The Endocrine System

Biol 105
Chapter 10
Outline

I. Function of Endocrine System
II. Hormones vs. Neurotransmitters
III. Types of Hormones and their actions
IV. Endocrine glands/organs and hormones
The function of the endocrine system is to work with the nervous system to regulate and control other systems and to maintain homeostasis.
The endocrine system functions by releasing hormones which travel through the body (usually via the bloodstream) to target cells.
Glands are secretory cells or structures derived from which type of tissue?

1. Muscle
2. Connective
3. Epithelial tissue
4. Nervous
Glands are secretory cells or structures derived from which type of tissue?

1. Muscle
2. Connective
3. Epithelial tissue
4. Nervous
These glands do not have tubes or ducts, they secrete hormones directly into blood stream.

1. Exocrine glands
2. Endocrine glands
These glands do **not** have tubes or ducts, they secrete hormones directly into blood stream.

1. Exocrine glands
2. Endocrine glands
Endocrine System Communication

The hormone diffuses into the bloodstream.

Capillary

The hormone travels throughout the body.

Hormone
What is a hormone?

- **Hormones** are chemical messengers that are secreted by one cell, travel through the body and affect only the **target cells** that have the correct **receptor**.
Target Cells

- Target cells have receptors that bind the hormones (ex: Osteoclasts).
- Non-target cells do not have the proper receptor and are unaffected by the hormone (ex: Osteoblasts).
Hormones and Target Cells

1. Endocrine cells release hormone.

2. Hormone enters circulation.

3. Hormone is carried throughout the body.

Hormone will not bind to cells that are not target cells.

4. Binding occurs, hormonal effects take place.

receptor

target cell (skeletal muscle)
Hormones vs. Neurotransmitters

**Similarities:**

- Endocrine and nervous systems work together to maintain homeostasis.
- Both need to bind to a receptor to illicit an effect.
## Hormones vs. Neurotransmitters - Differences

<table>
<thead>
<tr>
<th></th>
<th>Neurotransmitters</th>
<th>Hormones</th>
</tr>
</thead>
<tbody>
<tr>
<td>Where it’s located</td>
<td>Localized to nerve synapse</td>
<td>Throughout body in blood stream</td>
</tr>
<tr>
<td>How long it takes to act.</td>
<td>Quick to act</td>
<td>Slow to act</td>
</tr>
<tr>
<td>How long it lasts.</td>
<td>Taken away quickly</td>
<td>Remains longer in body</td>
</tr>
</tbody>
</table>
Types of Hormones

- There are two general types of hormones:
  1. Water Soluble (Hydrophilic)
  2. Lipid Soluble (Hydrophobic)
Amino Acid Hormones

- A single amino acid – ex: epinephrine.
- Polypeptides (a chain of amino acids) – ex: Anti-Diuretic Hormone
Amino Acid

Central carbon

Hydrogen atom

Amino group

Carboxyl group

Side chain

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Are Amino Acids Hydrophilic or Hydrophobic?

1. Hydrophilic
2. Hydrophobic

50% 50%
Are Amino Acids Hydrophilic or Hydrophobic?

1. **Hydrophilic**
2. **Hydrophobic**
Can an amino acid freely cross the plasma membrane?

1. Yes
2. No
Can an amino acid freely cross the plasma membrane?

1. Yes
2. No
Amino acids and polypeptides are examples of water soluble hormones.

Example: Epinephrine

The adrenal gland releases epinephrine into the blood stream, travels throughout the body.
Water Soluble Hormones

- Water soluble hormones bind to a receptor on the surface of the target cells (ex: muscle cells).

- The binding of the hormone epinephrine to the receptor triggers the formation of a secondary messenger (ex: cyclic AMP (cAMP)).
Water Soluble Hormones

- The secondary messenger triggers a cascade of events ending in cellular activity (ex: the breakdown of glycogen to glucose).

- **Note:** this type of hormone does not cross the plasma membrane and enter the cell.

- The **receptor** is on the **plasma membrane**.
**Step 1:** The water-soluble hormone (first messenger) binds to a receptor on the surface of the plasma membrane.

