Biology 120
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Chapter 45
The Endocrine System

The Endocrine system consists of a three **brain structures**, several large **glands** (called **endocrine glands**), and several smaller tissues that work together to secrete the various hormones and cytokines throughout the body that maintain metabolic **homeostasis**. The brain structures include the **Hypothalamus**, the **Pineal Gland**, and the **Pituitary Gland** (Figure 45.4). The major endocrine glands include the **Thyroid** and **Parathyroid glands**, the **Adrenal Glands**, the **Pancreas**, the **Ovaries** (in women) and the **Testes** (in men; Figure 45.4).

Some hormones are produced by neurons (ie-the neurons that make up the hypothalamus) and others are produced by the **parenchymal tissue** of the endocrine glands. Sometimes the production and release of hormones from these glands is regulated and controlled by hormones released from other endocrine glands or brain structures. Hormones produced by one gland that regulate and control the release of hormones from other hormone glands are called **Tropic Hormones**. Almost all of the **tropic hormones** come from the **Pituitary Gland** under orders from the **hypothalamus**. Thus, the hypothalamus and pituitary gland are extremely important components of the endocrine system.

Endocrine Glands vs. Exocrine Glands: There are two basic types of glands in the body, called endocrine glands and exocrine glands. The main difference between the two is that **exocrine glands** produce things like sweat, saliva, or digestive hormones, and deliver them to other parts of the body via **ducts** (tubes) lined with epithelial tissue. By contrast, **endocrine glands** produce hormones, which are either secreted into the bloodstream or the lymphatic system to stimulate distant organs; or diffuse through interstitial spaces to stimulate nearby cells. Their products (hormones) are not transported directly to other tissues or organs by special ducts. (Question: by this definition, is the liver an endocrine or an exocrine gland?) Some, rare glands do both! A good example of a gland that functions as both an endocrine and an exocrine gland is the **Pancreas**. Most cells in the pancreas (called **acinar cells**) produce **digestive enzymes** and **bicarbonate** that is sent via a duct to the **duodenum** (the exocrine function of the pancreas). Other cells called **alpha** and **beta** cells produce hormones called **glucagon** and **insulin,** and send them into the blood to regulate blood glucose levels (the endocrine function of the pancreas).

Steroid vs. Non-Steroid Hormones: Both plants and animals produce hormones to control their functions and actions. Mammals are more complicated than plants, and produce a larger variety of hormone types. Different hormones are made from different macromolecules, including proteins, lipids, or modified amino acids. For purposes of this discussion, we will consider hormones to be any macromolecule that are produced by one of the endocrine glands, and has broad effects on body systems, regardless of what the hormones are made of (lipid, protein etc.). However, hormones that are derived specifically from the lipid **cholesterol** are known as **steroid hormones**, while the other types are known as **non-sterioid hormones**. You will not be required to memorize what the non-steroid hormones are made of, but you will be

required to learn a few of the steroid hormones. (Specifically, **Testosterone** produced by the testes, and the **Estrogens** and **Progestins** produced by the ovaries.)

Cytokines vs. Hormones: Cytokines are usually composed of small proteins, and are produced by one type of cell, and act locally to signal other cells to differentiate into specialized cells. Good examples of cytokines are the small proteins that mediate hematopoiesis (ie-IL2, IL3, GM-CSF etc.). However, the distinction between cytokines and hormones is not always a clear one.

TYPES OF SIGNALING BY HORMONES

Endocrine Signaling: Is when an endocrine gland or endocrine cell produces hormones that enter the blood and stimulate cells or organs elsewhere.

Paracrine Signaling: Is when a paracrine gland (or cell) produces hormones that diffuse through local interstitial spaces and stimulate other cells nearby.

Autocrine Signaling: Autocrine signaling is when a cell secretes a hormone that stimulates itself to do something.

