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The Effects of Hormones on The Physiological System

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As a teacher within the middle school system, I see the effects that hormonal changes have on the students daily. As the students enter school in the fifth grade, most of their bodies and attitudes are immature. As we watch them progress through to the eighth grade, changes occur which transform their bodies and attitudes into miniature adults. All this as a result of hormones!

This curriculum will present this concept of hormones, and the influences that hormones have on our physiological system and behavior. In teaching this unit the students will be exposed to various materials and teaching situations that will assist in the learning process. At the end of this unit, the students will have gained a knowledge of what hormones are, where the important hormones are synthesized and secreted from, how hormones are transported and recognized by receptors, and what occurs once a hormone reaches its target site.

The class that this will be taught to is a seventh and eighth grade learning center. The students attend full time and have learning disabilities and are socially and emotionally maladjusted. As such this curriculum will be presented in short simple lessons to understand terms. The material presented in this unit is also written on a much simpler level than how it was learned. This was done so that the students and teacher can use this curriculum in the classroom, It can be copied in sections as needed and handed out ta the students as reading material.

As the material in each lesson is presented the students will be tested to check mastery of the content before moving on. Testing can be based on teacher observation or teacher-made tests. Throughout the lessons, teacher-made worksheets, diagrams and activities will be utilized to supplement discussion, Examples of these materials will be presented with each lesson, but they are not all inclusive. The more materials, the more interest on the students part and learning will take place.

Introduction

Objectives—The student will:

-state the overall function of the endocrine system
-define endocrine
-state the difference between endocrine and exocrine gland
-state the two types of hormones
-define peptide and steroid hormone
-state what a target or receptor site is
-state research techniques in hormone discovery and function.

The endocrine system is composed of cells that are organized into endocrine and exocrine glands. Endocrine glands secrete hormones into the bloodstream which in turn circulate throughout the body to specific locations at which they bond to receptors. (see diagram 1). Exocrine glands do not secrete hormones.

Hormones are like heat seeking missiles in that once fired, they will continue to seek out it's target until contact. Once contact has been made, the missile carries out it's mission, and a reaction takes place. When a hormone reaches its receptor site it also initiates a reaction within the cell or organ. Hormones are chemical substances made by the gland from which it is secreted which influence the activities of the cells, tissues, and organs of the body.

Hormones are divided into two groups based on their biochemical structure called peptides and steroids. Peptide hormones are made up of amino acids which are strung together they are composed of as few as 3 and as many as 237 amino acids. Peptides are synthesized in the pituitary, parathyroids, and pancreas. Examples of peptide hormones are oxytocin, vasopressin, insulin, thyrotropin, follicle-stimulating hormone, (FSH), and luteinizing hormone, (LH) The cells which make these hormones contain the genetic code which specifies the amino acid sequence for each hormone. Peptide hormones bind to their receptors on the surface of the cell.

Steroid hormones are made from cholesterol which forms a characteristic four ring structure. Steroid hormones bond to their receptors inside the cell membrane, They play an important sole in carbohydrate metabolism and electrolyte balance. Steroids are synthesized in the adrenal glands, ovaries, and testes.(see diagram 1)

Each gland produces one or more hormones, and it's activity is regulated so that the proper amount' of hormone is released at the proper time. When certain hormones reach their target sites the gland sends

another hormone or nerve signal back to the secreting gland and signals it to stop making that specific hormone. (see diagram 3). This system can be compared to checks and balances. The endocrine system and nervous system work together ta make ‘sure that there is not an overload of hormone production.

The inquiry into the function of the human body began thousands of years ago with the Greeks, and their theory that all things were composed of air, fire, water, and earth. Accurate knowledge of the function of the endocrine glands came about through the observation of diseased glands, removal of the organ, injecting organ extracts into the body, and through isolation of the hormone extracts themselves during which it’s chemical makeup was determined. In the mid-l9th century Addison, Bertholt, and Brown-Sequard conducted the first experimental studies in endocrinology. Addison noted a condition in which a variety of signs and symptoms were associated with the destruction of the adrenal gland by disease. The symptoms include hypoglycemia, which leads to muscular weakness , mental lethargy, and weight loss, which occur as a result of lowered plasma sodium concentration.

