UNIT 10. REGULATION – THE ENDOCRINE SYSTEM

ACTIVITY 10-1. NATURE OF ENDOCRINE REGULATION

The endocrine system, like the nervous system, is involved in the regulation of bodily processes. The endocrine glands produce substances called hormones. Endocrine glands are sometimes referred to as ductless glands because they release their secretions directly into the bloodstream. (The exocrine glands, such as salivary glands, release their secretions into ducts passing to other organs or to the outside of the body.)

Questions

1. Why are the organs of the endocrine system called ductless glands?
   It does not have ducts, uses bloodstream to transport hormones.

2. The substances produced by the endocrine glands are hormones.

3. What is an exocrine gland? Duct gland

4. Three exocrine glands are the pancreas, salivary gland and gallbladder.

The hormones secreted by the glands of the endocrine system include a variety of types of compounds. Most are proteins. Each hormone is released directly into the bloodstream, which carries it to all the tissues of the body. It exerts its effects on a distant organ, or target tissue. The effects of some hormones are limited to one specific target tissue or process, while other hormones have wide-ranging effects on a variety of metabolic processes. Hormones influence the rates of specific metabolic reactions in sensitive tissues. The actual mechanism by which this is accomplished is unknown. The effects of some hormones are almost immediate, while others take hours.

Questions

1. What is a hormone? Chemical released directly into the bloodstream.

2. The tissue acted on by a particular hormone is its target tissue.
feedback  For the most part, the secretion of hormones by the glands of the endocrine system is regulated by a feedback mechanism. Hormones are not secreted into the bloodstream at a constant rate. Instead, when the concentration of a particular hormone in the blood falls below a certain level, the gland is stimulated to increase its rate of secretion. When the level of the hormone in the blood rises to a certain level, the rate of secretion by the gland decreases. Generally, the secretion of a hormone by one gland is stimulated by the action of another hormone secreted by a second gland.

Question

Gland A secretes hormone A, which stimulated gland B to secrete hormone B.

a. As the level of hormone B in the blood increases, the rate of production of hormone A will \( \text{decrease} \).

b. As the level of hormone B in the blood decreases, the rate of production of hormone A will \( \text{increase} \).

endocrine vs. nervous system  Both the endocrine and nervous systems function in the regulation of the body and in the maintenance of homeostasis. The nervous system makes rapid adjustments to environmental stimuli, while the endocrine system generally makes slower, longer-lasting adjustments.

Question

*Fill in the blanks in the chart below.*

**COMPARATIVE FUNCTIONS OF NERVOUS AND ENDOCRINE SYSTEMS**

<table>
<thead>
<tr>
<th>NERVOUS REGULATION</th>
<th>ENDOCRINE REGULATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nerve endings secrete neurohumors</td>
<td>Endocrine glands secrete hormones</td>
</tr>
<tr>
<td><em>(neurotransmitters)</em></td>
<td></td>
</tr>
<tr>
<td>Maintains internal stability</td>
<td>Maintains internal stability</td>
</tr>
<tr>
<td>Some nerves stimulate glands</td>
<td>Glands stimulate other glands &amp; organs.</td>
</tr>
<tr>
<td>Nerve impulses are electrochemical in nature</td>
<td>Chemical in nature. Transported in blood.</td>
</tr>
</tbody>
</table>
## ACTIVITY 10-2. HUMAN ENDOCRINE SYSTEM

