PHYSIOLOGIC RESPONSES AND LONG-TERM ADAPTATIONS TO EXERCISE

Respiratory Responses to Exercise

Pulmonary ventilation increases almost immediately, largely through stimulation of the respiratory centres in the brain stem from the motor cortex and through feedback from the proprioceptors in the muscles and joints of the active limbs. During prolonged exercise, or at higher rates of work, increases in CO_2 production, hydrogen ions (H^+), and body and blood temperatures stimulate further increases in pulmonary ventilation. At low work intensities, the increase in ventilation is mostly the result of increases in tidal volume. At higher intensities, the respiratory rate also increases. In normal-sized, untrained adults, pulmonary ventilation rates can vary from about 10 liters per minute at rest to more than 100 liters per minute at maximal rates of work; in large, highly trained male athletes, pulmonary ventilation rates can reach more than 200 liters per minute at maximal rates of work

Resistance Exercise

The cardiovascular and respiratory responses to episodes of resistance exercise are mostly similar to those associated with endurance exercise. One notable exception is the exaggerated blood pressure response that occurs during resistance exercise. Part of this response can be explained by the fact that resistance exercise usually involves muscle mass that develops considerable force. Such high, isolated force leads to compression of the smaller arteries and results in substantial increases in total peripheral resistance (Coyle 1991). Although high-intensity resistance training poses a potential risk to hypertensive patients and to those with cardiovascular dis⍰ease, research data suggest that the risk is relatively low (Gordon et al. 1995) and that hypertensive persons may benefit from resistance training (Tipton 1991; American College of Sports Medicine 1993).

Skeletal Muscle

Adapted from Wilmore JH, Costill DL. Physiology of sport and exercise. Champaign, IL: Human Kinetics, 1994,
https://www.cdc.gov/nccdphp/sgr/pdf/chap3.pdf

The primary purpose of the musculoskeletal system is to define and move the body. To provide efficient and effective force, muscle adapts to demands. In response to demand, it changes its ability to extract oxygen, choose energy sources, and rid itself of waste products. The body contains three types of muscle tissue: skeletal (voluntary) muscle, cardiac muscle or myocardium, and smooth (autonomic) muscle. This section focuses solely on skeletal muscle. Skeletal muscle is composed of two basic types of muscle fibers distinguished by their speed of contraction—slow-twitch and fast-twitch—a characteristic that is largely dictated by different forms of the enzyme myosin adenosinetriphosphatase (ATPase). Slow-twitch fibers, which have relatively slow contractile speed, have high oxidative capacity and fatigue resistance, low glycolytic capacity, relatively high blood flow capacity, high capillary density, and high mitochondrial content (Terjung 1995). Fasttwitch muscle fibers have fast contractile speed and are classified into two subtypes, fast-twitch type “a” (FTa) and fast-twitch type “b” (FTb). FTa fibers have moderately high oxidative capacity, are relatively fatigue resistant, and have high glycolytic capacity, relatively high blood flow capacity, high capillary density, and high mitochondrial content (Terjung 1995). FTb fibers have low oxidative capacity, low fatigue resistance, high glycolytic capacity, and fast contractile speed. Further, they have relatively low blood flow capacity, capillary density, and mitochondrial content (Terjung 1995). There is a direct relationship between predominant fiber type and performance in certain sports. For example, in most marathon runners, slow-twitch fibers account for up to or more than 90 percent of the total fibers in the leg muscles. On the other hand, the leg muscles in sprinters are often more than 80 percent composed of fast-twitch fibers. Although the issue is not totally resolved, muscle fiber type appears to be genetically determined; researchers have shown that several years of either high-intensity sprint training or high-intensity endurance training do not significantly alter the percentage of the two major types of fibers (Jolesz and Sreter 1981)

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