A STUDY OF THE ENDOCRINE GLANDS AND THEIR
IMPLICATIONS FOR EDUCATION, WITH SPECIAL
EMPHASIS ON INDUSTRIAL ARTS

Earle Blanton
Major Professor

Attlee
Minor Professor

S. A. Blankemeyer
Director of the Department of
Industrial Arts

Dean of the Graduate School
A STUDY OF THE ENDOCRINE GLANDS AND THEIR
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EMPHASIS ON INDUSTRIAL ARTS

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217394
Lucius L. Cox, Jr., B. S.

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CHAPTER I

THE PROBLEM AND THE PROCEDURE

Introduction

In recent years man has become increasingly aware of the physical and personality differences between himself and his fellow man. Many of the physical and personality differences which have attracted attention are determined by the ductless or endocrine glands of the human body. These glands secrete minute but powerful secretions, called hormones, directly into the blood stream, and the blood carries the hormones to every part of the body. The hormones secreted are chemicals that work with the nervous system in keeping the body in harmonious operation.

At the present time the endocrine secretions are known to control the general form of the body, the length of the limbs, the shape and size of the head, the tone of voice, the distribution of hair and fat, the excitability of the nervous system, and the metabolism of food energy.¹ There are three major ways of determining the effects of these secretions upon human beings: experiments involving the use of animals have given information concerning the endocrine glands;

the study and treatment of accidental injuries of glands in man has provided a certain amount of information, and limited experiments on man himself have furnished some concrete information which cannot be gathered in any other known way.

The history of the endocrine glands dates back to the time of the Greeks. In about 350 B.C., Aristotle expressed in his teachings the theory that there were organs of the body which were inter-related with each other. Galen, who lived from 130 to 201 A.D., was the next person to contribute to the study of the ductless glands. "Galen believed that the blood, the splenic fluid, the bile and the mucus (phlegma) were the four juices or 'humors' produced by the various organs, and that an abnormal mixture of these humors resulted in a variety of dyscrasias or diseases."^2 The practice of venesection, or bleeding, was one of the outcomes of such theories, because it was reasoned that by bleeding the patient the proper mixture of these four juices could be returned to normal. In 1775 Bordeaux advanced the theory of the four so-called humors still further when he stated that every organ of the body manufactured a specific substance which was conveyed to the blood stream. Thus, there is a slight similarity of the knowledge of endocrinology at that time and our modern endocrinology which informs us that secretions of various glands are absorbed directly into the blood stream.

and an over- or under-secretion will cause mal-functioning of the body.³

The first person to discover the relationship between the endocrine glands and the circulatory system and to show how they affect the physical characteristics of animals was Berthold in 1849. He established the theory that the testicles control the masculine characteristics of the cock;⁴ his discovery, however, went almost unnoticed until 1889. Brown-Sequard's experiments in the same year brought to the attention of man for the first time facts concerning the body that were previously unknown. His experiments revealed beyond reasonable doubt that there were bodily chemicals circulating in the blood that affect the body itself or which have definite effects on the nerve centers; thus, a new field of study was opened which exhibited signs of being separate from the nervous system.⁵

**Purpose of the Study**

This is a study of the endocrine glands and their influence on the physical characteristics and behavior patterns of adolescents. The purpose of this study is not to present new ideas about the effects of the endocrine glands upon man, but to gather and present the information and data already

³Ibid., pp. 1-8.
available and to show how these glands of internal secretion
affect the individual in his ability to participate in an
educational program, with special emphasis on industrial arts.

Definition of Terms

Industrial arts has been defined by Wilber as the

- - phases of general education which deal
with industry - its organization, materials, occu-
pations, processes, and with the problems result-
ing from the industrial and technological
nature of society.6

Educational program has been defined in Webster's New
International Dictionary as the process or manner of train-
ing youth for their stations in life.7

Adolescent has been defined by Monroe in physical terms
as the period of growth beginning with puberty and ending
with adulthood.8

Behavior has been defined by Skinner as "that part of the
functioning of an organism which is engaged in acting upon or
having commerce with the outside world."9

Behavior pattern has been defined as "an organization of
actions or habits to form a larger whole..."10

6Gordon O. Wilber, Industrial Arts in General Education,
p. 2.
7Webster's New International Dictionary, second edition,
unabridged.
8Monroe's Encyclopedia of Educational Research, revised
edition.
10Kimball Young, Sociology, p. 986.
Physical characteristics have been defined as the embodied peculiarities of each individual which make for material bodily differences.

Limitations of the Study

This study, like all studies of the endocrine glands, is not conclusive. There are probably other endocrine glands and internal secretions that have not been isolated or identified. The study is further limited because it is prepared in a manner which will enable a person without technical training to read and understand its contents, and it is prepared by a student of industrial arts who has had only limited training in human physiology.

Sources of Data

The data for this study were gathered largely from books on endocrinology and related fields. The Reader's Guide to Periodical Literature was used as a source to locate the recent magazine articles related to the field of study.

