Curriculum Units by Fellows of the Yale-New Haven Teachers Institute
1988 Volume V: Hormones and Reproduction

The Affects of Hormones on Human Development

Curriculum Unit 88.05.05
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The purpose of designing a unit on “The Affects of Hormones On Human Development”, is to help students learn more about the physical and emotional changes they are experiencing by the time they reach adulthood.

This unit on “The Affects Of Hormones On Human Development” will deal with the anterior lobe of the pituitary gland, the adrenal glands (the adrenal medulla and the adrenal cortex), placenta, islets of Langerhans, the thyroid gland and the ovaries and testis.

Basic information is presented about hormones, and general information is given on hormones and the specific influence they exert on the activity of the target gland.

The unit can be taught to students in grades five through eight.

The science and health teachers are encouraged to use a team teaching approach. Other features included in the unit are content, lesson plans, resources, and a bibliography.

Often children will ask questions repeatedly until they have the chance to assimilate the new facts they are learning. This unit can help students by letting them know that we are receptive to their questions and ready to provide answers, either on a one-to-one basis or to the class as a whole.

As a classroom teacher, you may want to take an active part in reinforcing or extending the basic learning your students will be gaining from this unit.

I encourage you to work closely with other educators in the school. You may be interested in reviewing the materials that are written by the other six teachers in “The Hormones and Reproduction Program”.

The Productive Power Of Hormones

Certain glands exert enormous influence over the way we feel and the way we physically react. They exhibit this power through their control over that intriguing and not yet fully explored province of the body, its chemistry.

The endocrines are the great chemical regulators of bodily function. The substances which are secreted by the endocrines, and which serve as chemical messengers are called hormones, from the Greek hormon meaning arouse to activity. Another version of the word means vital principle which, the Greek believed, was contained in certain body secretions and generally enlivened the body.

Along with the nervous system, the endocrine system serves as the major means of controlling the body's activities. The nervous system is built for speed; it enables the body to adjust its internal processes rapidly, as changes take place in the environment. The endocrine, on the other hand, regulate continuing process of longer duration including the body's growth, sexual maturation and ability to reproduce. The pituitary at the base of the brain; the thyroid gland in the neck, the adrenals, a perched atop the kidney like miniature peaked caps; the insulin-making islets of Langerhans in the pancreas; the ovaries in the abdomen of the female; the testicles in the scrotum of the male. The placenta, which feeds the unborn child, also behaves like an endocrine, manufacturing special chemicals essentials to successful pregnancy.

Endocrines are bits of tissue tucked away in obscure corners of the body. But in the widespread control they exercise over the body, they are little giants.

All hormones regulate one or more chemical reactions in the body, but they seem to work in many different ways. Hormonal activity must remain in delicate balance or the entire body will be thrown out of balance.

Endocrinology is the study of endocrine systems. The primary function of endocrine system is to regulate physiological processes by means of groups of chemical messengers called hormones. These substances are released by an endocrine organ into the blood in which it travels to another site in the body where it exerts its effect.

Hormones Characteristics. Structure Physiology

The simplest endocrine system consists of an endocrine gland that secretes a hormone, the hormone itself and a target tissue that responds to the hormone. Most endocrine systems are considerably more complex than this. A given hormone may be secreted by more than one endocrine gland, a hormone may affect many different tissues, several endocrine glands may be functionally connected by hormones within a system, and the result of the action of a hormone on its target tissue may influence the secretion of that hormone. The basic function of any endocrine system is still that of regulation. The endocrine systems also provide coordination of function in a temporal sense. This type of regulation is particularly apparent in reproductive endocrinology, in which normal function requires extremely specific patterns of change in the secretion of various hormones.

Physiological organization is brought about by higher centers of the brain, the hypothalamus, of the nervous system and by chemical substances in the circulatory fluids which are carried everywhere in the body,

bringing about local changes, inequilibruim of physical and chemical conditions and affecting correlations of these changes in a bodywide way.

The functions of the body are regulated by the nervous system and by hormones. In general, the nervous system regulates the rapidly changing activities such as skeletal movements, smooth muscle contraction, and many glandular secretions. The hormonal system regulates the many metabolic functions of the body and the varying rates of chemical reactions. Hormones influence transport of substances through cell membranes and various aspects of cell metabolism and tissue growth. In some instances there are specific interrelationship between nervous stimuli and hormonal secretion. There are also many interactions between hormones, so that a disturbance in one endocrine gland can interfere with activities of other hormones. Hormones are specific in action and for specific cells respond.

In general, hormones are secreted into extracellular fluids and have effect on distant organs. In local hormones some physiologically active substances are released from specific sites in tissue.

