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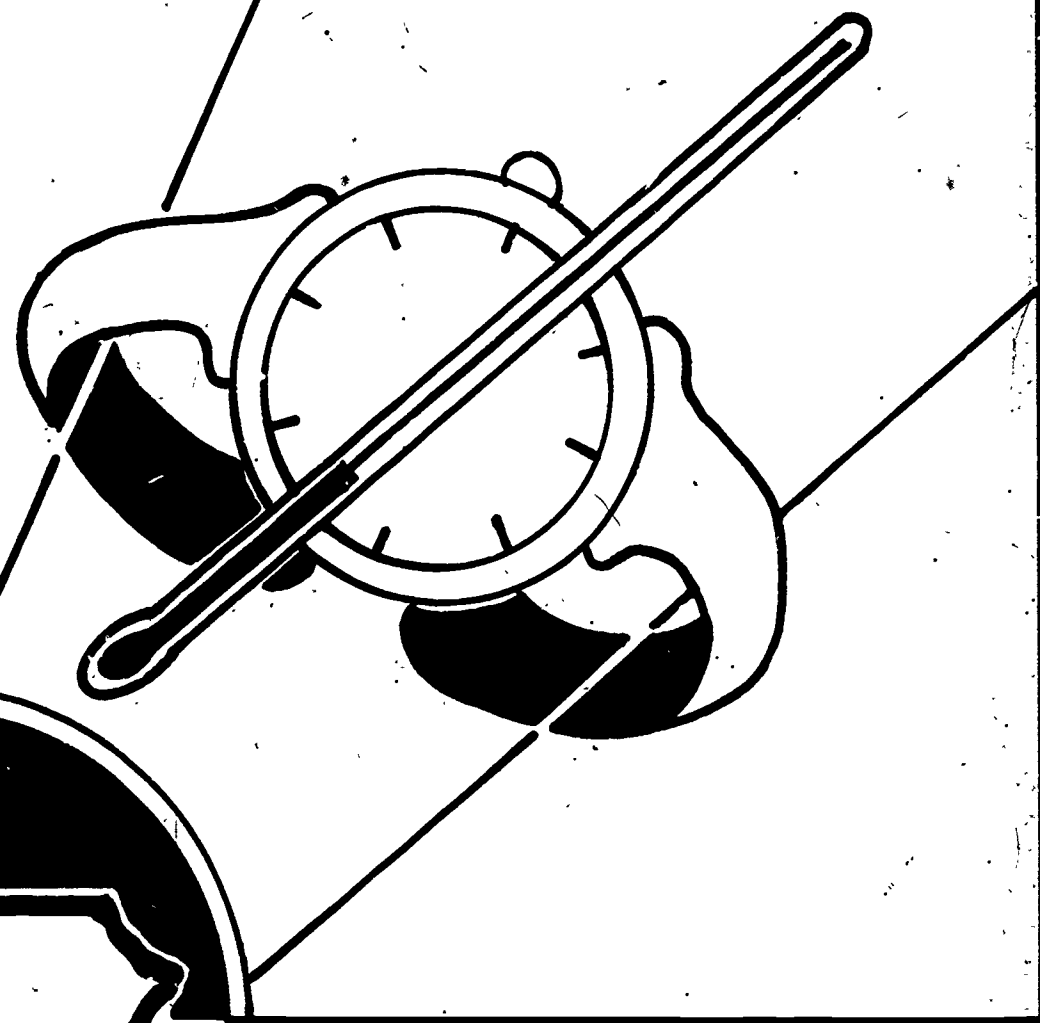
ABSTRACT

This module on the endocrine system is one of 17 modules designed for individualized instruction in health occupations education programs at both the secondary and postsecondary levels. It is part of an eight-unit miniseries on anatomy and physiology within the series of 17 modules. Following a preface which explains to the student how to use the module, the unit consists of a pretest with answers, six sections (information sheets) with their objectives (e.g., describe the basic functions of hormones and how their secretion is controlled), optional activities (e.g., find out the causes and effects of Addison's disease and Cushing's syndrome), and posttests, and a glossary of terms. Topics covered in the unit are introduction to the endocrine system, the pituitary gland, the thyroid and parathyroid glands, the adrenal glands, the pancreas, and the gonads. An accompanying instructor's guide contains suggestions for using the module and answers to the posttest. (KC)

HEALTH OCCUPATIONS EDUCATION MODULE



THE ENDOCRINE SYSTEM

Instructional Materials in Anatomy and Physiology
for Pennsylvania Health Occupations Programs

THE ENDOCRINE SYSTEM

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PREFACE

An understanding of basic human anatomy and physiology is essential to any person preparing to enter a health occupation. This instructional unit is designed to introduce you to the structures and functions of the human endocrine system--and the interrelationships of the two--and to familiarize you with some of the terms and concepts necessary for an understanding of the endocrine system.

This unit consists of a pretest, six modules with their optional activities, a glossary of terms, and a post-test.

Begin this modular unit by taking the brief pretest at the front of the booklet. Write your answers on a sheet of paper and pass it in to your instructor.

Next, read through each of the modules (Introduction to the Endocrine System, The Pituitary Gland, The Thyroid and Parathyroid Glands, the Adrenal Glands, The Pancreas and The Gonads) and investigate any of the optional activities that may be helpful or interesting to you. The optional activities will help you learn more about some of the materials presented.

At the end of this unit is a glossary which provides you with brief definitions of many of the terms used in the modules.

Upon completion of this unit, you should be able to demonstrate an understanding of the material presented by your performance on the post-test. When you have finished this unit, and feel that you understand the information presented, take the post-test that follows. Write down your answers on a sheet of paper and pass it in to your instructor, who will give you your grade.

Endocrine System
PRETEST

1. All endocrine glands secrete chemical messengers called:

_____.

2. Which endocrine gland is known as the master gland?

A. pancreas
B. pituitary
C. thyroid
D. adrenal

3. The four tiny endocrine glands located within the thyroid gland are the:

_____.

4. Which of the following is a hormone of the adrenal glands?

A. testosterone
B. insulin
C. estrogen
D. epinephrine

5. The pancreatic hormones regulate the level of which substance in the blood?

A. cholesterol
B. oxygen
C. glucose
D. carbon dioxide

6. What organs are the male gonads?

_____

7. The adrenal glands are located on top of which organs?

   A. lungs
   B. ovaries
   C. kidneys
   D. intestines

8. Which endocrine gland is directly connected to the hypothalamus?

   _____

9. The islets of Langerhans are the endocrine cells of what organ?

   _____

10. The functions of the endocrine system are most similar to the functions of which system?

    A. nervous
    B. respiratory
    C. digestive
    D. muscular

11. All endocrine glands secrete their hormones into:

    A. ducts.
    B. the bloodstream.
    C. organs.
    D. nerve tissue.

12. The most common mechanism of controlling hormone secretion is:

    _____

13. The posterior lobe of the pituitary is made of what kind of tissue?

_____

14. Secretions of the pituitary gland are controlled by what organ?

_____

15. The thyroid and parathyroid glands are located in the:

A. abdomen.
B. chest.
C. head.
D. neck.

16. What mineral is necessary for the synthesis of thyroid hormones?

_____

17. Which hormone deals with the transport of sodium ions in the kidneys?

A. testosterone
B. norepinephrine
C. adrenocorticotropin
D. aldosterone

18. Name the two layers of the adrenal glands.

_____

_____

19. The pancreas is located:

A. between the lungs.
B. behind the stomach.
C. below the intestines.
D. beside the liver.

20. Name the two hormones of the pancreas.

_____

_____

21. The male hormones are collectively known as the:

A. testicles.
B. estrogens.
C. progesterones.
D. androgens.

22. Name the two major female hormones.

_____ _____

_____ _____

INTRODUCTION TO THE ENDOCRINE SYSTEM

Objectives

Upon completion of this module, you should be able to:

1. Describe the general organization and basic functions of the endocrine system.
2. Describe the basic functions of hormones and how their secretion is controlled.

