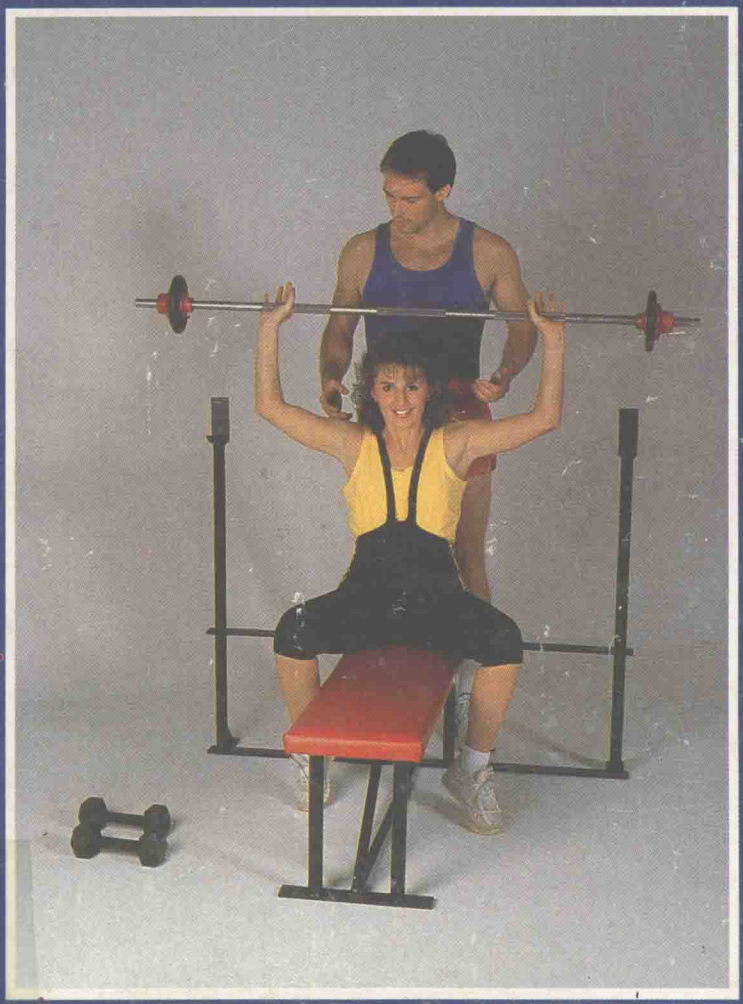
WEIGHT TRAINING Everyone



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WEIGHT TRAINING Everyone

4th Edition

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PREFACE

In the last fifty years, a phenomenal increase has occurred in the popularity of weight training: first, as a rehabilitation technique for World War II servicemen (bringing about a gradual acceptance by the medical profession), then as a training technique for athletes, and finally as a valuable tool for building and preserving physical fitness and strength for the general public.

It is because of this tremendous interest that the authors of *Weight Training Everyone* have decided to make available to the general public the experience and latest knowledge which they have acquired in developing strength for male and female athletes and students at four major universities and a noted National League football team.

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Weight Training: Today And Yesterday

WHY WEIGHT TRAINING?

The odds are that you are presently asking yourself why you chose an activity involving so much "hard work." Actually, there are a number of good reasons why weight training appeals to so many males and females and why it is rapidly becoming one of the most popular methods of maintaining fitness. Researchers agree that many people are dissatisfied with the shape of their bodies. Weight training not only allows individuals to target specific muscle groups, it also allows them to dictate the type of change the muscle will make. As you read this text, you will learn that different patterns of lifting can cause different changes in the muscle being exercised.

If you are the type of person who discourages easily and must see observable gains, then weight training should be your cup of tea. The serious weight trainer can often measure gains after only a few short weeks. Since it is customary to keep close records of the amount of weight lifted for each exercise, you will be able to see exactly how much progress you are making in developing strength, tone, or muscle size. The sport also allows nearly limitless variations in the workout as

the weight trainer varies his or her exercises to make the specific changes desired. The large "menu" of lifts and lifting patterns available should guarantee that you will never become bored with your workout.

