting in a rollback of training-induced adaptations). As a 22-year-old woman, Jessica is probably not much concerned about the degenerative aspects of aging, poised to strike like a crouching cougar lying in wait. But if she is going to offset the age-related trend of muscle loss and bone loss that will commence sometime around her 30th birthday, she is going to have to generate enhanced anabolic activity; and that means progressively increasing the e-intensity of her workouts. A modicum of added muscle and bone density secured in young adulthood pays large dividends later in life in terms of reducing the risk of osteoporosis and preserving the firm shapeliness that defines a youthful, sexy body.

With regard to load, the weight Jessica is using is too light, as evidenced by the fact that she can do 25 reps before each set becomes difficult. Inadequate resistance is problematic because, in addition to making it more difficult to generate sufficient intensity, it precludes stimulation of the full spectrum of muscle fibers. The inadequate load, as well as her low e-intensity level, probably stems from the popular notion that light weight and high reps are ideal for "toning-up." In fact, "toning-up" is an adaptive response, and Jessica's workout does not meet the standard for inducing such a response.

Now, let's analyze the aerobic component of Jessica's regimen:

Jessica deserves credit for including both resistance training and cardiovascular training in her exercise regimen, but she is making the same mistake with regard to the latter as she is with the former: no progression. Ideally, she should increase the e-intensity of her running by employing the interval format described on p. 267-268.

However, if she enjoys jogging, that's fine; she can rely on weight training for growth hormone release (provided she upgrades the intensity), and increase the distance rather than the intensity of her running. Low-intensity, high-duration aerobic exercise, while not ideal hormonally, is nevertheless beneficial in terms of cardiovascular fitness and fat loss. Jogging becomes hormonally problematic only when 1) it comprises your entire exercise regimen, or 2) when it "pushes you over the top" in terms of overall (aerobic + anaerobic) volume.

While increasing the distance she runs can help Jessica lose fat, it can also unfavorably shift her hormonal profile by increasing volume without a corresponding increase in intensity (thus reducing the intensity/volume ratio). Therefore, Jessica must be extra diligent in keeping her weight-training sessions brief, intense, and not too frequent in order to counter the intensity/volume reduction caused by increasing her running distance. In addition to the intensity/volume ratio, total volume must also be carefully monitored, with reference to sleep, nutrition, and emotional stress (see p. 258).

HYPOTHETICAL #3

Bill, a world-class rower, departs from his usual 60-minute workout in his boat and instead does a 60-minute workout, of equal e-intensity, consisting of calisthenics and running.

Effort Intensity: High (same as Bill's rowing workouts).

Relative Intensity: High (different from Bill's rowing workouts). Although Bill is a world-class athlete, he is a rower not a runner. And as you learned earlier, adaptations are stress specific and fitness increments obtained through one mode of exercise are not fully transferable to other modes of exercise. Therefore, although the e-intensity of his running/calisthenics workout is the same as the e-intensity of his rowing workouts, the r-intensity of his running/calisthenics workout is greater.

Growth Hormone/Adaptive Response: Yes. This hypothetical is based on a study of world-class rowers published in the *British Medical Journal* in 1973.[234] In this study, a 60-minute rowing workout did not elevate growth hormone levels, but a significant elevation was registered by the same subjects after a 60-minute running/calisthenics workout. This is an example of qualitative progression: the running/calisthenics workout represented an unaccustomed stress to the rowers and thus it triggered an adaptive response even though there was no increase in any quantitative stress factor.

The Hyperadaptive Period

(Beginner and Early Intermediate Stages)

Typically, the most dramatic results from exercise occur during the first 6-8 months. The adaptive response is greatest at this time, because the body is unaccustomed to the

stress of exercise. Adaptations occur in virtually all physiological systems, including: cardiovascular, neuromuscular, respiratory, endocrine, and skeletal.

With resistance exercise, hyperadaptivity is amplified due to the centrality of the neuromuscular system in this type of training. Neuromuscular conditioning is sometimes referred to as the "mind-muscle connection." No matter how big, a muscle is useless unless the brain can effectively communicate stimulatory signals to the motor units that comprise the muscle. When you begin a weight-training program, the mind-muscle connection is not well-established for the specific task of lifting weights. If you have ever experienced "the shakes" (where your hands quiver under the strain of lifting), you have experienced what happens when the brain tries to order the muscles to do something they are not accustomed to doing - they balk like a person given an urgent command in a foreign language. With each successive workout, the brain is able to recruit more motor units (motor unit = a motor nerve + the muscle fibers it activates). In technical terms, this is called "neural facilitation" or "neural disinhibition," and it constitutes a much larger component of "strength" than most people realize.

Enhanced motor unit recruitment is the most immediate and extensive improvement that occurs in response to resistance training. In fact, most of the strength gains that occur during the early stages of this type of exercise program result from neural facilitation not from structural changes in the muscle fibers.[235,236,237] This explains how substantial increases in strength can occur absent an increase in muscle size. During the first month of resistance training, approximately 70% of strength gains are owed to adaptations within the nervous system.[238] Thereafter, neural adaptations continue at a slower rate, and muscular adaptations become the predominant contributor to strength gains.

Thus, in the beginning, as new neuromuscular pathways are being established, strength improves independently of change in muscle structure (which also occurs, but accounts for much less of the initial jump in strength). After that, the rate of neural adaptation slows and, consequently, so do strength gains which now are wholly dependent on development of muscle fibers (a much slower and more energy-intensive process than neural facilitation). The sharp increase in strength that occurs during the first few months of resistance training allows for correspondingly greater physical stress self-imposition via exercise. Accordingly, quantitative progression occurs more or less automatically, and so do adaptive responses. For this reason, weight trainees typically experience a steady onward march of progress during the first 6-8 months. But as the hyperadaptive period ends, the rate of progress slows considerably.

Why Layoffs are Often More Helpful than Harmful

Just as neuromuscular conditioning occurs rapidly upon beginning a weight-training program, so neuromuscular de-conditioning occurs rapidly upon stopping working-out, accounting for much of the depressing drop in strength that results from even a brief layoff.[239] But take heart, "muscle memory" allows you to regain your strength faster than the first time around[240] (this is *not* intended to provide a rationalization for taking unwarranted layoffs!).

One detraining effect of taking a layoff from lifting weights is a steep reduction in muscle glycogen and water storage.[241] The combination of becoming "weaker" (from neuromuscular regression) and "smaller" (from a reduction in muscle glycogen and water content) can be quite unsettling for some people. It is common to hear people bemoan their rapid loss of muscle and strength following a brief layoff. In fact, this feeds the tendency toward overtraining. "Once bitten" by the psychological trauma of witnessing his or her hard-earned gains apparently evaporate in a matter of weeks, the weight trainee becomes "twice shy" about a repetition of this unpleasant experience; and this often manifests itself as an irrational fear of losing muscle and a consequent compulsion to train too frequently. But although the weight loss, muscle shrinkage, and strength reduction associated with a brief layoff are real and not imagined, these changes are not cause for alarm or despair because they do not reflect an actual loss of muscle mass; and the pre-detraining level of muscle size and strength can be restored as rapidly, or more rapidly, as it was lost.

In fact, layoffs can often work to your advantage both mentally and physically. Mentally, trainees frequently report renewed focus and resolve upon returning to the gym following a layoff. Physically, a layoff can have a "recharging effect," especially for someone who had been overtraining. Remember, overtraining is a cumulative phenomenon; and any time you are training at a high level of relative intensity you are, in effect, "training on the edge." (By "training on the edge," I am referring to the fact that there is a fine line between optimal training and overtraining, and when you train at a high level of relative intensity you are treading this line.) For this reason, I actually recommend occasional layoffs as a sort of "insurance" against overtraining.

Oftentimes, by re-igniting the adaptive process, a layoff will jump-start new physiological improvements, propelling you beyond barriers or plateaus. As odd as it may seem, it is not uncommon for anabolic and lipolytic hormone levels to *increase* during a brief layoff. For example, in a study conducted at East Carolina University, a 14-day layoff from training in weightlifters corresponded with increases in growth hormone (58.3%) and testosterone (19.2%), and a decrease in cortisol (21.5%).[242] Naturally, the hormonal benefits of a layoff are greater the more overtrained you are at the time of the layoff, and are minimal if you are not overtrained. But the point is that, contrary to what the average compulsive exerciser may think, and contrary to what his/her body may seem to be suggesting by becoming "weaker" and "smaller" during a brief layoff, an occasional layoff is, in the final analysis, more likely to be helpful than harmful.

Once the initial "shock" of a new form of physical stress (i.e., weight training) begins to taper-off, it becomes increasingly difficult to stimulate adaptive responses. Accordingly, after the hyperadative period ends, diminishing returns become the order of the day, leading to a cessation of noticeable improvement, referred to as a "plateau." Some people assume at this point that they have maximized their genetic potential - but this is rarely the case. It is at this point where bodybuilders, despairing of their lack of progress, will often begin to flirt with the idea of taking steroids.

To avoid "plateauing," it is important to understand that physical improvements resulting from exercise do not happen at a steady rate. Consider, for example, that it is not unusual for a man's bench press to increase from 150 lbs. to 200 lbs. during the first six months of a weight-training program. Does this mean that if this guy continues training consistently for the next ten years that he will be able to bench press more than 1,000 lbs.? (1000 = 50-pound increase every 6 months for twenty 6-month periods) Or that after twenty years he will be able to bench press a small automobile? I think not. Clearly, fitness/strength does not advance along a linear upward path. Rather, the greatest increment occurs during the hyperadative period.