The endocrine system is a small system, but one with a great deal of influence. It consists solely of glands and the substances they produce, hormones. The endocrine glands are also known as the ductless glands, because unlike exocrine glands in the body (for instance, some of the glands of the digestive system), the endocrine hormones are not transferred to other parts of the body by ducts. Instead, they are released directly into the blood. Thus, the effects of endocrine hormones can be quickly spread over the entire body.

It is surprising, in terms of their importance to the body, that there are so few endocrine glands. The endocrine system includes the pituitary gland, or hypophysis, the thyroid and parathyroid glands, the adrenal glands, the pancreas, and the gonads (the male and female primary reproductive organs). The placenta of the female also performs endocrine functions during pregnancy. Two mystery organs, the thymus and the pineal body, may also be part of the endocrine system. The system is structurally unusual in that most of its organs are not physically connected to each other, as are the organs of the other anatomical systems. Figure 1 shows the location of the glands in the different areas of the body.

Hormones are the chemical messengers of the endocrine system. Hormones are defined as the secretions or products of the endocrine glands. They are manufactured by the glands as needed. Hormones stimulate and/or regulate activities and processes in a variety of cells. The area or organs of the body that a hormone affects are called the hormone's target. Hormonal targets can be very specific; certain hormones have only endocrine glands as targets, and function to trigger the secretion of other hormones. Some hormones have very general targets; they can affect every body cell.

There are several mechanisms that determine when hormones will be secreted. The simplest and most direct mechanism is based on the body's needs. For example, certain hormones are secreted in direct response to specific blood concentrations of materials which are necessary to the body. Negative feedback is the most common and probably most important mechanism that controls hormone secretion. This mechanism works like a thermostat. For example, an oven set at 350 degrees will heat up until the temperature reaches 350 degrees inside the oven, then the

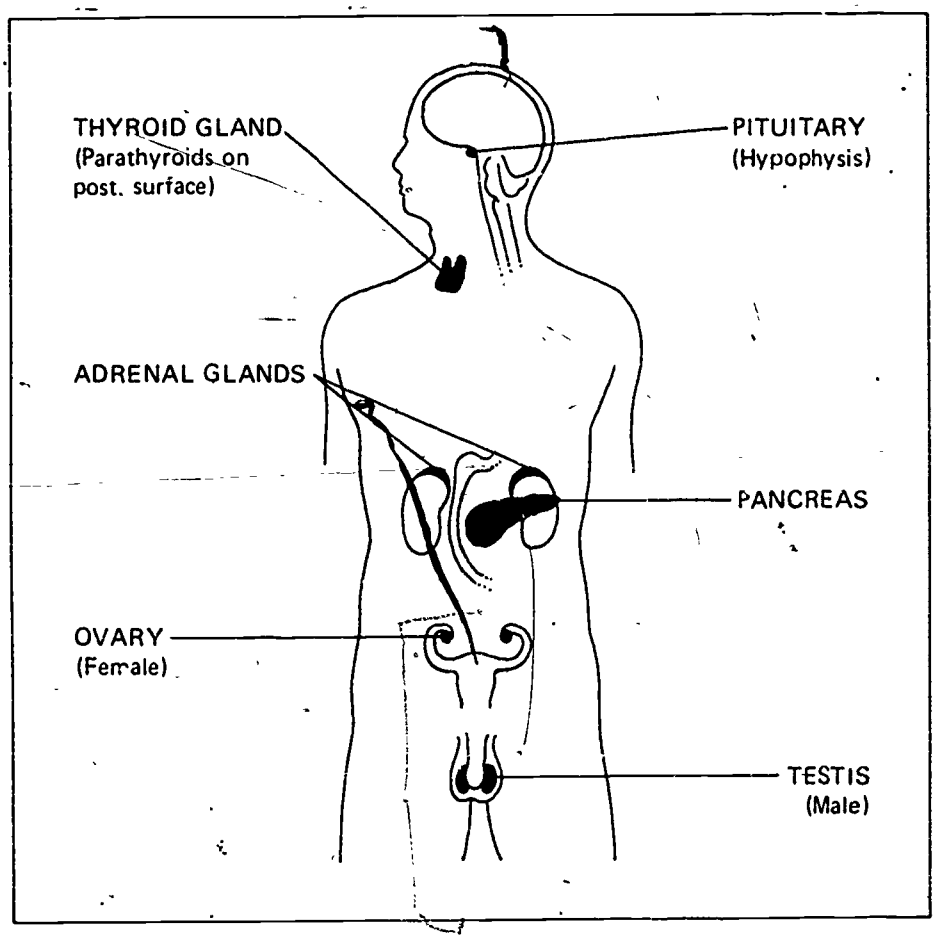


Figure 1. The Endocrine Glands

thermostat will automatically shut the heat off. When the temperature drops below 350 degrees the thermostat will turn the heat on again. Through this on-off process, a constant temperature of about 350 degrees is maintained.

An example of negative-feedback control of hormone secretion is the hormone insulin. Insulin is secreted from the pancreas when the blood-sugar level rises. The insulin lowers the level of blood sugar and this lowered concentration "shuts off" insulin secretion. Another rise in blood-sugar level will again "turn on" the secretion of insulin.

Not all negative-feedback systems are this simple. Certain hormones of the pituitary gland, called tropic hormones, stimulate the secretion of other hormones. The release of these tropic hormones into the blood causes their target glands to secrete the necessary hormones. When these target hormones are released into the blood, they inhibit the production of the tropic hormones. The tropic hormones then stop stimulating secretions of the target glands.

Much is still unknown about the workings of the endocrine system. For example, the exact mechanism of how hormones function--how, exactly, they produce the specific activities in their target cells--is still under investigation. Why hormones are so powerful in such small amounts is not understood. Another puzzle involves two special glands, the thymus and the pineal body. Both organs secrete substances that are carried by the blood to act upon other tissues of the body. In this respect they qualify as endocrine glands. However, the exact functions of these glands and their secretions is still a question.