In addition, since weight training involves simple movements which target specific muscle groups, you can begin to experience success early in your training. This cannot be said of other sports such as tennis or golf, which require years of practice before an individual can participate at a competitive level. And, unlike sports such as softball or basketball, you don't need to form a team to enjoy the benefits of a good weight training workout.

Another appealing feature of the sport is the limited amount of equipment needed. Of course, some of the machines pictured in this book are very expensive; however, a simple set of weights and bar will allow you to engage in an excellent program at a very modest cost.

If, on the other hand, you are already a serious competitor in another sport, weight training can improve your performance. A large volume of literature provides substantial proof that proper weight training techniques can improve your ability to compete. In fact, it is now commonly accepted in most sports that, given equal skill levels, the stronger athlete will be more successful.

Women should recognize that weight training can increase bone density and muscle strength. In fact, studies have shown that resistance exercise performed on a regular basis can reduce the levels of bone loss often reported in women as they age. And while on the subject of aging, senior citizens should also recognize the benefits that they can derive from this sport. Recent studies have shown that persons as old as ninety years of age can significantly increase their strength and mobility with regular weight training. A weight training program is now considered by many experts to be of more benefit to our older population than aerobic exercise, since stronger muscles can help the elderly to maintain balance and prevent falls. Once you have decided to begin lifting, you are involved in a true "lifetime" sport—and it's never too late to start!

ORIGIN OF WEIGHT TRAINING

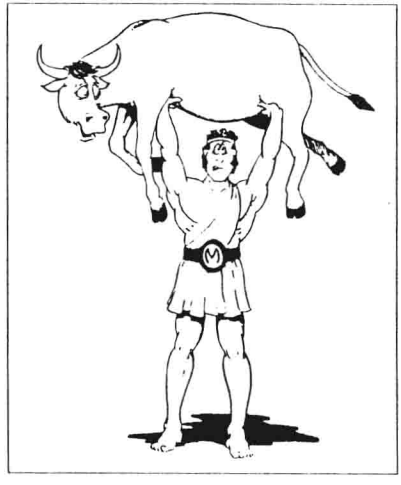
Prehistoric man, most likely, had no need to weight train. In the hostile environment where he existed, the development of a

strong, fit body was not a decision, but a necessity. Primitive life required hunting and gathering with the most inefficient of tools. Physical exercise and strength were necessary just to survive.

As humans developed civilizations with domesticated animals and improved tools, the physical requirements placed upon them were greatly reduced but they maintained their fascination with the human form. Paintings and sculptures from the early Egyptians and, especially, the Greeks, depicted athletes and their performances. City-states such as Sparta and Athens produced art depicting the perfect human body, attesting to the importance they placed on fitness. In addition, the great heroic figures depicted in their poems and stories, such as Achilles and Hercules, possessed strength beyond that of normal men, and it was this quality that made them heroes.

The members of these early civilizations understood the connection between fitness and exercise. In fact, the word *gymnasium* is derived from the Greek *gymnasion,* a place for exercise.

Possibly the most famous of these early lifters was Milo of Crotona. This incredible athlete was one of the first to practice progressive weight training. He did so by lifting a calf several times a week. As the calf grew and added weight, Milo also adjusted by building his muscle strength until eventually he was the only human strong enough to handle the fully grown beast.



It is said that Milo's pride and strength ultimately caused his death. The story goes that the strong man was going through a deep forest and noticed a wedge deeply imbedded in a tree stump. Accepting the stump as a challenge, he attempted to tear it apart with his bare hands. However, as the wedge fell out, his hand or hands became caught in the vacated crack and he was unable to free himself. The tale has it that the animals of the forest eventually devoured him at the scene of his entrapment.

The earliest recorded weight training objects were dumbbell-like devices developed by the Greeks and called *halters.* The Irish had their own method which consisted of lifting huge boulders. Perhaps this is why Julius Caesar is reputed to have once said, "Forget Ireland; the Irish are wild men and will never make good slaves."

The term *dumbbell* is believed to have originated in England in the 1600s. The original versions were constructed by mounting regular bells, without clappers, on each end of an axe handle or stick—hence the term *dumb bell.*

About 1728, John Paugh, another early weight trainer, decided that apparatus involving dumbbells would be a valuable training aid. This concept was later adapted by Frederick Jahn, who founded the German gymnastics and strength movement.