### HORMONES OF THE HUMAN ENDOCRINE SYSTEM

<table>
<thead>
<tr>
<th>Gland</th>
<th>Hormones</th>
<th>Functions of hormones</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pituitary—anterior</td>
<td>Growth hormone (STH)</td>
<td>Stimulates growth of bone and muscle.</td>
</tr>
<tr>
<td></td>
<td>Adrenocorticotropic hormone (ACTH)</td>
<td>Stimulates adrenal cortex to secrete cortin.</td>
</tr>
<tr>
<td></td>
<td>Thyroid-stimulating hormone (TSH)</td>
<td>Stimulates thyroid to secrete thyroxin.</td>
</tr>
<tr>
<td></td>
<td>Follicle-stimulating hormone (FSH)</td>
<td>Stimulates development of follicles in ovaries and sperm in testes.</td>
</tr>
<tr>
<td></td>
<td>Luteinizing hormone (LH)</td>
<td>Stimulates development of corpus luteum in ovaries and secretion of testosterone by testes.</td>
</tr>
<tr>
<td></td>
<td>Lactogenic hormone (prolactin)</td>
<td>Stimulates mammary glands to secrete milk.</td>
</tr>
<tr>
<td>Pituitary—posterior</td>
<td>Oxytocin</td>
<td>Stimulates contraction of uterus.</td>
</tr>
<tr>
<td></td>
<td>Vasopressin</td>
<td>Affects contraction of arterial walls and rate of water reabsorption by kidneys.</td>
</tr>
<tr>
<td>Thyroid</td>
<td>Thyroxin</td>
<td>Increases rate of metabolism.</td>
</tr>
<tr>
<td></td>
<td>Calcitonin</td>
<td>Affects calcium metabolism.</td>
</tr>
<tr>
<td>Adrenal—medulla</td>
<td>Adrenaline</td>
<td>Stimulates breakdown of glycogen to glucose, release of glucose into blood; increases rate of heartbeat and rate of respiration.</td>
</tr>
<tr>
<td>Pancreas—islets of Langerhans</td>
<td>Insulin</td>
<td>Stimulates glucose oxidation and removal from bloodstream (storage).</td>
</tr>
<tr>
<td></td>
<td>Glucagon</td>
<td>Stimulates breakdown of glycogen to glucose, glucose synthesis, and release of glucose into bloodstream.</td>
</tr>
<tr>
<td>Ovaries</td>
<td>Estrogen</td>
<td>Controls female secondary sex characteristics. Stimulates thickening of uterine wall in preparation for pregnancy.</td>
</tr>
<tr>
<td></td>
<td>Progesterone</td>
<td>Maintains uterine lining during pregnancy.</td>
</tr>
<tr>
<td>Testes</td>
<td>Testosterone</td>
<td>Controls male secondary sex characteristics.</td>
</tr>
<tr>
<td>Stomach—lining</td>
<td>Gastrin</td>
<td>Stimulates secretion of gastric juice by stomach.</td>
</tr>
<tr>
<td>Small intestine—lining</td>
<td>Secretin</td>
<td>Stimulates secretion of pancreatic juice by pancreas.</td>
</tr>
</tbody>
</table>
**pituitary gland**  The *pituitary gland* is a grape-sized structure that lies at the base of the brain. It consists of an *anterior*, an *intermediate*, and a *posterior lobe*. The intermediate lobe is present in infants, but becomes part of the posterior lobe in adults. The hormones of the anterior lobe include: growth, or somatotrophic hormone (STH); thyrotrophic, or thyroid-stimulating, hormone (THS); adrenocorticotropic hormone (ACTH); gonadotrophic hormones, which are follicle-stimulating hormone (FSH) and luteinizing hormone (LH); and lactogenic hormone. The hormones of the posterior lobe are oxytocin and vasoressin.

**Questions**

1. The two major parts of the pituitary glands are the *anterior* and *posterior* lobes.
2. An overabundance of growth hormone during childhood results in [*gigantism*].
3. A deficiency in growth hormone during childhood results in [*dwarfism*].
4. An overabundance of growth hormone in adults results in [*acromegaly*].
5. Three endocrine organs whose activity is stimulated by pituitary hormones are the thyroid, the adrenal, and the ovaries.
6. Fill in the blanks in the chart below.

**PITUITARY HORMONES**

<table>
<thead>
<tr>
<th>HORMONE</th>
<th>FUNCTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Growth</td>
<td>stimulates growth of bone and muscle</td>
</tr>
<tr>
<td>Thyrotrophic (TSH)</td>
<td>stimulates thyroid gland</td>
</tr>
<tr>
<td>Adrenocorticotropic (ACTH)</td>
<td>stimulates adrenal gland</td>
</tr>
<tr>
<td>Gonadotrophic (FSH) + (LH)</td>
<td>stimulates gonads</td>
</tr>
<tr>
<td>Lactogenic (Prolactin)</td>
<td>stimulates milk production</td>
</tr>
<tr>
<td>Oxytocin</td>
<td>stimulates uterine contracting</td>
</tr>
<tr>
<td>Vasoressin</td>
<td>stimulates water retention</td>
</tr>
</tbody>
</table>
thyroid gland  The thyroid gland is located in the front of the neck along the trachea. The cells of the thyroid have a unique ability to concentrate iodine from the blood. The iodine is a necessary part of the structure of the thyroid hormone thyroxin. They thyroid also secretes the hormone calcitonin.