The thymus is found in the upper chest just behind the sternum (breastbone). It has two lobes which, in children, reach past the trachea toward the lungs. (In adults the thymus is smaller. It appears to shrink after puberty.) Apparently the thymus is involved in the body's response to disease: not only does it produce white blood cells which fight disease, but it also secretes a substance that stimulates other tissues to produce lymphocytes. Research continues to try to establish the thymus as a true endocrine gland.

The pineal body is even more of a puzzle. This organ is a small, oval mass of tissue tucked behind the midbrain. It secretes two substances that are classified as hormones, although their functions in the body are unknown. Current research indicates that the pineal body is involved with the regulation of the body's rhythms or cycles, specifically those that depend on light and dark. How this works is still a mystery, especially since there is no apparent link between the pineal body and the eyes.

There is probably no body function which is not in some way affected by the endocrine system. The balances of the body are regulated by hormones. Hormones control the body's development from before birth until death. Metabolism--the utilization of foodstuffs and the production of energy--is under endocrine control, as is reproduction. It appears that there are few body processes that are not somehow influenced by the endocrine system.

THE PITUITARY GLAND

Objectives

Upon completion of this module, you should be able to identify and describe the location, structure, functions, and hormones of the pituitary gland.

The protected location of the pituitary gland hints at its importance within the body. This gland, also called the hypophysis, lies within a bony depression under the floor of the brain. Its protected position virtually isolates it from the rest of the body except through the circulatory system and a connecting stalk to the hypothalamus of the brain. The close link between the hypothalamus and pituitary has a great effect on the endocrine system as a whole.

The pituitary is only about the shape and size of a small, fat pea. Even so, it subdivides into two separate lobes with two separate sets of functions. In fact, the pituitary or hypophysis is really two separate glands. The anterior lobe (or adenohypophysis) comprises three-quarters of the gland. It consists of secreting or endocrine tissue. The anterior lobe is also supplied with a dense web of capillaries, through which it communicates with the hypothalamus.

Behind the anterior lobe is the tiny posterior lobe. This portion of the pituitary is made up of nerve tissue. For this reason the posterior lobe is also called the neurohypophysis. Nerve tracts from the hypothalamus run down the connecting stalk to the posterior lobe. These tracts provide a link between the hypothalamus and the posterior pituitary.

The pituitary hormones have a wide range of effects on both the body and the rest of the endocrine system. The anterior lobe of this gland secretes tropic hormones. Tropic hormones directly influence other endocrine glands rather than body tissues; they stimulate these glands to grow and develop, and also cause them to secrete their particular hormones. Because the pituitary controls much of the endocrine system through tropic hormones it is often called the master gland. The posterior lobe does not secrete tropic hormones. It instead releases two hormones which are important to the function of the body as a whole.

The effect of pituitary hormones ranges from being highly specific to being body-wide. The hormones released from the posterior lobe are an example. One of them, oxytocin, has as its target the female reproductive system. It causes the uterus to contract in the process of giving birth. It also causes the mammary glands to release their milk when stimulated by suckling. The other hormone of the posterior lobe is called antidiuretic hormone, or ADH. This substance is vital to the

regulation of fluid balance in the body. ADH is secreted when the body's fluid levels fall below a certain level. ADH's target cells include the kidneys, which respond by conserving rather than excreting water. ADH, by controlling fluid balance, also helps control blood pressure.

The hormones of the anterior lobe have a wider range of effects. The tropic hormones include the gonadotropins, follicle-stimulating hormone (FSH), and luteinizing hormone (LH). These act on the reproductive system to stimulate secretion of the reproductive hormones: estrogen and progesterone in the female, and testosterone in the male. Activation of the gonadotropins accounts for the changes of puberty in both males and females. The gonadotropins also control the female reproductive cycle. Thyroid-stimulating hormone (TSH) is another tropic secretion. It causes the thyroid gland to produce the hormones which affect the body's metabolic rate. Adrenocorticotropin (ACTH) has the same effect on the cortex of the adrenal gland.

The other anterior lobe hormones are not tropic in nature. Prolactin acts with the female hormones to cause production of milk by the mammary glands. Growth hormone (GH) affects the growth of the whole body. It acts with other hormones to cause growth of all body tissues; it also influences protein and carbohydrate metabolism. A seventh hormone, melanocyte-stimulating hormone (MSH), is secreted by the anterior lobe; it is believed to be involved in skin pigmentation.

The link between the pituitary and the hypothalamus is fascinating as well as necessary. The hypothalamus is believed to be the center of many emotions. This function may tie in with its endocrine-regulating functions. Emotions and hormones may be linked very closely. It is known that prolonged emotional stress can cause chronic high blood pressure, and we know that blood pressure is controlled by one of the posterior lobe hormones. Figure 2 charts the effects of the pituitary hormones.

Hormone	Effects
ANTERIOR PITUITARY	
Growth hormone	controls body growth involved in food metabolism
Thyroid-stimulating hormone	controls thyroid hormone production and secretion
Adrenocorticotropic hormone	controls secretions of adrenal cortex
Follicle-stimulating hormone	controls maturation of sperm and ovarian follicles
Luteinizing hormone	controls ovulation and secretions of sex hormones
Prolactin	controls lactation
Melanocyte-stimulating hormone	involved with skin pigmentation
POSTERIOR PITUITARY	
Oxytocin	causes uterine contraction and milk ejection
Antidiuretic hormone	regulates body's fluid balance

Figure 2

OPTIONAL ACTIVITY

- Describe how growth hormone is related to dwarfism, giantism, and acromegaly.

THE THYROID AND PARATHYROID GLANDS

Objectives

Upon completion of this module, you should be able to identify and describe the location, structures, functions, and hormones of the thyroid and parathyroid glands.

The thyroid gland and the parathyroid glands serve different functions but are usually discussed together. The reason for this is, because the parathyroids are embedded within the thyroid. The thyroid gland is located in the neck, right below the larynx or Adam's apple. It has two lobes which curve around behind the trachea. A narrow bridge of thyroid tissue, called the isthmus, crosses the front of the trachea to connect the lobes. The general shape of the thyroid gland has been compared to that of a butterfly. Two of the tiny parathyroid glands (there are usually four parathyroids in all) nestle into the back of each lobe. Each parathyroid is about the size and shape of a grain of wheat.

The thyroid gland plays an important role in the regulation of metabolism. It secretes three hormones: thyroxin (T_4), triiodothyronine (T_3), and calcitonin. T_3 and T_4 are very similar in both structure and function. Both hormones increase the use of oxygen by body cells, thereby increasing metabolic rates. Calcitonin is involved in the metabolism of calcium and phosphate in the body. The hormones are stored in hollow cells (called follicles) of the thyroid until needed. The thyroid is probably the only endocrine gland that stores its secretions. Release of the hormones is controlled by negative feedback. The hypothalamus stimulates the anterior lobe of the pituitary to secrete thyroid-stimulating hormone, or TSH. TSH then causes the thyroid to convert and release its stored hormones. When the concentration of thyroid hormones in the blood reaches a satisfactory level, the hypothalamus signals the anterior pituitary to stop secreting TSH. The thyroid then stops releasing thyroid hormones. It is important that the blood levels of these hormones remain fairly constant, because they are crucial to the body's normal functioning. Without them the metabolic rate slows down considerably and the body simply produces less energy for its vital processes.