This organization was later transplanted to America in the 1800s by migrating Germans and became known as the Turner Society, serving as a forerunner to the YMCA movement.

During the later 1800s, George Hackensmidt of Germany, who bent coins with his fingers, and other strong men like Eugene Sandow and Arthur Saxon performed in circuses and on stage. Unfortunately, many of these old time strength merchants did not present a desirable public image due to their being extremely fat. Because of this and the environment usually associated with weight lifting, the public indicated little interest in the sport during this era.

Undoubtedly the first Olympic games in 1896, and the succeeding games contributed greatly to the rising popularity of weight lifting and weight training. Until World War II, weight training continued to attract only a few professional strong men and a small group of competitive weight lifters.

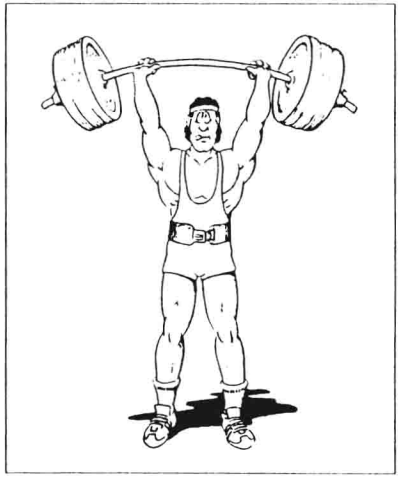
The man most responsible for correcting these misconceptions was T.L. DeLorme, an American army doctor. DeLorme, while working with soldiers requiring physical rehabilitation, introduced weight training equipment and techniques. The results of his rehabilitation program caused the medical profession to change its opinions about weight training. This in turn led to acceptance by coaches and physical educators.

Thanks to the continued work of strength coaches, physical educators and exercise physiologists, strength training has become an integral part of all competitive sports. It is well known that

resistance training can reduce the length of time necessary to recover from sports injuries and, in many instances, prevent their occurrence. One need only look at the number of gyms currently in operation in the United States and Europe to recognize that weight training is now an accepted form of physical exercise and has become an integral part of many lifestyles. The reason for this is simple—it works!

WEIGHT TRAINING TODAY

As late as the 1950s, weight training was confined to a select group of competitive lifters and bodybuilders. Weights were avoided by the general public as well as competitive athletes because of an unwarranted fear of becoming "muscle bound." With the advent of aerobic conditioning by Cooper in the 1960s, Americans became aware of the link between regular aerobic exercise, cardiovascular health, and weight control. A logical progression has led us to an understanding of the benefits offered by a regular weight training program.



Today's weight trainers can be classified into six basic categories:

Weight Lifters. Weight lifters are competitive performers with a primary interest in developing the techniques necessary for the two lifts used in Olympic competition—the two–hand snatch and the two–hand clean and jerk. They usually work at close to maximum resistance and rarely do more than three repetitions of any exercise at a given time. These athletes concentrate on extreme speed during each movement pattern. This is necessary since the competitive event requires the athlete to accelerate the weight as quickly as possible in order to complete the lift.

Power Lifters. These lifters have similar goals to those of the Olympic weight lifter. Their lifts are performed at high speed during

competition, and training consists of few repetitions using extremely heavy weights. They generally compete in three power lifts—the squat, the bench press, and the dead lift; however, other lifts may be added during competitions called Odd Lifts Meets.

Athletes. A weight lifting program is now an integral part of every athletes training, regardless of the level of competition. There is considerable information proving that regular resistance training can improve athletic competition. It is important to remember that the lifts chosen should be similar in movement pattern and physiological demand to those required for the athlete's sport. This will be covered in detail in Chapter 12.

Body Builders. This group is most interested in developing massive musculature and great definition. The goal of their lifting is to sculpt the body by maximizing the size of each muscle, developing perfect balance across each body part, and reducing subcutaneous fat to maximize definition. This requires hours of lifting since a large number of exercises are necessary to target each muscle, and a large volume of work must be done to achieve maximum size and definition.

Patients. There are two basic reasons why doctors prescribe progressive resistance (weight training) exercise for a patient. The most important, from a medical standpoint, is the restoration of strength; however, a patient may be more concerned with his or her appearance rather than ability to function at 100 percent. Fortunately, the two often go hand in hand so that both objectives can be attained at the same time.