Neuroendocrine Signaling: Where neurons in the brain produce hormones that are sent into the bloodstream; or stimulate endocrine glands directly (ie-the hypothalamus). The **Hypothalamus** is the main brain structure responsible for this function. Many sensory neurons run through the hypothalamus, telling it how cold or warm we are, how high our blood pressure is, etc., and the hypothalamus responds by telling the **pituitary gland** (located just underneath it) to release different hormones that maintain homeostasis.

Tropic (effector) Hormones vs. Non-Tropic Hormones: Tropic hormones (also known as **effector hormones**) are hormones released from endocrine glands that in turn regulate the activities of other endocrine glands. The best example of this is the pituitary gland, which releases tropic hormones (on command from the hypothalamus) which in turn regulate other endocrine glands, telling them to secrete other hormones.

NEUROENDOCRINE SIGNALING, THE HYPOTHALAMUS, PITUITARY GLAND, AND THE PINEAL GLAND (Figures 45.14, 15 and 16)

The **hypothalamus** contains many sensory neurons that are able to sense temperature, blood pressure, blood salt concentration and many other things, and is thus able to tell whether the body systems are in a state of homeostasis or not. If they are not, it sends neuroendocrine signals to the **pituitary gland** located just underneath it. The pituitary gland can then release a number

of different types of **tropic hormones** into the blood that are capable of regulating other endocrine glands that secrete hormones that can return the body to homeostasis.

The Posterior Pituitary: The pituitary gland is divided into an anterior and a posterior section (Figure 45.14). The **Posterior Pituitary** secretes **ADH** (antidiuretic hormone) and **Oxytocin**. As you learned previously, ADH increases water retention in the kidneys. Oxytocin stimulates release of milk from breasts during nursing. The sucking action of a baby on a nipple stimulates neurons in the nipple, which send signals to the hypothalamus, which stimulates the posterior pituitary gland to secrete Oxytocin. Oxytocin then stimulates the smooth muscles lining the insides of the mammary glands to push milk out. Oxytocin also causes smooth muscles lining the uterus to contract during child birth, pushing the baby out.

The Anterior Pituitary: The anterior pituitary secretes a number of different tropic hormones, including **GH (Growth Hormone)** which stimulates bone growth when we are young, **Prolactin**, which stimulates milk production in nursing females, **FSH (Follicle-Stimulating Hormone)** which stimulates sperm and ova production in male and female gonads (testes and ovaries, respectively), **TSH (Thyroid-Stimulating Hormone;** also known as **thyrotropin)** which stimulates metabolic activity of the **thyroid gland** (see below), and **ACTH (Adrenocorticotropic Hormone)** which stimulates the **Adrenal Glands** to produce Glucocorticoids (see below).

The Pineal Gland: The pineal gland is a small gland located in the brain just behind the eyes. The pineal gland produces **Melatonin**, which makes us drowsy and wanting to go to sleep. Melatonin production is inhibited by light that diffuses through the eyes. The production of melatonin in darkness, and lack of production in light is a key regulator of light/dark cycles and **circadian rhythms**. (Circadian rhythms are body functions that cycle through a 24 hour clock, and are mediated by hormones that ebb and flow on a repeating 24 hour cycle, and often respond to light and/or dark.)

OTHER ENDOCRINE GLANDS AND THEIR HORMONES

PANCREAS, Glucagon and Insulin: Insulin and Glucagon are a set of **antagonistic hormones** that regulate glucose levels in blood. Glucose is the main energy source for aerobic respiration. Glucose is recovered from digested food in the small intestine and sent to the liver via the **hepatic portal system**. Glucose is then converted into **glycogen**, and stored in the liver (and also in muscle tissue). Normal blood glucose levels are about 100mg/100mL of blood (about 1g/L). When blood glucose levels fall below this level it usually means you are either working hard and your cells are consuming more glucose, or you've missed a meal, and need to draw on your glucose reserves in the liver. In response, **alpha cells** in the **pancreas** release **glucagon** which stimulates **the breakdown of glycogen into glucose in the liver**. The glucose is then released into the blood until homeostasis is regained. On the other hand, if there is too much glucose in the blood it usually means you are resting, and your cells don't need as much glucose. So, **beta cells** in the pancreas produce **insulin**, which causes blood glucose to be converted back into glycogen for storage in the liver. **Insulin also causes glucose to be**