The presence of iodine in the diet is essential to proper functioning of the thyroid gland as both T_3 and T_4 are synthesized from iodine.

The parathyroid glands produce only one hormone, parathyroid hormone (PTH), also called parathormone. This hormone, along with calcitonin, controls the metabolism of calcium and phosphate in the body. The glands secrete PTH in direct response to the blood-concentration level of calcium. A lesser concentration of

calcium in the blood stimulates a greater secretion of PTH. PTH raises the levels of calcium in the body fluids by several methods. It promotes intestinal absorption of calcium from foodstuffs, it causes the kidneys to reabsorb calcium from the urine, and it causes breakdown of bone to free calcium into the body. Proper levels of calcium regulate the interaction of muscle with the nervous system, prevent muscle spasm and tetany (rigidity), and help in the clotting of blood.

OPTIONAL ACTIVITIES

- Define and discuss hypo- and hyperthyroidism.
- Explore the causes and treatments of a goiter.
- Find out why most salt is iodized, and how this affects the thyroid.

THE ADRENAL GLANDS

Objectives

Upon completion of this module, you should be able to identify and describe the location, structure, functions, and hormones of the adrenal glands.

Like the pituitary gland, the adrenal glands are composed of two separate types of endocrine tissue. Both glands consist partly of ordinary secreting tissue and partly of nervous tissue. The secreting tissue responds to various types of stimulation to produce its hormones; the nervous tissue produces hormones only if stimulated by nervous impulses.

There are two adrenal glands. They are found in the rear upper abdomen (retroperitoneal), where they rest atop the kidneys like little wrinkled stocking caps.

The two kinds of adrenal tissue are arranged in layers. The cortex is the outer layer; it makes up the greatest bulk of the gland. The cortical layer secretes three different hormones. The cortex is made up of endocrine tissue, but the medulla, or the inner adrenal layer, is made up of nervous tissue. The adrenal cortex and adrenal medulla can be regarded as two separate glands packed into one small organ. The cortex is essential to life, the medulla is not.

The secretions of the adrenal glands play a large part in the body's response to stress. The medulla, for instance, mimics the "fight or flight" reaction of the sympathetic nervous system. Hormones of the cortex help produce glucose, which provides instant energy to the body. Other functions of the adrenal glands are purely regulatory, and help maintain the body's equilibrium.

There are three classes of hormones produced by the adrenal cortex, generally called corticoids. The glucocorticoids are involved with the metabolism of carbohydrates and protein. These hormones increase the levels of blood sugar by accelerating carbohydrate and protein metabolism. They also play an important part in the body's resistance to stress. In combination with other hormones, the glucocorticoids have an anti-inflammatory effect. For this reason they are often used in the treatment of diseases such as rheumatoid arthritis.

The mineralocorticoids help maintain fluid and electrolyte balances. Electrolytes are the minerals in body fluids; proper electrolyte balance is essential to life. Aldosterone is the most important mineralocorticoid. It deals primarily with the transport of sodium ions in the kidneys.

The cortical sex hormones are the third class of corticoids; both male (androgens) and female (estrogens) hormones are produced. The function of these hormones is apparently to supplement the sex hormones produced by the gonads.

The secretion of all of the corticoids is at least partially controlled by the anterior pituitary gland. In a negative-feedback system, the pituitary secretes adrenocorticotropin, or ACTH, which stimulates the secretion of the corticoids by the adrenal glands. High corticoid levels exert the negative-feedback effect on the pituitary.

The adrenal medulla secretes two hormones, epinephrine (also called adrenalin) and norepinephrine (also called noradrenalin). Impulses from the sympathetic nervous system stimulate a very rapid release of these hormones. The effects of the medullary hormones are exactly like the effects of this branch of the nervous system. Epinephrine and norepinephrine increase heart rate, raise blood pressure, increase the alertness of the central nervous system, shut down the digestive organs, and divert blood to the muscles. These actions prepare the body to meet any unexpected or stressful occurrence. Everyone has felt the effects of these hormones; the tense alertness you feel when frightened, jumping when you hear a sudden noise behind your back, or when in danger, running faster than you ever thought you could.

These are the actions of both the sympathetic nervous system and adrenal medullary hormones. The medullary hormones serve to maintain and enhance the sympathetic control of the body--an example of the interrelationship between the endocrine and the nervous systems.

OPTIONAL ACTIVITY

- Find out the causes and effects of Addison's disease and Cushing's syndrome.

THE PANCREAS

Objectives

Upon completion of this module, you should be able to identify and describe the location, structure, endocrine functions, and hormones of the pancreas.

The pancreas functions as two different kinds of glands. Most of the pancreatic tissue secretes digestive enzymes which empty into the digestive system through ducts. But a tiny part of pancreatic tissue secretes two endocrine hormones which play a large role in the metabolic processes and health of the body.

The pancreas is located in the upper left side of the abdomen toward the back abdominal wall, where it sits below and slightly behind the stomach. It is about six inches long and weighs perhaps three ounces. Connective tissue divides the pancreas into several lobes which are composed primarily of enzyme-secreting tissue. However, scattered through this tissue are small groups, or islets, of endocrine cells. These groups are called the islets of Langerhans. They are ringed by capillaries which transport their secretions into the general circulation. Two types of secreting cells are found within the islets. They are classified as alpha cells or as beta cells depending on the hormones they secrete.

The alpha cells produce the hormone glucagon; the beta cells produce insulin. The secretion of these hormones is regulated by the level of glucose in the blood, or the blood sugar. A low blood-sugar level stimulates the production of glucagon, a hormone which acts on the liver. The liver stores glucose in the form of glycogen. Glucagon stimulates the liver to release the glycogen into the blood as glucose. Glucagon, then, functions to raise the level of blood sugar, or glucose in the blood.

A high blood-sugar level stimulates the secretion of insulin. Insulin decreases blood sugar by causing the body cells (especially muscle) to increase their uptake of glucose from the blood. The rate at which cells use glucose is regulated by the rate at which glucose is taken into the cells. So, by speeding up cell intake of glucose, insulin speeds up the rate of cell metabolism, and thus increases the production of energy throughout the body.

OPTIONAL ACTIVITIES

- Investigate the causes and effects of diabetes. Why is sugar in the urine a diagnostic test for diabetes? How does this relate to the pancreatic hormones?
- Investigate the causes and effects of hypoglycemia.

THE GONADS

Objectives

Upon completion of this module, you should be able to identify and describe the locations, structures, endocrine functions, and hormones of the gonads.

The male and female gonads have double roles to play. They produce the reproductive cells (sperm and ova) that furnish the genetic material of a new human being, and also function as endocrine glands which secrete the male and female hormones that are vital to the reproductive processes.