In 1949 Bertholt transplanted testes into a previously castrated cockerel and found that it prevented the retrogressive changes in sexual maturation and behavior. As a result of this, he concluded that the effects of the transplanted testes might be due to some substance that was secreted into the blood. Another technique is autoradiography in which a hormone containing radioactive atoms is infected into the animal and ‘later d picture is taken to find where the hormones are located. Other techniques include cross-circulation, and parabiosis in which a permanent union is established between two young animals and cross circulation develops as the tissue joined through surgery heals. This technique has been useful ln establishing the relationship between the pituitary and the gonads.

Classroom Activities

1. On diagram one, discuss with the students the route that the hormones will follow once excreted from the gland. Ask questions such as,’Where do the hormones go when excreted from the gland?” Use a diagram of the body to show the circulatory system and follow it to various parts of the body that the hormone may go to.
2. Hand out a blank chart with peptide on one side and steroid on the other. Have the students list the differences between each of hormone. Use diagram 1 as a reference,
3. Hand out a blank diagram of a cell membrane. Have the class draw how peptide hormones bind on the surface, and steroid hormones bind inside the cell membrane, using diagram 1 as a reference,
4. Have the class fill in a blank chart of the hormonal checks and balances.

(figure available in print form)
DIAGRAM 1
(figure available in print form)
DIAGRAM 2
(figure available in print form)

DIAGRAM 3

Part Two—The Tour

Objectives—The student will:
-state the major hormone producing glands in the human body:

hypothalamus	thyroid
pituitary	parathyroids
pancreas	pineal
adrenals	ovaries/testes

-show the location of each of the glands on a chart of the human body
-state the major hormones that each gland produces
-write the abbreviation of each hormone

We are about to embark on a tour of the human body. On this tour we will be stopping at each of the major hormone producing glands. We will learn about the major hormones that each gland generates and what effects these hormones have on the human body. Consider each gland a country and the hormones the product. Each of these products are exported to another area or country to their parts, or receptor sites, At this time, they are unloaded and which produces an effect. For example when food is exported to Ethiopia, it arrives in port, then it is transported to specific areas and given out. As result the people are happy because their hunger is satisfied. In the body, for another example, prolactin when it reaches it's target site, stimulates milk production. The controlling force which controls the rate of export is the hypothalamus gland which is where we will begin.

The hypothalamus gland sits above the pituitary gland and is responsible for integrating nerve messages from the brain into commands which are then transported via the portal circulation into the pituitary. (see diagram 4). From the pituitary, the hormones are released into the blood and circulated to their receptor sites. The hypothalamus differs from other glands in that it synthesizes hormones called releasing hormones. These then circulate through the portal veins to the pituitary and signal another specific hormone to be released, For example, gonadotropin-releasing hormone (GnRH), is synthesized in the hypothalamus then released into the blood vessels which lead to the anterior pituitary. Here the hypothalamic hormone stimulates the cells to release the pituitary hormone luteinizing hormone, (LH), into circulation, (refer to diagram 4), In the same way, the hypothalamus produces growth-hormone-releasing factor (GHRF), which in the pituitary will stimulate the release of growth hormone, (GH), into circulation. Prolactin-releasing hormone, (PRH) stimulates the release of prolactin into the bloodstream. Thyrotropin-releasing hormone, (TRH), stimulates the release of thyrotropin. Earlier we stated that the body has a system of turning off the production of hormones ta prevent overload. These hormones are called inhibiting hormones, or factors, and some are synthesized in the

hypothalamus. Growth-hormone-inhibiting factor, (GHIF), stops the production of growth hormone. Prolactin-inhibiting factor, (PIF), stops the production of prolactin.