Organization of the Study

Chapter I deals with the introduction and presents a brief outline of the functions and history of the endocrine glands, purpose of the study, definition of terms, limitations of the study, sources of data, and organization of the study. Chapter II deals with the structure, the location, and the history of the ductless glands. In Chapter III the general physiology
of the glands and the physical characteristics they establish in man are presented. In Chapter IV the functions of the ductless glands in the psychic area of development are projected. In Chapter V the effect that the endocrine glands have on an individual's ability to participate in an educational program, with special emphasis on industrial arts, is presented. Chapter VI presents the course of action that an industrial arts teacher may take to meet the individual differences established by the endocrine glands. Chapter VII embodies the summary, conclusions, and recommendations of the study.
CHAPTER II

THE HISTORY AND GENERAL DATA
ON THE ENDOCRINE GLANDS

Introduction

In this chapter the structure and location, the history, and some of the early theories about the functions of the endocrine glands will be presented. If one is to understand and appreciate the data that have been gathered, he must realize that many theories, hypotheses, and experiments have been proposed to gain the information available for use today.

Pituitary Gland

The pituitary gland, which is located in a centralized position in the head, was identified by Galen in the year 200 A.D. At that time he thought the purpose of the pituitary gland was to lubricate the throat. More than one thousand years later, Conrad Schreider's experiments proved that there were no passageways connecting the pituitary gland with the nose or throat. The first person to connect the pituitary gland with the growth process was Verge in 1846. He made the observation that one of his patients suffering from gigantism had an abnormal pituitary gland. Thirty years later a pathologist named Klebs published an accurate account
Fig. 1.—Locations of the endocrine glands
of a case of gigantism in which he emphasized the fact that
his patient had an oversized pituitary.

The pituitary gland is extended by a stalk from the
underside of the brain. The size of the gland varies in
man; usually, however, it is about the size of a large pea.
It weighs from three-fourths of a gram to one gram and struc-
turally consists of stalk and anterior and posterior lobes,
with the medullary center between them.¹ The three divisions
of the pituitary gland, anterior and posterior lobes, and the
medulla are easily distinguished microscopically.

The posterior lobe originates at the base of the brain
where a network of fibres is projected down from the brain
into the interior of the lobe. This network of fibres is
surrounded by many large cells filled with greenish-yellow
colored matter. The anterior lobe is often said to contain
an assortment of cells; it is believed, however, that this
assortment of cells actually represents different stages in
the functioning of the same cell.

The secretions of the anterior lobe pass directly into
the blood stream; thus, they do not pass through the posterior
section of the gland. The different divisions of the gland
are separated from each other by ingrowing mesodermal stroma
that has an abundance of blood vessels to carry the secretions
from the gland. The medulla of the pituitary is composed of

large cylindrical cells, and in between the cylindrical cells are spaces filled with colloid material.²

Pineal Body

The presence of the pineal body was known by the early Greeks, and it is mentioned in the writings of Galen. The function of the pineal gland is still a mystery to a certain extent. Descartes, in the middle of the seventeenth century, introduced the theory that the pineal gland housed the soul. Magendie, in 1775, advanced a more practical viewpoint when he projected the theory that the gland was merely a valve to control the flow of cerebrospinal fluid. As the name implies, the pineal gland is a cone-shaped body, and it is attached to the brain by a hollow stalk that is located opposite the pituitary gland. In the adult, the gland weighs approximately two grams and is approximately one-third inch long.

Microscopic examinations have failed to provide much evidence of internal secretion; the gland has a rich supply of blood, however, which suggests that the organ has an active secretion.³ The cells of the pineal gland are joined together by fine fibrils. After the seventh year of life the fibril tissues continuously increase in size, thereby stretching the cells apart from each other and forming spaces

²Weil, op. cit., pp. 35-38.
³Hoskins, op. cit., p. 254.
in the glandular tissue. These spaces are quickly filled with particles of calcium carbonate, calcium phosphate, and magnesium phosphate. The deposits are visible to the naked eye and are the so-called brain sand.4

**Thyroid Gland**

The history of the thyroid gland indicates that the people of two thousand years ago knew of its existence; the people of that period, however, knew nothing of the gland except the swelling condition known as goiter. There were many theories about the gland in these early years. Two of these early theories were that the gland was a device to keep the throat warm and that the gland was simply a "filling" that the creator used to round out the contour of the neck to make it beautiful. The most widely-accepted theory during the nineteenth century was that the gland had no significance except during the prenatal stage of existence. In 1806, Meckel contributed worthwhile information when he noted that the thyroid gland often swelled at critical periods in the sex life of women. Roger of Palermo revealed in 1180 that ashes of sponge and seaweed were beneficial to goiter; he knew of no acceptable explanation, however, as to why they were beneficial to goiter.5

Embryologically, the thyroid gland is an outgrowth of the digestive track; it soon is shut off from its place of

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origin, however, to form a ductless gland. In man the gland is attached to the larynx and consists of two lobes. The normal gland weighs from 20 to 25 grams, and, measured by scale of unit body weight, the gland is larger in women than in men and still larger in proportion to body size in children. Microscopically, the gland is made of numerous closed sacs filled with colloidal material which contains a number of active principles. One of these principles is thyroxine, the hormone which controls the metabolism of food energy.⁶

Parathyroid Glands

The parathyroid glands were discovered for the first time in 1885 by Remak, although credit for their discovery commonly goes to Sandstrom. In 1880 Sandstrom published a good description of the glands, regarding these glands as being displaced tissue of the thyroid. The independent function of the glands was discovered ten years later by Gley.