As you exit the hyperadaptive period, the rate of increase in strength (and therefore load) slows markedly. Similarly, once you reach 100% e-intensity on the last rep of each

set, this stress factor too supplies less stress than it had previously (when it was increasing). Thus, with quantitative progression grinding to a halt, the quantum of physical stress delivered by each workout diminishes. Recall that "the quantum of physical stress" = relative intensity = hormonal release. In effect, at this point you are "boxed-in" by your own progress. If you don't want to be stuck in this box forever, you had better pay close attention to the following discussion.

Progressing Beyond

(Late Intermediate and Advanced Stages)

As explained above, completion of the first 6-8 months of resistance training generally marks the beginning of the end of visible results. By this time, you have been training at 100% final-rep e-intensity for several months and (assuming you began training as a fully grown adult) your strength gains have begun to slow considerably. *To avoid having your results stymied by these inexorable trends, you must find a way to increase r-intensity by means other than increasing e-intensity or load.* In other words, you must find new ways to self-impose challenging physical stress.

You know, based on what you have learned so far, that although increasing frequency or duration would represent additional stress, it would likely be bad stress from a hormonal standpoint. Working-out more frequently would curtail recovery and, therefore, impede desired adaptations. In addition, because increased frequency would increase volume but not e-intensity, it would decrease the intensity/volume ratio. An increase in duration is likely to have an even worse effect on the intensity/volume ratio by both increasing volume and decreasing e-intensity. (And a reduction in the intensity/volume ratio negatively shifts your hormonal profile away from growth hormone and testosterone toward cortisol, right?)

Another way to introduce new stress is to increase load. Unlike increasing duration, increasing load does not decrease e-intensity. In fact, increasing load tends to boost e-intensity, because greater intensity of effort is required to lift a greater load than a lesser load over a given period of time, see p. 251. However, you are limited in your ability to increase load after the hyperadaptive period, because of a sharp reduction in the rate of strength gains. Thus, increasing load may force your repetitions down too low, resulting in sub-optimal muscle fiber recruitment. Furthermore, increasing load will increase volume if all other training variables remain the same; and higher volume brings you closer to overtraining.

As you can see, whereas quantitative progression was your ticket to success in the beginning and early intermediate stages of your exercise career, a new strategy for generating physical stress is required if you are to maintain r-intensity and continue to elicit positive adaptive responses. This new strategy is called qualitative progression.

Qualitative Progression

Unlike increasing e-intensity, frequency, duration, or load, qualitative progression does not involve changing the degree of stress, but rather the nature of stress. We saw an example of qualitative progression in Hypothetical #3 (p. 281).

The best and worst feature of exercise is that it is habit-forming.

The saying, "habit can be the best of servants or the worst of masters" applies to exercise. While habit can work to your advantage by keeping you adhered to an exercise program, it can also work to your detriment by keeping you in a rut once you get into one. There are many veteran exercise enthusiasts who do the exact same workout week after week, month after month, year after year. Any psychologist knows that routine is a source of psychological comfort and security. However, physical discomfort and insecurity imposed by unaccustomed stress is what triggers adaptive changes in the human body. This discrepancy represents a trap that ensnares most people who work-out.

This is not to suggest that you should not have a set routine. *Especially as a novice, you should be as consistent and regimented as possible;* and this means largely disregarding qualitative progression and, instead, concentrating on 1) gradually increasing e-intensity and load (quantitative progression) and 2) practicing proper exercise execution. Only later (6-12 months after beginning training) when quantitative progression becomes unavailing, does it become imperative to employ qualitative progression. And this entails deliberate departures from your training routine.

Apollo's Creed

Our discussion of qualitative progression calls to mind a scene from one of the Rocky movies. In Rocky III, Rocky's former-adversary-turned-trainer, Apollo Creed, asked Rocky's brother-in-law, Paulie, if Rocky could swim. Paulie replied, "With a name like Rock?" Undeterred, Creed had Rocky swim laps as part of his training regimen. When Paulie protested, Creed responded to the effect that Rocky had to stretch and use muscles he never knew he had. This emphasis, not on training harder or longer, but rather on training *differently,* illustrates the concept of qualitative progression.

The effects of qualitative progression can be quite remarkable. For instance, an experienced bodybuilder, who has for years intensely trained his shoulders and lats (muscles on the outer part of the back), is likely to experience acute soreness in those muscles as a result of hitting a punching bag. Even though the muscles trained are the same, hitting the punching bag is likely to produce much more soreness than the bodybuilder's weight-lifting workouts (and vice versa if a boxer who regularly hits the bag lifts weights one day instead). The same applies to a runner who goes roller-blading for the first time, or a long-jumper who high-jumps, or an overhand pitcher who throws sidearm.

Similarly, although weightlifters tend to scoff at push-ups because it is a relatively low-resistance exercise, push-ups can be an effective adaptive stimulus. Musculoskeletal exercises that entail moving the body through space against gravity, like push-ups and

pullups, involve neuromuscular activation patterns different from bench press and pulldowns, even though the movements are the same, respectively. Even a bodybuilder who can bench-press 500 pounds is likely to become very sore, indicating exposure to unaccustomed stress, if he attempts a workout of similar duration and e-intensity consisting of push-ups.

Likewise, whether you are a champion powerlifter who can squat 700 pounds or a 200-meter Olympic gold medalist, playing basketball is likely to produce soreness if your legs are not accustomed to the specific stress of jumping. Why? Because, although all three activities train the same bodypart, the stress imposed by each is *qualitatively* different. Unaccustomed physical stress is conducive to hormonal release.

Unaccustomed Stress —increases→ **Relative Intensity** —increases→ **Hormonal Release**

Even among advanced trainees, few make a calculated effort to introduce new stress. Instead, most people who exercise make the mistake of "sticking with what works" until it no longer works, and then continuing to stick with it. Avoid this mistake, don't stagnate. Keep your workout routine fresh and always stay one step ahead of your body by applying quantitative progression and then, when you are further along, qualitative progression as well. This will keep growth hormone flowing, and it will promote continued adaptation resulting in positive remodeling of your body.

Progression = Progress

You are limited only by your imagination in applying the principle of qualitative progression. Be creative. If you usually jog, try hiking. Or try running backwards (carefully), which shifts the emphasis from the hamstrings and calves to the quadriceps and tibialles anterior muscles. If you usually swim using the breast stroke and the crawl, try the backstroke and the butterfly. Apply qualitative progression in the gym by tinkering with: rest intervals between sets, exercise selection, repetition speed, or the sequence in which you perform exercises.

As elaborated below, you can also employ qualitative progression by means of short-term manipulations in volume. In other words, short-term alterations in *quantitative* factors - frequency, duration, e-intensity, and load - can act as a means of *qualitative* progression. Forced reps, a technique in which a spotter assists the lifter past the point of failure, thereby enabling the lifter to transcend 100% e-intensity, can be an effective means of introducing new stress. Other techniques like supersets and weighted negatives also can be used to vary the stress. However, these advanced techniques should be used sparingly and followed by added recovery time. Another caveat: do not go overboard with qualitative progression such that your exercise regimen loses all continuity and becomes haphazard. Maintain a foundational routine and work within those confines most of the time with only occasional, calculated departures.

Qualitative Progression is Good for the Brain

New and exciting research suggests that qualitative progression techniques not only benefit the body, but the brain too. Scientists have long known that exercise can elevate mood and foster feelings of well-being by means of its effect on neurotransmitters and endorphins. Now it is becoming evident that exercise can improve cognitive function, as well.[243,244,245,246,247]

Evidence suggests that establishing new neuromuscular pathways causes positive neurological changes in the structure of the brain,[248,249] which may be helpful in preventing Alzheimer's disease[250] and improving intelligence.[251,252] The key to obtaining these benefits is to challenge your brain and muscles to interact to produce new and different movements. Striving to master new motor skills by taking up new sports or physically demanding, technique-oriented hobbies like dance, rock climbing, or golf are effective ways to accomplish this objective. Weight training is exceptionally well-suited for improving motor skills because of the wide variety of movements and the coordination needed to execute the exercises properly.[253] Each time you master a new motor skill, you force your brain and muscles to develop a closer relationship by means of forging new mind-muscle connections. Furthermore, reinforcement of mind-muscle communication helps maintain reaction time, hand-eye coordination, and balance in the face of advancing age. In fact, it is lack of activity, more so than aging itself, that accounts for motor skill deterioration in the elderly.[254]

If you do aerobics at your gym, look into "boxercise," "aqua-aerobics," "jazzercise," "spinning," and "step aerobics." Rope skipping is an excellent form of exercise from a neuromuscular standpoint because of the cooperation it requires between the arms and legs. In short, seek out and pursue new neuromuscular challenges!

Testosterone Response to Exercise

The effect of exercise on androgen levels has been the subject of much study and debate for many years. The scientific evidence appears to be contradictory with studies showing exercise increases testosterone levels, others showing it decreases testosterone levels, and still others showing no effect. We can reconcile the seemingly conflicting evidence in view of our present understanding that the effect of exercise on testosterone status depends on the exercise variables that we have been discussing throughout this chapter (frequency, intensity, duration, volume, load, and exercise selection).

At the most basic level, exercise is physical activity and, in general, men who are active and fit have higher testosterone levels than men who are inactive and unfit. Exercise can lower testosterone levels too, however. As is the case with growth hormone, proper modulation of exercise variables is the key to testosterone enhancement. In particular, excessive volume is associated with reduced testosterone levels and elevated cortisol levels. Remember, too, that anything that supports growth hormone production indirectly enhances testosterone production due to the mutually-reinforcing relationship between these two hormones (see Chapter 4).