**Step 2:** Binding activates the enzyme responsible for producing cAMP (the second messenger) from ATP.

**Step 3:** cAMP initiates an enzyme cascade.

**Step 4:** Enzyme 3 stimulates the breakdown of glycogen to glucose.

Extracellular fluid

Water-soluble hormone

Receptor

Plasma membrane of target cell (lipid bilayer)

Enzyme

ATP

cAMP

Inactive enzyme 1

Active enzyme 1

Inactive enzyme 2

Active enzyme 2

Inactive enzyme 3

Active enzyme 3

Cytoplasm

Nucleus

Figure 10.4
Steroid Hormones

1. Steroid hormones have a structure similar to cholesterol.

Examples: estrogen, testosterone.
(a) Four-ring steroid structure
Steroids are...

1. Sugars
2. Proteins
3. Lipids
4. Complex Carbohydrates

25% 25% 25% 25%
Steroids are...

1. Sugars
2. Proteins
3. Lipids
4. Complex Carbohydrates
Are Steroids Hydrophilic or Hydrophobic?

1. Hydrophilic
2. Hydrophobic
Are Steroids Hydrophilic or Hydrophobic?

1. Hydrophilic
2. Hydrophobic
Can steroids freely cross the plasma membrane?

1. Yes
2. No
Can steroids freely cross the plasma membrane?

1. Yes
2. No
Steroids are examples of lipid soluble hormones

Example: Estrogen

The ovaries produce estrogen.
When DNA is copied to make mRNA this is:

1. Translation
2. Transcription
When DNA is copied to make mRNA this is:

1. Translation
2. Transcription
What is the product of translation?

1. DNA
2. RNA
3. Protein/polypeptide
4. Nucleotides
What is the product of translation?

1. DNA
2. RNA
3. Protein/polypeptide
4. Nucleotides
Lipid Soluble Hormones - Steroids

- Lipid soluble hormones enter the target cells, they can freely pass through the plasma membrane.

- Inside the cell, the hormone binds with a receptor (in the cytoplasm or nucleoplasm)
The hormone-receptor complex binds to DNA in the nucleus and activates the transcription of DNA to make mRNA.

The mRNA leaves the nucleus, binds to a ribosome and is translated to make proteins.
Step 1: The steroid hormone diffuses through the plasma membrane of the target cell.

Step 2: The steroid hormone binds to a receptor in the cytoplasm.

Step 3: The hormone-receptor complex enters the nucleus.

Step 4: The hormone-receptor complex binds to DNA.

Step 5: Certain genes are activated.

Step 6: Proteins, including enzymes, are synthesized.

Step 7: Enzymes alter the activity of the cell.

Lipid-soluble Hormones
Water Soluble vs. Lipid Soluble Hormones

- Note that the lipid soluble hormones will take longer to act than the water soluble hormones since they activate DNA transcription and translation to make a protein.

- Also remember that water soluble hormones do not enter the target cell, they work through secondary messengers, whereas lipid soluble hormones enter the cell.
### Endocrine Glands and Organs that Secrete Hormones

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

- Thymus gland
- Pineal gland
- Parathyroid glands (two of four)
- Heart
- Kidney
- Adrenal gland (one on each kidney)
  - Adrenal cortex
  - Adrenal medulla

Figure 10.2 (1 of 2)
Endocrine System

Figure 10.2 (2 of 2)

Thyroid gland

Stomach

Pancreas

Testis (one of a pair)

Small intestine

Uterus

Ovary (one of a pair)
(a) Side view of the pituitary gland
Hypothalamus

- Hypothalamus — regulates the internal environment through the autonomic nervous system.
  - Helps control heartbeat.
  - Helps control body temperature.
  - Helps control water balance.
Hypothalamus

- Hypothalamus – Secretes its own hormones and controls glandular secretions of the pituitary gland.

- Produces:
  1. antidiuretic hormone (ADH).
  2. Oxytocin.
  3. hypothalamic-releasing hormones.
  4. hypothalamic-inhibiting hormones.
(b) Close-up of the pituitary gland showing how it is attached to the hypothalamus by a short stalk
Nerve cells in the hypothalamus produce antidiuretic hormone (ADH) and oxytocin (OT). 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.

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). Nerve cells in the hypothalamus secrete releasing hormones and inhibiting hormones.