The parathyroid glands may be described as small bean-like yellowish-red organs that appear on the thyroid gland. In man they commonly occur in pairs and number four glands; they often vary in size and number. Their location on the thyroid is normally on the inner side and toward the back of the lobes.⁷ Sometimes they are found scattered in the neck region and are remote from the thyroid. This scattered

⁶Michael F. Guyer, Animal Biology, pp. 360-361.
⁷Hoskins, op. cit., pp. 103-105.
condition presents a problem when removal of the glands is necessary.  

The microscopic structure of the glands is made up of fibrous tissue with masses of epithelial cells separated by connective tissue. The cells themselves appear to be grouped in columns. Two kinds of cells have been recognized—principle and oxyphil. The functional relationship of the two different cells, however, has not been determined.  

Thymus Gland  
The thymus gland, like many of the other ductless glands, was also first discovered by the Greeks approximately two thousand years ago. The first significant discovery concerning the function of the gland was recorded by Plater in 1614. He found that a normal baby had an enlarged thymus gland; thus, he had evidence to support his belief that the thymus gland was implicated with development, because it was enlarged in a normal young child.  
The thymus gland is located above the heart where the chest narrows to become the neck. Structurally, the gland consists of two lobes made of a soft, white mass. When it is viewed by the microscope, two kinds of tissue can be distinguished—cortical tissue on the outer side and medullary  

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9Hoskins, op. cit., pp. 103-105.
tissue in the inner portion. The gland is largest in size at puberty and weighs approximately one ounce at this critical time in life. At birth the gland weighs one-fourth to one-half ounce. Normally the thymus gland will disappear or remain inactive at approximately thirteen years of age.

Pancreas Gland

Claud Bernard may well be considered a precursor in his work with the digestive tract and digestive juices. In the years from 1849 to 1856, Bernard's experiments with the pancreas juices established their importance by proving that they split fats, change sugar into starch, and break down proteins. He also established a relationship between animal glycogen and diabetes. This discovery made him a pioneer in endocrinology. Previous to his experiments all the secretions of the pancreas gland were considered to be gastric juices.

The discovery made by Bayless and Sterling in 1902 that the pancreatic gland was stimulated into releasing its juices by a hormone called secretin brought to light the true functions of the gland. These men discovered that the hormone secretin was secreted by the mucosa lining of the stomach and duodenum of the intestine and that the hormone stimulated the

12 Arthuro Castriglion, A History of Medicine, p. 683.
pancreas into releasing insulin. Thus, when food is eaten, the mucosa linings of the duodenum and stomach are aroused into releasing the hormone secretin into the blood stream. The blood carries the hormone to the pancreas, which is stimulated into releasing its juices. Morphologically the pancreas gland is a pink, tongue-shaped gland three or four inches long and is located just above and in front of the first lumbar vertebra. It is composed of fibrous tissues, and in between the tissue are cells called islets of Langerhans which are the source of insulin.

Mucosa

The mucosa lining of the stomach and intestine is known to secrete hormones into the blood stream. The first men to discover the mucosa and its internal secretions were Bayless and Starling in 1902. They established beyond reasonable doubt that the mucosa lining of the upper portion of the small intestine, called the duodenum, secreted the hormone called secretin into the blood. In recent years two more hormones have been found to be secreted by the mucosa; they are cholecystokinin, by the duodenum, and gastrin, by the stomach.

13Ibid., p. 940.
16G. A. Baitsel, Human Biology, p. 118.
Adrenal Glands

The triangular-shaped adrenal glands are located on the top of each kidney, and for study they are divided into two portions—cortex and medulla. The cortex is the outer surface and is divided into three zones of cells. The medulla is the brownish-red central portion and is composed of networks made up of strands and cells which vary in form but are usually elongated and arranged perpendicular to the walls of the sinus. The importance of the adrenals is suggested by their blood supply. They have the richest blood supply of any organ of the body. It has been estimated that six times their weight in blood passes through them each minute, and their weight is slightly more than one-third ounce. The glands are yellow in color and are approximately the size of a man's thumb. It has been established that the cortex of the gland is necessary for life, whereas the medulla is not.

Bartolomeo Eustacchio, who lived from 1520 to 1574, was the first person to discover the adrenal glands. Brown-Sequard's experiments in 1856 showed that removal of the gland caused death in a short time. He could not explain, however, the reason for death, and the true function of the

17Hoskins, op. cit., pp. 33-36.
18Baitsel, op. cit., p. 127.
glands in the existence of man remained a mystery until years later.20

Ovaries

The ovaries in woman are bean-shaped organs and are approximately an inch and a half long and an inch wide; they are located beneath the fallopian tubes in the upper half of the pelvis. Each ovary is made up of a cortical portion consisting of supporting connecting tissue that houses the follicles in which the egg develops. Within the cortex is the inner portion of medulla. It is composed of connective tissue, capillaries, blood vessels, strands of smooth muscle, and elastic tissue fibers.21 From 1899 to 1902 experiments were conducted by Glass, Morris, Marshall, and Jolly that proved the ovaries established sexual desires, menstruation cycles, and a general sense of well-being. By 1906, Lane-Claypon and Staring’s experiments on animals related the changes of pregnancy and lactation to an ovarian internal secretion. Two years later the studies of Tandler and Groz concerning castration of both sexes indicated that the sex glands not only were responsible for reproduction, but also functioned in determining the secondary sex characteristics, statural proportions, distribution of hair and fat, and mentality.22

