Bio 105: The Endocrine System

Lecture 12
Chapter 10

Outline

• Function of the Endocrine System
• Hormones and Neurotransmitters
• Types of Hormones & Their actions
• Endocrine glands/organs and Hormones

Review Questions

• Muscles cells are bundled together, these bundles are called ________.
• What is the plasma membrane called in muscle cells?
• What is the oxygen binding protein similar to hemoglobin, but found only in muscles?
• Where is Ca++ stored in muscle cells?
• What does Ca++ bind to when it is released?

Homeostasis

• Nervous and Endocrine Systems
  – Exert control over the other systems
  – Maintain homeostasis
  – Work closely to govern the internal organs

Endocrine System

• Function
  – Work with the nervous system to regulate and control the other systems and maintain homeostasis
  – Functions by releasing hormones which travel through the body to target cells

Review Questions

• Glands are secretory cells or structures derived from what type of tissue?
  a) Muscle
  b) Connective
  c) Epithelial
  d) Nervous
• What type of glands do not have tubes or ducts, but secrete hormones directly into the blood stream?
Hormones

- Chemical messengers
- Secreted by one cell and travels to another
- Affects only the target cells with the correct receptor

Hormones VS Neurotransmitters

- Endocrine VS Nervous Systems
  - Both controlled by negative feedback
  - Work together to maintain homeostasis

Hormones VS Neurotransmitters

<table>
<thead>
<tr>
<th>Differences</th>
<th>Hormones</th>
<th>Neurotransmitters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Where is it located?</td>
<td>Distributed throughout the body in bloodstream</td>
<td>Localized to nerve synapse</td>
</tr>
<tr>
<td>How long does it take to act?</td>
<td>Slow to act</td>
<td>Quick acting</td>
</tr>
<tr>
<td>How long does it last?</td>
<td>Remains longer in the body</td>
<td>Taken away quickly</td>
</tr>
</tbody>
</table>

Hormones

- 2 types
  - Water soluble
  - Lipid soluble
- Amino acid hormones
  - Single amino acid – ex. Epinephrine
  - Polypeptides – ex. Human growth hormone
- Water soluble
Amino Acid

Central carbon Hydrogen atom
NH
H
O
C
OH
Amino group Carboxyl group
Side chain

Figure 2.22

Review Questions

• Are amino acids hydrophilic or hydrophobic?
• Can amino acids freely cross the plasma membrane?

Water Soluble Hormones

• Bind to a receptor on surface of the target cells (ex. muscle cells)
• Bind of the hormone epinephrine to the receptor → triggers the formation of a secondary messenger (ex. cAMP)
• Secondary messenger triggers cascade of events ending in cellular activity

Water Soluble Hormones - cAMP Mediation

Lipid Soluble Hormones

• Steroid Hormones
  – Structure similar to cholesterol
  – Examples
    • Estrogen
    • Testosterone

Review Questions

• What biological molecule are steroids?
• Are steroids hydrophilic or hydrophobic?
• Can steroids freely cross the plasma membrane?
• What do you call the process of when DNA is copied to make mRNA?
• What is the product of translation?
**Lipid Soluble Hormones - Steroids**

- Enter the target cells
  - Can freely pass through the plasma membrane
- Binds with a receptor *(inside the cell)*
- The hormone-receptor complex binds to DNA in the nucleus and activates the transcription of DNA to make mRNA
- mRNA leaves the nucleus, binds to a ribosome and is translated to make proteins

**Water Soluble VS Lipid Soluble**

- **Water Soluble**
  - Take less time to act
  - Do not enter target cell
    - Work via secondary messengers
- **Lipid Soluble**
  - Take longer to act
    - Cause transcription and translation to make a protein
  - Enter the cell

**Endocrine Glands and Organs**

- **Primary**
  - Pituitary
  - Thyroid
  - Parathyroid
  - Adrenals
  - Pineal
  - Hypothalamus
  - Thymus
- **Secondary**
  - Pancreas
  - Ovaries
  - Testes
  - Heart
  - Placenta
  - Stomach
  - Intestines
  - Kidneys

**Hormones**

- **Water soluble Hormones**
  - Cyclic AMP pathway
    - [https://www.youtube.com/watch?v=Y2er_Dfgg44](https://www.youtube.com/watch?v=Y2er_Dfgg44)
- **Lipid Soluble Hormones**
  - [https://www.youtube.com/watch?v=C4m3ZT4Byvo](https://www.youtube.com/watch?v=C4m3ZT4Byvo)
**Hypothalamus**

- Regulates the internal environment through the autonomic nervous system
  - Heartbeat
  - Body temperature
  - Water balance

**Diuresis**

- A diuretic will make your urine
  - Dilute?
  - Concentrated?

- An antidiuretic will make your urine
  - Dilute?
  - Concentrated?
Hypothalamus

- Controls
  - Glandular secretions of the pituitary gland
- Produces
  - Antidiuretic hormone (ADH)
  - Oxytocin
  - Hypothalamic-releasing hormones
  - Hypothalamic-inhibiting hormones

Hypothalamus – ADH & Oxytocin

- **Produced** by
  - Neurosecretory cells in the hypothalamus
- **Stored** in the posterior lobe of the pituitary
- Posterior lobe **releases** these hormones when needed

ADH – Antidiuretic Hormone

- Function
  - Regulates water absorption in the kidneys
- Target
  - Kidneys

Antidiuretic Hormone (ADH)

- Image From: https://www.studyblue.com/notes/hotchly/lecture-exam-endocrine-system/6009368

ADH Disorders

- Disease
  - Diabetes Insipidus
- Cause
  - Deficiency of ADH
  - Excessive urine production \(\rightarrow\) dehydration
- Treatment
  - Administer synthetic ADH