absorbed into cells to be used for aerobic respiration. If insulin is lacking, or if the **insulin receptors** on the cells are defective, glucose can't get into cells, and the body switches to burning fat as an alternative source of energy. Rapid, excessive burning of fat leads to the production of acidic waste products in the blood, a condition known as **Diabetes Mellitus** (see below). (Canadian History Trivia: Insulin was discovered by Canadian scientists at the University of Toronto in 1921, and used as a treatment for Diabetes Mellitus. It is still used as a treatment for Diabetes Mellitus, where diabetics must inject themselves with insulin.)

THYROID GLAND, Thyroid Hormone and Calcitonin: The thyroid gland (located in the throat) is **stimulated by TSH from the anterior pituitary gland** to secrete **Thyroid Hormone** which increase the body's **metabolic rate**. This usually has the effect of increasing body temperature as well. The Thyroid gland also produces **Calcitonin** in **response to high blood calcium levels**. **Calcitonin lowers** blood calcium levels by **promoting calcium absorption by bones**. (Bones act as a calcium reserve in the body, but calcium is also critical for bone strength. So, calcium levels must be regulated to make sure enough calcium is getting to the bones. In **osteoporosis** [a disease where bones become weak in old age, particularly in women], this balance is lost, and bones become brittle.) Calcitonin also **enhances calcium release in urine from the kidneys**, and blocks calcium absorption from food by the small intesting.

PARATHYROID GLANDS and Parathyroid Hormone: The parathyroid glands are four small circular glands located on the posterior surface of the thyroid gland. They secrete **Parathyroid Hormone (PTH)** in response to **low** blood calcium levels. **PTH causes release of calcium from the bone matrix, stimulates reabsorption of calcium by the kidneys, and converts the inactive form of Vitamin D to the active form. The active form of Vitamin D stimulates absorption of calcium by the small intestine**. Thus, PTH and calcitonin are antagonistic to one another, with calcitonin causing absorption of calcium in bone, and PTH causing release of calcium from the bone.

The ADRENAL GLANDS and the Stress Response (Figure 45.21): One adrenal gland is located on top of each kidney. Each adrenal gland is divided into two parts, the **Adrenal Medulla** and the **Adrenal Cortex**. The Adrenal Medulla is stimulated directly by neurons (of the **autonomic**, or involuntary nervous system) to produce two hormones (**Epinephrine** and **Norepinephrine**) as a short term, immediate response to stress (fear, anger etc.). Epinephrine and norepinephrine **increase the heart rate**, breathing rate, cell metabolic rate, and blood pressure. The **Adrenal Cortex** secretes two classes of hormones (the **Mineralocorticoids** and the **Glucocorticoids**) in response to **ACTH** (**Adrenocorticotropic Hormone**) from the Anterior Pituitary Gland, as a long term response to stress. The **Mineralocorticoids** increase sodium and water retention by kidneys, thus increasing blood volume and blood pressure. The **Glucocorticoids** increase breakdown of proteins and fats, and their conversion into glucose to be used for energy.

The TESTES, FSH and the ANDROGENS: The testes are the male gonads, where sperm (the male gametes) are produced. Sperm is produced in response to **Follicle-Stimulating Hormone** released from the **anterior pituitary gland**. In addition, FSH also stimulates the testes to produce a class of hormones called the **androgens**, which are responsible for the

development of male secondary sexual characteristics. **Secondary Sexual Characteristics** are physical features that distinguish males from females, but which are not directly involved in sexual reproduction. (ie-male primates are bigger, more muscular, and have narrower hips and wider shoulders than females. Female primates have breasts, are smaller and have wider hips than males. Male birds are often more colourful than female birds etc.) The most important androgen (and the only one you're required to memorize) is the steroid hormone **testosterone**.