Testes

Developments during the eighteenth century intimated that the testes of the male were organs of internal secretions. Bordeaux compared the castrated and spayed animals and contended that the changes which occurred were due to deficiency of gonadal secretions. Berthold's experiments in 1849 concerning the transplanting of testicles of fowls produced the first scientific evidence advanced which indicated internal secretions of the testes. Berthold proved beyond reasonable doubt that the testicles of the cock controlled masculine characteristics.23

Structurally the testes are paired, elongated, ovid structures that are slightly thicker in one transverse diameter than in another. They vary in size but are usually about as large as a small hen's egg. They are contained in an extension of the body called a scrotum. The inner portion of the organ is divided into a number of compartments. In each division there is a testicular lobule. The number of testicular lobules varies in man, although they usually number two hundred fifty to four hundred. The lobules are composed of minute seminiferous tubules in which the sperm cells are made.24

In view of the information projected in this chapter, one can readily understand that the information accessible

for use today was attained through years of experiments and hypotheses that were proposed by men who tried to understand the physical and psychic development of man. In the next two chapters the known effects of the endocrine glands on the physical and mental development of anthropology will be presented.
CHAPTER III

GENERAL PHYSIOLOGY OF THE ENDOCRINE GLANDS

The endocrine glands, through all of their secretions, contribute significantly to the unity of the organism in the growth period of youth and in the following period of general cessation of growth. The hormones secreted by the ductless glands correlate the many parts of the body; thus, they tend to establish an equilibrium of activity and function throughout the entire organism. The glands of internal secretion contribute to both soma and psychic areas of development. In this portion of the study the writer has chosen to present a brief study of the bodily functions of the endocrine glands and the physical characteristics that they determine in anthropology. One should not try unduly to separate the soma and psychic functions of the organs of internal secretion; for simplicity, however, the psychic area of endocrinology will be treated in Chapter IV.

Hypophysis

One of the first glands that attracts attention in the study of endocrinology and the physical characteristics of man is the hypophysis. The functions of the various parts of the hypophyseal are related to many of man's physical characteristics. The hypophysis is undoubtedly highly
important in the glandular system and in the control and regulation of the entire body. The hypophysis has a pronounced influence upon the adrenals, the gonads, the thyroid, and the placenta when it is present.

The influence exerted by the pituitary gland is felt in many ways, such as the growth of the skeleton and muscular systems, the development of the sex organs, the metabolism of food energy, and the control of blood pressure. The anterior lobe of the gland is called the glandular portion, and the posterior lobe is called the nervous portion. The anterior lobe secretes, primarily, the growth hormone pituitrinum. The disorders of the pituitary gland may be divided into three periods—pre-adolescent, adolescent, and post-adolescent.

If a disorder of the anterior hypophysis occurs in the pre-adolescent and adolescent stages of development, a number of abnormalities may result. When the anterior lobe is underactive, the growth and development of the individual are impaired, and in certain cases dwarfism may result. The retardation of growth may take different forms. In some patients the upper half of the body will outgrow the lower half; thus, the individual will have a long body and arms and short legs. The exact reverse occurs when the legs grow and become long and the body remains short. The pituitary

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1Lawrence H. Mayers and Arthur D. Welton, What We Are and Why, pp. 57-63.
Fig. 2.—Pituitary control of the body

2Jennie Gregory, ABC of the Endocrines, p. 17.
arresting of growth may undergo spurts and remissions, and growth may continue until the thirtieth year. Any portion of the body may be affected, and the retarding of growth is divided into two portions—proportional and disproportional.

The proportional retarding of growth occurs when the individual remains normal as far as the relationship of the body to the extremities is concerned, and the disproportional retarding of growth may cause the body or extremities to be abnormal in relationship to each other.\(^3\) The under-active anterior hypophysis often causes derangement of metabolism by its affect on the thyroid gland. The retarding of the thyroid will cause less food energy to be burned in basal metabolism, and the individual will become slow, sluggish, and adipose tissue will be deposited throughout the body. The retarding effect of the hypophysis on the gonads will cause under-development of the sex organs and the secondary sex characteristics. The adrenals will protest the under-active pituitary by secreting less adrenalin, thereby causing loss of capillary tone, loss of blood pressure, loss of strength, and derangement of metabolism. One should keep in mind that an individual with a hypopituitary condition may exhibit one or all of these symptoms.\(^4\)

If the anterior hypophysis is over-active in the pre-adolescent and adolescent stages of development, a general

\(^3\)Hans Curschmann, *Endocrine Disorders*, pp. 65-105.

\(^4\)Hoskins, *op. cit.*, pp. 131-140.
over-growth of the body will result, and in extreme cases gigantism will prevail. The sudden acceleration of growth is most frequent in boys at puberty. Their lower extremities suddenly begin to grow more rapidly than their body. If the growth process stimulated by the anterior hypophysis continues and the adolescent becomes abnormally tall, the condition of gigantism may result. The growth pattern in gigantism will usually continue until the twentieth year, and in some cases the growth may continue beyond the twenty-fifth year. In the last portion of the growth process connected with gigantism, the ends of the extremities and other parts of the body become conspicuously large.  