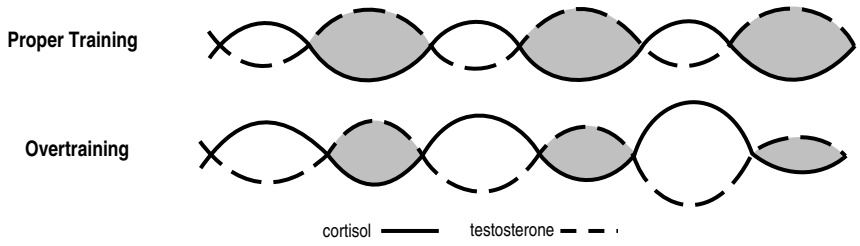
If you overtrain, your testosterone levels will fall, period. Subject to that important qualification, resistance exercise is less likely to lower testosterone levels and more likely to raise them than endurance exercise. Endurance exercise, by increasing overall fitness, can increase testosterone levels;[255] however, this type of physical stress (low e-intensity) does not evoke substantial positive testosterone or growth hormone responses.

Unchecked by a countervailing anabolic stimulus, low-intensity/volume-ratio exercise produces a substantial catabolic effect when volume is high. Especially where sleep, nutrition, and emotional stress are sub-optimal, endurance training is hormonally problematic.

The effect of endurance training on testosterone status can be summarized as follows. Moderate-volume endurance exercise may increase testosterone levels as compared with being sedentary, and it generally will not lower testosterone levels. However, a training regimen that consists of high-volume, aerobic-only exercise is likely to reduce testosterone levels. This may not be welcome news to avid joggers, but the scientific evidence leaves no doubt regarding the potentially suppressive effect of high-volume, low-intensity exercise on testosterone levels in men.[256,257,258,259,260,261,262]

Unlike endurance training, resistance training, with its higher intensity/volume ratio, positively impacts upon the pituitary-testicular axis.[263,264,265] Whereas the stimulus for testosterone enhancement - intensity - is the same as for growth hormone enhancement, the testosterone response to exercise is more complex. Specifically, testosterone enhancement resulting from resistance training is a net result produced by the enhancing effect outweighing an associated suppressive effect (see diagram p. 265). The growth hormone response, by contrast, is more immediate and one-directional. The delayed and dualistic nature of the testosterone response to resistance training creates an opportunity to either magnify or negate the hormonal benefits of such exercise depending on how adeptly you manipulate recovery periods and other variables. Where exercise variables are properly modulated, resistance training increases testosterone levels in men.[266,267,268]

Whereas the pituitary/adrenocortical (growth hormone and cortisol) response to exercise is rapid and occurs during exercise, the gonadal (testosterone) response is largely delayed and occurs mainly during the recovery period. For a period of time after an intense workout, testosterone levels are suppressed and cortisol levels are elevated. If, *and only if*, adequate recovery time follows, testosterone will rebound beyond initial levels to drive the anabolic process, and cortisol levels will fall (see diagram p. 265). **This flip-flop in the testosterone/cortisol ratio is the pivotal event in the muscle-building process**. If you train too frequently, testosterone never gets a chance to rebound fully, and cortisol remains elevated. In this catabolic hormonal state, muscle growth cannot occur. If you chronically make this mistake, you become overtrained, a condition marked by the predominance of cortisol over testosterone.[269,270,271]

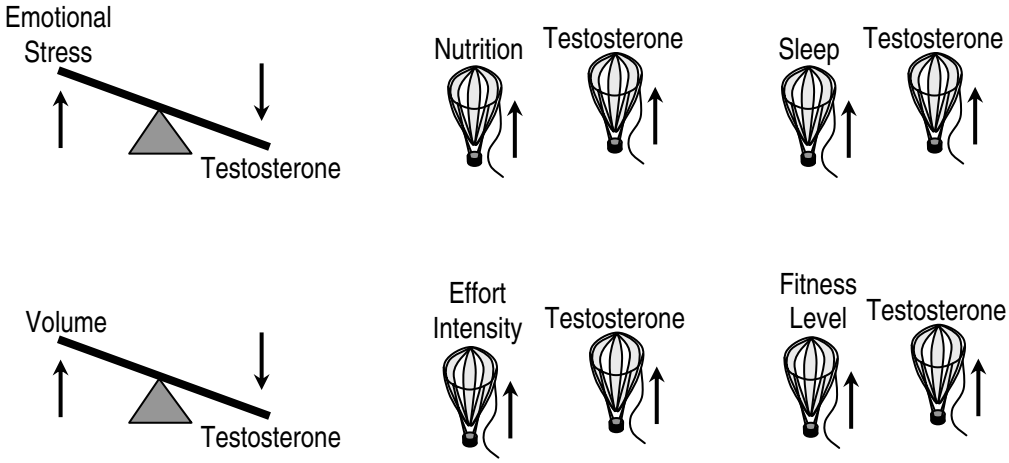


Let's examine testosterone kinetics more closely. Shortly after a workout ends, or during a workout if it runs too long, testosterone levels fall.[272,273,274] Where intensity is high, testosterone can begin its descent as early as 30 minutes after you begin exercising.[275] Continuing to hammer-away at the weights after testosterone has begun to fall exacerbates the decline, forcing testosterone levels even lower while elevating cortisol levels. If like so many enthusiastic and dedicated weight trainees you are doing 2-hour marathon workout sessions - WAKE-UP - you are sabotaging muscle growth and undermining your hormonal health. Train intensely and get out of the gym within one hour, preferably within 30-45 minutes.

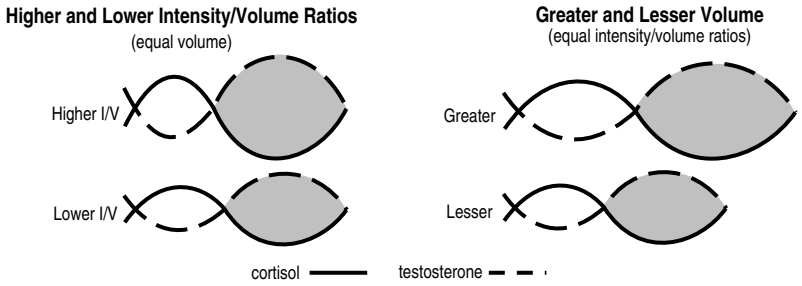
You will be amazed at how focus and intensity can more than compensate for duration; and a time limit promotes focus and intensity. By contrast, not having a time limit fosters a leisurely attitude inconsistent with the burning sense of purpose that is the quintessence of great workouts. Thus, you will find that self-imposed time urgency serves not only to constrain your workout to hormonally correct duration, but it also helps you cultivate a more focused workout mindset.

Remember, **from the time you begin your workout**, **the hormonal clock is ticking**.

The amount of time after an intense workout ends before testosterone rebounds can range from a few hours to several days.[276] There are several factors that influence the timing of the testosterone rebound, all of which have appeared repetitively throughout this chapter. The better your status in terms of *fitness level*, *nutrition*, *emotional stress*, and *sleep*, the shallower the exercise-induced testosterone drop will be and the quicker and stronger the rebound will be.



The greater the volume of a workout, the deeper testosterone will drop[277] and the longer it will take to make its comeback. E-Intensity modifies this dynamic,[278] with higher e-intensity propelling testosterone higher on the rebound and increasing the potential differential between the catabolic period and the ensuing anabolic period (see discussion of "anabolic potential" on p. 253).



Where a man exercises at an intensity level greatly in excess of his fitness level, testosterone can remain depressed for several days. Conversely, an insufficiently intense workout is likely to produce a minimal post-exercise drop in testosterone (or none at all). This may, on the surface, appear desirable. But no drop means no rebound, and no rebound means no enhancement. *The strategy for testosterone enhancement is to exercise at an intensity level sufficient to cause a* ***temporary post-exercise drop*** *in testosterone and then use optimal nutrition and rest to cause a* ***rapid and exaggerated rebound****.*

When testosterone consistently rises higher than it falls and stays high longer than it stays low, the net result is a higher overall testosterone level (hormonal enhancement).

Anabolic intensity (see p. 254) is the decisive variable in testosterone enhancement, but even where a-intensity is low, men will derive testosterone-boosting benefits from exercise due to increased blood flow to the testicles. Leg presses and squats, in particular, channel blood flow to this area. This serves to illustrate how, in terms of testosterone status (and all other physiological parameters, for that matter), *although more exercise is not necessarily better, some exercise is better than no exercise.*

Beyond the fact that testosterone levels dip in the post-intense-exercise hours and then rebound later, it is difficult to generalize about the schedule of exercise-induced testosterone fluctuations because of the multitude of variables that affect it. This makes determining optimal recovery periods an inexact science. Even so, the factors discussed on p. 289 will give you meaningful guidance regarding how to structure your training program for optimal testosterone response.

In addition to the factors discussed on p. 289, genetics bear on testosterone levels and on hormonal status in general. Like all biological parameters, testosterone levels reflect a continuum, ranging from low-normal to high-normal. For a man with naturally high testosterone levels, the lows will be higher and the highs will also be

higher than for a man with a lower baseline testosterone level. Nonetheless, no matter where you are on the testosterone continuum, optimizing nutrition, fitness, exercise volume and the intensity/volume ratio, sleep, and emotional stress, will translate to higher testosterone levels and improved hormonal status across the board.

Steroids and Testosterone Levels

Steroids block cortisol and unnaturally enhance testosterone, thereby blunting the exercise-induced fall in testosterone and hastening and heightening the testosterone rebound. This accounts for the enhanced recovery ability of steroid-users *and it exposes the folly of adopting the training routines of professional bodybuilders* (since virtually all pro bodybuilders take steroids, see Appendix A). The powerful anabolic and anti-catabolic effects of steroids explain why steroids are so effective at building muscle. While there is no doubt that steroids facilitate muscle growth, there is also no doubt that they can cause serious health problems. We have discussed the dangers of exogenous hormones at various points in this book, and I would recommend closely re-reading those sections if you are considering taking steroids (see also "Yuppie Steroids - The Testosterone Revolution," in Chapter 22).