The pituitary gland receives hormone signals from the hypothalamus and in turn stimulates the production of hormones that regulate different physiological processes throughout the body. One of the hormones released by the pituitary is called growth hormone, (GH), GH acts directly on the cells to promote growth, and it causes the cells to multiply by increasing the rate at which amino acids enter the cells and are built into proteins. This building process is called anabolism and is accomplished through cyclic AMP. Cyclic AMP activates the appropriate enzymes to get a job done, which in this case is to build up proteins. Follicle-stimulating hormone (FSH), induces the follicles to mature in the ovaries, and sperm to mature in the testes. Luteinizing hormone, (LH), stimulates ovulation, progesterone production by the corpus luteum, and the formation of the corpus luteum in the female. In the male, LH stimulates testosterone production in the testes.

The way these hormones work, is that the hypothalamus receives a nerve signal from the brain to release a releasing hormone into the portal vessels, These hormones stimulate the production of LH, FSH, or GH in the pituitary and they are released into the blood, These hormones circulate to the ovaries, testes, or liver. The way that the hormone is recognized is that it can only bond to a specific receptor site. FSH can only bond to receptors at the ovary, and GH can only bond to receptors at the liver or cells that it acts on. Once bonded at the cell membrane, a reaction occurs which brings about the change.

Prolactin is produced by the pituitary, and is responsible for stimulating milk production in the breasts, and breast enlargement in pregnant women. Thyroid-stimulating hormone, (TSH), is released by the pituitary and is responsible for promoting the synthesis of hormones in the thyroid gland.

The pineal gland is located in the brain and may regulate daily changes in body activity and temperature. It is possibly a mechanism which regulates the reproductive process, Scientists hypothesize that the pineal may induce the onset of puberty. Changes are observed in animals often exposed to continuous light or darkness. For example in hamsters, continuous light leads to early onset of sexual development and increase in gonadal weight, whereas constant darkness prevents maturation of the gonads, The pineal produces melatonin. It’s release is affected by the variations of light received in the light received in the eye. It is released rhythmically.

The thyroid gland is located in the neck region. It produces the hormones thyroxin and thyrocalcitonin. The most characteristic effect of thyroxin is to increase energy production and oxygen consumption of the tissues. It increases the rate at which carbohydrates are burned, and it stimulates cells to break down proteins for energy rather than using them for building processes.Thyrocalcitonin is involved in the homeostasis of blood calcium levels. It lowers the calcium in the bloody by inhibiting bone breakdown. It opposes the parathyroid hormone. (see diagram 5).

The parathyroids are located next to the thyroids and are responsible for producing parathyroid hormone, (PTH). PTH regulates the blood calcium levels. Calcium regulates the permeability of the cell membrane, and is required for bone and teeth formation. PTH increases the rate of calcium absorption from the intestine into the blood, and it increases the amount of bone-destroying cells which break down bone tissue causing calcium to be released into the blood. Cholecalciferol, (vitamin D), is the hormone which opposes PTH by promoting the uptake of calcium by bone.

The adrenal cortex secretes aldosterone and hydrocortisone. Aldosterone acts on the kidneys causing them to increase their absorption of sodium and water. A decrease in blood volume from a sodium deficiency brings

about low blood pressure. As a result, the kidney cells secrete the enzyme renin into the blood, which indirectly will stimulate the adrenal cortex to produce aldosterone which will bring about increased blood volume through increased sodium and Prater reabsorption. Hydrocortisone is responsible for providing resistance to stress. If, for example, we were introduced ta a stress factor such as being hit by a car, the body would suddenly increase the availability of glucose through the breakdown of proteins and tissue to make into amino acids and glucose, thus making the body more alert and ready to act. Our body would then have the immediate energy to combat the stressor, such as quickly swerve away from the oncoming car. This breaking down of proteins and tissue to make into glucose and amino acids is called catabolism. In running this sequence from the hypothalamus, in response to stress, the hypothalamus secretes adrenocorticotropin-releasing factor, (ACTRF) . When it reaches the pituitary via the protal system, the pituitary secretes adrenocorticotropic hormone, (ACTH), which circulates to the adrenal cortex. The adrenal cortex then secretes the glucocorticoids, hydrocortisone, which provides the body with immediate energy. (Diagram 6).