Because the anterior lobe has so much influence on growth and development, it is not surprising to find a difference between the adolescent and the post-adolescent functions of the gland. During the pre-adolescent and adolescent stages of development, an over-active anterior hypophysis will lead to over-growth and gigantism; an under-active anterior hypophysis will lead to under-growth and dwarfism. In the post-adolescent stage the body developments are complete and stationary; thus, general over-growth of the body is not possible as a result of over-activity of the lobe. However, the condition of acromegaly is produced when the hypophysis continues to flood the body with growth, producing hormones

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5Weil, op. cit., pp. 149-153.
after the growth of the body has been stationary for a period of time. Acromegaly is a rare condition, and it makes itself known by gradual increases in the size of the head, the features of the face, and the extremities.

The internal organs of the body are also sometimes affected, and a tumor of the pituitary gland is usually present. The tumor has many complications, because the pituitary gland is housed in a bony enclosure; therefore, any swelling on the gland will cause the entire region to be subjected to pressure, and the pressure built up in the bony cavity has far-reaching effects. The tumor often causes brain symptoms such as disturbance of vision, headaches, vomiting, and finally psychic regression. In the majority of sufferers, the hands, feet, facial features, and tongue usually hypertrophy first. While the physical characteristics are being altered, other changes are taking place internally. The general ability of an individual is lowered; this change is caused by deposits of adipose tissue and deranged metabolism. The person suffering from hypertrophying of the anterior lobe is ordinarily tall. The nose, chin, and lower lip usually increase in size. The person may have one or all of these symptoms. Changes in the hands and feet are frequently noticed. The hands become huge and resemble soft-padded paws. The length, width, and thickness of the hand increase in a disproportionate manner. The feet behave in a similar manner, although the toes may become especially grotesque. The hypertrophy
of the hands and feet is made even more apparent by the fact that the arms and legs remain normal. Thus, in a brief physiological study of the hypophysis one can perceive that many of man's soma characteristics are governed by a small gland, located in the center of the head, that is no larger than a pea.

Pineal Body

The pineal gland is considered to be the most baffling of all the endocrine glands. Little is known of its functions in the body; it is believed, however, that the gland plays an important role in regulating the rate of body development of the pre-adolescent, and it may delay puberty. The gland is larger in children than in adults, and it begins to decrease in size at about the seventh year. The position of the gland in the head has had much to do with the mystery of its functions.

A tumor of the pineal gland in children has been associated with acceleration of intelligence, body growth, and sexual functions. In one case of pineal tumor, a lad of six years had the mental age of seventeen years. It is not known whether or not the acceleration of these bodily and mental achievements can be attributed wholly to the pineal.


7 Mayers and Welton, op. cit., pp. 64-65.

8 Weil, op. cit.; p. 249.
body. The many difficulties in an operation may explain the lack of sufficient evidence to determine the exact function of the gland.\(^9\)

Tumors of the pineal gland have been observed to promote puberty, thereby causing an acceleration of such organs and characteristics as penis, testes, prostate gland, growth of hair, and facial expressions. The dimensions of the body also hypertrophy along with the sex organs, and the voice becomes deep and coarse. The hands and feet grow at a rapid rate; the skin becomes coarse, and a more adult characteristic is attained. A number of other symptoms of increased cerebral pressure, such as headache, vomiting, slowness of pulse, and impaired vision, usually accompany the tumor in its later stage.\(^10\)

In a summary of the pineal body it may be said that the functions of the gland are to aid in the delaying of development. The gland is larger in children, and it does suffer regression; therefore, it can be simply stated that the gland appears to keep the individual from developing too fast in the early years of life. Then when its job is done, it begins to become less active, and the growth and development of the individual will accelerate.

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\(^9\)Ibid., pp. 249-250.

Thyroid Gland

The portion of glandular tissue located on each side of the trachea (wind pipe) is called the thyroid gland. The main function of the gland is to produce an iodine-containing material called thyroxine. The purpose of the hormone thyroxine is to regulate the oxidation of food energy; thus, the thyroid gland and its hormone thyroxine regulate the general level of body metabolism. The thyroid also has many implications with the other endocrine glands. The derangement of the thyroid will affect all of the endocrine glands and particularly the pituitary, the gonads, and the adrenals. In return the mal-functioning of the other endocrine glands will affect the thyroid; the hypophysis, the adrenals, and the gonads have the most influence. The thyroid hormone is produced synthetically, and it is in common use today. The gland itself may be diseased, and it often demands attention. In most cases it will simply provide an under- or over-supply of thyroxine. In either case this hormone can cause serious trouble.\textsuperscript{11}

The over-secretion of the hormone thyroxine will cause an increase in the metabolism of food energy in the cells of the body. The body condition which results from this over-secretion of thyroxine is called hyperthyroidism; it is characterized by increased heart beat and high body temperature;

\textsuperscript{11}Mayers and Welton, \textit{op. cit.}, pp. 65-69.
Fig. 3.—Relationship of the thyroid to the other endocrine glands.\textsuperscript{12}

\textsuperscript{12} Gregory, \textit{op. cit.}, p. 52.
in general, all body activities are speeded up. Other characteristics of an individual suffering from hyperthyroidism are bulging eyes, hypertension of the nervous system, and loss of weight and thinness. The individual will be a very energetic person, and at times he may be very irritable. The cure of hyperthyroidism may be affected by surgical removal of part of the gland, thus cutting down on the active secretion of throxine.