Antidiuretic hormone (ADH)
Oxytocin (OT)

Kidney tubules
Smooth muscle in uterus
Mammary glands
Thyroid gland
Adrenocorticotropic hormone (ACTH)
Cortex of adrenal gland

Thyroid-stimulating hormone (TSH)
Mammary glands

Growth hormone (GH)
Prolactin (PRL)

Follicle-stimulating hormone (FSH) and Luteinizing hormone (LH)

Ovaries, testes
Bones, muscles

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Figure 10.6
A Diuretic Will Make Your Urine:

1. More dilute
2. More concentrated
A Diuretic Will Make Your Urine:

1. More dilute
2. More concentrated
An Antidiuretic Will Make Your Urine:

1. More dilute
2. More concentrated
An Antidiuretic Will Make Your Urine:

1. More dilute
2. More concentrated
Hypothalamus – ADH and Oxytocin

- Neurosecretory cells of the hypothalamus **produce** antidiuretic hormone (ADH) and Oxytocin.

- Antidiuretic hormone (ADH) and oxytocin are "**stored**" in the posterior lobe of the pituitary gland.

- Posterior pituitary gland **releases** these hormones when needed.
Antidiuretic hormone (ADH)

Function: regulates water reabsorption in the kidneys (H₂O is returned to the bloodstream).

Target: Kidneys
Disorders

- **Diabetes insipidus** – Caused by a deficiency of ADH.

- Results in excessive urine production, leading to dehydration.

- Treatment: administer synthetic ADH.
Oxytocin

- **Function:** stimulates uterine contraction during childbirth and milk *release* (ejecting milk from the glands) also may play a role in social bonds.

- **Target:** Smooth muscle of the Uterus and mammary glands.

- **Pitocin:** Synthetic form of OT, given to induce labor.
Hypothalamic-Releasing and Hypothalamic-Inhibiting Hormones

- The hypothalamus produces hypothalamic-releasing and hypothalamic-inhibiting hormones.

- These hormones travel a short distance in the bloodstream to the Anterior Pituitary Gland.
The hypothalamic-releasing hormones stimulate the Anterior Pituitary Gland to release (secrete) its hormones.
The hypothalamic-inhibiting hormones inhibit the Anterior Pituitary Gland from releasing (secreting) its hormones.
The anterior pituitary gland produces:

1. Thyroid-stimulating hormone (TSH)
2. Adrenocorticotropic hormone (ACTH)
3. Gonadotropin hormones – (FSH and LH)
4. Prolactin (PRL)
5. Growth hormone (GH)
Nerve cells in the hypothalamus produce antidiuretic hormone (ADH) and oxytocin (OT).

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.

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).

Nerve cells in the hypothalamus produce antidiuretic hormone (ADH) and oxytocin (OT).

Antidiuretic hormone (ADH) travels to the kidney tubules and influences smooth muscle in the uterus.

Oxytocin (OT) travels to the mammary glands and influences smooth muscle in the uterus.

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).

Anterior pituitary
- Thyroid-stimulating hormone (TSH)
- Adrenocorticotropic hormone (ACTH)
- Follicle-stimulating hormone (FSH) and Luteinizing hormone (LH)
- Growth hormone (GH)
- Prolactin (PRL)

Posterior pituitary
- Antidiuretic hormone (ADH)
- Oxytocin (OT)

Kidney tubules
Smooth muscle in uterus
Mammary glands
Thyroid gland
Cortex of adrenal gland
Bones, muscles
Ovaries, testes

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1.) Prolactin (PRL)

- PRL is produced by the Anterior Pituitary.
- **Target**: Mammary glands.
- **Function**: causes mammary glands to develop and produce milk.
2.) Growth Hormone (GH)

- GH is produced by the Anterior Pituitary.
- **Target**: Bones, muscles, and cartilage.
- **Function**: promotes skeletal and muscular growth.
Gigantism – Too much GH during childhood can result in rapid growth and attaining heights of 8 – 9 feet.

Treatment – if caused by a pituitary tumor then treatment is to remove or reduce the tumor using surgery, radiation or chemotherapy.
Gigantism
Acromegaly – Too much GH in adulthood can result in a thickening of the bones of the extremities and face as well as the tongue.

Same treatment as gigantism.
Acromegaly

(a) Age 9

(b) Age 16

(c) Age 33

(d) Age 52
Disorder - Pituitary dwarfism

- **Pituitary Dwarfism** – Insufficient GH production results in sterility and attaining maximum height of about 4 ft.

