Muscle Contraction Theory

What really happens when muscles contract? How does it occur and what can individual exercisers do to control it or enhance it? Those are all questions that need to be answered if we are to understand the mechanisms behind human performance. First we must understand the structure of the basic muscular system in order to make sense of how it operates. In short, all a muscle can do is get shorter or longer, and since the muscle is attached to bone, the result is movement of our limbs.

Structure

The muscle is really made up of many thousands of microscopic fibers called filaments. However, that is getting too far ahead of the picture. We will return to filaments later but let's begin our search at the large level that is visible to the naked eye. The Muscle we see on the surface is primarily a long cylinder, tapering at both ends where it attaches to tendon. If we look further inside, we see that this muscle is comprised of several bundles of even smaller groups of similar objects called Fascicles. A look inside a single fascicle reveals several yet smaller groups of bundled objects, called Myofibrils, which are in turn made up of even smaller objects—the Filaments mentioned earlier. The filaments are long string-like microscopic structures divided into even smaller pieces called Sarcomeres, which are stacked end to end along the entire length of the muscle. There are literally hundreds of thousands of sarcomeres and they are made up of tiny opposing fingerlike projections called Actin and Myosin. Finally then, actin and myosin make up the basic contracting fibers that cause the entire muscle to shorten. Hundreds or thousands of these single muscle fibers are grouped together and controlled by one nerve ending which are collectively called a Motor Unit.

Mechanism

The previous description may sound complicated but it really only takes a few simple steps to achieve muscular contraction. First, an electrical signal called an Action Potential is sent from the brain to the motor unit it wishes to contract. When the signal reaches the motor unit the signal enters the fibers, causing the release of calcium. Calcium then allows the actin and myosin fingerlike projections to combine and pull against one another, which causes the filaments to slide past one another and thereby shorten. This process is known as the "Sliding Filament Theory" and is the predominant theory governing muscular contraction. Of course this process requires some type of fuel but that is another column on another day.

Conclusion

It should be apparent from the preceding description that muscular contraction involves both a neural and a physical event. In this way the system may be regulated from either side. A greater number of brain signals will cause a more forceful contraction, and likewise, a greater number of muscle fibers will result in more applied force. Different muscle fiber types will respond to brain signals in a specific manner and will require training specific to the outcome. In the next column we will discuss training the physical portion of the contraction system, specifically how it relates to muscle hypertrophy and gaining size through resistance training.
References

About the Author
Lee E. Brown, Ed.D., EPC, CSCS,*D, is Assistant Professor and Director of the Human Performance Laboratory at Arkansas State University. He received his Doctorate at Florida Atlantic University, where he was Health Sciences Lab Coordinator. Dr. Brown is a Fellow of the American College of Sports Medicine, a USAW Certified Club Coach and a Certified Strength and Conditioning Specialist with Distinction (CSCS,*D) with the NSCA. He will be exploring topics of human physiology each month in this column.