Given the vagaries of testosterone dynamics, it would be of great help to be able to monitor changes in testosterone levels (and growth hormone and cortisol levels, too, for that matter). In fact, daily blood sampling has reportedly been employed by Eastern European athletes for decades; and this practice has likely been instrumental in the training innovations that have emanated from that part of the world. I predict that blood sampling will become an increasingly common practice among world-class athletes, as it takes much of the guesswork out of designing a training program. For the average person, regular blood sampling is impractical. One highly inexact but easy way for men to gauge their testosterone status is to monitor sex drive and potency, which tend to track testosterone fluctuations.

Testosterone Dynamics and the Effect on Muscle Growth and Sex Drive

The sweaty aftermath of an appropriately brief and intense workout session is typically characterized by a transient increase in sex drive owing to a lingering elevation in the "excitatory" neurotransmitter dopamine.[279] (In addition to conducting mind-muscle impulse traffic during exercise,[280] dopamine facilitates sexual arousal and orgasm.[281,282]) Shortly thereafter, conditions change.

Around the time when perspiration ceases and blood flow to the muscles normalizes after an intense training session, dopamine levels fall and serotonin levels rise.[283] Serotonin has the opposite effect of dopamine on alertness[284] and sex drive[285,286] (explaining why diminished libido is a common side effect of serotonin-re-uptake-inhibitor anti-depressant drugs). This pro-serotonin shift in your neurotransmitter profile accounts for why you feel tired after an intense workout (not because of physical exhaustion per se, as most people logically assume, but because of a shift in brain chemistry occasioned by intense physical activity). The

concomitant rise and fall of serotonin and dopamine, respectively, coincides with post-intense-workout testosterone suppression.*

The post-intense-workout, low-testosterone period is marked by relatively diminished sex drive and sexual potency. During this period, the body is in a catabolic state, with the testosterone/cortisol ratio tipped sharply in favor of cortisol. Acidic conditions prevail inside the muscles at this time, and muscle tissue may still be getting broken-down even though the workout has ended (the post-workout meal is an extremely important factor here). I call this the "pre-recovery" stage. During "pre-recovery," the body struggles to neutralize the trauma caused by the workout and re-establish homeostasis. Specifically, biological toxic wastes produced by intense exercise are cleared away and pH balance is restored. Until your biochemistry (which is significantly altered by an intense workout) stabilizes, the beneficial restructuring process cannot proceed.

At about ten hours post-intense-exercise (maybe sooner, maybe later, depending on nutrition [better = sooner], fitness level [higher = sooner], emotional stress [more = later], and workout volume [greater = later]), testosterone will begin its resurgence, culminating in the all-important "exaggerated rebound." In most cases, testosterone will peak sometime between 24 and 48 hours post-exercise, rising above baseline levels and staying there for 1-3 days.[287] During this anabolic period, the muscles are "remodeled" in accordance with the physical stress imposed by the workout; and additional calories are burned to fuel this energy-intensive restructuring process.

During the time when the testosterone/cortisol ratio is high, libido and sexual potency are high. This is also when muscle growth occurs. Assuming adequate recovery time and sound nutrition, the net effect of this cycle will be positive, with the testosterone peak more pronounced and longer-lasting than the valley; and the opposite true of cortisol.

Missing your post-workout meal - don't - in the wake of an intense weight training session will retard pre-recovery thereby postponing recovery, deepen the post-workout testosterone fall, and delay the testosterone rebound. **The post-workout meal provides the nutritional raw materials needed by the body to turn the tide from catabolism to anabolism**. By neglecting to eat soon after working-out (ideally within 40 minutes), you are ensuring that you will remain mired in a catabolic state for longer than is

* The decline in dopamine relative to serotonin probably influences the post-exercise drop in testosterone, and perhaps vice versa, given the close relationship between dopamine and testosterone.[287a,287b,287c] The subsequent rebound in dopamine levels probably helps drive the testosterone rebound, and perhaps vice versa. This is another illustration of the intimate interrelationship between neurotransmitters and hormones, which we explored earlier in connection with food cravings, energy levels, mental productivity, and emotional well-being (see Chapters 10, 11, 17). The hormone/neurotransmitter nexus is a frontier with profound implications for health and human performance. Together, neurotransmitters and hormones influence everything that goes on inside our body and our mind. I believe that the hormone/neurotransmitter connection, exceedingly complicated and marginally understood though it is at this juncture, holds the key to unlocking human potential. The new millennium will, hopefully, witness great strides in this area.

necessary. Because an intense workout temporarily suppresses digestion,[288,289] a protein shake (see p. 243) is the most effective way to deliver nutrients to muscles immediately after training. This should be followed, 2-3 hours later, by a medium-sized meal. By employing this strategy, you get two smaller feedings into the critical first three hours post-workout, rather than one large feeding; hence, higher protein absorption (which promotes a speedy transition from catabolism to anabolism) and more stable insulin levels (which maximizes post-workout fat burning).

For a fit athlete training in a hormonally intelligent fashion and practicing good nutrition, the post-workout low-testosterone sexual symptoms are likely to be mild and fleeting; therefore, they may be imperceptible. Even so, where one trains at a high level of intensity, sexual desire and performance will be greater during the anabolic "rebound" period than during the post-exercise catabolic period. Chronic sexual apathy is suggestive of overtraining, whereas consistently powerful sex drive indicates a low probability of overtraining (but does not necessarily mean you are training optimally).

Guidelines for Structuring a Hormonally Intelligent Weight Training Routine

Don't Lift Weights Every Day

It should be obvious to men from the foregoing discussion that in order to reap the benefits of the "testosterone/cortisol flip-flop," which generally occurs 24-48 hours post-exercise, you cannot weight train every day. The cumulative effect of weight training every day is a decrease in testosterone levels. For women, too, training with weights every day is inadvisable.

Like men, women experience a hormonal "flip-flop" in which catabolism yields to anabolism. But with women, testosterone is not the major player in this process that it is with men, anabolism in women does not produce large muscles, and menstrual cycles modify the hormonal response to exercise.[290] Notwithstanding these differences, the basic principles of hormonally intelligent training apply to both sexes. In both men and women, cortisol levels rise and growth hormone levels fall if volume is excessive. This catabolic hormonal profile, if it persists, will inhibit, bar, or cause a reversal of, progress in both men and women. *

Recovery Requires Energy

Remember, the adaptive remodeling process occurs mainly during rest not during work. In other words, the physical improvements you seek, though they are prompted by what you do *during your workouts*, are brought to fruition during the period of time *between workouts*. Moreover, the beneficial restructuring of the body - a function of

* Because women have less muscle, less ability to regain lost muscle, smaller bones, and less ability to regain lost bone, catabolic hormonal shifts are arguably more damaging to them.

recovery* - requires energy. **The more energy you expend exercising**, **the less energy is available to fuel the recovery process and**, **consequently, the slower recovery will proceed**. Therefore, the greater the volume of exercise you do, the more time you must allow for recovery. One practical implication of this is that moderate-volume aerobic exercise performed on days when you do not lift weights is generally okay and will not interfere with recovery. However, a greater volume of aerobic exercise necessitates a reduction in frequency, *not intensity*, of your weight-training workouts.

> **EXAMPLE**: Four days per week of weight training might be okay (depending on nutrition, sleep, and emotional stress) if you are either not exercising at all on the other three days of the week or if you are doing moderate-volume cardiovascular exercise on those days. If, however, on your three weight-training "off days," you are engaging in high-volume cardiovascular exercise, your hormonal profile is likely to shift unfavorably, leading to overtraining syndrome. Note that the adverse effects of this training regimen may not be immediately apparent. As explained earlier, *overtraining syndrome is a cumulative phenomenon*. In other words, if you consistently overtax your body's recovery abilities, eventually you will pay the price.

Men who are concerned solely with building maximum muscle mass are advised to minimize aerobic exercise or eliminate it, to allow for the fastest possible recovery. Faster recovery means you can train more frequently. Extrapolated over time, *and assuming full recovery after each workout*, more workouts translates to more muscle growth in a given period of time.

The Body Must be Viewed Both as the Sum of its Parts and as an Integrated System

One of the more popular, and more pernicious, misconceptions is that weight training every day is okay provided that you do not train the same muscles two days in a row. The flaw in this thinking is that it envisions the human body as merely the sum of its parts, failing to appreciate its identity as an integrated system. You must view the body from both perspectives in order to avoid the pitfalls of overtraining. There are two such pitfalls:

Localized Overtraining: Refers to overtraining individual bodyparts

Systemic Overtraining: Refers to overtraining the body as a system
(and is associated with elevated cortisol levels)

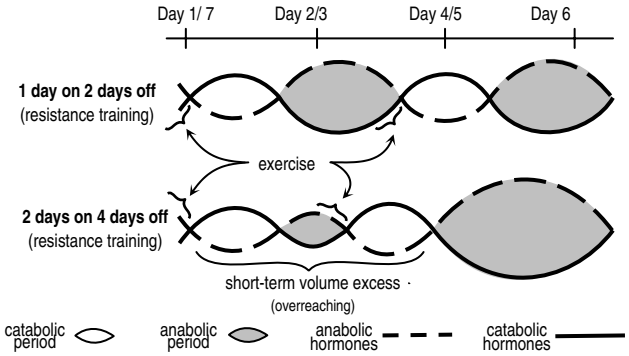
* Technically, recovery refers to the restoration of the body to the level it was at before the workout. This is called *restitution* or *compensation*. But the adaptive response generally "overshoots" the stress by a narrow margin. The extra increment is called *supercompensation*; it represents the adaptive element, and it accounts for the improvements wrought by exercise. In the case of weight training, supercompensation manifests itself as stronger muscles. For the sake of simplicity, I am employing the generic usage of "recovery," which encompasses both compensation and supercompensation. Take note of the fact that because compensation must occur before supercompensation can occur, if you train too frequently you may be permitting sufficient time for compensation but insufficient time for supercompensation. When this happens, you make no progress. If you train more frequently than this, you may curtail compensation. When this happens, you regress.

