Chapter 5

Hormonal Responses to Exercise

Objectives

1. Describe the concept of hormone-receptor interaction.
2. Identify the four factors influencing the concentration of a hormone in the blood.
3. Describe the mechanism by which steroid hormones act on cells.
4. Describe the “second messenger” hypothesis of hormone action.
5. Describe the role of hypothalamus-releasing factors in the control of hormone secretion from the anterior pituitary gland.

Objectives

6. Describe the relationship of the hypothalamus to the secretion of hormones from the posterior pituitary gland.
7. Identify the site of release, stimulus for release, and the predominate action of the following hormones: epinephrine, norepinephrine, glucagon, insulin, cortisol, aldosterone, thyroxine, growth hormone, estrogen, and testosterone.
8. Discuss the use of testosterone (an anabolic steroid) and growth hormone on muscle growth and their potential side effects.

Objectives

9. Contrast the role of plasma catecholamines with intracellular factors in the mobilization of muscle glycogen during exercise.
10. Graphically describe the changes in the following hormones during graded and prolonged exercise and discuss how those changes influence the four mechanisms used to maintain the blood glucose concentration: insulin, glucagon, cortisol, growth hormone, epinephrine, and norepinephrine
11. Describe the effect of changing hormone and substrate levels in the blood on the mobilization of free fatty acids from adipose tissue.

Neuroendocrinology

Blood Hormone Concentration

- Determined by:

Factors That Influence the Secretion of Hormones

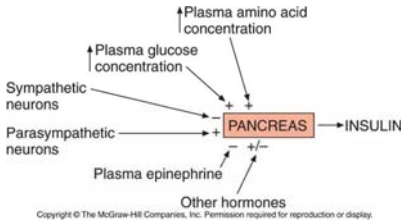

Figure 5.1

Hormone-Receptor Interactions

Mechanisms of Hormone Action

- Altering membrane transport
- Stimulating DNA to increase protein synthesis
- Activating second messengers via G protein

Mechanism of Steroid Hormone Action

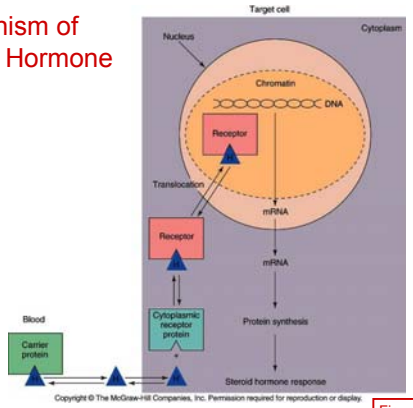

Figure 5.2

Cyclic AMP "Second Messenger" Mechanism

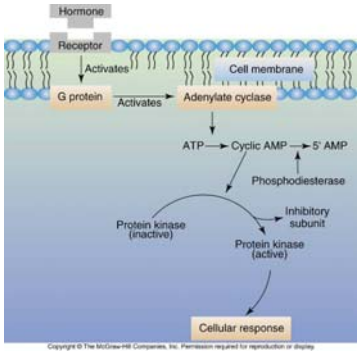

Figure 5.3

Calcium and Phospholipase C Second Messenger Mechanisms

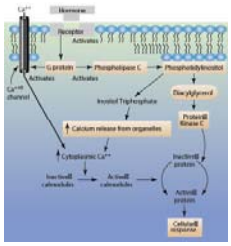

Figure 5.4

Hormones: Regulation and Action

- Hormones are secreted from endocrine glands
  - Hypothalamus and pituitary glands
  - Thyroid and parathyroid glands
  - Adrenal glands
  - Pancreas
  - Testes and Ovaries

Hypothalamus and Pituitary Gland

- Hypothalamus
  - Controls secretions from pituitary gland
- Anterior Pituitary Gland
  - Adrenocorticotropic hormone (ACTH)
  - Follicle-stimulating hormone (FSH)
  - Luteinizing hormone (LH)
  - Melanocyte-stimulating hormone (MSH)
  - Thyroid-stimulating hormone (TSH)
  - Growth hormone (GH)
  - Prolactin
- Posterior Pituitary Gland
  - Oxytocin
  - Antidiuretic hormone (ADH)

Hormones Released From the Anterior Pituitary Gland

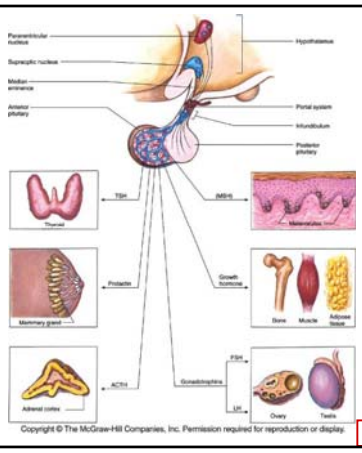

Figure 5.5

Growth Hormone (GH)

