UNIT 1---- CONTINUED

Long-Term Adaptations to Exercise Training

Respiratory Adaptation

The major changes in the respiratory system from endurance training are an increase in the maximal rate of pulmonary ventilation, which is the result of increases in both tidal volume and respiration rate, and an increase in pulmonary diffusion at maximal rates of work, primarily due to increases in pulmonary blood flow, particularly to the upper regions of the lung.

Metabolic Adaptations

Significant metabolic adaptations occur in skeletal muscle in response to endurance training. First, both the size and number of mitochondria increase substantially, as does the activity of oxidative enzymes. Myoglobin content in the muscle can also be augmented, increasing the amount of oxygen stored in individual muscle fibers (Hickson 1981), but this effect is variable (Svedenhag, Henriksson, Sylvén 1983). Such adaptations, combined with the increase in capillaries and muscle blood flow in the trained muscles (noted in a previous section), greatly enhance the oxidative capacity of the endurance-trained muscle. Endurance training also increases the capacity of skeletal muscle to store glycogen (Kiens et al. 1993). The ability of trained muscles to use fat as an energy source is also improved, and this greater reliance on fat spares glycogen stores (Kiens et al. 1993). The increased capacity to use fat following endurance training results from an enhanced ability to mobilize free-fatty acids from fat depots and an improved capacity to oxidize fat consequent to the increase in the muscle enzymes responsible for fat oxidation (Wilmore and Costill 1994)

These changes in muscle and in cardiorespiratory function are responsible for increases in bothVO˙ 2 max and lactate threshold. The endurance-trained person can thus perform at considerably higher rates of work than the untrained person. Increases in VO˙ 2max generally range from 15 to 20 percent following a 6-month training period (Wilmore and Costill 1994). However, individual variations in this response are considerable. In one study of 60- to 71-year-old men and women who endurance trained for 9 to 12 months, the improvement in VO˙ 2 max varied from 0 to 43 percent; the mean increase was 24 percent (Kohrt et al. 1991). This variation in response may be due in part to genetic factors and to initial levels of fitness. To illustrate the changes that can be expected with endurance training, a hypothetical sedentary man’s pretraining values have been compared with his values after a 6-month period of endurance training and with the values of a typical elite endurance runner

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

Responses to endurance training are similar for men and women. At all ages, women and men show similar gains in strength from resistance training (Rogers and Evans 1993; Holloway and Baechle 1990) and similar gains in $\dot{V}O_2$ max from aerobic endurance training (Kohrt et al. 1991; Mitchell et al. 1992).

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