- **Treatment** – Administer GH during childhood.
Pituitary Dwarfism
3.) Thyroid-Stimulating Hormone (TSH)

- TSH is produced by the Anterior Pituitary.
- **Target**: Thyroid gland.
- **Function**: stimulates the thyroid gland to produce thyroxine.
(a) The thyroid gland lies over the trachea, just below the larynx.
Thyroid Gland

- Thyroid gland - large gland located below the larynx. Requires iodine to make hormones.

- Produces:
  1. Thyroid Hormones (TH):
     - Thyroxine (T4)
     - Triiodothyronine (T3)
  2. Calcitonin.
Thyroid Hormones - Regulate metabolism by stimulating protein synthesis, the breakdown of lipids, and the use of glucose for the production of ATP.

Target: most cells in the body.
Disorders – Simple Goiter

- Simple goiter:
  - Results in an enlarged thyroid gland.
  - May be caused by a diet deficient in iodine, which is needed for the production of TH.
  - Can be treated by iodine supplements or administration of TH.
Disorders - Cretinism

- Cretinism:
  - Caused by too little TH during fetal development or infancy.
  - Results in dwarfism and delayed mental and sexual development.
  - Treatment: Administer TH.
Disorders - Myxedema

- Myxedema.
  - Caused by too little TH in adulthood.
  - Results in a condition in which fluid accumulates in facial tissues and a decrease in alertness, body temperature, and heart rate.
  - Treatment: Administer TH.
Disorders - Graves’ Disease

- Caused by an oversecretion of TH.
- Results from an autoimmune disorder leading to the production of antibodies that mimic the action of TSH.
Disorders - Graves’ Disease

- Symptoms include:
  - Increased metabolic rate and heart rate accompanied by sweating, nervousness, and weight loss.
  - Many also have exophthalmos.

- Treatment: Administer drug that blocks the synthesis of TH, thyroid gland may be reduced by surgery or radioactive iodine.
Exophthalmos

(c) Exophthalmos
4.) AdrenoCorticoTropic Hormone (ACTH)

- ACTH is produced by the Anterior Pituitary.
- Target: Adrenal Cortex.
- **Function**: stimulates the adrenal cortex to produce **cortisol**.
(a) Each adrenal gland sits on top of a kidney.
(b) A section through the adrenal gland reveals two regions, the outer adrenal cortex and the inner adrenal medulla. These regions secrete different hormones.
Adrenal Cortex

- Two types of hormone secreted by adrenal cortex:
  1. Mineralocorticoids
  2. Glucocorticoids
Mineralocorticoids – example: aldosterone

Effects: Mineral homeostasis and water balance.
Adrenal Cortex - Mineralocorticoids

- Effects of Aldosterone:
  - Promotes renal re-absorption of Na\(^+\) and renal secretion of K\(^+\).
  - Increases blood pressure.
- Target: Kidneys.
Glucocorticoids – ex: cortisol. Influences carbohydrate, protein, & fat metabolism, suppress the immune system.
Adrenal Cortex - Glucocorticoids

- Effects of Cortisol:
  - Affect glucose homeostasis.
  - Act on the liver to promote the conversion of fat and protein into intermediate substances available to the body’s cells.
  - Inhibit the inflammatory response.
Which of the following affects the adrenal cortex?

1. ACTH
2. TSH
3. FSH
4. Nerves
Which of the following affects the adrenal cortex?

1. **ACTH**
2. TSH
3. FSH
4. Nerves
The complex carbohydrate stored in humans is:

1. Cellulose
2. Starch
3. Glycogen
4. Triglycerides
The complex carbohydrate stored in humans is:

1. Cellulose
2. Starch
3. **Glycogen**
4. Triglycerides
Where is glycogen stored in the body:

1. Adipose tissue
2. Muscle
3. Liver
4. 2 and 3
Where is glycogen stored in the body:

1. Adipose tissue
2. Muscle
3. Liver
4. 2 and 3
Cortisol – a stress hormone

- The pituitary gland produces and releases ACTH (adrenocorticotropic hormone).
- ACTH travels to the adrenal gland where it stimulates the adrenal cortex to release glucocorticoids like cortisol.
- Cortisol plays a role regulating how much free glucose there is in the body.
- Cortisol prompts the **muscles** to breakdown glycogen and release glucose.