Jane and John Doe. This group is probably the largest of all, yet it often remains unnoticed since it is made up of the everyday males and females who lift for health, conditioning and recreation. It includes the high school student who wants to develop larger and more defined muscles, the elderly man or woman who wishes to strengthen muscles and increase bone density, college students who wish to remain fit while completing their studies, the middle-aged man or woman who finds that lifting adds to personal energy and self–image, and the recreational athlete who uses weights to improve performance. This group includes all of you who, for whatever reason, have chosen to begin a weight training program. The remainder of this book is dedicated to presenting the information necessary to help you accomplish this goal. All you need to do is read, and **hit the weights.**

Chapter

2

Scientific Principles

MUSCLE PHYSIOLOGY

To develop an understanding of how weight training works, it is essential to recognize the physiological principles on which it is based.

MUSCLE STRUCTURE

The muscle itself is composed of a number of individual protein building blocks which allow it to conduct electricity and contract. Of all the organs in the body, this is probably the clearest example of a pure structure–function relationship. This means that the structures of its proteins are perfectly suited for its job—to contract and make bones move.

Muscle is primarily composed of two amazing proteins, myosin and actin. When these two proteins come together, they cause both the release of energy for contraction and the mechanical movement itself. It is extremely interesting to examine the process of contraction, and it should help you to appreciate the changes you can make in this fascinating organ we call muscle.

MUSCLE FIBER

Each muscle is composed of many thousands of individual cells called muscle fibers. Each fiber is the thickness of fine thread

and has its own separate nerve and contractile mechanism. Any changes in the strength and speed of a muscle are controlled by changes in each of these fibers.

All muscle fibers are wrapped in a connective tissue sheath which allows them to work as a single unit with the fibers around them. When they are examined under high magnification, they appear striped or "striated" due to the overlapping of their contractile proteins (see Figure 2-1). When viewed under the powerful electron microscope (see Figure 2-2), it can be seen that each fiber is covered with a series of "bumps," which are made up of two very different structures.

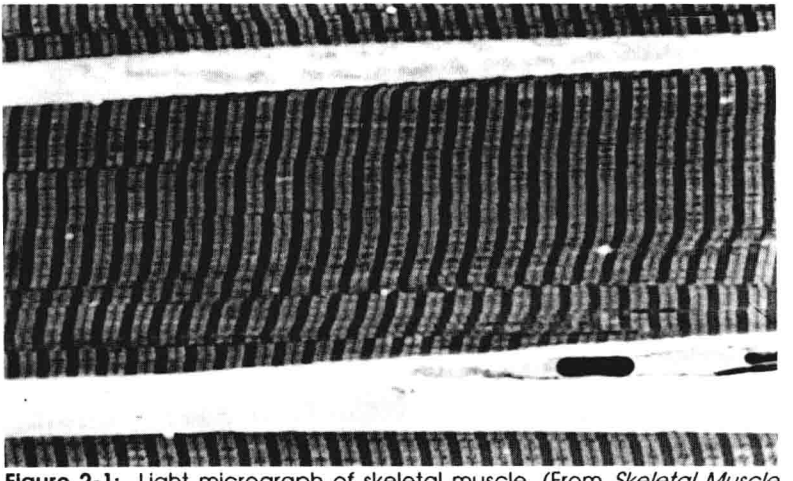


Figure 2-1: Light micrograph of skeletal muscle. (From *Skeletal Muscle Structure and Function*, by R.L. Lieber, Williams and Wilkins: Baltimore, MD. 1992. Used with permission.