The testes, or male gonads, are located external to the body. They are two small glands roughly oval in shape. They are made up of several hundred feet of microscopic coiling tubes called the seminiferous tubules. Interstitial cells fill the spaces between the tubule coils. These are the endocrine cells, the cells responsible for the secretion of hormones.

The testes (one of which is called a testis or testicle) produce the male reproductive cells or sperm, and secrete the male hormones. The male hormones are collectively called the androgens; testosterone is the principal androgen.

The anterior lobe of the pituitary controls secretion of hormones by the testes. Luteinizing hormone (LH) when secreted by the pituitary, stimulates the interstitial cells to produce androgens. Luteinizing hormone is therefore called interstitial cell stimulating hormone (ICSH) in the male. ICSH becomes active at puberty.

The androgens affect sexual development before birth and again beginning at puberty. The presence of the male hormones is necessary for the fetus to develop male genitalia. The secretion of androgens at puberty brings about the physical changes associated with the maturing reproductive system. Testosterone causes the development of the male secondary sex characteristics at puberty, such as the growth of pubic and body hair, the rapid bone growth that makes boys suddenly grow taller, the deepening of the voice, and increased muscular development.

The function of the female gonads is the same as that of the male gonads: to produce the reproductive cells and the hormones that maintain reproductive activities. The major female hormones are estrogen and progesterone.

The female hormones cause the development of the female external genitalia and the female reproductive system in the fetus. Estrogen is primarily responsible for the bodily changes at puberty. Estrogen affects the pattern of fat deposition;

breasts and hips become more rounded due to the action of this hormone. Estrogen also causes the pelvis to widen, stimulates the growth of pubic hair, and assists in maintaining the reproductive cycle after puberty. Progesterone helps prepare the reproductive organs for pregnancy. It brings about growth and thickening of the lining of the uterus, for the purpose of supporting and nourishing the developing embryo. When the progesterone level decreases, the uterine lining breaks down and sloughs off in the process of menstruation.

The cyclic changes of the menstrual process prepare the woman's body for pregnancy. These cyclic changes are the result of a complex yet orderly secretion of hormones from the anterior pituitary gland and the female gonads. The cycle begins with the secretion of follicle-stimulating hormone (FSH) from the pituitary gland. This hormone causes one follicle (containing an immature ovum) to begin growing and maturing. Around the fourteenth day of the cycle there is a sharp increase in luteinizing hormone (LH, another pituitary hormone) and some increase in FSH secretion. This causes the follicle to rupture releasing the ovum (ovulation). The ovum is drawn into the uterine tubes and towards the uterus. Meanwhile, the ruptured follicle under the influence of LH, undergoes a rapid growth, forming a ball of yellowish cells. This new ball of cells is called the corpus luteum. The corpus luteum is maintained by LH for ten to twelve days, during which time it secretes progesterone. If pregnancy occurs, the corpus luteum secretes progesterone until the developing placenta assumes that function. If pregnancy does not occur, the corpus luteum shrivels up and stops producing progesterone causing the blood level of that hormone to drop sharply. This triggers the anterior lobe of the pituitary to secrete FSH again, thus beginning a new hormonal (menstrual) cycle.

If fertilization does occur, the cycle takes a slightly different course. Another female endocrine gland, the placenta, develops and becomes functional. It secretes a hormone that inhibits the corpus luteum from degenerating. This prevents the occurrence of the menstrual flow and subsequent beginning of a new menstrual cycle.

During pregnancy, the placenta will function both as a source of fetal nourishment and as an endocrine gland. Its functions cease at birth when it is expelled from the body.

The placenta attaches to the uterine lining, usually on the upper back wall of the uterus. It is a flat, irregular, dark red, membranous organ. Blood vessels from both the mother's and the fetus's circulatory systems make up the placenta. It also has a layer of small gland cells. Both the nourishing and the endocrine capabilities of the placenta perform the same basic functions: sustaining the pregnancy. Without the endocrine activity of the placenta, the uterus would probably abort the embryo.

The placenta secretes hormones throughout the pregnancy. The hormones secreted include chorionic gonadotropin (which resembles LH), estrogen, progesterone, and some of the same hormones as the adrenal cortex. Adrenocorticotropic hormone controls the secretion of these adrenal cortical hormones, as it does in the adrenal gland itself. Towards the end of the pregnancy, the placenta also secretes

a hormone called relaxin. Relaxin acts on the pelvic ligaments and bones, increasing their flexibility. This will ease the passage of the fetus through the birth canal. The placental hormones also stimulate the breasts to develop their milk-producing glands to prepare for the need to nourish the infant after birth.

Placental hormones function to sustain the pregnancy and to protect the fetus. Progesterone especially maintains the uterine lining and prevents the uterus from expelling the fetus prematurely. Together these hormones, and hormones from the anterior pituitary, regulate the complex cycles of the female reproductive system.

OPTIONAL ACTIVITY

S	R	K	U	O	A	D	S	I	N	G	E	D	S	E	S
P	A	V	L	I	D	I	O	R	Y	H	T	A	R	A	P
V	P	N	I	T	C	A	L	O	R	P	N	N	O	S	R
H	Y	A	E	E	H	V	U	P	Q	H	O	D	A	G	O
Y	N	O	N	L	J	E	O	A	E	P	G	R	T	I	G
N	E	N	T	C	L	C	S	O	N	M	A	O	E	N	E
G	G	N	A	W	R	X	A	T	O	Z	C	G	N	W	S
E	N	I	O	S	Z	E	L	A	R	D	U	E	E	U	T
D	A	C	E	M	T	T	A	I	E	O	L	N	C	E	E
O	D	E	N	L	R	A	S	S	T	E	G	S	T	O	R
V	O	X	B	O	A	O	Q	Y	S	Q	P	E	I	N	O
E	M	S	P	A	C	S	H	E	O	A	T	I	N	E	N
V	C	I	U	I	D	C	U	E	T	E	S	G	M	N	E
D	C	I	D	G	B	H	N	I	S	A	E	A	C	R	W
N	N	F	I	G	A	I	D	D	E	D	N	R	L	D	O
G	X	B	U	P	I	T	U	I	T	A	R	Y	T	F	B

Find the following terms in this maze by circling the words. They may appear frontwards or backwards, vertically, horizontally, or diagonally.

androgens
estrogen
glucagon
hormone
pancreas
parathyroid
pituitary
progesterone
prolactin
testosterone
tropic

GLOSSARY

adenohypophysis:	the anterior lobe of the pituitary gland.
adrenal cortex:	the outer layer of the adrenal gland, made up of endocrine tissue.
adrenal glands:	endocrine glands composed of an outer cortex and inner medulla; located directly above the kidneys.
adrenal medulla:	the inner layer of the adrenal gland, made up of nervous tissue.
adrenocorticotropin (ACTH):	a hormone secreted by the pituitary, essential to the growth and maintenance of the adrenal cortex.
aldosterone:	a mineralocorticoid secreted by the adrenal cortex.
alpha cells:	cells found within the pancreas which produce and secrete glucagon.
androgens:	male sex hormones.
antidiuretic hormone (ADH):	a hormone secreted by the posterior lobe of the pituitary gland, regulates fluid balance.
beta cells:	cells found within the pancreas which produce and secrete insulin.
calcitonin:	a hormone secreted by the thyroid gland.
corpus luteum:	a yellow body of cells which develops from the ovarian follicle following ovulation.
corticoids:	adrenal cortical hormones.
endocrine system:	the system of glands which secrete hormones directly into the bloodstream.