- It also prompts the **adipose tissue** to breakdown fat.

- So basically it tells the body to take biomolecules out of storage so it can be used for energy.
Side Effects of cortisol

- It interferes with the functioning of the hippocampus (remember this functions to make long term memories).
- It weakens the immune system – inhibits inflammatory response.
- Constricts arteries (increasing risk of heart attacks).
- Interferes with insulin regulation of glucose (leads to adult onset diabetes).
Which of the following glands secretes cortisol?

1. pituitary
2. pancreas
3. adrenal medulla
4. adrenal cortex
Which of the following glands secretes cortisol?

1. pituitary
2. pancreas
3. adrenal medulla
4. adrenal cortex
Disorders of the Adrenal Glands

- Two disorders:
  - Addison disease
  - Cushing’s syndrome
Addison Disease

- *Addison Disease* - Hypossecretion of the adrenal cortex. **Not enough** hormones are secreted. Can not recover from stressful situations, can lead to low blood pressure and dehydration. Can be fatal if not treated.

- Treatments: supplement with glucocorticoids and mineralocorticoids.
Cushing’s Syndrome

- **Cushing’s Syndrome** - Hypersecretion of the adrenal cortex. **Too much** hormone is secreted. Can result in diabetes, and redistribution of fat and reduced muscle mass.

- **Treatments:** if caused by a tumor, removal of the tumor if possible with surgery. Can treat with radiation and chemotherapy. Can be treated with drugs to reduce the activity of the adrenal cortex.
5.) Gonadotropic Hormones

- Gonadotropic Hormones - stimulate the gonads to produce gametes and hormones.
  - FSH
  - LH
Gonadotropic Hormones

- The two gonadotropic hormones are:
  - Follicle Stimulating Hormone (FSH) – stimulates gamete development in males and females.
  - Luteinizing Hormone (LH) – stimulates the production of estrogen and progesterone in females, and testosterone in males.
Gonads – Ovaries and Testes

- They are controlled by the hypothalamus and the pituitary gland – see the Gonadotropic Hormones.
- Testes produce testosterone.
- Ovaries produce estrogen and progesterone.
Effects:

- During development, testosterone stimulates growth of male reproductive organs.
- Responsible for male secondary sex characteristics.
- Prompts larynx & vocal cords to enlarge.
- Responsible for muscular strength of males.
Gonads - Estrogen and Progesterone

- **Effects:**
  - During development, stimulates growth of female reproductive organs
  - Responsible for secondary sex characteristics.
  - Necessary for egg maturation.
  - Regulates uterine cycle.
Which of the following hormones stimulates water reabsorption by the kidneys?

1. insulin
2. thyroxin
3. ADH
4. calcitonin

25% 25% 25% 25%
Which of the following hormones stimulates water reabsorption by the kidneys?

1. insulin
2. thyroxin
3. **ADH**
4. calcitonin
What hormone stimulates the adrenal cortex to produce cortisol

1. insulin
2. thyroxin
3. ADH
4. ACTH
What hormone stimulates the adrenal cortex to produce cortisol

1. insulin
2. thyroxin
3. ADH
4. ACTH
Which gland produces oxytocin

1. Anterior Pituitary
2. Posterior Pituitary
3. Hypothalamus
4. Adrenal Cortex
Which gland produces oxytocin

1. Anterior Pituitary
2. Posterior Pituitary
3. **Hypothalamus**
4. Adrenal Cortex

### Graph

- Anterior Pituitary: 25%
- Posterior Pituitary: 25%
- Hypothalamus: 25%
- Adrenal Cortex: 25%
Which gland produces prolactin

1. Anterior Pituitary
2. Posterior Pituitary
3. Hypothalamus
4. Adrenal Cortex
Which gland produces prolactin

1. **Anterior Pituitary**
2. Posterior Pituitary
3. Hypothalamus
4. Adrenal Cortex
Thyroid Gland - Calcitonin

- **Calcitonin** - lowers blood calcium levels.