What about Weight Training Two Days in a Row?

The rule against weight training every day should not be construed as a prohibition against weight training two days in a row. In general, it is preferable to allow an "off" day between weight-training sessions when you do either moderate-volume aerobics or no exercise. However, there are two bases upon which you should depart from this general rule and weight train two, or sometimes even three days in a row. First, necessity (created by work schedule or other obligations); second, as a means of qualitative progression.

Recall from our discussion of qualitative progression that once you master the fundamentals and become stronger and fitter, you should occasionally change your workout routine, in a calculated fashion, to increase r-intensity. Short-term manipulation of volume represents new stress and therefore increases r-intensity. For example, switching from a one-day-on, two-days-off weight training routine to a two-days-on, four-days-off routine, or vice versa, then back again, is an effective application of qualitative progression, which will stimulate renewed hormonal responsiveness and spur the adaptive process.

When weight training two days in a row, be sure to compensate by allowing extra recovery time. For instance, whereas two days may be a sufficient recovery period following one weight-training session, at least three days off the weights is advisable after two consecutive days of weight training. (Note - this does not mean that three days is sufficient recovery time for a *bodypart*, rather it is a guideline for avoiding systemic overtraining when different bodyparts are trained.) This adds-up to about three days of weight training per week, which is the right amount for most people under most circumstances. Four days per week is okay occasionally, as a means of qualitative progression, provided that extra recovery time follows; and two days per week is more appropriate for individuals engaged in high-volume cardiovascular exercise on their weight-training "off days."



Note that two weight-training sessions performed on consecutive days constitutes short-term volume excess (short-term volume excess results in short-term catabolic predominance). However, do not confuse short-term volume excess (overreaching) with long-term volume excess (overtraining). The former is a potentially advantageous manipulation of physical stress, whereas the latter is unequivocally bad. Provided that extra recovery time follows, short-term catabolic predominance caused by short-term weight-lifting-volume-excess will generate a compensatory anabolic response.

Four days of weight training per week is the *maximum*. For the vast majority of non-steroid-users, regularly weight training more than four days per week will lead to a catabolic hormonal state. (This will come as a real shocker to the millions of gung-ho weight trainees who lift five or six days per week. If you are among this group, now you know why you haven't seen any positive results in the last few months or years.)

Bodypart Groupings and the Split Routine

Another way to apply qualitative progression is to change bodypart groupings. For example, it is advisable for advanced weight trainees to split bodyparts into narrower groupings to enable him/her to focus more intensely on each bodypart. Even after you have graduated from the standard upper-body/lower-body split (which I recommend for beginners) to a more advanced split (in which you do three different workouts instead of two), you should periodically revert. Training muscles in different combinations changes the nature of the stress imposed. For example, although a 3-day split is more "advanced" than the beginner's 2-day upper-body/lower-body split, training the entire upper body in one workout represents "new stress" (translating to higher relative intensity) to someone who is not accustomed to doing so. Bodybuilders who consider themselves too advanced to periodically revert to a more rudimentary training routine are also too advanced to get optimal results from training.

Review: Guidelines for Structuring a Hormonally Intelligent Weight-Training Routine

- Don't directly train the same muscles two days in a row. (Because muscles work in overlapping patterns of cooperation, you may train a muscle group directly one day and indirectly the next day. For example, in some split routines "upper back and chest" are trained on one day and "arms and shoulders" are trained on another day. In this scenario, shoulders are being trained two days in a row: indirectly as complementary or "helper" muscles on the first day and then directly on the second day.)

- Where weight-training "off" days consist of high-volume aerobic exercise or a large volume of other physical activity, additional recovery time is needed between weight-training workouts. However, low-volume aerobic exercise on weight-training "off" days does not impede recovery, and may even facilitate it (see below).

- *Don't regularly weight train three days in a row*, unless one of the three workouts is limited to any, or at most two, of the following bodyparts: calves, abdominals,

forearms, or lower back. (The reason for this exception is that these are comparatively small muscles and, therefore, training them taxes the neuroendocrine system to a much lesser extent than training major muscle groups, i.e., upper back, chest, and legs.)

- *Don't regularly weight train more than three days per week.*

NOTE - The reason for the modifier "regularly" in the previous two rules is that, as discussed on p. 295, occasionally doing an excessive volume of exercise can be an effective means of qualitative progression for advanced weight trainees, *provided* that an extended recovery period follows.

One additional point - If you opt for a routine that has you weight training two days in a row, try to allow at least 20 hours between workouts. Obviously, training the same time each day would put you in compliance with this recommendation. What should be avoided is training late in the evening on Day 1 and then early in the morning on Day 2 - this is hormonally incorrect. To understand why, let's consider the following hypothetical:

Day 1, weight-training workout at 8 p.m.

Day 2, weight-training workout at 9 a.m.

The timing of these two workouts relative to each other maximizes cortisol output and promotes systemic overtraining. To appreciate why, remember from our discussion of the post-workout meal that food offsets catabolism. The better your nutrition, the faster your recovery because food provides the energy (calories), building material (protein), and catalysts and cofactors (vitamins, minerals, and electrolytes) necessary for recovery.

With the nutrition/recovery relationship in mind, let's analyze the hypothetical above. Unless this person wakes-up in the middle of the night to eat, he or she will, at most, consume two meals between workouts: dinner on Day 1 and breakfast on Day 2. This translates to two meals during the 13-hour period between workouts. Essentially, this amounts to a fast (hence break*fast*); and fasting retards recovery. **Fasting in the wake of a weight-training session amplifies the catabolic response**. By way of clarification, I am not implying that occasional fasting is a bad idea - I am stating that fasting *after an intense workout* is a bad idea.

Let's analyze three hypothetical workout routines. This will provide practical insight into how the principles we have been discussing apply in real life.

Practical Applications

HYPOTHETICAL #1

Jerry has a biceps obsession. His entire exercise program consists of doing five sets to failure of curls every day.

Analysis: Jerry is violating three rules with this routine by 1) not training all muscles, 2) directly training the same muscles two days in a row, 3) weight training every day.

Beginning with the first of these transgressions, this is an ill-conceived routine because you should not train only one muscle or muscle group. To have a proportional physique you must train all muscles. Developmental imbalances detract from your body not only aesthetically, but functionally as well. Especially where imbalances exist between antagonistic muscles (like biceps and triceps, hamstrings and quadriceps, chest and upper back), the likelihood of injury increases. Except where one is rehabilitating a specific muscle after disproportionate disuse, all muscles should be treated equally.

Pounding-away at the same muscles every day is Jerry's second mistake. This leads to *localized overtraining* of the biceps, resulting in cessation or undoing of positive results, and a heightened likelihood of injuring his biceps.

Jerry is also breaking the rule prohibiting weight training every day. However, in this instance, because of the brevity of his workouts and because the biceps are relatively small muscles, the hormonal effects are not nearly as bad as they would be if he were training a major muscle group every day. Therefore, *systemic overtraining* is not an inevitable consequence of this routine. Similarly, because curls are one of the less taxing exercises (again - because the biceps comprise a very small percentage of human musculature), Jerry's routine does not severely deplete energy resources needed for recovery.

Nonetheless, with Jerry's routine, the chronic trauma to the muscle tissues of the biceps, caused by localized overtraining, disrupts recovery and development of the biceps in the same way that constantly picking at a scab disrupts the healing of a wound. In addition, the risk of injury to the biceps muscles and the surrounding tendons and ligaments is heightened considerably by this training regimen. Therefore, although Jerry's workout routine will not necessarily have an adverse impact on his hormonal status, there are other problems that essentially make this routine, at best, a waste of time.

HYPOTHETICAL #2

Steven has adopted the weight-training routine – called the "Get Thick Quick Program" - endorsed by Mr. Olympia and featured in one of the bodybuilding magazines he reads religiously. Steven, however, does not take anabolic drugs (unlike the pros). He trains at a high level of intensity, five days per week, resting on Saturday and Sunday. Despite his determined efforts, Steven has not been making satisfactory progress and therefore he has set-up an appointment with Leo "The Exercise Master," to have Leo troubleshoot his training routine. Leo has recently earned his nickname and a great deal of admiration due to the astonishing improvements in his physique that occurred after applying the principles and techniques contained in *Natural Hormonal Enhancement* and *Hormonally Intelligent Exercise.*

Steven shows Leo his routine, which looks like this:

Mon	**Tues**	**Wed**
chest	triceps and shoulders	back and biceps
Thurs	**Fri**	**Sat/Sun**
abdominals and quadriceps	hamstrings and calves	off

Leo tells Steven that although he is directly training each bodypart only once per week, he is overtraining his body *as a system*, with consequent depletion of energy resources needed for recovery and an unfavorable anabolic to catabolic hormonal ratio. Leo recommends that Steven change his routine so he is lifting three days per week rather than five days. Steven listens politely, thanks Leo for his advice, and walks-out, convinced that Leo doesn't know what he's talking about. It is impossible for Steven to believe that *less* working-out will produce more and better results. Besides, he reasons, the pros know more than Leo does about working-out and many of them train five days per week. If the "Get Thick Quick Program" worked for Mr. Olympia, it will work for him too, Steven concludes. Ironically, Steven, not knowing Leo's secret (NHE/HIE) assumes that Leo must be taking steroids or some other muscle-building/fat-burning drug in light of Leo's recent burst of progress despite such "flawed" thinking about how to work-out.