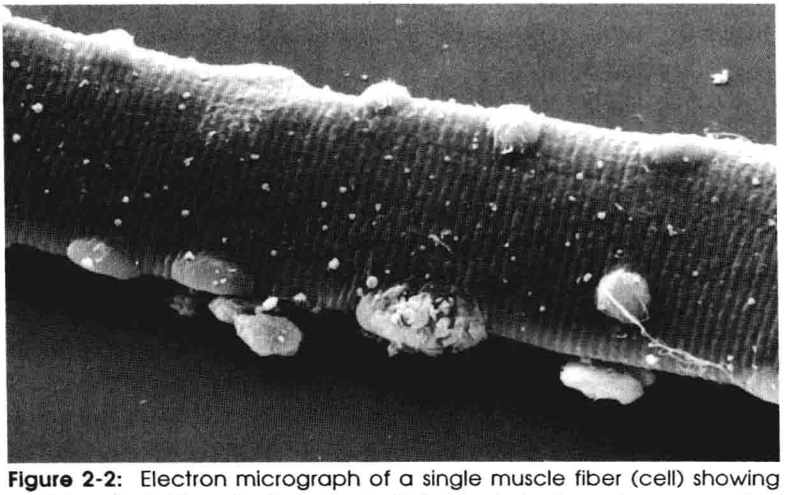


Figure 2-2: Electron micrograph of a single muscle fiber (cell) showing nuclei and satellite cells. (From Bischoff, R., "Analysis of muscle regeneration using single myofibers in culture." *Medicine and Science in Sports and Exercise*. 21(5), 5164-5172, 1989. Used with permission.

One set of "bumps" are the nuclei of the muscle cell. These tiny structures are the designers of the muscle. When you exercise they receive information about the amount of weight you are lifting, how fast you are moving, how long you are performing the activity, and all the other factors involved. They use your needs to make the molds on which new proteins are produced. If you look at the number of nuclei on the muscle, and you realize that most other cells in the body have only one, you can appreciate how quickly and efficiently your muscles can change in response to the exercise you perform. This is biological "supply and demand," where you make the muscle work a certain way (demand) and it changes according to your wishes (supply).

The second set of "bumps" are a series of cells on the outside of the muscle called satellite cells. These can best be described as immature muscle cells that develop into fibers when there is damage to the muscle. The possible contributions of satellite cells during training will be described later in this chapter.

Inside the Fiber

As stated earlier, the two major proteins which make up muscle are actin and myosin (see Figure 2-3). Actin looks something like a twisted strand of rope, and myosin is shaped like your arm with a hand which can bind to actin, and a wrist and elbow which can

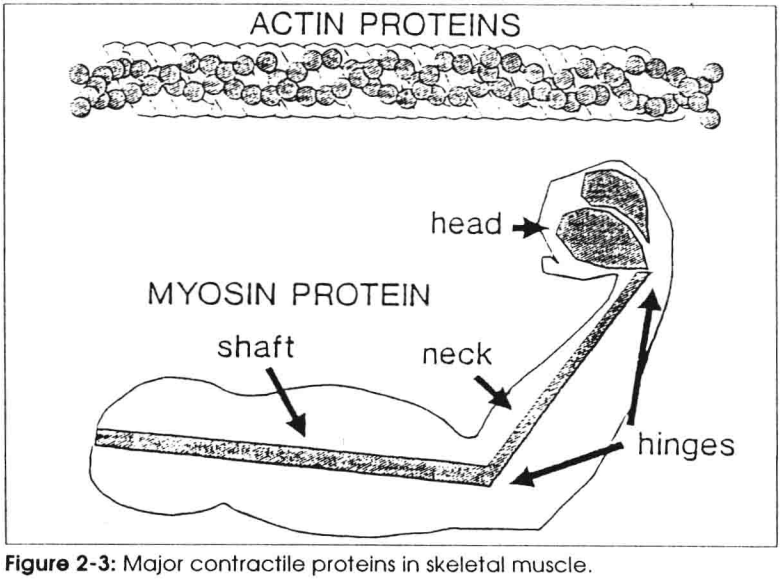


Figure 2-3: Major contractile proteins in skeletal muscle.

bend and pull the actin. To understand the way this works, imagine holding ropes on each side of your body and crossing your arms as you pull them in. The ropes would literally slide across you and anything attached to the ends of them would move closer together. If you tie a whole series of these ropes together, and have each in the hands of a separate person, all the people would move together and the overall distance between them would be greatly reduced. This is what happens to the proteins in your muscle when it contracts.