- Secreted from the anterior pituitary gland

The Influence of the Hypothalamus on GH Secretion

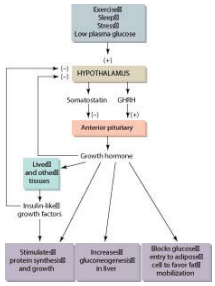

Figure 5.6

Antidiuretic Hormone (ADH)

Δ in Plasma ADH Concentration during Exercise

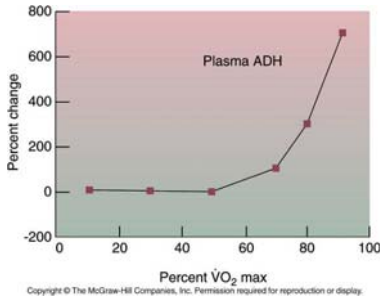

Figure 5.7

Thyroid Gland

- Stimulated by TSH

Adrenal Medulla

- Secretes the catecholamines

Adrenal Cortex

- Aldosterone (mineralcorticoid)

Δ in Renin, Angiotensin II, and Aldosterone during Exercise

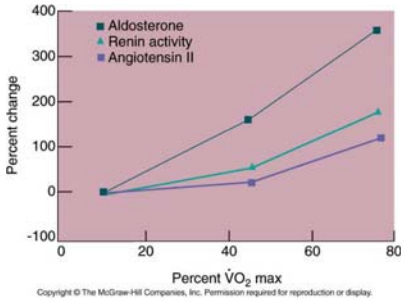

Figure 5.8

Adrenal Cortex

- Cortisol (glucocorticoid)

Control of Cortisol Secretion

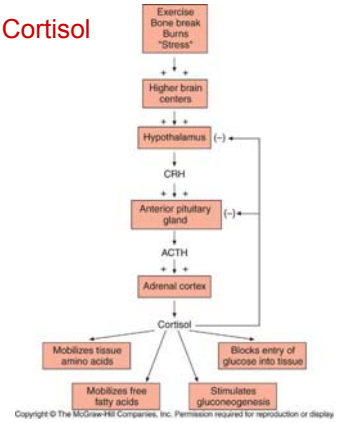

Figure 5.9

Pancreas

- Both exocrine and endocrine functions

Testes and Ovaries

- Testosterone
- Estrogen

Control of Testosterone Secretion

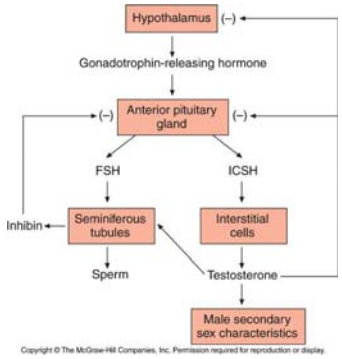

Figure 5.10

Control of Estrogen Secretion

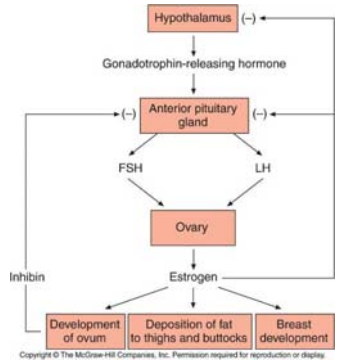

Figure 5.11

Δ in FSH, LH, Progesterone, and Estradiol during Exercise

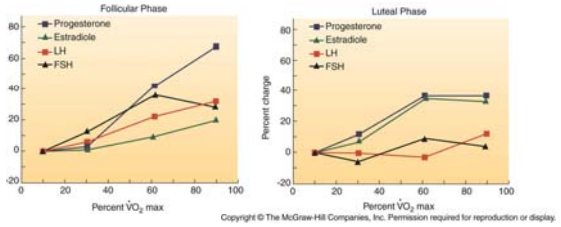

Figure 5.12

Muscle Glycogen Utilization

- Glycogenolysis is related to exercise intensity
- Plasma epi is a powerful simulator of glycogenolysis