OVARIES, FSH, the ESTROGENS and the PROGESTINS: The ovaries are the female gametes where **ova** (eggs, the female gametes) are produced. Ova are produced in response to FSH from the Anterior Pituitary Gland. FSH also stimulates the ovaries to produce a class of hormones called the **estrogens**, which are responsible for the development of female secondary sexual characteristics. The ovaries also produce a class of hormones called the **progestins** (the most important of which is called **progesterone**) which prepare the walls of the uterus to receive a fertilized egg (ie-at the start of a pregnancy).

S CELLS and Secretin: Food entering the stomach is partially broken down by the enzyme **pepsin**, which works at a very low pH. The partially digested food then moves to the small intestine (via the duodenum) where another set of digestive enzymes (that work at high pH) are added. In order to make the switch from a low pH to a high pH environment, **bicarbonate** is added to the partially digested food in the duodenum; but only when cells in the duodenum (called **S Cells**) sense a drop in pH. S Cells then produce a hormone called **Secretin** that stimulates **acinar cells** in the pancreas to produce bicarbonate ions and send them (via the pancreatic duct) to the duodenum.

PATHOLOGIES OF THE ENDOCRINE SYSTEM

PATHOLOGIES OF THE DIGESTIVE SYSTEM:

Diabetes Mellitus: Cells are unable to take up glucose to meet their metabolic needs, and instead break down fat for energy. Rapid breakdown of fat causes accumulation of acidic waste products in the blood which can eventually be fatal. (Diabetes was fatal until scientists at the University of Toronto discovered Insulin in 1921, for which they won the Nobel Prize.) Diabetes is characterized by high glucose levels in blood and urine, excessive urination, and rapid weight loss due to breakdown of fat as an alternative to glucose. In **Type 1 Diabetes** (also known as '**insulin-dependent diabetes'**) glucose is not taken in by cells because the beta cells in the pancreas are defective, and do not produce insulin. This can be treated by injection with insulin. In **Type 2 Diabetes** ('**insulin-independent diabetes'**), insulin is produced, but either the insulin receptors on the cells are defective, or the signal transduction pathway associated with the receptor is defective.

PATHOLOGIES OF THE THYROID GLAND:

Hypothyroidism: The thyroid gland produces too little thyroid hormone, leading to lack of energy, lethargy, intolerance to cold, and weight gain.

Hyperthyroidism: The thyroid gland produces too much thyroid hormone, leading to chronic hypertension (high blood pressure), high body temperature and sweating, weight loss, irritability, and **bulging eyes**. In some cases, hyperthyroidism is treated by killing the thyroid gland with radiation.

Graves' Disease: A form of hyperthyroidism caused by an **autoimmune disease** where the body produces antibodies that bind to and stimulate the thyroid receptors for TSH, constantly stimulating them to produce thyroid hormone whether TSH is being produced by the anterior pituitary or not. The hypothalamus will try to compensate for the high levels of thyroid hormone in the blood by cutting back on production of TSH, but this does not counteract the effect of stimulation by antibodies. Thus, one of the ways to distinguish Graves' Disease from regular hyperthyroidism is that Graves' Disease is characterized by abnormally high levels of thyroid hormone being produced *despite* abnormally *low* levels of TSH being produced.

PATHOLOGIES OF THE PITUITARY GLAND:

Diabetes Insipidus: Both Diabetes Mellitus and Diabetes Insipidus are characterized by excessive urination, but for different reasons. In Diabetes Insipidus, the posterior pituitary gland fails to produce sufficient ADH, leading to excessive urination, excessive water loss, and excessive thirst.

Pituitary Dwarfism: The pituitary gland fails to produce enough GH during adolescence leading to dwarfism. (Not to be confused with **Achondroplasia**, which is a genetic disease affecting a growth factor receptor, causing dwarfism for a different reason.)

Giantism: The pituitary gland produces too much GH during childhood, causing the person to be extremely tall (up to 2.4 meters).

PRACTICE QUESTIONS:

Extended Matching: Match the term to the definition.