Types Of Hormones

Hormones are categorized according to their biochemical structure or to their function. Structurally, all established hormones are peptides or proteins, steroids, or amino acid derivative. In addition to its structural classification, hormones are also classified functionally or nontropic hormones. A tropic hormone is secreted by one endocrine gland and has its primary function the regulation of another endocrine gland. The secretion of the tropic hormone is in turn under the regulation of the hormone from the gland it regulates.
(figure available in print form)

The Pituitary Gland

The pituitary gland is one of the endocrine glands. The pituitary hangs from the bottom of the brain by a little stalk just above the nasal passage. See figure below. Because of its many hormones which are vitally concerned in fundamental physiological functions, it is sometimes designated as the master gland. It is about the size of an acorn. The pituitary is actually two glands in one, the posterior and anterior. Of the two, the posterior pituitary manufactures no hormones of its own, but stores two hormones that are initially secreted in a part of the brain known as the hypothalamus. The hormones are oxytocin, which is believed to stimulate labor at the end of pregnancy, and vasopressin, which helps the body retains its fluids.

The anterior pituitary controls the overall growth of the body. The anterior lobe originates embryonically from the epithelial lining of the pharynx. The anterior portion has many functions and several of its hormones have been isolated.

(figure available in print form)
The growth hormone, sometimes called somatotropin, regulates the growth of bone, muscle, and other tissues from top to toe. In some individuals, fortunately only a few, underproduction or over-production of somatotropin occurs during childhood. Either extreme causes growth abnormalities. Excessive production can result in gigantism or acromegaly; decreased production is responsible for certain types of dwarfism. The

pituitary dwarf almost never attains adult proportions or sexual maturity, although his or her I.Q. is normal.

In the average person the anterior pituitary hormones are of great concern because it regulates other endocrines.

The gonadotropic or follicle-stimulating, FSH and luteinizing hormones, LH, are intimately connected with ovarian function and menstruation. In the male, the follicle-stimulating hormone induces the development of spermatozoa in the testicle while the luteinizing hormone stimulates the production of the male sex hormone, testosterone.

The lactogenic hormone prolactin is necessary for the initiation of the flow of milk and normal laction following pregnancy.

The adrenocorticotropic hormone, ACTH, promotes hydrocortisone production in the presence of stress. (i.e. Punch on the nose or fever or worry) Hydrocortisone raises blood sugar (for healing process) and acts as an anti-inflammatory.

The thyrotropic or TSH, signals the thyroid to manufacture thyroxine when the level gets too low. Without thyrotropic hormone, thyroid gland undergoes atrophy; in the presence of excess, the thyroid increases in glandular tissue and function.

Endocrine control works both ways. Just as a thermostat, which fires a furnace into activity when the room temperature drops, is itself turned off when the temperature rises high enough, the production of each of the stimulating hormones in the pituitary is suppressed by the presence in the blood of the hormone which it stimulated. Thus, as the level of thyroxine drops, TSH is poured out to goad the thyroid cells into activity; but as soon as production has been speeded up, the very presence of thyroid hormone in quantity in the bloodstream blocks the pituitary's release of more TSH until thyroid activity slows down again. The result of this cycle is the maintenance of a remarkably steady balance of thyroid hormone in the bloodstream at all times. Such a feedback system serves to regulate the levels of adrenal hormones and sex hormones in much the same way.

Adrenal Gland

The two adrenal glands are small, triangular structures situated on the upper portion of each kidney just below the diaphragm. They are composed of two portion, called the adrenal medulla; and the outer portion, called the cortex. Each portion has a separate secretion and function. Epinephrine and norepinephrine are secreted into the blood stream by the medullary portion. This medullary portion of the gland is derived from the same embryonic cells that form the sympathetic nervous system. Fear, anger, excitement, sudden physical exertion are some of the stimulating factors, both to the sympathetic nervous system, and, in turn, to the secretion of epinephrine.

Adrenaline is the trade name for epinephrine. On the other hand norepinephrine serves as an effective aide to epinephrine, causing an increase in the rate of heartbeat and constricting the skin capillaries so that blood is forced out of them and shunted, by the action of the epinephrine to the body's major organs.

A number of hormones which may be divided into four groups: Mineralocorticoids or Aldosterone which

promotes retention of sodium and water in the body effecting blood pressure, glucocorticoids hydrocortisone which acts to raise blood glucose levels and as an anti-inflammatory agent, steroids, related to sex hormones. See diagram.

Response of Body Stress

(figure available in print form)

The presence of intact adrenal cortices appears to be essential to enable animals to react to environmental change, and it has lately been suggested that in man exposure to continued environmental stress may bring about functional and morphological changes in the adrenal cortex which may form the basis for the so-called stress diseases.

In Addison's disease, progressive destruction of the cortex of the adrenal, usually as the result of tuberculosis gives rise to symptoms resulting from deficiencies of the hormones listed above. In the Waterhouse-Friderichsen syndrome, destruction of part or the whole of one or both glands by hemorrhage occurring in the course of meningitis due to meningococci leads to sudden collapse and death unless very prompt treatment by replacement of the absent hormones is available. The most common cause of Addison's disease is pituitary tumor.