The under-active thyroid gland (hypothyroidism) will cause the chemical processes of the body to proceed sluggishly. The result will be decreased metabolism and decreased heart beat; in general, all body activities will be retarded or slowed down. The glandular, muscular, and mental functions are impaired, and the body temperature is lowered.  

A person suffering from hypothyroidism is characteristically slow, sluggish, over weight, and he is usually thought of by his associates as being lazy. However, when one examines the hypothyroid condition, he finds that the individual may be a victim of things that are not his own doing. Previously mentioned was the fact that hypothyroidism resulted in a marked decrease in metabolism of food energy. If the individual continues to eat a normal diet, he will undoubtedly become fat, because when the food intake remains the same and the intake of fats and carbohydrates is no longer

13Ibid.
utilized, the adipose tissue will begin to form throughout the body. If the carbohydrates and fats are not utilized, they are deposited in the subcutaneous tissue as fats. The administration of thyroid preparation will cause the accumulated fat of the subcutaneous tissue to disappear or to be used as food energy. If a thyroid extract is not injected soon, the fat will invade the muscle tissue; the muscle will tend to degenerate, and the sluggishness will become even more apparent.\textsuperscript{14}

In a brief synopsis of the thyroid gland one could safely imply that the function of the gland is to regulate the general level of body activity, and in regulating the metabolic process, the thyroid has many implications in the physiological processes of growth and development.

Parathyroid Glands

The parathyroid glands, located on the lobes of the thyroid, share with vitamin "D" in controlling the calcium and phosphorus content of the blood. Calcium is extremely important in many physiological processes, such as clotting of blood, formation and growth of the skeleton or bony portions of the body, and in the maintenance of muscular tone. The deficiency of the parathyroid glands is characterized by overexcitability of the nervous system and delay in healing of bones; in the young, the growth of the skeleton is retarded.\textsuperscript{15}

\textsuperscript{14} Weil, op. cit., pp. 80-95.  \textsuperscript{15} Guyer, op. cit., p. 362.
The mild form of parathyroid deficiency is most important because it is most frequently encountered. The mild form of a parathyroid deficiency will be characterized by fatigue, slowness of growth, and behavior disorders. Any one of these characteristics has many implications in the physical development of the individual, because they are all connected with the metabolic process. The extreme condition of fatigue and the irritability of behavior usually cause the individual to lose weight, and very little subcutaneous adipose tissue is found; thus, the joints of the person will tend to protrude. The slowness of growth is caused by the sluggish metabolic process which results from the low calcium content of the blood.\(^{16}\)

The primary function of the parathyroid glands was discovered when these glands were removed with the thyroid. Patients who had the parathyroids removed developed a spasmodic ailment called tetany. It was also discovered that the calcium content of the blood was low in the patients who suffered from tetany. Collip prepared an extract from parathyroids which prevents tetany in parathyroidectomized animals when it is administered with calcium. Thus, it is assumed that the parathyroid glands control the calcium content of the blood and tissue.

The symptoms of an acute parathyroid deficiency are similar in nature. The onset of the spasmodic ailment is

\(^{16}\)Walter Timme, Lectures on Endocrinology, pp. 55-64.
exhibited by pains and tingling in the hands and feet. Then a tonic spasm usually occurs suddenly, primarily in the flexors and adductors of the arms and legs. The hands become claw-like in appearance and the feet, equine. The muscles of the elbows, shoulders, knees, and hips are usually involved in the spasm; the muscles of the trunk and neck, however, are not usually affected. Occasionally the spasm attacks the tongue and eye muscles. The attack may continue for minutes or for days. Other symptoms, such as swollen face, falling hair, and nail changes, may indicate an associate hypothyrosis. Another symptom of defective parathyroid glands is the cataract. In the young child, cataracts usually are nuclear, without cortical changes. Cataracts have been formed in parathyroidectomized rats to further establish the relationship of tetany to cataracts.

The disease tetany is often inherited; if it is not directly inherited as a condition of the family, nervous symptoms caused by a low calcium content of the blood and tissue will usually be displayed. When the condition occurs in the young, the muscles of the face, trunk of the body, respiratory system, and heart may be included in the spasmodic attack. The breathing in most cases is laborious, and there are always conditions of anxiety, unrest, and disturbance of consciousness displayed by the patient. The attacks of the spasm often follow eating and psychic conditions such as
anger, fear, and sudden awakening of the individual suffering from this disease.\(^{17}\)

In conclusion, the fundamental function of the parathyroid glands is to control the calcium content of the blood, and in doing so the glands exert a powerful influence upon the physical and behavior developments of man.

**Adrenal Glands**

The adrenal glands are made up of two portions—the cortex and the medulla. The two portions of the gland appear to have no direct relationship as to function; thus, for study, the two portions are viewed separately. In studying the gland, perhaps the first observation should be the ratio of size between the portions. The medulla is nine times the size of the cortex. In lower animals the cortex is found in an even smaller ratio.