A. ACTH
B. ADH
C. Autocrine
D. Calcitonin
E. Endocrine
F. Epinephrine
G. Estrogen
H. Exocrine
I. FSH
J. GH
K. Graves'
L. Hypertension
M. Hypothalamus
N. Insulin
O. Oxytocin
P. Paracrine
Q. Pituitary
R. PTH
S. Melatonin
T. Neuroendocrine
U. Neurohormone
V. Progesterone
W. Testosterone
X. Thyroid
Y. Tropic
Z. TSH

1. A type of hormone signal where the cell that produced the hormone is stimulated by the hormone it produced.
2. A tropic hormone released by the anterior pituitary gland which stimulates release of Glucocorticoids and Mineralocorticoids from the Adrenal Cortex.
3. A male steroid hormone produced by the testes, which promotes general development of male secondary sex characteristics.
4. A hormone produced by the parathyroid glands that increases blood calcium levels by causing calcium to be released from the bone matrix.
5. A hormone produced by the Pineal Gland that helps synchronize circadian rhythms with light/dark cycles.
6. A female steroid hormone that promotes the general development of female secondary sexual characteristics.
7. A hormone that increases the heart rate.
8. A hormone that lowers blood glucose levels partly by stimulating the conversion of glucose to glycogen in the liver.
9. A hormone secreted by the anterior pituitary gland that stimulates the thyroid to produce TH, and increase cell metabolism and body temperature.
10. A female steroid hormone that specifically prepares the walls of the uterus to receive a fertilized egg (a zygote).
11. A hormone produced by the posterior pituitary gland that promotes secretion of milk.
12. A hormone that promotes production of sperm and ova in male and female gonads, respectively?
13. A hormone that promotes growth of bones during childhood.
14. A hormone that promotes water retention by kidneys.
15. Name for an autoimmune disease of the thyroid gland.
16. Another term for 'high blood pressure.'
17. A hormone that lowers calcium levels in blood.
18. Endocrine gland that produces Calcitonin.

19. A structure in the brain that senses changes in homeostasis, and signals release of tropic hormones from the pituitary gland to correct them.
20. A hormone produced by the brain (or by neurons) rather than by endocrine glands.
21. Refers to tropic hormones produced by neurons or structures in the brain.
22. Refers to a type of hormone that regulates the activities of endocrine glands.
23. Refers to glands that export their products to other places via special ducts, rather than through the bloodstream.
24. An endocrine gland located just underneath the hypothalamus, which stores or releases a number of tropic hormones.
25. Refers to hormones that are secreted into the blood.
26. A type of hormone signal where the hormone stimulates cells located nearby, rather than having to travel through blood.

Short Answer Questions:

1. What is the general term for a hormone (produced by an endocrine gland) that regulates the production and release of hormones from other endocrine glands?
2. Give an example of a steroid hormone that is important to women.
3. Give an example of a steroid hormone that is important to men.
4. Give an example of a non-steroid tropic hormone produced by the anterior pituitary gland that stimulates production of both sperm and testosterone.
5. Give an example of a non-steroid tropic hormone produced by the anterior pituitary gland that stimulates production of both ova (egg cells) and estrogen.
6. What macromolecule are steroid hormones originally derived from?
7. Give an example of a large gland in the body that has both an exocrine and an endocrine function that is important to food digestion.
8. What central brain structure is important to hormone regulation, and what is the name of the gland that is associated with it? (2 points)
9. What are two main functions of insulin?
10. What is the main function of glucagon?
11. What type of pancreatic cells make Insulin?
12. What type of pancreatic cells make Glucagon?
13. What type of pancreatic cells make digestive enzymes?
14. What are the three main cell types that make up the pancreas, and what do they produce? (3 points)
15. In what form is glucose stored in the liver?
16. What are the two hormones that regulate blood calcium levels, and in what structures are they produced? (3 points)
17. Name two types of things exported from the pancreas as part of its exocrine function. (2 points)
18. Name two types of hormones exported from the pancreas as part of its endocrine function. (2 points)
19. In what form is glucose stored in the liver, and which hormone is capable of converting it back to glucose for release into the bloodstream? (2 points)
20. Another term for high blood pressure.
21. What is one of the functions of Vitamin D?

