The Endocrine System

Exocrine Glands vs. Endocrine Glands
Two different modes of secretion

<table>
<thead>
<tr>
<th>Exocrine Glands</th>
<th>Endocrine Glands</th>
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</thead>
<tbody>
<tr>
<td>&quot;exo-&quot; = external, &quot;-crine&quot; = secretion</td>
<td>&quot;endo-&quot; = internal, &quot;-crine&quot; = secretion</td>
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<tr>
<td>Gland using a duct to carry secretion to the body surface.</td>
<td>Gland directly secreting hormones into the bloodstream without using a duct.</td>
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Ex: sweat glands  Ex: adrenal gland

Negative Feedback Mechanism

If your home is cold, the thermostat senses this drop and turns on the heat.

If the heat were to stay on indefinitely, the house would become too hot.

So, at a certain determined point (equilibrium/homoeostasis), the thermostat senses that the right temperature has been reached and the heat is turned off.

This process is called "negative" because the feedback turns the system off.
Negative Feedback Mechanism

Feedback Mechanisms

Introduction

• Both the nervous and endocrine systems are involved in homeostasis (balance) by regulating the body's activities (i.e., growth, sleep, emotions, metabolism, sexual function, and development).
• Compared to the nervous system, the endocrine system is more closely associated with growth and development, and its responses tend to be long-lasting, whereas nervous system responses tend to be rapid and discrete.
• What's the benefit of the endocrine system's long-lasting responses? How can it be a detriment?
Introduction to Endocrine System

Hormones

- The endocrine system releases powerful, stimulating hormones (chemical messengers/catalysts) directly into the bloodstream which target specific cells.
  - These chemical messengers are like switches which “start” or “stop” various physiological processes in the body.
  - Hormones increase or decrease the rates of normal cellular activity.

Endocrine Glands Explored

- Endocrine glands include:
  - Pituitary Gland
  - Thyroid Gland
  - Parathyroid Gland
  - Adrenal Gland
  - Pineal Gland
  - Thymus **

- Several organs containing endocrine tissue that also perform other functions:
  - Pancreas
  - Gonads (Ovaries & Testes)
  - Placenta

**Technically, considered a lymphoid organ not an endocrine gland.
Hypothalamic-Pituitary-Target Gland Axis

• Concepts:
  – Hypothalamus:
    • Main visceral control center of the body and is vitally important to overall body homeostasis
    – Influences blood pressure, rate and force of heartbeat, digestive-tract motility, eye pupil size; initiates most physical expressions of emotion; regulates body temperature; regulates food intake/satiety-hunger; regulates water balance and thirst; regulates sleep-wake cycle; controls endocrine system functioning.

Hypothalamic-Pituitary-Target Gland Axis

• Concepts:
  – Pituitary Gland:
    • Securely seated in the sella turcica of the sphenoid bone, this pea-sized gland secretes at least nine hormones.
    • Gland has two lobes
      – Posterior Pituitary (lobe) is primarily nerve fibers and acts as a hormone-storage area.
      – Anterior Pituitary (lobe) is glandular tissue which manufactures and releases hormones.
### Hypothalamic-Pituitary-Target Organ Axis

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Hormone</th>
<th>Target Organs &amp; Effects</th>
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<tbody>
<tr>
<td>GH</td>
<td>Growth hormone</td>
<td>Liver, muscle, bone, cartilage, and other tissues: anabolic hormone; stimulates somatic growth; mobilizes fats; spares glucose</td>
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<tr>
<td>TSH</td>
<td>Thyroid-stimulating hormone</td>
<td>Thyroid gland: stimulates thyroid gland to release thyroid hormone</td>
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<tr>
<td>PRL</td>
<td>Prolactin</td>
<td>Breast secretory tissue: promotes lactation</td>
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<tr>
<td>ACTH</td>
<td>Adrenocorticotropic hormone</td>
<td>Adrenal cortex: promotes release of glucocorticoids and androgens; help both to resist stressors</td>
</tr>
<tr>
<td>FSH</td>
<td>Follicle-stimulating hormone</td>
<td>Ovaries &amp; testes: in females, stimulates ovarian follicle maturation and estrogen production; in males, stimulates sperm production.</td>
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<tr>
<td>LH</td>
<td>Luteinizing hormone</td>
<td>Ovaries &amp; testes: in females, triggers ovulation and stimulates ovarian production of estrogen &amp; progesterone; in males, promotes testosterone production</td>
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<tr>
<td>ADH</td>
<td>Antidiuretic hormone or vasopressin</td>
<td>Kidneys: stimulates kidney tubule cells to reabsorb water</td>
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<tr>
<td>Oxytocin</td>
<td>Oxytocin</td>
<td>Uterus: stimulates uterine contractions; initiates labor; breast: initiates milk ejection.</td>
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### Thyroid Gland

- **Location:**
  - Anterior neck, on trachea just inferior to larynx.

- **Function:**
  - Secretes thyroid hormone (T4 & T3) which regulates various aspects of metabolism.
Thyroid Gland
Common Pathologies

• Hypothyroidism
  – Underactive thyroid gland due to thyroid defect, postsurgical damage/removal, radiotherapy, iodine deficiency or congenital/autoimmune conditions.
  – Low metabolic rate; feeling chilled; constipation; thick, dry skin and puffy eyes; edema; lethargy; mental sluggishness; and goiter (enlarged thyroid gland).