It should now become obvious that the more lines of people you have, and the more ropes you can pull, the more weight you can move. This is what happens as your muscle fiber grows during weight training. This growth is called **hypertrophy.**

Energy And Structure

The energy which allows the myosin "arms" to pull the actin "rope" is provided by a number of different systems depending on the activity. If you perform repeated activity at very low resistance, such as running or swimming, the muscle uses fats and carbohydrates and "burns" them in the presence of oxygen (aerobic). To accomplishment this, the muscle fiber must have:

1. a large number of blood vessels (capillaries) which supply the oxygen;
2. a large number of powerhouses (the mitochondria) which use this oxygen to burn the fuel;
3. thin fibers to allow the oxygen to easily pass (diffuse) into the muscle.

On the other hand, if you perform mostly heavy resistance short–term exercise, the muscle fiber produces systems which don't require oxygen (anaerobic). In this case, the muscle fiber has different needs which require different changes:

1. much thicker fibers to stand up to the higher weights;
2. structures which can break down carbohydrates very quickly to allow greater speed of movement (glycolytic enzymes).

Exercise scientists can examine muscle fibers and determine their properties by looking at their structure. This allows them to classify the muscles into various groups such as:

Slow Oxidative—having slow contractile speeds but the ability to contract for long periods of time with little fatigue due to their ability to use oxygen.

Fast Glycolytic—having fast contractile speed and very high force production but fatiguing very rapidly due to their poor oxygen delivery and utilization.

Fast Oxidative Glycolytic—having moderately fast contractile speed with moderately high oxygen delivery and utilization, and therefore, fair resistance to fatigue.

Although we don't know if human muscle can change from one muscle type to another during training, one thing is clear: muscle fibers can change their structure extensively in response to training. This ability to change makes weight training rewarding.

Muscle Plasticity And Training

Muscle is said to have a great deal of plasticity. Obviously this doesn't mean that it's made out of the same material as your typical model airplane or toy doll. What it does mean is that muscle has a tremendous ability to change structure and thus change function (recall the structure–function relationship).

If we force the muscle to do more work than it normally does (overload), over a period of time it will make the exact changes (specific adaptations) which the exercise demands. This is called **training.** For the muscle to continue to improve, it must be continuously overloaded as it adapts. In weight training, this usually involves increasing the weight as you improve. This is called "progressive resistance."

Specificity Of Training And Change

We can control five basic factors to force our muscles to change exactly as we wish—this is called specificity of training. Once you know what these factors are and how they affect your muscles, you can make the exact changes you desire.

The five variables are:

1. **Intensity.** How heavy is the weight you will lift?
2. **Frequency.** How many times a week will you workout?
3. **Duration.** How many exercises will you do? How many times will you do one complete movement (a repetition or "rep")? And, how many "sets" of reps will you do?
4. **Speed.** How fast will you move?
5. **Specificity.** What muscle will you target and what will you ask it to do?

Putting It All Together

Let's take a few examples using all the information presented above. You decide to lift a heavy weight, let's say 85 percent of your maximum. You do five repetitions, rest, do five more, rest and do a final set of five. What message is sent to your muscle, what change does it make, and how does it make that change?

Eighty–five percent of your maximum lift is fairly heavy; therefore, the nuclei of the muscle receive a message that says: "Make more actin and myosin—we've got a lot of weight to move." However, five repetitions take a fairly short time to complete. This sends a second message to the nuclei: "We don't need to use a lot of oxygen here—spend your time making the muscle larger, not better at delivering and using oxygen." Therefore, the changes made by the muscle would be to increase in size so it could produce more force, but not to expend a lot of its energy in making the structures that deliver and use oxygen.

If we look at the other extreme, where you decide to lift 50 percent of your maximum for three sets of twenty-five repetitions, as you can guess, two very different messages are sent. First: "This isn't too much weight, we still need to increase size, but not very much." And second: "This is taking a fairly long time so we need to make a better oxygen delivery and utilization system." In this case, the muscle would show a more limited increase in size, but much better endurance properties. Exercise scientists can actually measure this change in endurance by counting the number of mitochondria (those little "powerhouses"). He or she can also predict the speed of contraction of the muscle by measuring its levels of glycolytic enzymes (fast proteins).

These principles work no matter what changes you desire. The purpose of this text is to teach you which exercises affect certain muscles and how to vary your workout to get the exact changes you want.

How Do Your Muscles Grow?

We have now examined the changes that are possible and why they happen, but one final question remains: How do they happen? There are two ways in which a muscle can grow—the first, hypertrophy, has already been mentioned. *Hyper* means *exces-*