22. Which hormone activates the inactive form of Vitamin D?
23. Name two endocrine organs, either of which could cause hyperthyroidism if they malfunction. (2 points)
24. Name an autoimmune disease associated with the thyroid gland.
25. Name of the hormone produced by the pineal gland (in the brain) that regulates day/night circadian rhythms.
26. Where are the parathyroid glands in relation to the thyroid gland, and how many parathyroid glands are there? (2 points)
27. Where are the adrenal glands located?
28. Which part of an adrenal gland is controlled by the autonomic nervous system, and which part is controlled by tropic hormones? (2 points)
29. What do you call physical features that distinguish males from females, but which are not directly involved in reproduction?

EXOCRINE vs. ENDOCRINE: Say whether each of the following is an endocrine gland or an exocrine gland.

1. Liver
2. Hypothalamus
3. Adrenal gland
4. Prostate gland
5. Testes
6. Pancreas (acinar cells)
7. Pancreas (alpha cells)
8. Pineal gland
9. Ovaries
10. Thyroid gland
11. Mammary glands (ie-breasts)
12. Pancreas (islets)
13. Posterior pituitary gland
14. Salivary gland
15. Parathyroid gland
16. Anterior pituitary gland
17. Pancreas (beta cells)
18. Sweat gland
19. Pancreas (beta cells)

Definition Questions: Define the following terms (5 points each).

1. What is paracrine signaling?
2. What is autocrine signaling?
3. What is neuroendocrine signaling?
4. What is a tropic hormone?
5. What is an effector hormone?
6. What are secondary sexual characteristics?
7. What are androgens?
8. What are estrogens?
9. What is hyperthyroidism?
10. Graves' Disease (10 points)

Essay Questions:

1. **Explain how Insulin and Glucagon work to maintain blood glucose homeostasis. Include the organs and cells that produce these hormones, and the organs they affect. (Hint: Figure 45.13; 20 points).**

2. **Explain how the Thyroid and Parathyroid glands are able to regulate calcium levels in blood. (20 points)**
3. **Explain how the Pineal Gland is able to regulate our circadian rhythms. (20 points)**
4. **What is the difference between an exocrine gland and an endocrine gland? (10 points)**
5. **Explain how S Cells are critical to digestion of food. (20 points)**
6. What is the difference between a steroid hormone and a non-steroid hormone? (10 points)
7. What is the difference between a tropic and a non-tropic hormone? (10 points)
8. What is the difference between endocrine and paracrine signaling? (10 points)
9. What is the difference between paracrine signaling and autocrine signaling? (10 points).
10. What is neuroendocrine signaling? (10 points)
11. The Thymus and Thyroid Glands are often confused because the names sound similar. Where is each located, and what is the function of each? (10 points)

General Questions About Hormones:

A. ADH (antidiuretic hormone)
B. ACTH (adrenocorticotropic hormone)
C. Epinephrine
D. Norepinephrine
E. Glucocorticoids
F. Mineralocorticoids
G. Oxytocin
H. Progestins
I. Thyroid hormone
J. PTH (parathyroid hormpone)
K. Calcitonin
L. GH (growth hormone)
M. Prolactin
N. Testosterone
O. Estrogen
P. FSH (Follicle-Stimulating Hormone)
Q. TSH (Thyroid-Stimulating Hormone)
R. ACTH (Adrenocorticotropic Hormone)
S. Melatonin

1. Which are tropic hormones?
2. Which is a class of female hormones that prepares the uterine wall to receive a fertilized egg (a zygote) at the start of pregnancy?
3. Which is/are secreted from the Thyroid Gland?
4. Which is/are secreted from the Parathyroid Glands?
5. Which are secreted from the posterior pituitary gland?
6. Which are secreted from the anterior pituitary gland?
7. Which stimulates the adrenal cortex?
8. Which are produced by the adrenal cortex?

