THE BIOLOGY OF EXERCISE

by M. Doug McGuff, M.D.

Does it seem like you just don't have the time to exercise? What if you only needed 15 minutes a week to work out? Don't laugh, it's possible now. We have time-saving technologies in almost every other area of our life, except exercise. To make exercise efficient, we need to know what makes it work. We need to understand the biology of exercise.

The tanning industry is an example of a group that understands the biology of what it is trying to do. While tanning is not necessarily a healthy biological adaptation, it serves our discussion well. You can get a tan by laying out in the sun, but it is quite time-consuming to get a meaningful tan. What actually stimulates your body to develop a tan is just one small component of Sulight. That component is UV radiation. Sunlight also contains full-spectrum light. We could expose someone to grow lights almost indefinitely and produce little tan. Sunlight also contains radiant heat. We could expose someone to french fry warmers, or a dry sauna and never produce a tan. But, if we expose you to UV radiation, you will expose your body to a stimulus which will result in the desired adaptive response...a tan! If you are able to remove the non productive components of sunlight such as full-spectrum light and radiant heat, and add in extra amounts of the productive component (UV radiation) you would then have a tanning bed. With intensification of the stimulating component, and removal of the non-productive component, you can now produce a tan in 10-15 minutes a week. Furthermore, you won't have to get hot and sweaty to do so. Furthermore, since the dose of the key ingrediant is known, you can achieve your goal without getting burned. Remember, I am not endorsing tanning beds; I am just making a point.

Exercise as it currently exists is not based on an understanding of the biology of exercise. Much like the person laying in the sun, the key ingredient in typical exercise programs is floating around in a soup of non-important, but contaminating ingredients. As such the key ingredient is in relatively low concentration. Therefore, it takes an inordinate amount of time to accumulate enough of the key ingredient to make a difference. More importantly, in accumulating enough of the key ingredient, you also accumulate large amounts of contaminating ingredients (impact forces, joint friction, heat production, etc.). These contaminating ingredients act to exhaust your body's resources before you can accumulate enough of the key ingredient to make the endeavor worthwhile.

If the key ingredient could be isolated from all the contaminating ingredients and concentrated, then time efficient results could be had. Exercise as we currently know is like a prospector panning for gold. One out of a thousand will actually sift out enough gold to make the endeavor worthwhile. Exercise as we would like to have it would be like being handed a bar of solid gold. Once again, the key to doing this is to understand the biology of the process.

S >>>>> O >>>>> R

The biology of exercise is similar to other biological processes. Humans, like other animals, are adaptive organisms. We receive stimuli that may be irritating or threatful, and we make make adaptive responses to these stimuli. So the first thing we must understand is that exercise is simply a stimulus...nothing more, nothing less. Exercise does not cause any direct change in the body. You here this notion all the time on TV infomercials...

"The Ab-Gizmo will firm and tighten your abs". Refer to the diagram above. It is a generic biological equation. "S" stands for stimulus. The stimulus is some sort of irritant or threat to the organism. "O" stands for organism, which is what you are. The organisms receives the stimulus and will make an adaptive response which is represented by the "R" in the equation above. However, the response will only be made provided that a couple of conditions are met. First, the stimulus actually has to be severe or meaningful enough for the organism to even bother making an adaptation. Sunlight in February won't result in enough threat for a significant adaptation, Sunlight in August will. Second, the organism has to have the resources and time to synthesize the adaptive response. If there are too many other contaminating ingredients the organism cannot cope. If the stimulus is reintroduced too quickly, the organism will not have time to make a protective response and will end up suffering damage (sunburn in our tanning example, overuse injury and fatigue in our exercise example).

With the biological model in mind, let us now turn our attention toward the key stimulus in exercise. This is analogous to UV radiation in our tanning analogy. The key stimulus in exercise is something called "inroad". Inroad is the momentary weakening of a muscle. When you first hear that inroad is the key stimulus, two thoughts might pop into your head. Your first thought might be "weakening muscle? I thought exercise was supposed to make me stronger". Well you are right, but the strengthening is the Response, the Stimulus is the weakening or inroad. Your second thought might be "well that covers the muscles, what about my cardiorespiratory system". Believe it or not, the cardiorespiratory system is secondary and tracks along with the inroading process. Remember, the cardiovascular and respiratory systems can only be stimulated by performing mechanical work with muscle. The type of mechanical work with muscle that results in significant fatigue and weakening of muscle (inroad), will also strongly stimulate the cardiorespiratory system. Remeber, the cardiorespiratory system supports the mechanical working of the musculature. Refer to the diagram below for a representation of the inroading process.

INSERT INROADING DIAGRAM

This diagram refers to a single set of the type of resistance training we will recommend in this book. Let us say that your fresh strenght in a given exercise is an arbitrary "100 units (U)". When you try as hard as you can, you can produce 100 units of force. We will select 80 units of resistance for you to lift. We will now have you lift this 80U of weight very slowly, taking 10 seconds to lift it. At the top, we will have you smoothly change directions and lower it over 10 seconds. As you approach the bottom of the movement, you don't allow any respite, you simply begin lifting again very slowly. This slow style of lifting prevents you from getting the weight moving under its own momentum. When you cannot use momentum, the muscle is under the load of the weight continuously and it never gets a respite. As a consequence, the muscle fatigues quickly and must recruit more motor units (segments of the muscle, sort of like units in an army). As the muscle recruits and quickly fatigues more motor units, it becomes weaker and weaker. If the resistance is properly selected, about 80 or 90 seconds into the process the muscle will have fatigued such that its force output is now only 79 units. At this point, the 79 units of force from the muscle can no longer overcome 80 units of resistance. At this point of the exercise, movement has stopped. If you then attempt to produce movement for another 10 seconds your force output will drop to about 70 units. If you refer to the diagram below, you will see that as muscle strength progressively drops,

muscle motor unit recruitment increases. This is important because muscle recruitment is directly proportional to the effect on the cardiovascular, respiratory and metabolic systems of the body.

INSERT DIAGRAM

If we refer to the diagrams above, we will see that we have become 30% weaker in 90 seconds. This is a rate of fatigue, and a depth of fatigue that the body is not used to seeing. As such, this type of inroading serves as a powerful stimulus to the organism. More importantly, your body does not "know" it is making weights go up and down. Your body is simply having a profound metabolic experience. The set of exercise is interpreted as some sort of metabolicstruggle of a certain magnitude. For all your body knows, you could be wrestling a saber-toothed tiger. Most importantly, at the end of this metabolic experience, the organism could not move against the resistance. Movement is your most protected biological function. Without movement, you can't get food or keep from becoming food. As such, fatiguing until you can no longer produce movement under a given load amplifies the biological impact of the inroading process and makes for a stimulus that your body will respond dramatically to. It is this process of fatiguing deeply that represents the key ingredient we have been searching for. In the chapters that follow, we will describe the exercise technique that allows us to acquire this key ingredient without involving contaminating ingredients that could result in harm. Essentially, we will show you how to trick mother nature into thinking it must adapt to a threatful situation, without putting ourselves at risk for injury.