Chapter 45: Hormones and the Endocrine System

The Body’s Long-Distance Regulators

- Animal hormones are chemical signals that communicate regulatory messages within the body.
  - Hormones may reach all parts of the body, but only specific target cells respond to specific hormones.
  - Hormones traveling in the bloodstream initiate specific responses from its target cells, while other cell types ignore that particular hormone.

Extracellular fluid ➔ Circulatory System ➔ Chemical Signal

The endocrine and nervous system act individually and together in regulating an animal’s physiology

- All of an animal’s hormone secreting cells comprise of its endocrine system
  - Endocrine glands, also known as ductless glands, secrete chemical messengers directly into the extracellular fluid.
- There is an overlap between the endocrine system and nervous system
  - Neurosecretory cells in the brain release neurohormones into the blood.
- Some chemicals can serve as hormones and signals (e.g., Epinephrine)
- Nervous system controls certain sustained responses through increasing or decreasing secretion from endocrine glands.
- Recall: receptors, control centers, effectors from Chapter 40.
  - In endocrine and neuroendocrine pathways, efferent signal is a hormone/neurohormone which acts on effector tissues, causing specific physiological or developmental changes.
- Simple Hormonal pathways: endocrine, neurohormone, and neuroendocrine pathways
- Feedback loops connect the response to the initial stimulus
  - Negative feedback causes the effector response to reduce the initial stimulus
  - Positive feedback reinforces the stimulus and causes a greater response

Hormones and other chemical signals bind to target cell receptors, initiating pathways that culminate in specific cell responses

- Three classes of molecules function as hormones in vertebrates: proteins, amines, steroids
  - Reaction ➔ Signal Tranduction ➔ Response
- Receptors for most water soluble hormones are embedded in the plasma membrane, alternately, lipid soluble hormones (from steroids, thyroid) have intracellular receptors.
- Hormone+ Receptor ➔ signal transduction pathway: a series of changes in cellular proteins that converts an extracellular chemical signals into a specific intracellular response.
- Paracrine signalling: when local regulators convey messages between neighbouring cells
The hypothalamus and pituitary integrate many functions of the vertebrate endocrine system

- Local regulators can act on target cells within seconds, eliciting cell response faster than that of hormones.
- Important local regulators: cytokines, growth factors, nitric oxide, and prostaglandins

**Never signals → Hypothalamus → endocrine signals**

- The pituitary gland is an endocrine gland at the base of the hypothalamus
  - Consists of two lobes:
    - Posterior lobe stores and releases two hormones (ADH and oxytocin) produced by the hypothalamus
    - Anterior lobe produces and secretes hormones that regulate bodily functions
- Trophic hormones coordinate endocrine signalling throughout the body
- Anterior pituitary releases:
  - Trophic hormones (FSH, LH, TSH, ACTH)
  - FSH and LH are gonadotropins, because they stimulate activities in gonads
  - Non trophic hormones (prolactin, melanocyte stimulating hormone, β-endorphin)
  - One hormone exhibiting hybrid characteristics: Growth hormone

**Nonpituitary hormones help regulate metabolism, homeostasis, development, and behaviour**

- Thyroid gland (two lobes on ventral surface of trachea) produces T<sub>3</sub> and T<sub>4</sub> hormones

**Hypothalamus → TRH → Anterior Pituitary → TSH → Thyroid → T<sub>3</sub> and T<sub>4</sub> → Regulation**

- Control of blood calcium is essential as calcium is needed for normal functioning cells
  - Parathyroid glands (embedded in thyroid), release PTH when Ca<sup>2+</sup> levels fall below 10mg/100mL.
    - PTH stimulates conversion of inactive vitamin D to active vitamin D, which augments effect of PTH
  - Thyroid glands release calcitonin when Ca<sup>2+</sup> levels in blood rise above 10mg/100mL
- Islets of Langerhans in the pancreas produce hormones which regulate blood glucose level
  - Alpha, beta, and delta cells in the islet produce glucagon (raises blood glucose level), insulin (lowers blood glucose level), and somatostatin (inhibit release GH), respectively
  - A deficiency or decreased response of insulin results in Diabetes Mellitus (Type 1 or 2)
- Adrenal glands (adjacent to kidneys) are responsible for stress management
  - Adrenal medulla mediates short term responses to stress by releasing catecholamine hormones: epinephrine and norepinephrine
  - Adrenal cortex secretes corticosteroids (glucocorticoids, mineralocorticoids) to control responses to long term stress
- Gonads release sex hormones: male → androgens, female → estrogen
  - Secretion is controlled by gonadotropins (FSH and LH) from the anterior pituitary gland
- Pineal gland (small tissue near center of brain) secretes the hormone melatonin, which regulates skin pigmentation and biological rhythms associated with reproduction
Chapter 45 Quiz

1. Which body system releases hormones into the bloodstream?
   a) nervous system
   b) digestive system
   c) endocrine system
   d) Both a) and c)

2. Which of the following is responsible for the halt in production of T4 cells as it accumulates in the body?
   a) glycogen
   b) negative feedback
   c) extracellular fluid
   d) positive feedback

3. What occurs first when a hormone binds to its receptor?
   a) a nuclear response
   b) a signal transduction pathway
   c) a cytoplasmic response
   d) β receptors are released

4. Which of the following causes paracrine signalling?
   a) Classic hormones
   b) Neurohormones
   c) Local regulators
   d) Low iron levels

5. Which of the following local regulators helps in the fertilization process?
   a) cytokines
   b) growth factors
   c) nitric oxide
   d) prostaglandins

6. Which of the following is not a gland in the endocrine system?
   a) adrenal
   b) pancreas
   c) colon
   d) thyroid
7. Which of the following cells are not produced in the pancreas?
   a) Alpha cells
   b) Beta cells
   c) Gamma cells
   d) Delta cells

8. Diabetes mellitus is caused by:
   a) high concentration of erythrocytes
   b) decreased response to insulin in target tissues
   c) deficiency of insulin
   d) Both b) and c)

9. Which of the following is not an effect of epinephrine and norepinephrine?
   a) increased blood pressure
   b) increased metabolic rate
   c) decreased blood glucose
   d) All are correct effects

10. If you had arthritis in your hand, your physician would most likely treat this with what?
    a) glucocorticoids
    b) mineralocorticoids
    c) calcitonin
    d) melatonin

**Short Answer Response**

1. Describe how the body would respond if there was a fluctuation (increase and decrease) of Ca$^{2+}$ levels in the blood. Please be sure to include the glands and hormones involved in this homeostasis.
Chapter 45 Quiz: Answer Key

1. D
2. B
3. B
4. C
5. D
6. C
7. C
8. D
9. C
10. A

Short Answer Response

1. The parathyroid and thyroid glands control responses to fluctuations in blood calcium ion levels. When Ca$^{2+}$ levels fall below 10mg/100mL, the parathyroid glands release parathyroid hormone (PTH). In the bones, PTH causes osteoclasts to release Ca$^{2+}$ in the blood by breaking up the mineralized matrix in the bone. PTH also causes the conversion of inactive vitamin D in the kidneys, to its hormonal active form. This active form of vitamin D stimulates the uptake of Ca$^{2+}$ from food. When Ca$^{2+}$ rise above 10mg/100mL, the thyroid gland releases calcitonin, which has opposite effects on the bones and kidneys than that of PTH, thus lowering calcium ion levels.