epinephrine (adrenalin): a hormone secreted by the adrenal medulla.

estrogen: a female sex hormone.

exocrine gland: a gland whose secretion reaches the exterior of the body directly or through ducts.

follicle-stimulating hormone (FSH): a tropic hormone secreted by the anterior lobe of the pituitary.

glands: secretory organs or structures.

glucagon: a hormone secreted by the alpha cells of the pancreas.

glucocorticoids: adrenal cortical hormones which are involved with protein and carbohydrate metabolism.

gonadotropins: gonad-stimulating hormones.

gonads: sex glands, ovaries and testes.

growth hormone (GH): a hormone released by the anterior pituitary, regulates growth.

hormones: chemical messengers secreted by endocrine glands.

hypophysis: the pituitary gland.

hypothalamus: portion of the diencephalon; controls pituitary activities.

insulin: a hormone secreted by the beta cells of the pancreas.

interstitial cells: cells which produce testosterone, located in the testes.

interstitial cell stimulating hormone (ICSH): luteinizing hormone, secreted by the pituitary.

islets of Langerhans: clusters of endocrine cells within the pancreas.

luteinizing hormone (LH): tropic hormone secreted by the anterior lobe of the pituitary.

melanocyte-stimulating hormone (MSH): a hormone secreted by the anterior lobe of the pituitary, believed to be responsible for darkening skin color.

mineralocorticoids: hormones produced by the adrenal cortex, maintain fluid and electrolyte balances.

negative feedback: a process by which hormone secretion is controlled.

neurohypophysis: posterior portion of the pituitary gland.

norepinephrine (noradrenalin): a hormone produced by the adrenal medulla.

oxytocin: a pituitary hormone which stimulates contractions in the uterus and release of milk from the mammary glands.

parathyroid glands: endocrine glands, located close to the thyroid.

parathyroid hormone: (parathormone) the hormone secreted by parathyroid glands.

pineal body: a small gland attached to the posterior of the third ventricle of the brain; it may or may not be an endocrine gland.

pituitary gland (hypophysis): the endocrine gland attached to the base of the brain, secretes several hormones which regulate many body processes and activities; often called the master gland.

placenta: an organ in the uterus through which the fetus receives nourishment; it also secretes hormones.

progesterone: a female hormone which stimulates and regulates many reproductive activities.

prolactin:	a hormone produced by the pituitary gland, initiates lactation.
relaxin:	a hormone secreted by the placenta near the end of pregnancy.
seminiferous tubules:	small channels within the testes in which semen is produced and conducted.
testes: (s. testis, testicle)	male reproductive glands, located in the scrotum, which produce spermatozoa and testosterone.
testosterone:	principal androgen, stimulates growth of male sex characteristics.
thymus:	a "mystery" gland, apparently involved in the body's response to disease.
thyroid gland:	an endocrine gland located in the base of the neck, helps control body metabolism.
thyroid-stimulating hormone (TSH):	a tropic hormone which stimulates production of thyroid hormones.
thyroxin:	a hormone produced by the thyroid gland.
triiodothyronine:	a hormone produced by the thyroid gland.
tropic hormones:	hormones which stimulate the secretion of other hormones.