Desperate to look like the guys in the bodybuilding magazines, but seeing no progress in that direction six months after spurning Leo's advice, Steven decides that the solution is to work out *more*. Accordingly, he increases exercise frequency to six days per week. In addition, Steven starts spending $100 per month on dietary supplements, most of which don't work, that are supposed to build muscle and burn fat. Leo "The Exercise Master" meanwhile, a regular visitor to the Extique website where objective and unbiased information regarding supplements can be found, spends less than $50 per month on supplements and takes only those supplements that are proven to be effective, none of which Steven takes.

One year later, Leo appears on the cover of a local fitness magazine after placing 1st in a statewide "natural" (drug-tested) physique competition. Steven, on the other hand, is now spending close to $200 per month on supplements and has defaulted on his last car payment. In addition, Steven is finding himself unable to shake a cold that has been lingering for the past month. He has not lost any bodyfat, but his weight has dropped by five pounds due to muscle loss. His relationship with his girlfriend, Sara, is in serious trouble because he has become irritable and grouchy and spends virtually all his free time at the gym, convinced that longer, harder workouts are the answer to his problems. Sara was further offended recently when Steven asked to borrow money to buy a new bodybuilding supplement that promised to build “rock-hard granite slabs of Godzilla-like muscle mass practically overnight.” Adding insult to injury is the fact that, in the minimal amount of time they do spend together, Steven, formerly a competent and enthusiastic lover, shows no interest in sex and his occasional efforts at performance are lame despite his girlfriend's patient and supportive coaxing.

Depressed, frustrated, and desperate for answers, Steven begins taking anabolic steroids. Finally, he begins seeing results despite working-out six days per week. After three months on " 'roids," Steven quits taking them, prompted by concern for his long-term health. Consequently, despite continuing the exact same training routine, he begins rapidly losing muscle mass, and his sex drive, which had returned, plummets. Unable to bear watching his hard-earned muscle mass evaporate like a puddle in the desert, Steven resumes taking steroids. Five years later, Steven is still taking steroids. Sarah meanwhile has found a new boyfriend, named Leo.

Analysis: The story of Steven is common and some version of it is playing itself out in gyms across America. *The path of Steven or Leo is your choice.*

Leo's critique of Steven's workout routine is basically correct. There is, however, an additional mistake that Steven is making. Leo's evaluation of Steven's training regimen was that it promotes systemic overtraining. True. But it will likely lead to localized overtraining of the shoulders, too. A great many people overtrain their shoulders, because they do not appreciate that some combination of the shoulder muscles (anterior, posterior, and/or medial deltoids) are involved in practically every upper-body exercise. Even though Tuesday is the only day on which Steven directly trains his shoulders, they are engaged as complementary or "helper" muscles on Monday and Wednesday as well. Training the same muscles three days in a row is not advisable, even where on two of the three days the muscles are trained indirectly.

This general rule applies especially to the shoulders. Like the knee, the shoulder joint is highly susceptible to overuse injuries. And like the knee, a shoulder injury can be debilitating. Bodybuilders don’t realize that although they may have massive shoulder muscles, their shoulder joint is delicate. In fact, the disparity between the high developmental capacity of the shoulder muscles and the low developmental capacity (or, in many cases, cumulative degeneration) of the shoulder joint, causes the risk of shoulder injury to increase with advancing strength and years of lifting. Furthermore, the shoulder joint is subject not only to forces generated by the deltoid muscles, but is also caught in the crossfire of the much larger pushing (chest) and pulling (upper back)

muscles of the upper body. These facts about the shoulders, along with the widespread lack of appreciation of the extensive "helper" role they play in exercises not denominated as "shoulder exercises," explain why shoulder problems are so common among veteran weight trainees.

Another reason for the prevalence of shoulder problems among weight lifters is poor *exercise selection* and poor *exercise execution.* An example of faulty exercise selection is doing behind-the-neck barbell presses with heavy weight. The behind-the-neck press, a popular exercise, is murder on your rotator cuffs. Weighted dips is another extremely hazardous exercise. Exercise execution (biomechanics) is discussed below.

HYPOTHETICAL #3

Lauren, like most women, would like to get her hips, legs, and butt into better shape. With this objective in mind, Lauren adopts a weight-training routine in which she does squats every day, having been told that squats are a great exercise for the glutes (i.e., gluteus maximus) and thigh muscles. She does no other exercises, and trains at a high level of intensity.

Analysis: Lauren's routine is analogous to Jerry's (Hypothetical 1) insofar as they both perform only one exercise targeted at the bodypart each is interested in improving. Whereas Jerry trains only a small fraction of his musculature, Lauren trains a much larger percentage of hers. Still, Lauren's routine, like Jerry's, is flawed because it selectively works certain muscles while neglecting other muscles. Her choice of squats, though, is a good one.

The squat, provided it is properly executed (which it usually is not, see p. 309), is an outstanding exercise. In fact, the squat is the best exercise one can do for the lower body. Besides being a terrific exercise for the glutes, the squat works the quadriceps (front upper leg), hamstrings (back upper leg), hip flexors, lower back, and, to a modest degree, the calves. The squat is also a powerful growth hormone releaser, and that spells fat loss. Furthermore, squats heavily engage the heart and lungs, thus imparting a training effect beyond the musculoskeletal system. However, the principal virtue of the squat is also its principal drawback.

In addition to being a highly technique-oriented exercise (meaning it requires practice and instruction to execute it properly), squats are an inherently high-volume (due to high load) exercise. The squat engages a larger percentage of the human musculature than any other weight-lifting exercise, except for deadlifts. The gluteus maximus and the muscles of the upper leg are the largest muscles in the body; throw in the hip flexors, lower back, and calves, and you have an exceptionally taxing exercise. Consequently, doing squats every day at a high level of intensity will result not only in localized overtraining of the leg muscles, but it will also rapidly lead to systemic overtraining. Stated differently, the same characteristics that make the squat potentially a powerful anabolic stimulus also make it potentially a powerful catabolic stimulus. In Lauren's case, because she trains every day, the catabolic potential, not the anabolic potential, will be actualized.

Overtraining vs. Undertraining

I have devoted much space to discussing overtraining, and particularly systemic overtraining, which directly impacts on hormone levels by causing an unfavorable shift away from anabolism toward catabolism. The extensive treatment is warranted because systemic overtraining is the negation of your efforts in the gym and the undoing of your hormonal health. One study examining the effects of overtraining in endurance athletes found that a reduction in both the testosterone/cortisol ratio and sperm count caused by overtraining persisted for three months after resumption of normal training volume.[291]

Other research confirms that recovery from overtraining can take weeks, or in severe cases, months.[292] And as the foregoing study demonstrates, unless you stop training altogether (which no fitness enthusiast wants to do), hormonal imbalance can linger for a considerable period of time after you have reduced volume. In other words, overtraining syndrome, once it sets in, is an albatross not easily dispossessed. Therefore, to make continuous, uninterrupted gains you must avoid overtraining. However, to progress we must impose physical stress on our bodies. Thus, we are forever compelled to flirt with overtraining, while diligently guarding against traversing the blurry line that separates "optimal" from "over."

On the other hand, undertraining is not good either; and it will surely hold you back from achieving your potential. If it seems like you are treading a fine line here, you are. But overtraining does not happen overnight. Rather, it is a cumulative syndrome caused not by one lapse in judgment, but by a consistent misapplication of energy and effort. If you study NHE/HIE, you should be able to spend your life in the optimal exercise zone, where the benefits keep accruing and the detriments are avoided.

While both overtraining and undertraining are problematic, overtraining is more insidious because it results from a misapplication of the most admirable qualities: commitment, self-discipline, and determination. In most other endeavors, these traits, like a well-trained seeing-eye dog, will unfailingly lead you in the right direction. When it comes to exercise, however, these traits can betray you if they are not tempered by an understanding of the hormonal dynamics of exercise.

Undertraining, by contrast, generally results from a lack of will not of knowledge. As a practical matter, where there is a will there is not always a way. But where there is no will there is no way. Therefore, undertraining is an obvious and conspicuous enemy and is simple to defeat - intensify your commitment and redouble your resolve, and you will not undertrain.

Where there is a will, there is not always a way.
But where there is no will, there is no way.

Remember that sleep deprivation, nutritional inadequacies, and emotional stress each impede recovery and promote a catabolic hormonal state. The same exercise routine that

will produce overtraining syndrome in a stressed-out, sleep-deprived, poorly fed person may be ideal for someone without these deficits. Pay attention to these variables, and get in touch with your body. If you were up late cramming for an exam or trying to beat a work deadline, you might be better off skipping your workout the next day.

RULE: No matter how good you feel, *don't* train sooner than you are supposed to; however, if you are sick or run-down due to lack of sleep, poor nutrition since your last workout, an infection, or extreme emotional stress, *do* postpone your workout.

Do not invent excuses to miss workouts, but do not be so rigid that you feel obligated to workout in a compromised physical state. And if you find yourself slipping into overtraining, you should scrutinize your training routine with reference to your emotional, sleep, and nutritional status. This raises the question: how do you know when you are overtraining?

I have made reference at various points in this book to becoming attuned to your body. This is generally good advice that I am sure you have heard before, but it has special significance and applicability to Natural Hormonal Enhancement. Hormonal changes manifest themselves in ways discernible to those attuned to their body. Earlier, we discussed how diminished sex drive can be a signal to men that their testosterone/cortisol ratio is low and consequently their "muscle axis" (see Chapter 4) is out-of-whack in favor of catabolism. A chronically low testosterone/cortisol ratio is indicative of systemic overtraining. In women, too, diminished sex drive can be symptomatic of overtraining, because cortisol is antagonistic to female sex hormones (see p. 256).

While sex drive should be monitored for insight into hormonal state, do not put too much stock in it; psychological factors play a big role here. Rather, use sex drive as an alarm system: if your sexual desire slumps for no apparent reason, you should inquire further into your hormonal state. Less ambiguous than sex drive in signaling the onset of overtraining is **immunity, waking heart rate**, **exercise performance,** and **sleep quality**.

