7.4.3

Types of Muscle Contraction

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Muscle contractions are described based on two variables: force (tension) and length (shortening). When the tension in a muscle increases without a corresponding change in length, the contraction is called an **isometric contraction** (iso = same, metric=length). Isometric contractions are important in maintaining posture or stabilizing a joint. On the other hand, if the muscle length changes while muscle tension remains relatively constant, then the contraction is called an **isotonic contraction** (tonic = tension). Furthermore, isotonic contractions can be classified based on how the length changes. If the muscle generates tension and the entire muscle shortens than it is a **concentric contraction**. An example would be curling a weight from your waist to your shoulder; the bicep muscle used for this motion would undergo a concentric contraction. In contrast, when lowering the weight from the shoulder to the waist the bicep would also be generating force but the muscle would be lengthening, this is an **eccentric contraction**. Eccentric contractions work to decelerate the movement at the joint. Additionally, eccentric contractions can generate more force than concentric contractions. Think about the large box you take down from the top shelf of your closet. You can lower it under total control using eccentric contractions but when you try to return it to the shelf using concentric contractions you cannot generate enough force to lift it back up. Strength training, involving both concentric and eccentric contractions, appears to increase muscle strength more than just concentric contractions alone. However, eccentric contractions cause more damage (tearing) to the muscle resulting in greater muscle soreness. If you have ever run downhill in a long race and then experienced the soreness in your quadriceps muscles the next day, you know what we are talking about.

Muscle size is determined by the number and size of the myofibrils, which in turn is determined by the amount of myofilament proteins. Thus, resistance training will induce a cascade of events that result in the production of more proteins. Often this is initiated by small, micro-tears in and around the muscle fibers. If the tearing occurs at the myofibril level the muscle will respond by increasing the amount of proteins, thus strengthening and enlarging the muscle, a phenomenon called hypertrophy. This tearing is thought to account for the muscle soreness we experience after a workout. As mentioned above, the repair of these small tears results in enlargement of the muscle fibers but it also results in an increase in the amount of connective tissue in the muscle. When a person "bulks up" from weight training, a significant percentage of the increase in the size of the muscle is due to increases in the amount of connective tissue. It should be pointed out that endurance training does not result in a significant increase in muscle size but increases its ability to produce ATP aerobically.