(figure available in print form)

The Thyroid Gland

This important gland of internal secretion is made up of two flattened lobes lying beneath the superficial muscles of the lower anterior part of the neck on either side of the trachea. The two portions of the gland are connected by a small bridge of thyroid tissue may sometimes be present along the length of the trachea. See figure below. During pregnancy and menstruation the thyroid may temporarily. increase in size. Complete removal and abnormal secretion of the gland causes grave systematic disturbances. The gland is also subject to tumor formation, which may be benign, i.e.

a cyst causing enlargement only, or malignant (solis tumor).

The function of the thyroid is to serve as a storehouse for iodine and to secrete into the blood stream thyroid hormone, which has a stimulating effect on growth and metabolism. The thyroid affects other ductless glands and the sympathetic nervous system. In a reverse manner, other endocrine glands in turn influence the thyroid; this is particularly true of the pituitary gland, which has a multiplicity of influences on the endocrine system.

Diseases of the thyroid may be classified as hypofunction, hyperfunction, tumors, goiter, cancer or inflammatory disease.

The hormone produced by the thyroid is now called thyroxine which exercises control over the rate at which food is converted into heat and energy in all the body's cells. See figure below. Without sufficient thyroxine the individual feels constantly cold, drowsy, unable to do anything without considerable exertion. Respirations are slow, heart rate sluggish, appetite and sex functioning both below pars. Sometimes there is a weight gain despite a distinctly meager diet. The opposite of hypothyroidism is hyperthyroidism. An individual with this condition is likely to be nervous, jittery and overactive, with a pounding heart and labored respirations, able to

gorge yet lose weight, as though all the body fires were burning out of control.

(figure available in print form)
Homeostasis of the Thyroid Gland
(figure available in print form)

Islets Of Langerhans

Between the alveoli small groups of cells are found, which are termed, the islets of Langerhans. They are surrounded by a rich capillary of network and furnish the internal secretion of the pancreas; insulin and glucagon.

Two secretions are formed in the pancreas, The pancreatic fluid is an external secretion and is poured into the duodenum during intestinal digestion and the secretion formed by the islets of Langerhans are the internal secretions of insulin and glucagon, which are absorbed by the blood, carried to the tissues, and aid in regulating glucose metabolism.

Several types of cells are in t¥e islet group. The beta cells secrete insulin, and the alpha cells secrete glucagon. Insulin increases cell permeability to glucose. See figure below.

Insulin promotes the utilization of glucose in tissue cells and thereby decreases blood glucose concentration.

Insulin is essential for the maintenance of normal levels of blood glucose. Hypoglycemia can result from increased insulin secretion or from the injection of too much insulin. Hyperglycemia and glycosuria, a condition which the urine contains glucose, may result from insufficient secretion of insulin. Marked increased levels of blood sugar, if untreated, lead to coma and death. This condition is known as diabetes mellitus.

(figure available in print form)

The Ovary

The ovaries are the sex gland of the female. In humans they are two in number, three to four centimeters in diameter, almond-shaped, and situated on either side of the pelvis in the folds of the broad ligament which supports the uterus. See figure below. With the onset of puberty, cyclic changes take place in the ovaries: after menopause they diminish in size and activity.

The function of the ovaries is the production of ova, and the sex hormones, progesterone and estrogens. The ovaries are glands of internal secretion, or endocrine glands. Two types of hormones are produced, the estrogenic group of which estradiol is the most important, and corpus luteum hormone or progesterone. These substances are concerned with the changes characteristic of menstruation, those following impregnation which are necessary for the development of the fertilizated ovum, and the changes in the ma??mary glands occurring during pregnancy. The ovary produces hormones that cause development of the female genital organs and secondary sex characteristics. The ovary is directly stimulated or inhibited by hormones from other endocrine glands, notably the pituitary.

The Testis

The testicles are the two male glands which are suspended from the groin by the spermatic cords, and are supported and enclosed by the scrotum. Each gland measured about 1 1/2 inches in length, 1 inch width and about 3/4 in thickness from side to side. The testicle is joined to the spermatic cord by way of the epididymis which is a coiled duct Lying at the upper portion of the testicle. When uncoiled this duct measures 20 feet in length. The function of the testicles is to produce spermatozoa and the male sex hormone; See figure, next page. If both testicles are removed before puberty, secondary sex characteristics fail to develop, due to the absence of testosterone. The skin remains smooth, the voice is high-pitched, fat develops around the breasts and buttocks, and the pubic hair is scanty. Erections are feeble, and no ejaculation occurs. The individual is timid, lacks ambition, normal combativeness and aggressiveness. Such an individual is known as a eunuch. Eunuchoidism usually results from failure of development of testes, which is usually secondary to a pituitary disorder.