Glycogen Depletion during Exercise

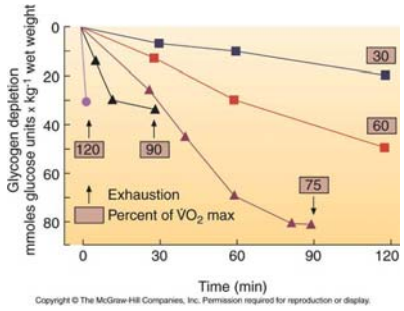

Figure 5.13

Plasma Epi Concentration during Exercise

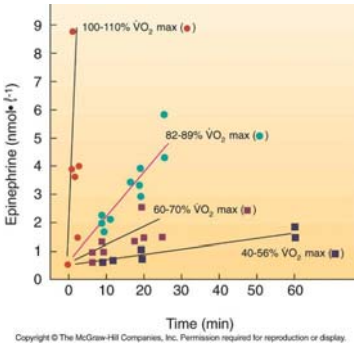

Figure 5.14

Control of Muscle Glycogen Utilization

- Breakdown of muscle glycogen is under dual control
- Evidence for role of Ca^{+2}-calmodulin in glycogenolysis

Control of Glycogenolysis

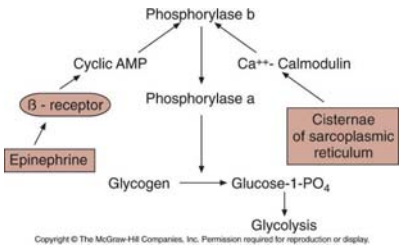

Figure 5.16

Blood Glucose Homeostasis during Exercise

- Plasma glucose maintained through 4 processes:

Permissive and Slow-Acting Hormones

Role of Cortisol in the Maintenance of Blood Glucose

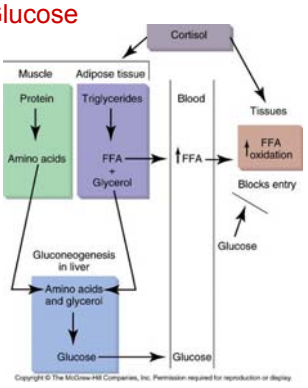

Figure 5.17

Δs in Plasma Cortisol during Exercise

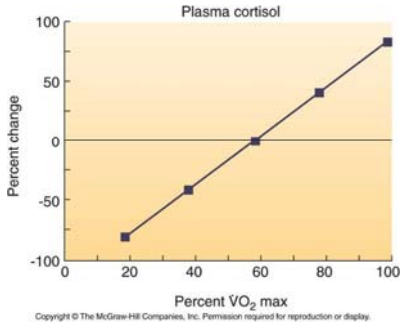

Figure 5.18

Role of GH in the Maintenance of Plasma Glucose

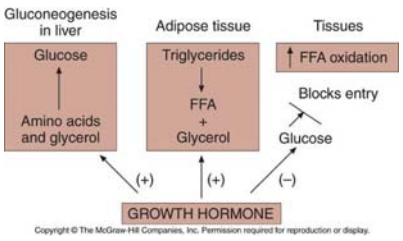

Figure 5.19

Δs in Plasma Growth Hormone during Exercise

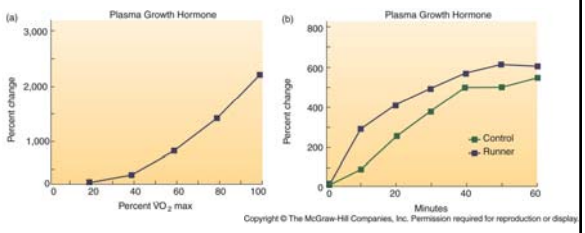

Figure 5.20

Fast-Acting Hormones

Role of Catecholamines in Substrate Mobilization

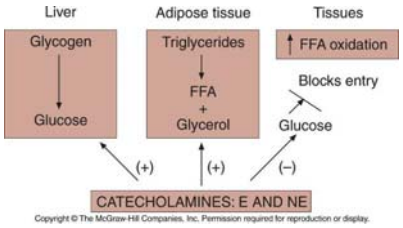

Figure 5.21

Δ in Plasma Epi & NE during Exercise

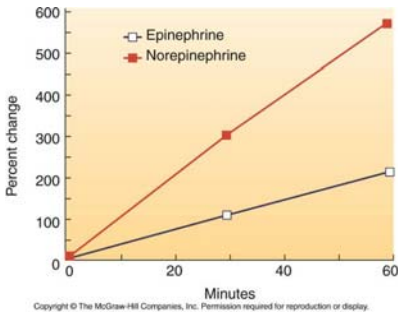

Figure 5.22

Plasma Catecholamines Responses to Exercise Following Training

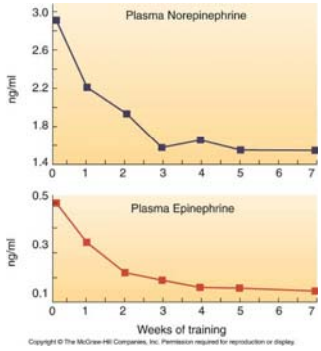

Figure 5.23

Fast-Acting Hormones

Effects of Insulin & Glucagon

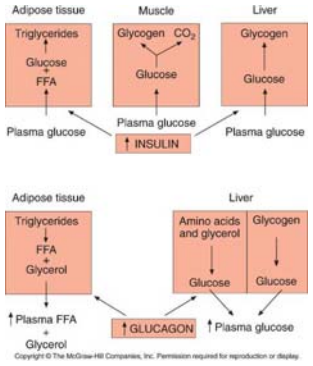

Figure 5.24

Δs in Plasma Insulin during Exercise

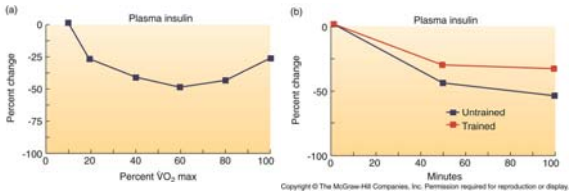

Figure 5.25

Δs in Plasma Glucagon during Exercise

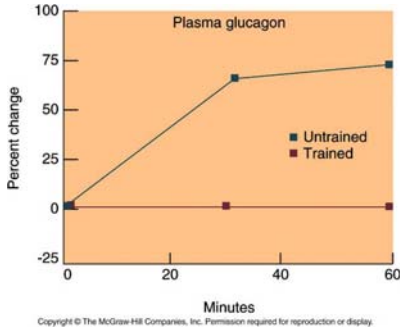

Figure 5.26

Effect of Epi & NE on Insulin & Glucagon Secretion

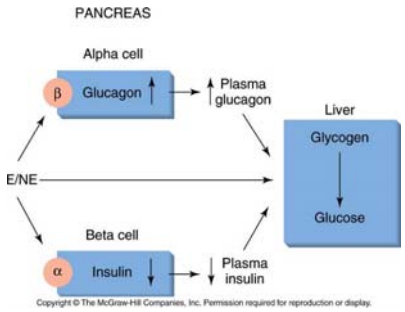

Figure 5.27

Effect of the SNS on Substrate Mobilization

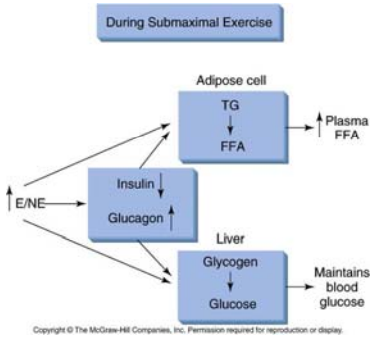

Figure 5.28

Summary of the Hormonal Responses to Exercise

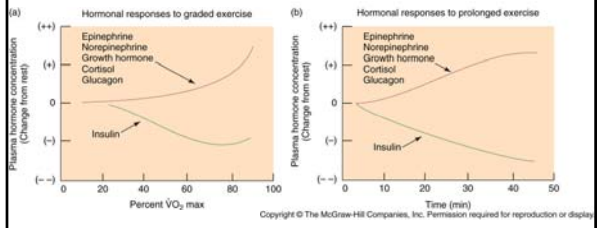

Figure 5.29

Hormone-Substrate Interaction

Δs in Plasma FFA Due to Lactic Acid

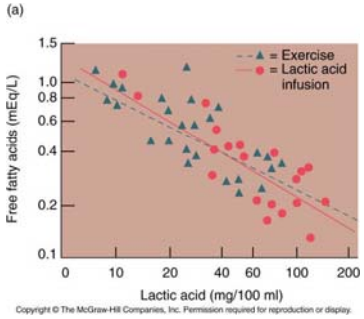

Figure 5.30

Effect of Lactic Acid on FFA Mobilization

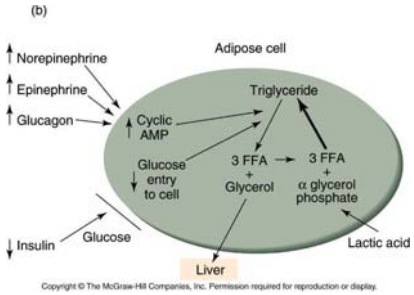

Figure 5.30