UNIT 1---- CONTINUED

Metabolic Rate

The rate at which the body uses energy is known as the metabolic rate. When measured while a person is at rest, the resulting value represents the lowest (i.e., basal) rate of energy expenditure necessary to maintain basic body functions. Resting metabolic rate is measured under highly controlled resting conditions following a 12-hour fast and a good night's sleep (Turley, McBride, Wilmore 1993). To quantify the rate of energy expenditure during exercise, the metabolic rate at rest is defined as 1 metabolic equivalent (MET); a 4 MET activity thus represents an activity that requires four times the resting metabolic rate. The use of METs to quantify physical activity intensity is the basis of the absolute intensity scale.

Maximal Oxygen Uptake

During exercise,VO2 increases in direct proportion to the rate of work. The point at which a person'sVO2 is no longer able to increase is defined as the maximal oxygen uptake (˙VO2 max) . A person's ˙VO2max is in part genetically determined; it can be increased through training until the point that the genetically possible maximum is reached. VO ˙ 2max is considered the best estimate of a person's cardiorespiratory fitness or aerobic power (Jorgensen et al. 1977).

Lactate Threshold

Lactate is the primary by-product of the anaerobic glycolytic energy system. At lower exercise intensities, when the cardiorespiratory system can meet the oxygen demands of active muscles, blood lactate levels remain close to those observed at rest, because some lactate is used aerobically by muscle and is removed as fast as it enters the blood from the muscle. As the intensity of exercise is increased, however, the rate of lactate entry into the blood from muscle eventually exceeds its rate of removal from the blood, and blood lactate concentrations increase above resting levels. From this point on, lactate levels continue to increase as the rate of work increases, until the point of exhaustion. The point at which the concentration of lactate in the blood begins to increase above resting levels is referred to as the lactate threshold. Lactate threshold is an important marker for endurance performance, because distance runners set their race pace at or slightly above the lactate threshold (Farrell et al. 1979). Further, the lactate thresholds of highly trained endurance athletes occur at a much higher percentage of theirVO2 max, and thus at higher relative workloads, than do the thresholds of untrained persons. This key difference is what allows endurance athletes to perform at a faster pace.

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

Hormonal Responses to Exercise

The endocrine system, like the nervous system, integrates physiologic responses and plays an important role in maintaining homeostatic conditions at rest and during exercise. This system controls the release of hormones from specialized glands throughout the body, and these hormones exert their actions on targeted organs and cells. In response to an episode of exercise, many hormones, such as catecholamines, are secreted at an increased rate, though insulin is secreted at a decreased rate .

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Hormone	Exercise response	Special relationships	Probable importance
Catecholamines	Increases	Greater increase with intense exercise; norepinephrine > epinephrine; increases less after training	Increased blood glucose; increased skeletal muscle and liver glycogenolysis; increased lipolysis
Growth hormone (GH)	Increases	Increases more in untrained persons; declines faster in trained persons	Unknown
Adrenocorticotropic hormone (ACTH)-cortisol	Increases	Greater increase with intense exercise; increases less after training with submaximal exercise	Increased gluconeogenesis in liver; increased mobilization of fatty acids
Thyroid-stimulating hormone (TSH)-thyroxine	Increases	Increased thyroxine turnover with training but no toxic effects are evident	Unknown
Luteinizing hormone (LH)	No change	None	None
Testosterone	Increases	None	Unknown
Estradiol-progesterone	Increases	Increases during luteal phase of the menstrual cycle	Unknown
Insulin	Decreases	Decreases less after training	Decreased stimulus to use blood glucose
Glucagon	Increases	Increases less after training	Increased blood glucose via glycogenolysis and gluconeogenesis
Renin-angiotensin-aldosterone	Increases	Same increase after training in rats	Sodium retention to maintain plasma volume
Antidiuretic hormone (ADH)	Expected increase	None	Water retention to maintain plasma volume
Parathormone (PTH)-calcitonin	Unknown	None	Needed to establish proper bone development
Erythropoietin	Unknown	None	Would be important to increase erythropoiesis
Prostaglandins	May increase	May increase in response to sustained isometric contractions; may need ischemic stress	May be local vasodilators

Adapted from Wilmore JH, Costill DL. *Physiology of sport and exercise*. Champaign, IL: Human Kinetics, 1994, p. 136.

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