Goiter

Thyroid Gland
Common Pathologies

• Graves' Disease
  – Most common hyperthyroid pathology.
  – Autoimmune disease
  – Person has abnormal antibodies which mimic TSH and continuously stimulate TH release.
  – Elevated metabolic rate; sweating; rapid, irregular heartbeat; nervousness; weight loss despite adequate food intake; exophthalmos (protrusion of eyeballs).

Exophthalmos

Parathyroid Gland

• Location:
  – Four to eight, tiny, yellow-brown glands in the posterior aspect of thyroid gland.

• Function:
  – Parathyroid hormone: controls the calcium balance in the blood.
    • Important for transmission of nerve impulses, muscle contraction, and blood clotting.
Parathyroid Gland
Common Pathologies

• Hyperparathyroidism
  – Rare, usually results from parathyroid gland tumor.
  – Calcium is leached from bones; bones soften and deform as their mineral salts are replaced with fibrous connective tissue.

• Hypoparathyroidism
  – Most often due to parathyroid gland trauma or removal during thyroid surgery.
  – Can be due to excessive deficiency of dietary magnesium.
  – Loss of sensation, muscle twitches, convulsions, congenital abnormalities.

Adrenal Glands

• Location:
  – Pyramid-shaped organs perched atop the kidneys; enclosed in a fibrous capsule and a cushion of fat.

• Function:
  – Each adrenal is structurally and functionally two endocrine glands.
  – Adrenal Medulla—part of the sympathetic nervous system; synthesizes catecholamines
  – Adrenal Cortex—glandular tissue synthesizes corticosteroids.
Adrenal Glands

- **Hormones**
  - Adrenal Cortex
    - **Corticosteroids**
    - Over two-dozen steroid hormones
    - Steroid hormones are not stored in cells; rate of release in response to stimulation depends on rate of synthesis
    - Primary hormones produced: aldosterone, cortisol, testosterone and estrogen
  - Adrenal Medulla
    - **Catecholamines**
    - Epinephrine
    - Norepinephrine
    - Activated in a fight-or-flight response by some short-term stressors.
    - Unlike adrenocortical hormones, which promote long lasting responses to stressors, catecholamines cause fairly brief responses.

Parasympathetic-Sympathetic Regulation

Adrenal Glands

- **Common Pathologies**
  - **Aldosteronism**
    - Typically results from adrenal tumors
    - Resulting in hypertension, edema and potassium loss
    - If K+ is extreme, muscle weakness and eventually paralysis occurs.
  - This is Very Rare.
Adrenal Glands
Common Pathologies

• Addison’s Disease
  – Deficits in both glucocorticoids and mineralocorticoids
  – Weight lose; severe dehydration; hypotension

• Cushing’s Syndrome
  – Persistent elevated blood glucose levels; dramatic loss in muscle and bone protein; water and salt retention—leading to hypertension and edema.
  – Because of enhanced anti-inflammatory effects, infections may become overwhelmingly severe

• Adrenogenital Syndrome
  – Masculinization
  – Females develop a beard and masculine pattern of body hair distribution, and the clitoris grows to resemble a small penis.
  – In young men, early maturation of sex organs, secondary sex characteristics, and high sex drive.
Pancreas

• Location:
  – A soft, triangular organ partially behind the stomach in the abdomen
  – Composed of both endocrine and exocrine gland cells
  – Produces insulin and glucagon to regulate blood glucose levels.

Pancreas Common Pathologies

• Diabetes Mellitus (DM)
  – Insulin is absent or deficient; blood glucose levels remain high after meals because glucose is unable to enter most tissue cells.
  – When hyperglycemia is excessive, person is nauseated; goes in a sympathetic response with increased blood glucose levels
  – When glucose cannot be used for fuel, more fats are used resulting in high levels of fatty acids in the blood (ketones).
  – If untreated, ketoacidosis (accumulation of ketones in the blood) disrupt heart activity, oxygen transport and severe depression of nervous system leads to coma and death.
  – Three cardinal signs of DM
    • Polyuria—large urine output; leading to decreased blood volume & dehydration.
    • Polydipsia—excessive thirst; stimulated by dehydration
    • Polyphagia—excessive hunger and food consumption; unable to use the glucose, the body begins to utilize its fat & protein stores for energy.

Pineal Gland

• Location:
  – Tiny, pine cone-shaped organ hanging from roof of the third ventricle

• Function:
  – Not fully understood
  – Major secretory product is melatonin, a powerful antioxidant and hormone derived from serotonin.
  • Help to make us drowsy
  • Affects timing of puberty
  • Circadian rhythm
Gonads

- Male and female primary reproductive organs
- Location & Function:
  - Females: ovaries
    - Small, oval organs located in the female’s abdominopelvic cavity
    - Produce estrogens & progesterone
  - Males: testes
    - Located in the scrotum, an extra-abdominal skin pouch
    - Produce sperm and testosterone

Thymus

- Location:
  - Deep to sternum in thorax.
  - Diminishes in size throughout adulthood.
    - By old age, it is composed largely of adipose and fibrous connective tissue.
- Function:
  - Not well understood; involved in normal development of T lymphocytes and immune response.