9. Which are produced by the adrenal medulla?
10. Which cause an increase in heart rate and breathing rate?
11. Which cause increased retention of sodium and water by the kidneys, leading to higher blood pressure?
12. Which cause increased breakdown of proteins and fats, and their conversion into glucose, causing blood glucose levels to increase?
13. Which stimulates production of both sperm and ova in male and female gonads, respectively?
14. Which LOWERS calcium levels in blood by preventing calcium from being absorbed by bone, and increases calcium release in urine.
15. Which RAISES calcium levels in blood by causing release of calcium from the bone matrix, and enhancing reabsorption of calcium by the kidneys?
16. Which increases cellular metabolism (and thus, increases body temperature)?
17. Which stimulates secretion of milk from mammary glands?
18. Which stimulates development of male secondary sexual characteristics (muscle mass etc.)
19. Which is also known as Vasopressin?
20. Which stimulates development of female secondary sexual characteristics (breast development etc.)
21. Which regulates circadian rhythms?
22. Which is responsible for bone growth as we are growing up?
23. Which regulates water re-absorption by the kidneys?
24. Which is/are secreted by the pineal gland?
25. Which increases the number of aquaporin water channels in the nephron collecting duct, thus increasing water retention?

Hormone sources and targets: for each hormone, list where it is produced, and what it does. (5 points each)

1. **Insulin**
2. **Glucagon**
3. **Androgens**
4. **Calcitonin**
5. **Parathyroid Hormone**
6. **Glucocorticoids**
7. **Mineralocorticoids**
8. **Secretin**
9. **Estrogens**
10. **ADH**
11. **Progestins**
12. **Oxytocin (2 functions)**
13. **Melatonin**
14. **TSH (Thyroid-Stimulating Hormone)**
15. **Thyroid Hormone**
16. **FSH (Follicle-Stimulating Hormone)**
17. **ACTH (Adrenocorticotropic Hormone)**

ENDOCRINE SYSTEM PATHOLOGIES: Answer the questions regarding the following pathologies of the endocrine system.

A. Dwarfism (in some cases)
B. Diabetes Insipidus
C. Insomnia (in some cases)
D. Hyperthyroidism

E. Diabetes Mellitus
F. Hypothyroidism
G. Graves' Disease
H. Giantism
I. None of the above

1. Which is/are caused by malfunctions of the thyroid gland? (Be careful, this is a trick question!)
2. Which is/are caused by malfunctions of the pineal gland?
3. Which is/are caused by malfunctions of the pituitary gland?
4. Which is/are caused by malfunctions of the anterior pituitary gland?
5. Which is/are caused by malfunctions of the posterior pituitary gland?
6. Which is/are caused by malfunctions of the spleen?
7. Which is/are caused by malfunctions of the immune system?
8. Which is/are caused by malfunctions of the pancreas?
9. Which is/are characterized by bulging eyes?
10. Which is/are characterized by excessive urination?
11. Which is/are characterized by rapid weight loss?
12. Which is/are characterized by sweatiness and hypertension?
13. Which is/are characterized by lethargy and weight gain?
14. Which is/are caused by a deficiency of GH?
15. Which is/are caused by a deficiency of melatonin?
16. Which is/are caused by a deficiency of ADH?
17. Which is/are caused by a deficiency of insulin (in some cases)?

Essay Questions About Endocrine Pathologies:

1. How does Type 1 Diabetes differ from Type 2 Diabetes? (10 points)
2. What is the difference between Diabetes Mellitus and Diabetes Insipidus? (10 points)
3. What is the difference between hypothyroidism and hyperthyroidism, and what are the signs and symptoms of each? Name two endocrine organs, each of which could cause these conditions. (10 points)
4. People with hyperthyroid condition can have either a malfunctioning thyroid gland or a malfunctioning anterior pituitary. However, treatment of hyperthyroid condition usually involves killing the thyroid gland with radiation, regardless of whether it is the thyroid gland or the pituitary gland that is malfunctioning. Why do you think this is? (10 points)
5. How do you tell the difference between Graves'Disease and regular hyperthyroidism? (10 points)