Becoming Attuned to Your Body

Immunity: There is good news to report: exercise can bolster the immune system. And there is bad news: exercise can weaken the immune system - if you overtrain. Our immune system stands between us and death. Immune deficiency disorders, like AIDS, illustrate this fact all too graphically. Without a functioning immune system, you would fall prey to the bacteria, viruses, molds, yeasts, and toxins that attack you each day, and are routinely repelled each day by your immune system. Even cancer is increasingly being viewed as a failure of the immune system.[293,294,295,296] Among its multitude of defensive tasks, the immune system destroys aberrant cells before they become established. Newly acquired insights into the immune/cancer connection has led to the

development of promising experimental vaccines designed to enhance cellular immunity against tumors.[297,298]

Tumor biologist P. B. Medewar has said that every person develops cancer thousands, perhaps millions, of times. The immune system nips the problem in the bud almost every time, and you are no worse for wear. It's the "almost" part that gives rise to life-threatening malignancies. When you come to appreciate that your immune system performs lifesaving acts for you every day, you realize that supporting your immune system should be at the top of your list of priorities.

To understand how exercise can affect immunity we need only remember that growth hormone enhances immunity (see p. 5); whereas cortisol, associated with overtraining, is poison to the immune system, impairing its functioning and in some cases destroying disease-fighting cells (see p. 92). In this connection, you may find it interesting that no one ever dies of starvation. Before a starving person gets down to zero bodyfat, he/she dies of disease. The disease results from an immune system compromised by nutritional deficiency and assaulted by catabolic hormones. Under the extreme stress of starvation, ultra-high levels of cortisol and glucagon literally eat-away at the immune system. (Remember, catabolic hormones break-down protein; most of the immune system is made-up of protein.) The increasing predominance of catabolism over anabolism with advancing age[299] is a major reason why deadly diseases afflict older people at a much higher rate than younger people.

By enhancing growth hormone and suppressing cortisol, hormonally intelligent exercise can strengthen immunity and combat the immunosuppressive age-related increase in the catabolic/anabolic ratio. The immune consequences of exercise are volume-dependent and divide along the fault-line marked by overtraining: the right amount of exercise improves immunity, whereas too much of it suppresses immunity.[300,301,302,303] Reflective of the immune-boosting potential of exercise, a study published in the *International Journal of Sports Medicine* shows higher levels of natural killer cell activity in trained athletes than in sedentary people.[306] Similarly, animal studies show superior resistance to infection[304,305] and cancer[307,308] in trained subjects as compared with controls. The cancer/exercise linkage is further supported by studies consistently finding lower cancer rates among active people than inactive people, with the strongest associations found for cancers of the prostate, colon, and breast.[309,310,311,312,313,314] One study estimates that adopting an active lifestyle can reduce all-cause cancer rate by as much as 46%.[315]

The other side of this coin is represented by studies showing overtrained athletes with ravaged immune systems, characterized by reduced immune cell counts and increased incidence of infection.[316,317,318,319,320,321] With these facts in mind, you should monitor your infection rate and duration. If you find yourself getting sick often and find that colds have a tendency to linger for an undue period of time, you should carefully evaluate your workout routine and be on the look-out for other telltale signs of overtraining.

Waking Heart Rate: Checking your pulse rate immediately upon waking in the morning is a good practice to adopt. Do it before you get out of bed. Later, emotions, activity, and digestion will confound the analysis. Also, take your pulse in the same position each time; standing heart rate is slightly higher than seated heart rate which is slightly higher than lying-down heart rate.[322] If your waking heart rate on a given day is elevated by more than seven beats per minute over your average for the preceding week, be on notice that you may be developing overtraining syndrome. When assessing your heart rate, keep in mind that there is likely to be a downward trend in your resting heart rate correlating with increasing cardiovascular fitness. This can mask an elevated waking heart rate if you do not keep track of changes in your resting heart rate over time.

Another test performed upon waking is what I call the "Three-Second Test." It involves monitoring how you feel during the first three seconds after awakening in the morning. The instant you wake-up you should feel either a bit drowsy or refreshed but relaxed. If, instead, upon opening your eyes you are consumed with nervous energy - an uncomfortable jittery feeling - there is a good chance that your pulse is elevated and you have dipped into an overtrained, catabolic state. The “waking jitters” reflects neurotransmitter disturbances associated with overstimulation of the sympathoadrenal system (adrenal glands + nervous system). This is an early-stage indicator of overtraining.

If overtraining persists, jitteriness yields to lethargy; and chronic fatigue and inability to emotionally “get up” for training or competition (known as “staleness” in the sports world) become the dominant symptoms. At this point, you are suffering from adrenal exhaustion (see p. 250) in which the neuroendocrine system is incapable of mounting a full response to exercise. Specifically, catecholamines (adrenaline and norepinephrine) levels become depressed as a result of overtraining.[323] The catecholamines are the “biological juice” that drives exercise. They regulate virtually every aspect of exercise, including: blood flow distribution, cardiac contractility, energy mobilization, and mind-muscle communication.[324] A blunted catecholamine response to exercise can severely hamper performance.

Exercise Performance: Decrements in exercise performance are a telling symptom of overtraining.[325,326,327] If you are becoming weaker rather than stronger or are experiencing decreases in endurance rather than increases, you are obviously doing something wrong; and overtraining is very likely the cause of these reversals. Becoming weaker and feeling listless in the gym are warning signs that should not be ignored.

Sleep Quality: Overtrained people do not sleep well,[328] and they often wake-up with the uncomfortable jittery feeling (described above) in the morning, and sometimes in the middle of the night as well. Because sleep is a buffer against overtraining, sleep disturbances aggravate overtraining.

Mood: Overtraining is reliably linked to mood alterations.[329,330] Most commonly, these changes are manifested as depression and loss of motivation to train. The depressive effect of excessive exercise on mood contrasts sharply with the elevating effect that moderate exercise has on mood, outlook, and self-esteem.[331,332] If you find that your enthusiasm for life and specifically for exercise, has diminished, you should suspect overtraining.

Warm-Up

Warming-up before exercising is imperative. Warming-up facilitates improved subsequent performance and reduces risk of injury. **Whether you are doing aerobic or resistance exercise**, **the session should begin with a relatively brief**, **low-/moderate-intensity aerobic warm-up**.

A common mistake is to begin a workout by stretching, prompted by conventional wisdom which holds that this reduces the risk of injury. In fact, this practice promotes injury.[333] If you are going to stretch, do so after the aerobic warm-up. *Never stretch a cold muscle* - doing so is the most effective way to pull a muscle.

The aerobic warm-up serves to prepare your body for the demands of higher intensity work. This includes slightly raising body temperature and increasing oxygen transport to the muscles via enhanced blood flow. A brief, moderate-intensity warm-up also allows the cardiovascular system to gear-up, thereby offsetting the risk of irregular heartbeats or other abnormal electrocardiographic changes. The low-/moderate-intensity aerobic warm-up need only last 5 minutes; it is designed to shepherd your body past the "sweat threshold."

The importance of warming-up cannot be overstated in light of the fact that while exercise can reduce the risk of heart attack (including the risk of heart attack resulting from sudden exertion) sudden exertion can trigger a heart attack.[334] Warming-up is the way to obtain the cardioprotective benefits of exercise while avoiding the risk. In one study, 44 men free of overt symptoms of coronary disease ran on a treadmill at a high level of intensity for 10-15 seconds without prior warm-up. Electrocardiogram tracings indicated that 70% of the subjects displayed abnormal electrocardiographic changes. Significantly, when 22 of the men with abnormal ECGs during the treadmill test were again tested, this time after a 2-minute warm-up, 20 of the men exhibited improved electrocardiographic responses.[335] Another study found similarly beneficial effects of warming-up in relation to blood pressure changes attendant with sudden physical exertion.[336] These observations underscore the fact that coronary blood flow response to a sudden increase in cardiac work is not instantaneous, and momentary heart oxygen starvation (called transient myocardial ischemia) can occur in apparently healthy individuals. Warming-up prior to exercise helps even-out the supply and demand of cardiac oxygen, thereby substantially reducing the risk of sparking adverse coronary events at the onset of exercise.

In addition to safety considerations, warming-up can improve subsequent exercise performance.[337,338] Your warm-up should be gradual and of sufficient volume slightly to increase body temperature without causing fatigue or depleting energy stores; and the actual workout should commence promptly thereafter. If you are going to be doing a resistance workout, you should perform an additional specific warm-up directed at the muscles you will be training. But remember, never touch a weight until you have broken a sweat. The specific warm-up, which immediately follows the aerobic warm-up, can be accomplished by preceding each exercise with a "warm-up set" in which you use relatively light weight to "pump" or channel blood flow to the particular muscles you intend to train.

By beginning a resistance workout with a low- to moderate-intensity aerobic warm-up followed by warm-up sets, you increase the elasticity of the muscles and tendons. This reduces significantly the likelihood of muscle/connective tissue injury, which, though largely preventable, is widely prevalent among weight trainees.[339] In addition, you will get a better workout because "pumped" muscles perform better than cold muscles.[340]

Organizing Your Workout: The Order of Operations

Should You Do Aerobic Exercise on the Same Day You Weight Train?

There are a couple of reasons why it is better to do weight training and cardiovascular exercise on separate days than to do them in the same workout. For one, low-/moderate-intensity aerobic exercise performed on your weight training "off" days serves as a form of "active recovery." Active recovery facilitates recovery by increasing blood flow and transport of oxygen and nutrients to the muscles. In addition, with workouts on successive days, the potential exists to get two exercise-induced growth hormone surges instead of just one. The next best option, if your schedule does not permit you to do weight training and aerobic training on separate days, is to do one in the morning and the other in the afternoon. However, this is often inconvenient or impractical; and psychologically, "two-a-days" can be a real drag.