The pancreas secretes insulin which regulates the rate at which sugar is used by the cells of the body. Insulin is a peptide hormone released into the bloodstream from the pancreas following food ingestion. At intake of food, the glucose in the food causes a rise in blood glucose levels. This stimulates the cells to produce insulin which will restore the glucose levels to normal.The three main target sites for insulin are the liver, muscle, and fat tissue. Glucagon has the effect of augmenting low blood sugar levels by causing the cells of the muscle and liver to convert stored nutrients to glucose. Glucagon has a balancing effect correcting low blood sugar levels in the same way that insulin reduces high blood sugar levels. Glucagon functions when the carbohydrate supplies are minimal or when the tissue cells consume glucose at a rate which brings the blood sugar levels too low. (see diagram 7).

During the first ten years of life, the hypothalamic production of LHRH remains at a very low level. The onset of puberty is brought on by an increase of the pulsatile releasing of LHRH to the pituitary which stimulates the release of LH and FSH into the bloodstream. Once these hormones begin circulating, the testes begin to produce the hormone testosterone, and the ovaries produce the hormone estrogen. These hormones in turn initiate the development of secondary sex characteristics such as pubic and arm hair, breast development, zygote maturation, and the onset of menstruation. In males, these hormones bring about enlargement of the penis and scrotum as well as pubic, arm and facial hair growth.

Classroom Activities

1. At the start of Part Two-The Tour, hand out a diagram of the human body and have the students locate and color in each gland as it is discussed.
2. For each hormone discussed, draw a schematic diagram on the board to show the process that the hormone goes through to leach the target site.
3. Make up a blank chart with the name of the hormones discussed in this section. Have the students fill in the abbreviation and write what each hormone does.
4. Utilize transparencies in your discussion of each of the glands. Note the shape of each gland, and the location of the blood vessels that feed into the gland
5. Post charts around the room of the endocrine system, give the students+ assignments daily to answer questions about a specific gland or to note the nearby organs, etc.

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DIAGRAM 4
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DIAGRAM 5
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DIAGRAM 6
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DIAGRAM 7

Hormones and Their Roles

Hypothalamus Gland

1. Growth hormone releasing factor (GHRF)—stimulates release of growth hormone
2. Gonadotropin releasing hormone (GNRH)—stimulates release of FSH and LH
3. Thyrotropin releasing factor (TRF)—TSH secretion
4. Prolactin releasing hormone (PRH)—prolactin secretion
5. Growth hormone inhibiting factor (GHIF)—inhibits release of GHRF
6. Prolactin inhibiting factor (PIF)—inhibits release of PRH

Pituitary Gland

1. Growth hormone (GH)—acts as growth promoter
2. Thyroid stimulating hormone (TSH)—thyroid hormone synthesis
3. Prolactin - milk synthesis
4. Follicle stimulating hormone (FSH) male—spermatogenesis
   female—ovarian follicle growth estrogen synthesis
5. Luteinizing hormone (LH) male—testicular testosterone synthesis
   female-ovulation progesterone synthesis

Pineal Gland

1. melatonin—possibly gonadal development

Thyroid Gland

1. thyroxin—growth, increased metabolism and oxygen consumption

Parathyroids Glands

1. parathyroid hormone (PTH)—increase blood calcium, lower blood phosphate levels

Adrenal Cortex

1. Hydrocortisone—increase carbohydrate levels in the blood, stress response, anti-inflammatory
2. Aldosterone—modulates sodium electrolyte levels, blood pressure

Adrenal Medulla

1. Epinephrine fight or flight response, multiple effects on nerves, muscles

Pancreas

1. Insulin—lower blood glucose levels, increase protein synthesis
2. Glucagon—raises blood glucose levels, opposes insulin action

Ovaries

1. Estradiol—female sexual development and behavior

2. Progesterone—corpus luteum, increase mammary gland growth, maternal behavior

Testes

1. Testosterone—male sexual development and behavior, pituitary FSH secretion

Classroom Materials

text on anatomy and physiology

diagrams of the human body

copies of charts utilized in each lesson

colored pencils

blank white paper

blank chart of hormones produced by the human body

Biology charts

transparencies

models of the endocrine glands

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Teacher Bibliography

It is recommended that teachers refer to the above bibliography for information.

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