Questions

1. What is the function of the hormone thyroxin? stimulates metabolism

2. The secretion of thyroxin is stimulated by TSH, which is produced by the anterior pituitary gland.

3. What is a simple goiter and what are some of its symptoms? lack of iodine causes growth of thyroid gland.

4. What is hyperthyroidism and what are some of its symptoms? increased metabolic rate, nervousness, irritability.

5. A deficiency of thyroxin during childhood results in a condition called Cretinism.

6. A deficiency of thyroxin in adults results in a condition called Myxedema.

7. Why is radioactive iodine useful in diagnosing and treating certain thyroid conditions? It can be used as a tracer and it can kill cells if there are too many thyroid cells in an overactive gland.

parathyroid glands  Embedded in the thyroid are two pairs of small glands – the parathyroids. The hormone secreted by these glands is parathormone. Accidental removal of the parathyroids or a severe deficiency of parathormone results in death unless treated.

Questions

1. The hormone secreted by the parathyroid glands is called Parathyroid hormone.

2. The parathyroid hormone regulates the metabolism of phosphorus and calcium.

3. A deficiency of parathyroid hormone can cause involuntary muscle contractions of a type called Muscle spasms.
adrenal glands

The adrenal glands are small, cap-shaped structures located on top of each kidney. The outer portion of the adrenals is called the cortex, while the inner portion is the medulla. The cortex, which is necessary for life, produces a mixture of steroid hormones that are known collectively as cortin. The medulla produces the hormones adrenaline and noradrenaline.

Questions

1. Fill in the blanks in the chart below, stating how adrenaline affects the activities listed.

<table>
<thead>
<tr>
<th>Rate of heartbeat</th>
<th>increases heart rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blood pressure</td>
<td>increases blood pressure</td>
</tr>
<tr>
<td>Blood supply to heart, lungs, arms and legs</td>
<td>increase blood supply, breathing</td>
</tr>
<tr>
<td>Blood clotting</td>
<td>increases blood clotting</td>
</tr>
<tr>
<td>Amount of glucose in blood</td>
<td>raises blood sugar level</td>
</tr>
<tr>
<td>Air passages in lungs</td>
<td>widen air passages</td>
</tr>
</tbody>
</table>

2. Other names for adrenaline and noradrenaline are epinephrine and norepinephrine.

3. Why is adrenaline used in the treatment of an asthma attack?
   It increases air passages.

4. What are three functions of the hormones of the adrenal cortex?
   1) maintain sodium and potassium balance
   2) increase sodium reabsorption
   3) raise blood glucose level
   4) breakdown of protein + fat

5. Destruction of the adrenal cortex leads to a condition known as Addison's disease.

6. What type of substances make up cortin? What is the best known of these hormones?
   Steroid hormones, cortisol
pancreas  The pancreas is both an exocrine and an endocrine gland. Its exocrine cells produce digestive enzymes that pass into the pancreatic duct leading to the small intestine. The endocrine part of the pancreas consists of masses of cells called the islets of Langerhans, which are scattered throughout the organ. These cells secrete two hormones – insulin and glucagon.

Questions

1. What is the function of insulin? To lower glucose levels by storing glucose into the liver.
2. What happens when the pancreas does not secrete adequate insulin? Too much glucose in blood.
3. The disease in which there is an insulin deficiency is diabetes mellitus.
4. The condition in which there is an abnormally high concentration of glucose in the blood is called hyperglycemia, while an abnormally low concentration of glucose in the blood is called hypoglycemia.
5. What are the metabolic effects of the hormone glucagon? Increases glucose levels in blood.

ovaries and testes  The ovaries and testes, in addition to their roles in the production of eggs and sperm respectively, function as endocrine organs. The ovaries produce several hormones known collectively as estrogens, and they also produce the hormone progesterone. The testes produce a group of hormones called androgens, the most important of which is testosterone.