The cortex arises embryologically from the same source as the gonads. The diseases of the adrenal cortex have many curious and baffling characteristics. If the cortex of the female is diseased, the result is a male distribution of pubic hair. The growth of a hairy chest, the growth of a mustache, and the growth of a beard make the female discontent and miserable. The secretion of the cortex also appears to have depressive effects on the medulla; thus, a fall in blood pressure will prevail, because the medulla produces and

\(^{17}\)Curschmann, *op. cit.*, pp. 50-63.
secretes hormones which influence the blood pressure. The disturbance of the suprarenal cortex also may result in abnormal deposits of pigments of the skin.\textsuperscript{18}

In the last few years two new hormones associated with the adrenal cortex have been discovered. The first one is the adrenocorticotrophic hormone of the hypophysis. This hormone is secreted by the pituitary gland, and it will stimulate the adrenal cortex into releasing one of its hormones named cortisone. Cortisone has been found to be the initiator in the rebuilding of severely-damaged tissue; in general it tends to aid in the combating of many present-day ailments and infections. The presence of cortisone in the blood appears to accelerate the production of new cells. If a large amount of tissue has been damaged in a victim's body, the injection of cortisone into the blood stream will accelerate the building of new tissue.\textsuperscript{19}

The medulla of the suprarenal is one of the best known and, perhaps, the most understood of the endocrine glands. The hormone of the medulla is adrenalin, which was the first active principle to be isolated from the endocrine system. The medulla and the secretion of adrenalin provide man with extra strength for life preservation. The medulla has been found unnecessary for life, whereas the removal of the cortex

\textsuperscript{18}Timme, op. cit., pp. 84-88.

\textsuperscript{19}John E. Pfeiffer, "How Hormone Team Is Saving Lives," Popular Science, CLVIII (June, 1951), 97-100.
will bring death in a short time. The hormone of the medulla has a number of dynamic functions. When the medulla is stimulated by the nervous system into releasing its hormone adrenalin, a number of changes take place in the body. The blood pressure is increased in general by the contraction of the blood vessels on the surface of the skin and in the body; furthermore, the activity of the heart is increased. Thus, more blood is made available to carry the extra energy and oxygen to the muscles and to remove the waste.

Adrenalin also stimulates the liver, and it releases a stored amount of sugar into the blood for extra energy. The spleen will contract and force any stored red corpuscles out into the blood stream to facilitate the food- and oxygen-carrying capacity of the blood. The connection between the psychic and soma is made by the sympathetic nervous system; thus, the mind and body are made ready to work or fight for survival. The providing of extra strength for life preservation is not the only function of the medulla. The hormone adrenalin is an important factor in the controlling of blood pressure and body temperature. The adrenal gland appears to work specifically in conjunction with the thyroid, the hypophysis, and the gonads.

An over-secretion of adrenalin will cause such symptoms as poor resistance to disease, rapid pulse, flushed skin, large eye pupils, heightened temperature and blood pressure, and a lessening of all secretions in general. Such an
Individual with an over-active suprarenal will be a very dynamic, active, optimistic person, and he is easily excited. One suffering from a hyperadrenal condition may resemble a person with an over-active thyroid.20

**Thymus Gland**

The ductless gland found behind the upper portion of the sternum is called the thymus. Normally it increases in size from birth to just before puberty. The gland begins to regress in size and function at about the age of ten. The functions of the thymus are rather obscure; it is believed, however, that it is an important factor in mineral metabolism; thus, it has implications in the over-all growth and development of the pre-adolescent. The functions of the thymus gland in regard to the genital development and blood formation are not fully understood. Authorities have associated the thymus with the lymphatic system, and they imply that the gland must have implications in the fighting of bacterial infections, such as colds, sore throats, and tonsillitis. The children who suffer from enlarged thymus display signs of these infections, and they do not develop very readily.21

Timme presented a more exact explanation of the functions of the thymus gland than any of the other investigators.

20 Timme, *op. cit.*, pp. 84-100.
when he said:

... it is perhaps fair at this stage to assume that under the influence of the thymus gland—the other glands of internal secretion being normal—the body takes on growth and accretion and that certain inhibitions, chiefly in the direction of the gonads, are at the same time operative.22

If this is true, then derangements of the thymus should be accompanied by signs of disturbances in body growth and in sex development. Timme proposes that the effects of the thymus gland may take two paths—a thymus gland that remains active too long and a thymus gland that does not remain active long enough. One who has a thymus gland that remains active too long will have such physical characteristics as soft and smooth texture of skin, no mustache or beard in the male, lack of pubic hair, teeth that are not uniform in size and placement, weak joints, and under-developed genital apparatus. The thymus conditions are accompanied by subnormal temperature, low blood pressure, slow pulse, and fatigue.

In contrast to the thymus state just discussed, there is the early retarding of the thymus. In this situation a rapid differentiation of sex is attained, and the "old-young" type is produced. The individuals in this group show lack of growth in stature, early ossification of the bones, early development of the teeth, early growth of secondary hair, and early development of the sexual apparatus.23

22Timme, op. cit., p. 7.

23Ibid., pp. 4-20.
Ovaries

The basic function of the ovary is to produce and house the germ cells which insure the preservation of the race; scarcely less important is its secretion as a ductless gland. The function of the ovary as a ductless gland is of major importance in physical development and maturation and in the founding of normal psychic behavior. The secretions of the ovary have been identified with the growth and development of the mammary glands and the uterus, with the placement of fat, with the development of the bone structure of the pelvic region, and with many other of the feminine characteristics.