- **Target:**
  - Bones – stimulates osteoblasts (type of bone cells) to deposit calcium.
  - Kidneys – stimulates kidneys to excrete more calcium in the urine.
Parathyroid Glands

- Parathyroid glands - embedded in the lobes of the thyroid gland.
- Secretes: Parathyroid hormone (PTH).
Parathyroid Glands - Parathyroid Hormone

- Parathyroid hormone (PTH) – functions to increase blood calcium levels.
Parathyroid Glands - Parathyroid hormone

- Targets:
  - **Bone**: Stimulates the osteoclasts (type of bone cell) to release calcium
  - **Kidneys**: Stimulates the kidneys to reabsorb calcium
  - **Intestine**: Stimulates the intestine to increase absorption of calcium.
Regulation of Calcium Levels in Blood

- Calcium levels in blood too low:
  - PTH is released from parathyroid gland.

- Effects: PTH causes the...
  - bone to release calcium.
  - kidney to reabsorb calcium.
  - intestine to absorb more calcium.
Regulation of Calcium Levels in Blood

Figure 10.13 (2 of 2)

When levels of calcium are low, the parathyroid glands release PTH. In response, calcium is released by bones, reabsorbed by kidneys, and absorbed by the intestines.
Calcium levels in blood too high:
  - CT is released from Thyroid gland.

Effects: CT cause the:
  - bone to deposit calcium.
  - kidney to excrete more calcium.
Regulation of Calcium Levels in Blood

When levels of calcium are high, the thyroid gland releases CT, and calcium is taken up by the bones.

Thyroid gland secretes CT

CT

Bones take up calcium

High blood calcium

Blood calcium decreases

Homeostasis
Normal blood calcium
Calcitonin **lowers** or **raises** the blood's calcium level?

1. Lowers
2. Raises
Calcitonin lowers or raises the blood's calcium level?

1. **Lowers**
2. **Raises**
Calcitonin is produced by the

1. Hypothalamus
2. Thyroid
3. Parathyroid
Calcitonin is produced by the

1. Hypothalamus
2. **Thyroid**
3. Parathyroid
(a) Each adrenal gland sits on top of a kidney.
Adrenal Glands

(b) A section through the adrenal gland reveals two regions, the outer adrenal cortex and the inner adrenal medulla. These regions secrete different hormones.

Adrenal cortex:
• Mineralocorticoids
• Gonadocorticoids
• Glucocorticoids

Adrenal medulla:
• Epinephrine
• Norepinephrine
Adrenal Glands

- Adrenal glands—sit on top of the kidneys.
- There are two parts of the adrenal glands:
  - Adrenal medulla
  - Adrenal cortex
Control of the Adrenal Glands

- The adrenal glands is controlled by both nerves and hormones.
  - **Adrenal medulla**: controlled by nerves from the hypothalamus.
  - **Adrenal cortex**: controlled by ACTH (a hormone) secreted by the anterior pituitary gland.
Hormone secreted by adrenal medulla:

- Epinephrine - prepares the body for quick action. “fight or flight” / short-term response to stress.

- Effects: Increases blood pressure, increases heart rate, increases blood glucose levels.
(a) Structure of the pancreas and associated ducts. Exocrine cells of the pancreas secrete digestive enzymes into the pancreatic duct, which unites with the common bile duct before entering the small intestine.
Hormones of the pancreas

Secreted from the pancreatic islets (Islets of Langerhans)

Regulate blood glucose levels through two hormones:

1. glucagon
2. insulin
(b) Section of pancreatic tissue. Endocrine cells of the pancreas are found in clusters called pancreatic islets. Surrounding the islets are exocrine cells.
Glucagon - raises blood glucose levels of the blood.

Target and effects:

- Liver – stimulates the breakdown of glycogen to glucose, and to form glucose from lactic acid.
Pancreas Gland Hormones

When the level of glucose in the blood is low, the pancreas is stimulated to secrete glucagon, which, in turn, increases glucose in the blood by causing the liver to break down glycogen into glucose.
Pancreas - Insulin

- **Insulin** - lowers glucose levels of the blood.
Insulin Target and Effects

- Stimulates transport of glucose into muscle cells, white blood cells, and connective tissue cells.

- Liver: Inhibits the breakdown of glycogen to glucose.

- Prevents conversion of amino and fatty acids into glucose.