Oxytocin (OT)

- Function
  - Stimulates uterine contraction during childbirth and milk letdown
- Target
  - Uterus
  - Mammary glands
- Synthetic: Pitocin
Hypothalamus

- Hypothalamic-releasing hormone
- Hypothalamic-inhibiting hormone
  - Both produced by hypothalamus
- Target
  - Anterior Pituitary Gland
  - Releasing → release/secretion of hormones
  - Inhibiting → inhibits release/secretion

Anterior Pituitary Gland

- Produces
  - Thyroid stimulating hormone (TSH)
  - Adrenocorticotropic hormone (ACTH)
  - Gonadotropic hormones (FSH and LH)
  - Prolactin (PRL)
  - Growth Hormone (GH)

Posterior Pituitary Gland

- 2 sections to pituitary gland
  - Anterior
  - Posterior
- Posterior Pituitary Gland
  - Receives ADH and Oxytocin from hypothalamus
  - Stores and Releases

Anterior Pituitary Gland

- Produces
  - Thyroid stimulating hormone (TSH)
    - Thyroid
    - Produce T3 and T4
  - Adrenocorticotropic hormone (ACTH)
    - Adenal cortex
    - Produce glucocorticoids
  - Gonadotropic hormones (FSH and LH)
    - Ovaries and Testes
    - Produce estrogen and testosterone
  - Prolactin (PRL)
    - Breast
    - Milk let-down
  - Growth Hormone (GH)
    - Bones and muscle
    - Growth

Pituitary Gland – Anterior and Posterior

- Nerve cells in the hypothalamus secrete releasing hormones and inhibiting hormones.
- Releasing and inhibiting hormones travel by way of the bloodstream to the anterior pituitary and cause it to modify secretion of its six hormones (FSH, LH, GH, PRL, ACTH, and TSH).
- ADH and OT travel to the ends of the cells in the posterior pituitary, where they are released into the bloodstream to influence target tissues.

Hawaii

Anterior Pituitary Gland
- Produces hormones
- Releases when receives hypothalamic-releasing hormones from the hypothalamus

Thyroid Stimulating Hormone (TSH)
- Produced by
  - Anterior Pituitary
- Function
  - Stimulates thyroid gland to produce thyroxine
- Target
  - Thyroid gland

Adrenocorticotropic Hormone (ACTH)
- Produced by
  - Anterior Pituitary
- Function
  - Stimulates adrenal cortex to produce cortisol
- Target
  - Adrenal cortex

Gonadotropic Hormones
- Produced by
  - Anterior Pituitary
- Function
  - Stimulate gonads to produce gamets and hormones
  - FSH
  - LH
- Target
  - Ovaries
  - Testes

Gonadotropic Hormones
- Follicle Stimulating Hormone (FSH)
  - Stimulates gamete development
    - Males and Females
- Luteinizing Hormone (LH)
  - Stimulates ovaries to produce estrogen and progesterone in females
  - Stimulates testes to produce testosterone in males

Prolactin (PRL)
- Produced by
  - Anterior Pituitary Gland
- Function
  - Causes mammary glands to develop and produce milk
- Target
  - Mammary Glands
**Growth Hormone**

- **Produced by**
  - Anterior Pituitary Gland
- **Function**
  - Promotes skeletal and muscular growth
- **Target**
  - Bones
  - Muscles
  - Cartilage

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**Growth Hormone Disorders**

- **Disease**
  - Gigantism
- **Cause**
  - Too much GH during childhood
- **Treatment**
  - If caused by pituitary tumor – remove or reduce the tumor

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**Gigantism**

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**Growth Hormone Disorders**

- **Disease**
  - Acromegaly
- **Cause**
  - Too much GH in adulthood
  - Thickening of the bones of the extremities, face and tongue
- **Treatment**
  - Same as gigantism

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**Acromegaly**

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**Growth Hormone Disorders**

- **Disease**
  - Pituitary Dwarfism
- **Cause**
  - Insufficient GH production
  - Sterility
- **Treatment**
  - Administer GH during childhood
Review Questions

- What hormone stimulates water resorption by the kidneys?
- What hormone stimulates the adrenal cortex to produce cortisol?
- Which gland produces oxytocin?
- Which gland produces prolactin?
Thyroid Gland

- Large gland located below the larynx
- Requires iodine to make hormones
- Produces
  - Thyroid hormones (TH)
    - Thyroxine (T4)
    - Triiodothyronine (T3)
  - Calcitonin

Thyroid Gland Disorders

- Disease
  - Simple Goiter
- Cause
  - A diet deficient in iodine
- Treatment
  - Iodine supplements or administration of thyroid hormone

Thyroid Gland Disorders

- Disease
  - Cretinism
- Cause
  - Too little TH during fetal development or infancy
  - Dwarfism and delayed mental and sexual development
- Treatment
  - Administer TH

Thyroid Gland Disorders

- Disease
  - Myxedema
- Cause
  - Too little TH in adulthood
  - Fluid accumulates in facial tissues
  - Decrease in alertness, body temperature and heart rate
- Treatment
  - Administer TH

Thyroid Gland Disorders

- Disease
  - Graves’ disease
- Cause
  - Oversecretion of TH
  - An autoimmune disorder due to production of antibodies that mimic the action of TSH
Thyroid Gland Disorders

• Graves’ Disease cont’d
• Symptoms
  – Increased metabolic rate and heart rate
  – Sweating, nervousness and weight loss
  – Many have exophthalmos
• Treatment
  – Drug that blocks the synthesis of TH
  – Reduce thyroid gland by surgery or radioactive iodine

Review Questions

• What is the target of thyroxine?
• Does calcitonin lower or raise the blood’s calcium level?
• What gland produces calcitonin?