Animal: Endocrine system

Hormones have central roles in integrating the activities of individual cells in ways that benefit the whole body.

Outline

1. Key concepts
2. Nervous system & Endocrine system
3. Human endocrine system
4. Some endocrine glands
5. Diabetes
6. Key terms
7. Conclusions

Key Concepts:

1. Animals have two systems of internal communication and regulation
   - The nervous system and the endocrine system
2. Hormones may reach all parts of the body
   - But only certain types of cells, target cells, are equipped to respond
3. Many types of hormones influence gene transcription and protein synthesis in target cells
4. The hypothalamus and pituitary gland interact in ways to coordinate the activities of endocrine glands
Nervous system & Endocrine system

Nervous system: electrical signals - rapid, short duration
Endocrine system: chemical signals – longer response time, longer acting
Hormones: organic molecules, formed & secreted in one location, transported to another location where they exert their effects

Human endocrine system

Exocrine glands – release their secretions into ducts that lead to the outside of the body or into the digestive tract.
Endocrine glands – ductless, hormone-producing glands that release their secretions into blood.
Pancreas:
A. Exocrine – enzymes
B. Endocrine - hormones
Three major classes of molecules function as hormones in vertebrates
- Proteins and peptides
- Amines derived from amino acids
- Steroids
Target tissue: cells with receptors for the hormone

Exocrine and Endocrine Glands
Changes in Target Cell Activity

SECRETORY CELL

Hormone molecule via blood
Signal receptor

TARGET CELL

Signal transduction pathway
Response in cytoplasm
Response in nucleus

The Human Endocrine System

The Human Endocrine System

Table 50.1 Major Human Endocrine Glands and Some of Their Hormones

<table>
<thead>
<tr>
<th>Gland</th>
<th>Hormones Released</th>
<th>Chemical Class</th>
<th>Representative Actions</th>
<th>Regulated By</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypothalamus</td>
<td>Hormones regulate the anterior pituitary and thymus.</td>
<td>Peptide</td>
<td>Specific proteins</td>
<td>Hypothalamic hormones</td>
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<td>Peptide</td>
<td>Regulates blood calcium level</td>
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Changes in Target Cell Activity

(a) Receptor in plasma membrane
(b) Receptor in cell nucleus

Changes in Target Cell Activity

The Human Endocrine System

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Some endocrine glands

1. Hypothalamus pituitary complex

The hypothalamus is a part of the brain that contains clusters of specialized nerve cells (neurosecretory cells). These cells synthesize peptide hormones, store them, and release them when stimulated.

The pituitary gland (master gland) is a pea-sized gland that dangles from the hypothalamus by a stalk.

The pituitary consists of two lobes: the anterior pituitary and posterior pituitary.

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<td>Melanin</td>
<td>Steroid</td>
<td>Involved in bodily rhythms</td>
<td>Lepthrin cycle</td>
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<td>Adrenal glands</td>
<td>Epinephrine and norepinephrine</td>
<td>Steroid</td>
<td>Stimulates cardiovascular system; causes heart rate to increase</td>
<td>ADH, Norepinephrine</td>
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<tr>
<td>Adrenal cortex</td>
<td>Glucocorticoids</td>
<td>Steroid</td>
<td>Maintains blood glucose level</td>
<td>ACTH, cortisol</td>
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<td>Estrogens</td>
<td>Steroid</td>
<td>Support sexual function; development and maintenance of reproductive characteristics</td>
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<td>Testes</td>
<td>Androgens</td>
<td>Steroid</td>
<td>Support sperm formation; development and maintenance of male secondary sex characteristics</td>
<td>FSH, LH</td>
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Some endocrine glands

Anterior pituitary (adenohypophysis):

- a. Thyroid stimulating Hormone (TSH) (stimulate release of thyroid hormones)
- b. Follicle-stimulating Hormone (FSH) (In females – estrogen secretion and egg maturation; in male – helps stimulate sperm formation)
- c. Growth Hormone (GH)

Posterior pituitary (neurohypophysis):

- a. Antidiuretic Hormone (ADH) - Enhances water reabsorption in the kidneys
- b. Oxytocin – Induces uterine contractions and milk ejection
Neural-Endocrine Control Center

Pituitary gland interacts with the Hypothalamus

The Hypothalamus and Pituitary Gland

Pituitary Gland

Posterior lobe

1. Cell bodies of secretory neurons in hypothalamus synthesize ADH or oxytocin.
2. These hormones move down axons of the secretory neurons and accumulate at axon endings.
3. Action potentials trigger the release of these hormones, which enter blood capillaries in the posterior lobe of the pituitary.
4. Small blood vessels deliver hormones to the general circulation.

The Hypothalamus and Pituitary Gland (Anterior lobe)

Hypothalamus

neurosecretory cells

- Releasing hormone
- Inhibiting hormone

2. First capillary bed, in base of hypothalamus, picks up hormones.
3. Hormones are delivered into second capillary bed, in anterior lobe of pituitary.
4. Releasing or inhibiting hormones diffuse out of the capillaries, act on endocrine cells in the anterior lobe.
Examples of Abnormal Pituitary Output

Gigantism
- Excess GH in childhood

Dwarfism
- Underproduction of GH

Growth hormone (GH)
- Promotes growth directly and has diverse metabolic effects
- Stimulates the production of growth factors by other tissues
Some endocrine glands

2. Pancreas
   - Insulin – lowers blood sugar level
   - Glucagon – raises blood sugar level

3. Gonads (testes and ovaries)
   - Produce most of the body’s sex hormones: androgens, estrogens, and progestins

Diabetes

[Normal] Starch → glucose → blood → blood glucose level goes up → triggers insulin release (beta cells) → enable cells take up glucose (facilitated diffusion) → blood glucose level lower → triggers release of glucagon (alpha cells) → glycogen breakdown into glucose → raise blood glucose level

[Type I Diabetes Mellitus] Starch → glucose → blood → glucose level of blood goes up → insufficient insulin → blood glucose level stays up
Blood Glucose Level Control

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**Key Terms**

- Hormone
- Target cells
- Endocrine glands
- Neurosecretory cells
- Releasing hormone
- Inhibiting hormone
- Posterior pituitary (neurohypophysis)
- Growth hormone
- Insulin
- Pineal gland
- Thyroid gland
- Parathyroid glands
- Adrenal glands
- Hypothalamus
- Anterior pituitary (adenohypophysis)
- FSH
- TSH
- Pancreas
- Alpha cells
- Glucagon
- Beta cells
- Androgen
- Estrogen
- Progestins
- Diabetes

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**In Conclusion**

1. Integration of cell activities requires the stimulatory or inhibitory effects of signaling molecules
2. In target cells, hormones influence gene activation, protein synthesis, and alterations in existing enzymes
In Conclusion

4. The posterior pituitary gland stores and secretes ADH and oxytocin
5. The hypothalamic hormones called releasing and inhibiting hormones control secretions from different cells of the anterior lobe of the pituitary gland
6. The anterior lobe makes many hormones