- Adipose tissue: Stimulates formation of triglycerides from glucose.
When the level of glucose in the blood is high, the pancreas secretes insulin. Insulin lowers blood glucose by its effects on the liver and cells of muscle and adipose tissue.
Diabetes mellitus - caused by the lack of insulin or by the inability of cells to respond to insulin as they should.

- Type 1 Diabetes – Autoimmune disorder that causes the pancreas to not produce enough insulin.

- Type 2 Diabetes - Inability of cells to respond to insulin. (cells do not have enough insulin receptors).
What type of diabetes mellitus is caused by the lack of insulin?

1. Type 1
2. Type 2
What type of diabetes mellitus is caused by the lack of insulin?

1. **Type 1**
2. **Type 2**
Glucagon lowers the blood glucose levels

1. Lowers
2. Raises
Glucagon ________ the blood glucose levels

1. Lowers
2. Raises
Thymus Gland

- Thymus gland - lies behind the sternum.
- Secretes the hormones: **Thymopoietin** which stimulates T-cell lymphocyte production and **Thymosin** which stimulates T-cell lymphocyte development – important in immune system function.

- Target: Bone marrow and T-cells
- Large and most active in children.
thyroid gland

thymus gland

parathyroid glands (on posterior surface of thyroid gland)
Pineal Gland

- Located in the brain.
- Secretes the hormone: **melatonin**.
  - Involved in our daily sleep-wake cycle. (circadian rhythms)
  - Regulates sexual development.
  - May play a role SAD – Seasonal Affect Disorder.
Which endocrine gland is the most involved in the immune response?

1. adrenal medulla
2. pancreas
3. thymus
4. ovaries
Which endocrine gland is the most involved in the immune response?

1. adrenal medulla
2. pancreas
3. thymus
4. ovaries
Kidneys

- The kidneys release the hormones:
  - **Erythropoietin** – stimulates the **bone marrow** to produce more red blood cells.
  - **Renin** – through a series of reactions, stimulates the **adrenal cortex** to release aldosterone which increase blood pressure.
Adipose Tissue - Leptin

- Leptin is a hormone produced in adipose tissue and effects the hypothalamus to tell the person that they are full and don’t need to eat anymore.
Prostaglandins