Questions

1. The gonads consist of the female ovaries and the male testes.
2. The hormones produced by the ovaries include estrogen and progesterone.
3. The major hormone produced by the testes is testosterone.
4. In the female, the development of secondary sex characteristics is stimulated by estrogen.
5. Development of ova is stimulated by the hormones FSH and LH.
6. Male sex hormones in general are called **androgens**.

7. In the male, the development of secondary sex characteristics is stimulated by **testosterone**.

**stomach and small intestine** The lining of the **stomach** secretes the hormone gastrin when stimulated by the entrance of certain types of food into the stomach. The lining of the **small intestine** secretes the hormone secretin. Secretin secretion is stimulated by the passage of acidic chyme into the small intestine.

**Questions**

1. The hormone secreted by the lining of the stomach is called **gastrin**.

2. This hormone stimulates the secretion of **enzymes** by the **gastric gland**.

3. Chyme entering the small intestine from the stomach stimulates the secretion of the hormone **secretin** by the **small intestine**.

4. This hormone stimulates the production of **intestinal enzymes**.

**hypothalamus** The **hypothalamus**, a part of the brain, is physically connected to the posterior lobe of the pituitary gland. It is believed that the hypothalamus secretes hormonelike substances called **releasing factors** that stimulate the anterior lobe of the pituitary lobe to secrete its hormones through the nervous connection between them.

**Questions**

1. Where is the hypothalamus located? **in the brain**

2. What are the functions of the hypothalamus and how are these carried out? **to release releasing factors, stimulate anterior lobe of the pituitary gland**

**pineal gland** The **pineal gland** is located between the cerebrum and cerebellum. In some animals the pineal gland may play a role in biorhythms. No hormone has been isolated from the human pineal gland, although this structure may be involved in male sexual development.

**Questions**

1. Where is the pineal gland located? **between cerebrum and cerebellum**

2. Does the pineal gland serve any known endocrine functions in humans? **secretes melatonin, regulates sleeping pattern**
The thymus, which was once thought to serve as an endocrine gland, is now thought to be involved in the body's immune system. The gland, located in the chest cavity, increases in size from birth until adolescence, then gradually diminishes to its original size.

Questions

1. Where is the thymus located? in the chest cavity above heart.

2. What is the function of the thymus? releases thymosin.

3. Label the parts of the human endocrine system on the diagram below.
A. Fill in the blanks in the statements below.

1. The organs of the endocrine system are also known as **endocrine** glands.

2. The tissue on which a hormone exerts its effect is its **target** tissue.

3. The secretion of most hormones is regulated by a **feedback** mechanism.

4. The three lobes of the pituitary are the **anterior**, **posterior** and **intermediate** lobes.

5. The pituitary hormone that stimulates the adrenal cortex is **ACTH**.

6. The pituitary hormone that stimulates the thyroid gland is **TSH**.

7. The gonadotrophic hormones of the pituitary are **FSH** and **LH**. They are produced by the **pituitary** lobe.

8. The hormones of the posterior lobe are **oxytocin** and **vasopressin**.

9. The hormone produced by the thyroid is **thyroxine**.

10. The thyroid hormone controls the rate of **metabolism**.

11. Calcium and phosphorus metabolism is controlled by the hormone **parathormone**.

12. The hormone that stimulates the development of female secondary sex characteristics is **estrogen**.

13. A serious deficiency of thyroid hormone from infancy results in **cretinism**.

14. The pancreatic hormone that causes an increase in the blood glucose level is **glucagon**.

15. The pancreatic hormone that lowers the blood glucose level is **insulin**.

16. The endocrine cells of the pancreas are known as the **islet of Langerhans**.

17. The hormone that is sometimes used in the treatment of asthma is **adrenaline**.

18. The hormone secreted by the lining of the stomach is **gastrin**.

19. The hypothalamus stimulates the production of milk by the mammary glands is **prolactin** hormone.