The Endocrine System
POST-TEST

1. All endocrine glands secrete their hormones into:

   A. ducts.
   B. the bloodstream.
   C. organs.
   D. nerve tissue.

2. The functions of the endocrine system are most similar to the functions of which system?

   A. nervous
   B. respiratory
   C. digestive
   D. muscular

3. The most common mechanism of controlling hormone secretion is:

   _____.

4. Which endocrine gland is known as the master gland?

   A. pancreas
   B. pituitary
   C. thyroid
   D. adrenal

5. Tropic hormones exert their effect directly on the:

   A. endocrine glands.
   B. heart.
   C. nervous system.
   D. brain.

6. Which endocrine gland is directly connected to the hypothalamus?

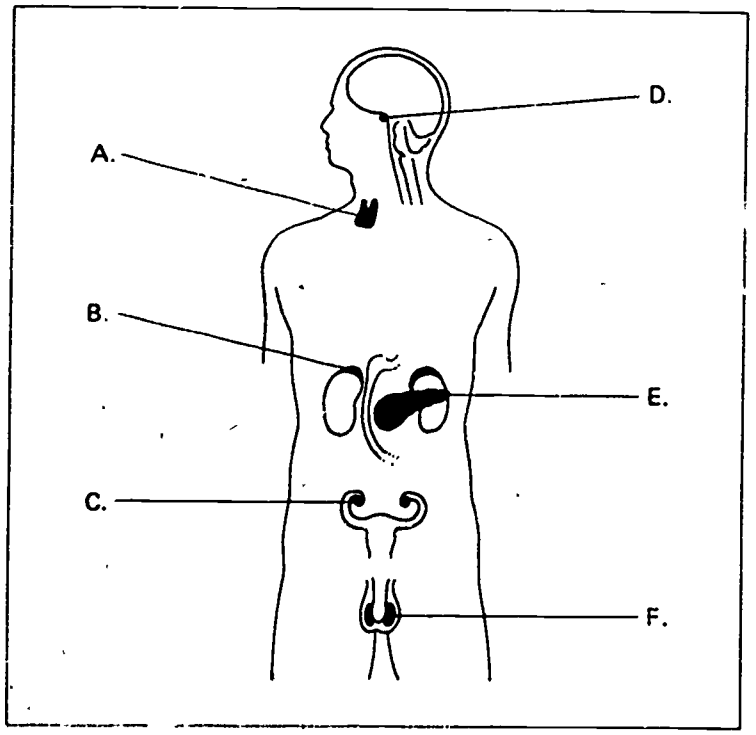
_____

7. Name the two "mystery organs" that may qualify as endocrine glands.

_____

_____

8. Match the endocrine gland to its name below by putting the correct letter on the line next to the name of the gland.



_____ pituitary

_____ thyroid

_____ pancreas

_____ adrenal

9. All endocrine glands secrete chemical messengers called:

_____.

10. The four tiny endocrine glands located within the thyroid gland are the:

_____.

11. Give another name for the pituitary gland.

_____

12. The hypothalamus communicates with the anterior pituitary through a:

A. web of capillaries.
B. master gland.
C. connection of bones.
D. nerve network.

13. The posterior lobe of the pituitary is made of what kind of tissue?

_____

14. The pituitary hormone that helps control the body's fluid balance is:

A. oxytocin.
B. antidiuretic hormone.
C. prolactin.
D. luteinizing hormone.

15. What part of the pituitary gland secretes tropic hormones?

_____

16. Which pituitary hormone controls secretions of the thyroid gland?

_____

17. Secretions of the pituitary gland are controlled by what organ?

_____

18. The thyroid and parathyroid glands are located in the:

A. abdomen.
B. chest.
C. head.
D. neck.

19. The hormones of the thyroid play an important role in the body's regulation of:

A. balance.
B. fluids.
C. metabolism.
D. cholesterol.

20. Which of the following hormones is NOT secreted by the thyroid gland?

A. adrenalin
B. thyroxin
C. calcitonin
D. triiodothyronine

21. What mineral is necessary for the synthesis of thyroid hormones?

_____

22. Name the hormone of the parathyroid glands.

_____

23. The parathyroid glands control the blood-level concentration of which substance?

A. iron
B. potassium
C. calcium
D. sodium

24. The adrenal glands are located on top of which organs?

A. lungs
B. ovaries
C. kidneys
D. intestines

25. Name the two layers of the adrenal glands.

_____

_____

26. Which of the following is a hormone of the adrenal glands?

A. testosterone
B. insulin
C. estrogen
D. epinephrine

27. The actions of the adrenal hormones are very similar to the actions of what part of the nervous system?

_____

28. Which class of adrenal hormones is primarily concerned with the metabolism of carbohydrates and protein?

A. mineralocorticoids
B. androgens
C. glucocorticoids
D. estrogens

29. Which hormone deals with the transport of sodium ions in the kidneys?

A. testosterone
B. norepinephrine
C. adrenocorticotropin
D. aldosterone

30. Name the two adrenal hormones that increase heart rate, raise blood pressure, increase alertness, and divert blood to the muscles in "fight-or-flight" situations.

_____

_____

31. The pancreas is located:

A. between the lungs.
B. behind the stomach.
C. below the intestines.
D. beside the liver.

32. Name the two types of endocrine cells in the pancreas.

_____

_____

33. The pancreatic hormones regulate the level of which substance in the blood?

A. cholesterol
B. oxygen
C. glucose
D. carbon dioxide

34. Name the two hormones of the pancreas.

_____

_____

35. The secretion of pancreatic hormones is controlled by:

A. metabolic rates.
B. pancreatic enzymes.
C. tropic hormones.
D. blood-sugar levels.

36. The islets of Langerhans are the endocrine cells of what organ?

_____

37. What are the endocrine cells of the testes called?

_____

38. The male hormones are collectively known as the:

A. testicles.
B. estrogens.
C. progesterones.
D. androgens.

39. Name the two major female hormones.

_____

_____

40. The male hormone that causes the development of secondary sex characteristics at puberty is:

_____

41. Which of the following is a function of the female sex hormones?

A. regulation of the menstrual cycle
B. initiation of nervous system impulses
C. control of skeletal muscle contractions
D. maintenance of blood-sugar levels

42. What hormone is mainly responsible for the creation and maintenance of the corpus luteum?

_____

43. What female endocrine gland only becomes functional during pregnancy?

_____

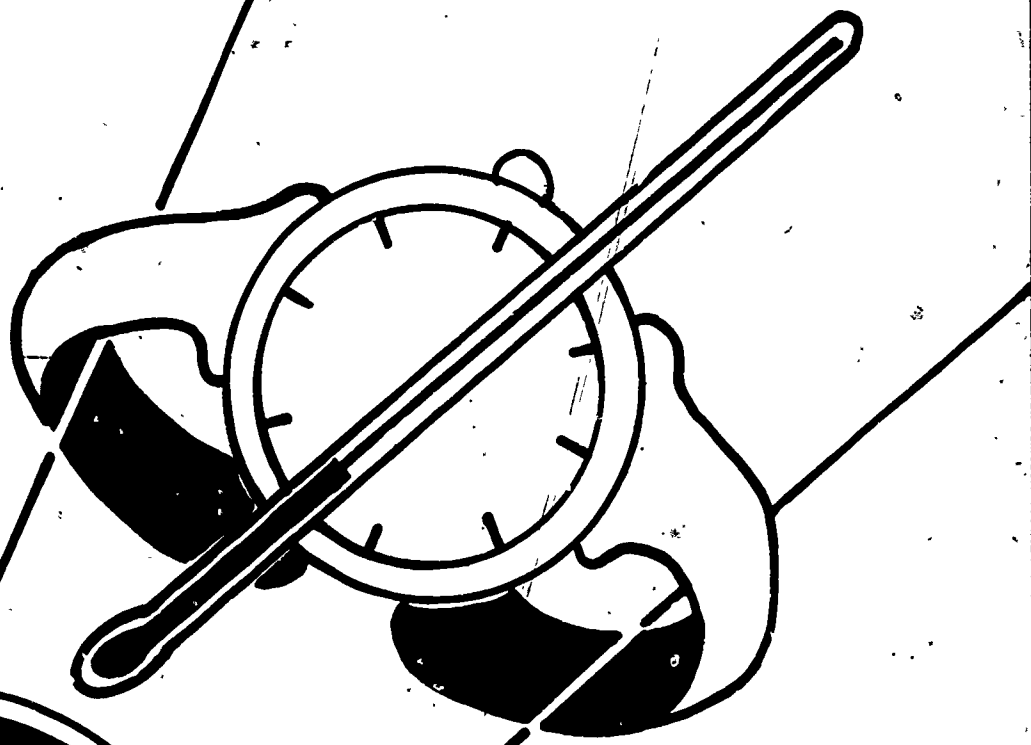
44. Which female hormone acts to soften pelvic bones and ligaments to facilitate birth?

A. luteinizing hormone
B. progesterone
C. follicle-stimulating hormone
D. relaxin

45. What organs are the male gonads?

_____

HEALTH OCCUPATIONS EDUCATION MODULE



INSTRUCTOR'S GUIDE: THE ENDOCRINE SYSTEM

Instructional Materials in Anatomy and Physiology
for Pennsylvania Health Occupations Programs

INSTRUCTOR'S GUIDE:

THE ENDOCRINE SYSTEM

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INTRODUCTION

These instructional modular units have been developed for the Pennsylvania Department of Education for use in vocational education programs. They were designed on the assumption that a basic understanding of human anatomy and physiology is essential to any person preparing to enter a health care occupation such as practical nursing, nursing assistant, medical assistant, emergency medical technician, or dental assistant. Each of these modular units will cover the most important aspects of one of the major systems of the human body. In the first four units the following systems are covered: circulatory system, respiratory system, musculoskeletal system, and digestive system. In the second four units, the endocrine, reproductive, nervous, and genitourinary systems are covered.

This Instructor's Guide is designed to provide suggestions on how to use a modular unit most effectively in your instruction. These recommendations, however, do not represent the only way to use these units: you may be able to devise more beneficial uses for the materials.

THE MODULAR UNITS

Each modular unit is made up of several components: a pretest, three to six instructional modules with optional activities for the students, a glossary of terms used in the unit, and a post-test. Each of these components has a specific purpose and is organized in a specific way, as explained in the following sections.