- Prostaglandins – locally acting messengers.
Homeostasis

- The nervous and endocrine systems exert control over the other systems and thereby maintain homeostasis.
- Both systems work closely together to govern the internal organs.
<table>
<thead>
<tr>
<th>Hormone</th>
<th>Where Produced</th>
<th>Released from</th>
<th>Target</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADH</td>
<td>Hypothalamus</td>
<td>Post. Pit.</td>
<td>Kidney</td>
</tr>
<tr>
<td>Oxytocin</td>
<td>Hypothalamus</td>
<td>Post. Pit</td>
<td>Uterus, mammary glands</td>
</tr>
<tr>
<td>hypothalamic releasing hormones</td>
<td>Hypothalamus</td>
<td>Hypothalamus</td>
<td>Anterior pituitary</td>
</tr>
<tr>
<td>hypothalamic inhibiting hormones</td>
<td>Hypothalamus</td>
<td>Hypothalamus</td>
<td>Anterior pituitary</td>
</tr>
<tr>
<td>Hormone</td>
<td>Where Produced</td>
<td>Released from</td>
<td>Target</td>
</tr>
<tr>
<td>--------------</td>
<td>----------------</td>
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<td>---------------------------</td>
</tr>
<tr>
<td>TSH</td>
<td>Ant. Pituitary</td>
<td>Ant. Pit.</td>
<td>Thyroid</td>
</tr>
<tr>
<td>ACTH</td>
<td>Ant. Pituitary</td>
<td>Ant. Pit.</td>
<td>Adrenal Cortex</td>
</tr>
<tr>
<td>FSH</td>
<td>Ant. Pituitary</td>
<td>Ant. Pit.</td>
<td>Ovaries, testes</td>
</tr>
<tr>
<td>LH</td>
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<td>Ant. Pit.</td>
<td>Ovaries, testes</td>
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<tr>
<td>Prolactin</td>
<td>Ant. Pituitary</td>
<td>Ant. Pit.</td>
<td>Mammary glands</td>
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<tr>
<td>GH</td>
<td>Ant. Pituitary</td>
<td>Ant. Pit.</td>
<td>Bones, muscle, cartilage</td>
</tr>
<tr>
<td>Thyroxine</td>
<td>Thyroid</td>
<td>Thyroid</td>
<td>Throughout body</td>
</tr>
<tr>
<td>Tri-iodothyronine</td>
<td>Thyroid</td>
<td>Thyroid</td>
<td>Throughout body</td>
</tr>
<tr>
<td>Hormone</td>
<td>Where Produced</td>
<td>Released from</td>
<td>Target</td>
</tr>
<tr>
<td>------------</td>
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<td>---------------------</td>
<td>------------------------------------</td>
</tr>
<tr>
<td>Calcitonin</td>
<td>Thyroid gland</td>
<td>Thyroid gland</td>
<td>Bones, kidneys</td>
</tr>
<tr>
<td>PTH</td>
<td>Parathyroid gland</td>
<td>Parathyroid gland</td>
<td>Bones, kidneys, intestine</td>
</tr>
<tr>
<td>Cortisol</td>
<td>Adrenal Cortex</td>
<td>Adr. Cortex</td>
<td>Muscle, adipose tissue, immune system</td>
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<tr>
<td>Aldosterone</td>
<td>Adr. Cortex</td>
<td>Adr. Cortex</td>
<td>Kidney</td>
</tr>
<tr>
<td>Epinepherine</td>
<td>Adr. Medulla</td>
<td>Adr. Medulla</td>
<td>Throughout body</td>
</tr>
<tr>
<td>Insulin</td>
<td>Pancreas</td>
<td>Pancreas</td>
<td>Liver, muscle, wbc, connective tissue, adipose</td>
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<tr>
<td>Hormone</td>
<td>Where Produced</td>
<td>Released from</td>
<td>Target</td>
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<tr>
<td>Glucagon</td>
<td>Pancreas</td>
<td>Pancreas</td>
<td>Liver, muscle, adipose</td>
</tr>
<tr>
<td>Testosterone</td>
<td>Testes (and other tissues)</td>
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<td>Throughout body</td>
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<tr>
<td>Estrogen</td>
<td>Ovaries</td>
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</tr>
<tr>
<td>Thymosin</td>
<td>Thymus</td>
<td>Thymus</td>
<td>T Cells</td>
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<tr>
<td>Thymopoietin</td>
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<td>T Cells</td>
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<tr>
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<td>Kidneys</td>
<td>Kidneys</td>
<td>Bone marrow</td>
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<tr>
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<td>Kidneys</td>
<td>Kidneys</td>
<td>Adrenal cortex</td>
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<td>Adipose</td>
<td>Adipose</td>
<td>Hypothalamus</td>
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<td>Prostaglandins</td>
<td>Throughout body</td>
<td>Throughout body</td>
<td>Throughout body</td>
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</table>
Important Concepts

- Read Chapter 11 for next lecture
- What is the function of the endocrine system
- What are similarities and differences between neurotransmitters and hormones
- What are the two types of hormones; How do the two types of hormones work, how do they effect the target cells, know the differences between the two types of hormones, and examples of each type of hormone
Important Concepts

- Where are all the hormones in this lecture produced and released from, and what are the functions of the hormones, and what is the target of the hormones.

- Know all the disorders discussed in the lecture, what are the causes, effects of the disorder and what are the treatments of the disorders.

- Know the location and names of the endocrine glands, be able to label a drawing with the glands.
Important Concepts

- How does the hypothalamus control the pituitary gland.
- What is the function of the hypothalamus.
- How are the adrenal glands controlled.
- What are the two parts of the adrenal glands, and how is each part controlled, and which hormones are released from which part.
- What are the side effects of cortisol.
Important Concepts

- How are calcium levels in the blood regulated, what hormones and glands regulate it.

- How are blood glucose levels regulated, what hormones and glands regulate it, know the causes of the two types of diabetes.
Definitions

- Endocrine glands, Hormones, receptor, target cells, non-target cells, exophthalmos, pancreatic islets, negative feedback, water soluble, hydrophilic, lipid soluble, hydrophobic, secondary messenger, transcription, translation, produce, release, dilute, concentrated, extremities, deficient, sufficient, synthesis, reabsorption, inhibit, stimulate, extremities, prostaglandins, pancreatic islets, Islets of Langerhans