In early fetal life both the ovaries and the testicles lie in front of and below the kidneys. During fetal growth they descend. The ovaries finally lodge on the side wall of the pelvic cavity. The testicles normally continue downward and descend through and out of the abdomen in the region of the groin to the scrotum. This descent may be arrested along any portion of this pathway, and one or both testicles may remain in the abdominal cavity, in its wall or groin. The condition is known as cryptorchidism. Men with undescended testicles because sperm gets too warm, are sterile but are sexually normal otherwise. The situation is corrected by an operation in which the undescended testicles is brought down to its normal scrotal position. This operation is best done at or shortly after puberty.

In some cases glandular injections will cause the testicle to descend without operative interference.

Diseases affecting the testicles are tumors, which are rare and infections.

The testes are controlled by hormones secreted from the anterior pituitary. Two pituitary hormones are involved in regulation of testicular function, one for the endocrine component and the other for the gametogenic component. Luteining hormone, LH acts on leydig cells to stimulate testosterone secretion and follicle-stimulating hormone or FSH acts on the seminiferous tubules to promote spermatogenesis. (See figures A,B, and C).

Lesson Plan I

Vocabulary

Define the following words.

1. Hormone
2. Endocrine

3. Gland
4. Homeostasis
5. FSH
6. TSH
7. ACTH
8. STH
9. LH
10. Ovaries
11. Testis

Lesson Plan II

Describe the function(s) of the following glands.

A. Pituitary Gland
B. Adrenal lands
C. Thyroid land
D. Islets of Langerhans
E. Ovaries
F. Testis
G. Placenta

Write at least one hormone associated with each gland.

What could happen if homeostasis does not occur? Will the body continue to operate the same?

Lesson Plan III

Type of Hormones

WHAT HAPPENS IN ENDOCRINE GLANDS

A. Hormone is made, and stored. At appropriate response stored hormone is released.
Examples: The protein hormones....Insulin
Glucagon
Thyroid Stimulating Hormone
Follicle Stimulating Hormone
Luteinizing Hormone
Prolactin
Adrenocorticotropin
B. The enzymes involved in the synthesis of the hormone are stimulated following an appropriate response.
Examples: The steroid hormones....Estradiol
Progesterone
Hydrocortisone
Aldosterone
Testosterone
The amino acid derivatives....Thyroxine
Triiodothyronine
Adrenaline
Noradrenaline

Structurally, all established hormones are peptides or proteins, steroids, or amino acid derivatives.

Name three hormones that are protein, steroid and amino acid. Also name their target glands.

Lesson Plan IV

APPLY WHAT YOU KNOW

Today is not a happy day for you. You came to school late and you are tired. You are angry with your boyfriend and can't function in school.

Do The Following:

1. Explain briefly the physiological response to stress.
2. Differentiate between the actions of epinephrine and morepinephine.

Lesson Plan V

Draw a picture of your ovary or your testes. Describe what affect you think these glands have on your sexuality. How do you feel about the physical changes you recognize at your present age?

Lesson Plan VI

GLANDS

Glands are structures in the body that secrete fluids which perform certain functions, such as stimulating other organs. On the blanks write the name of the gland which performs each of the following services to the body:

1. Controls the rate at which the body oxidizes food ___
2. Helps the body prepare for greater activity ___
3. Master gland, which regulates growth ___
4. Helps to lubricate food and break down starches before they reach the stomach ___
5. Lubricates the skin and the hair ___
6. Produces milk ___
7. Secretes insulin, which helps the body use carbohydrates ___
8. Gland in the skin which helps to maintain normal body temperature ___
9. Lubricates the eyes ___
10. Man's largest gland, which secretes bile, converts sugar into glycogen and stores it ___

Lesson Plan VII

Body Facts

Use the words below to label this diagram. Then, in the space provided, briefly describe the role each body part plays in the reproduction process.

(figure available in print form)

Egg ___

___

Fallopian tubes ___

___

Ovary ___

___

Uterus ___

___

Vagina ___

___

Lesson Plan VIII

Body Facts

Use the words below to label this diagram. then, in the space provided briefly describe the role each body part plays in the reproduction process.

(figure available in print form)

Penis ___

___

Prostate gland ___

___

Scrotum ___

___Seminal vesicles ___

___

Testicles ___

___

Urethra ___

___

Vas deferens ___

___

Lesson Plan IX

Match the correct hormone on the left to the appropriate gland on the right.
(figure available in print form)

TEST

1. Name the hormones of the anterior pituitary and explain the function of each.
2. Which of the adrenal hormones are essential for life? Explain.
3. What is the name of the scientist who studies the endocrine system'
4. What are proteins?
5. What are Amino Acids?

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