Pretest

After reading the preface, which is simply an introduction to these instructional units, students working through a modular unit should first take the pretest. Their answers should be written on a separate piece of paper labeled "Pretest" (they should not have access to these answers when taking the post-test). As its name

implies, this test is designed to be taken by the student before beginning work on the materials contained in the unit. Its purpose is twofold: (1) to stimulate interest in the modular unit by giving the student a preview of the topics covered, and (2) to provide information to the instructor on what students do and do not know, before and after working through the unit. Based on the student's performance on the pretest, the instructor may wish to emphasize those areas of the modular unit which may require special attention and extra effort on the part of the students. Instructors should score the pretests after the students have completed them, but should not share these scores with the students. After completing the unit, students will then take the post-test (which involves all of the questions on the pretest, and more). Instructors may then compare post-test scores to pretest scores in order to evaluate the amount that students have learned from the unit.

Instructional Modules

This modular unit is composed of six separate but closely related modules, including: Introduction to the Endocrine System, The Pituitary Gland, The Thyroid and Parathyroid Glands, The Adrenal Glands, The Pancreas, and The Gonads. After taking the pretest, students should read through and study each of the instructional modules. For the students' benefit, each module begins with a statement of the objectives that a student should have mastered upon completion of that particular module. The level of achievement of these goals is measured by students' performance on the corresponding section of the final post-test. The language level and content of each module is aimed toward students seeking an introduction to the components, structures and functions, and the basic terminology required for an understanding of the endocrine system. However, some material may be too technical or otherwise inappropriate for certain programs. Instructors are urged to use their judgment to determine if any areas are too difficult and should be omitted.

Optional Activities

Following many modules are optional activities intended to provide the student with an opportunity to pursue the content of the module at a more in-depth level. Many of these activities may require teacher participation, at least in obtaining and preparing additional materials for students to utilize.

In addition to the optional activities available, you may choose to provide further information to the students by developing a brief unit on the common disorders of the endocrine system. Discussion of these disorders has not been included in the

text because a basic knowledge of the proper structure and function of the human body in a healthy individual seems more appropriate for the purposes of an introductory program. If you do choose to discuss common disorders, the most effective approach may be one in which you use disorders to illustrate what can go wrong in the body, as a means of clarifying the students' understanding of how the body works when functioning properly.

You may also wish to provide students with the names of books or articles as suggested readings to further their understanding of a particular area.

Glossary

After the last of the modules in the unit is a glossary. This is not intended to be a comprehensive glossary to be used by students as a dictionary. Rather, it includes the basic terms used in the unit which are necessary to an understanding of the system covered. Those underlined words which appear in the modules and have been defined in the text are not always defined in the glossary. Some of these particular terms have been used in the module because they are essential but difficult terms needed to explain the content taught in the unit. Students should use the glossary to review the vocabulary essential to the unit before taking the post-test.

Post-Tests

The post-test is the final assessment of a student's understanding of the material presented in each module. It consists of multiple-choice and open-ended questions designed to measure a student's mastery of the objectives stated at the beginning of each module. Each of the questions has been written to measure an aspect of the skills and/or knowledge that a student may be expected to acquire as a result of working through a particular unit. The post-test includes the questions used in the pretest, which can be used for before-and-after comparisons; and it includes additional difficult questions which measure knowledge of subjects treated specifically in the modules.

SCORING THE POST-TESTS

As previously mentioned, the purpose of the post-tests is to measure whether or not a student has mastered the objectives stated at the beginning of each module. Due to the variety of ways in which teachers may choose to utilize these modules, and discrepancies among students' previous exposure to the subject matter, it is not practical to set a standard cut-off score on the post-test that would indicate mastery of the objectives. Rather, teachers are asked to use their professional judgment in individual cases to determine if a student's performance on the post-test indicates that he or she has mastered the objectives stated for the modules. In making this determination, you should consider at least all of the following factors:

(1) How long is the post-test?

(2) How much information is included in each module and how complex is the information, relative to other modules?

(3) Has the student been exposed to the kind of curricular material before? That is, has the student been taught the basics of this system of the body before?

(4) Should the entire class be required to achieve a certain score in order to pass, or should each student be considered individually? (This depends on how and with whom you use this module as instructional material.)

(5) Should the student be graded pass/fail on mastery of objectives in each module, or on the unit as a whole?

To facilitate the scoring of the post-test, each student will record his or her answers on one separate sheet of paper. You should first mark each answer correct or incorrect. Then give the student a "pass" or "fail" on each module by counting the questions answered correctly, or score the unit as a whole by adding up all of the correct answers.

Because of the subject matter, responses to open-ended questions may vary slightly from those provided, but these responses may also be acceptable. Again, in these cases instructors are asked to use their professional judgment to determine if a response is correct.

In order to compare the students' scores on the pretest and post-test, review the scores each student achieved on the pretest, then total the score students achieve on these same questions appearing in the post-test. (Please note: these questions have been placed in different sequence and renumbered; both their old and new numbers are listed in the answer key.) You may wish to compare the students' scores on the entire set of items which appears in both tests, or on the items for each module, or on each item individually. Whichever approach seems most useful can be accomplished by using the information given.

On the following pages is a list of answers to the pretest and post-test questions, which is provided to facilitate the grading of your students' papers.

ANSWER KEYS

Pretest

1. hormones
2. B
3. parathyroid glands
4. D
5. C
6. testes
7. C
8. pituitary
9. pancreas
10. A
11. B
12. negative feedback
13. nerve
14. hypothalamus
15. D
16. iodine
17. D
18. cortex, medulla
19. B
20. insulin, glucagon
21. androgens
22. estrogen, progesterone

Post-test

NOTE: Starred question numbers indicate those questions which also appeared on the pretest. The pretest number of each repeated question is given in parentheses. Post-test questions 1-3, 5, and 7-9 refer to materials presented in module 1, Introduction to the Endocrine System; questions 4, 6, and 11-17 refer to module 2, The Pituitary Gland; questions 10 and 18-23 refer to module 3, The Thyroid and Parathyroid Glands; questions 24-30 refer to module 4, The Adrenal Glands; questions 31-36 refer to module 5, The Pancreas; and questions 37-45 refer to module 6, The Gonads.

*1. (11) B
*2. (10) A
*3. (12) negative feedback
*4. (2) B
5. A
*6. (8) pituitary
7. thymus, pineal body
8. D, A, E, B
*9. (1) hormones
*10. (3) parathyroid glands
11. hypophysis
12. A

*13. (13) nerve

14. B

15. anterior lobe

16. thyroid-stimulating hormone

*17. (14) hypothalamus

*18. (15) D

19. C

20. A

*21. (16) iodine

22. parathormone or PTH

23. C

*24. (7) C

*25. (18) cortex, medulla

*26. (4) D

27. sympathetic

28. C

*29. (17) D

30. epinephrine, norepinephrine

*31. (19) B

32. alpha cells, beta cells

*33. (5) G

*34. (20) insulin, glucagon

35. D

*36. (9) D

37. interstitial cells

*38. (21) D

*39. (22) estrogen, progesterone

40. testosterone

41. A

42. luteinizing hormone

43. placenta

44. D

*45. (6) testes