How to Structure a Workout to Include Both Weight Training and Aerobic Exercise

If your schedule is such that on certain days of the week you cannot exercise at all, you will be forced to do resistance exercise and aerobic exercise on the same day. Remember, though, the laws of human biochemistry do not bend to accommodate your schedule. Therefore, the duration rule still applies (see p. 263).

Conforming a workout which includes both weight lifting and cardiovascular exercise to the one-hour time limit may seem impossible to someone accustomed to long, leisurely, unfocused, or excessive-volume workouts - but it's not. With a well-designed routine (which would likely include "splitting" your bodyparts in this case, see p. 296), a proper amount of time between sets, and focused intensity, you can get an excellent

weight-lifting workout in 20-30 minutes. This leaves 30 minutes for the aerobic component of your workout. (The warm-up does not count toward the one-hour limit.)

If you do interval training as recommended in this book, 30 minutes is more than enough time for a cardiovascular workout. Even if you do not do interval training, recall that as your cardiovascular fitness level increases, you should increase the intensity, not the duration, of your cardiovascular workouts. Therefore, 30 minutes is sufficient for a cardiovascular workout regardless of your fitness level.* As you can see, it is easy to keep your workouts under one hour if you properly organize your workouts - and your mindset.

Which Should You Do First in a Dual Workout, Weight Training or Aerobic Exercise?

When doing resistance exercise and aerobic exercise in the same workout, do resistance exercise first (but after the 5-minute aerobic warm-up). It is more important to preserve your strength and energy for the weight-training component of the workout, because intensity is more critical to weight training than to cardiovascular training. With this in mind, and because you are more capable of generating intensity at the beginning of your workout than at the end of it, it is advantageous to structure your workout such that weight training precedes aerobic training.

Moreover, structuring a dual workout in this way can help you burn more fat than if you did the aerobic part first. Here's how: recall that weight training is the most effective form of exercise for stimulating growth hormone release, and growth hormone increases the percentage of fat burned for energy. Recall also that if your workout is sufficiently intense, growth hormone can increase within minutes. Therefore, the earlier in your workout you stimulate growth hormone release, the better; because it maximizes the amount of fat burned to fuel your workout.

Review - Organizing Your Workout: The Order of Operations

Best – Resistance exercise one day, aerobic exercise the next day. [Allows for highest intensity and lowest duration per workout (thus increasing the intensity/volume ratio), allows for two growth hormone surges, and enhances recovery.]

Next Best - Same day: part 1 in the morning, part 2 in the afternoon. [Allows for two growth hormone surges, but intensity and enthusiasm are likely to flag during the second

* Although 30 minutes is sufficient for a cardiovascular workout regardless of fitness level, it is to your benefit occasionally to alter your workout such that intensity is decreased and duration is increased, even though this would reduce the intensity/volume ratio. If you have any question about why such a manipulation of exercise variables would be advantageous, please refer to the preceding discussion of *qualitative progression*.

workout; and it is often inconvenient, impractical, or psychologically draining to train twice in one day.]

Third Best - Same day, same workout: first resistance exercise, then aerobic exercise. [Reduces overall intensity, requires more focus and efficiency to stay within the one-hour time limit, and allows for only one exercise-induced growth hormone surge.]

Biomechanics

Biomechanics refers to the way you execute exercises. It is often referred to as "form" or "technique"; and it is exceedingly important for avoiding injury and achieving full benefit from weight lifting. I have trained in gyms across the United States, and I am consistently dismayed at the prevalence of faulty exercise execution. Based on my observations, *I have no hesitation in saying that in any given gym in America, at any given moment in time, there are more people doing exercises incorrectly than there are people doing exercises correctly.* Along with overtraining, undertraining, and poor exercise selection, flawed biomechanics deprives millions of people of the results from exercise they seek - and often produces negative results, including injury. Here are a couple of examples.

EXAMPLE 1 (Bench Press)

Bench press is one of the more popular exercises, and it is one of the more effective exercises for stimulating growth hormone release. However, the difference between executing the bench press correctly and incorrectly is literally a matter of inches, and relates to the "touchpoint" (where the barbell touches the chest). The touchpoint should be at approximately nipple level. Next time you are in a gym, take note of how many people bring the bar down to a touchpoint high on the chest; or simply take my word for it - a lot.

By lowering the barbell to a touchpoint closer to the collarbone than to the nipples, these individuals are de-emphasizing their chest in favor of their anterior deltoids. What is worse, because bench press entails greater load than any other upper-body exercise (due to the many muscles that assist in this movement) and because a high touchpoint requires the shoulders to exert force from a biomechanically compromised position, performing this exercise with incorrect form invites rotator cuff problems. Anyone who has experienced a rotator cuff injury knows that it is a sharply painful, partially disabling, never-ending nuisance. Just a few inches makes the difference between an exceptionally effective growth-hormone-releasing chest exercise, and a minimally effective chest exercise hazardous to your rotator cuffs.

EXAMPLE 2 (Squat)

In Hypothetical 3 on p. 301, you saw that the squat can be a superb exercise for the lower body. And like the bench press, the squat is an excellent growth-hormone releaser.

One of the many virtues of the squat is that it works the glutes (butt). Like the abdominals, the glutes are generally regarded as one of the more significant "cosmetic" muscle groups. But unlike the abs, the glutes are difficult to target. There is an endless variety of exercises that work the abdominals, but very few that work the glutes. This fact makes the squat an exercise of exceptional importance for individuals seeking to firm and shape this area. However, while many people do squats for their glutes, a large percentage commit a biomechanical error that essentially takes the glutes out of the exercise.

The biomechanics of the squat are such that from the bottom position to the point where your upper leg is parallel to the ground, the glutes and hamstrings are primarily engaged. From the parallel point up to the standing position, the emphasis shifts to the quadriceps muscles of the front thigh. In light of these facts, it should be obvious that if you go down only halfway, your glutes and hamstrings are largely excluded from the exercise.

Most people do not appreciate that half squats produce half results. In addition, there is a popular idea being passed along from the misinformed to the uninformed that full squats are bad for your knees. In fact, the opposite is true.

Before I go any further, let me make this clear: if you have a lower back problem, a knee problem, or any other musculoskeletal deficiency in your lower body, you should not do any type of weighted squat: half, full, or otherwise. Doing weighted squats requires a sound lower body, so if you have old war injuries - forget it. Having said that, I believe, based on anatomical considerations and my own practical experience, that half squats are bad for your knees, not full squats. If I am right, then there is a perverse situation prevailing in gyms across America: people are doing the right exercise (squats) the wrong way (half-way down) for the right reason (to protect their knees). The net result is that they are putting their knees at risk while greatly diminishing the effectiveness of the exercise.

When doing a half squat, the knees absorb most of the stress of decelerating (stopping) the weight midway through the movement. By contrast, in the deep position, the movement reaches its natural termination point, and in rising from the bottom position the knees get assistance, not only from the quadriceps but also from the hamstrings and glutes. I have been doing full squats with heavy weight for many years without any problem (and I know many other people who have been, too). The one time I tried half squats with heavy weight, I felt a shooting pain that caused my athletic career to flash before my eyes (if there's "good pain" and "bad pain," shooting knee pain is definitely in the latter category). One final point on the knee issue: if you execute the squat properly, not only is it not bad for your knees but, in fact, it is good for your knees because it strengthens the surrounding tendons, ligaments, and muscles, thereby stabilizing the joint.

There are other important biomechanical features of the squat that are crucial to avoiding injury and maximizing the effectiveness of the exercise. First, never, ever, bounce out of the bottom position - this is a prescription for disaster. Instead, *ease* into

the bottom position, then rise from the bottom position in a forceful but fully controlled manner. I believe that the prevalence of this technical flaw - bouncing out of the bottom position - and the resulting injuries, is what gave rise to the myth that full squats are dangerous and should be avoided in favor of half squats. Secondly, it is crucial that you keep your back flat, as opposed to rounded, when doing squats. Performing squats with a rounded back is highly conducive to lower back injury (in the same way that a high touchpoint when doing bench press is highly conducive to rotator cuff injury). As is the case with knees, if you perform the squat improperly you can injure your lower back; but if you perform the squat properly (with a flat back), it will strengthen your lower back.

A good tip to remember when doing squats is to keep your head up - focus your eyes on the spot directly in front of you where the wall meets the ceiling. This will help you keep your back flat. Also, if you have never done squats or if you are new to weight training, I strongly recommend doing squats without weight the first few times. Graduation to weighted squats is not appropriate until you are certain that your biomechanics are correct. And remember that the bar itself weighs a significant amount (about 45 lbs.); so the bar only is your next step up from non-weighted squats. One more point - squats, like bench press, *should not* be performed without a spotter (i.e., someone ready to assist you if necessary). In fact, anytime you are training intensely with weights, you should have a spotter.

You see how important proper biomechanics is for avoiding injury and getting the most out of your workouts. Other Extique products provide a wealth of biomechanical tips and techniques along the lines of that presented here. If you can afford it, I also recommend that you hire a personal trainer for at least one session to demonstrate how properly to execute exercises and to critique your biomechanics. As noted on p. 249, there is vast disparity in quality among personal trainers. And, in many ways, you will be far ahead of those trainers who have not yet read this book. Having said that, the general knowledge level among personal trainers on the subject of exercise execution is fairly high, so listen to what the trainers have to say on this subject.

While personal trainers can be helpful, be wary of vocal self-proclaimed experts at your gym. There appears to be a direct correlation between the readiness with which a person gives unsolicited training advice and the likelihood that the advice given is inaccurate. I hope you will take advantage of other Extique resources to help you progress in your journey to achieving your utmost potential and realizing all the benefits that Natural Hormonal Enhancement has to offer.

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