The major portion of the information available about the ovary was obtained from experiments on animals. The removal of the ovary in the immature may cause such characteristics as the building of adipose tissue in an abnormal manner, the over-growth of the long bones, the depression of the sex instinct, and the fall of basal metabolism. The influence of the ovary on the other endocrine glands is not fully understood; it is reasoned, however, that the ovary retards the effect of the hormones of the anterior hypophysis; thus, when the growth-retarding hormones of the ovary are removed, the growth-producing substances of the anterior hypophysis will cause over-growth and over-development. The thyroid and the adrenal glands are also undoubtedly affected by the ovarian secretions because of the derangement of metabolism following
removal of the glands. The ovary is responsible for the many bodily changes that occur in the sex life of women. The menstrual period is undoubtedly influenced, if not controlled entirely, by the ovary. Perhaps special attention should be given to this period and its implications. The excitability at menstrual periods is due in part to the increased activity of the thyroid and a change of metabolic action. The menstrual blood contains a large amount of calcium; therefore, the individual may exhibit signs of one who has a low calcium content of the blood. If calcium is administered a few days before the menses occur, much of the excitability, nervousness, and pelvic distress of the female may be obviated.

The hormone adrenalin also has implications at this point, because if the blood pressure is low and the body is not prepared to meet the onset of the menstrual period, intense weakness, astheria, and collapse may be the outcome. Adrenalin will accelerate the activity of the heart and cause many blood vessels to contract, thereby attempting to keep the blood pressure normal. Some authorities also maintain that the headaches that often accompany the menses are caused by the effect of the ovaries on the hypophysis.

The ovary is also responsible for the increased affection of the female for the opposite sex at the time of mating.

24A. S. Parkes, The Internal Secretions of the Ovary, pp. 70-81.

When the egg is released, the cells of the ruptured follicle secrete a hormone into the blood which increases the female's affection for the opposite sex.\textsuperscript{26} Thus, mating in animals will occur at the proper time for fertilization of the egg.

**Testes**

The male sex glands, the testes, like the ovaries, perform a double task. Their primary purpose, of course, is to produce the male germ cells. The primary function of producing and storing spermatozoa is by no means the only function of the testes. The glands appear to work with the hypophysis, the thyroid, the adrenals, and the other endocrine glands in controlling many soma and psychic characteristics of the male. The majority of information has been gathered from experiments on animals which were castrated. If a male is castrated before puberty, the accessory sex organs and secondary sex characteristics fail to develop; the body growth appears to accelerate; the bones become long and more fragile, and the muscles become less developed, with adipose tissue forming within the muscle. There is also a change of psychic behavior, and the sex urge is depressed. The hormones of the testes have a great influence on the other ductless glands, and if the testes are removed or are under-active, the thymus, the pituitary, the adrenal, and the other endocrine glands are affected. The testes appear to secrete a

\textsuperscript{26} Arthur Grollman, *Essentials of Endocrinology*, pp. 517-518.
growth-retarding hormone, much like the ovaries. In the case of removal of the testes or of under-active testes, the growth-retarding hormones will be removed, and the growth-producing hormones of the hypophysis will cause over-growth and over-development. The mal-functioning of the testes shows no relationship to metabolism in some experiments; however, most authorities believe that they do share with the pituitary, the adrenals, and the thyroid in controlling the metabolism of food energy.  

The testes are influenced in return by the thyroid, the hypophysis, and the adrenals. The thyroid appears to affect the gonads in their development and activity. In some cases the thyroid has been found to be the source of mal-functioning in a hypogonad condition. The anterior lobe of the hypophysis tends to be the dominant controlling factor implicated with the gonads. When the gonad stimulating hormones of the hypophysis are hypo-active, the germ cells in the testes fail to develop, and the genital organs begin to regress. A lessening of the sexual impulse has also been observed. The cases of under-activity of the adrenals appear to have much the same effect as the hypothyroid condition. A deficiency of the adrenals may cause failure in the production of germ cells and a change in psychic behavior.

The testes are also charged with the responsibility for the far-reaching changes that occur at puberty. The child

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27 Ibid., pp. 465-470.
before puberty is usually sexually neutral. The testes establish the many sex characteristics, such as the tone of voice, the growth of beard and hair, the psychic attitude toward the opposite sex and life, and the vigor of life itself.\textsuperscript{28}

In this chapter the general physiology of the endocrine glands and the physical characteristics they establish in man have been presented. The functions and interrelationships of the endocrine glands have many curious and baffling effects on man and his physical characteristics. Many of the present known implications of the endocrine glands in connection with man's physical development have been projected in this chapter with the intention of placing before the reader the evidence that people are many things that are not of their own doing. In the next chapter the psychic area of the ductless glands will be adduced, and the personality traits that emerge as a result of the dominance of any one gland, as well as a combination of glands, will be presented.

\textsuperscript{28}\textit{Hoskins, op. cit.}, pp. 201-226.
CHAPTER IV

PERSONALITY TRAITS ESTABLISHED IN MAN

BY THE ENDOCRINE GLANDS

This chapter treats the personality and behavior traits that the endocrine glands tend to establish in man. The data are gathered in an effort to enable the reader to visualize that many things previously attributed wholly to the mind now have a more acceptable explanation in endocrinology. Increasing daily is the realization that a full and healthy life is to a large extent due to the glands of internal secretion. One's personality is not determined wholly by the glands of internal secretion, but the personality of an individual is in direct cooperation with the ductless glands. In the following pages of this chapter the personality traits which emerge as a result of the dominance of any one gland, as well as a combination of glands, will be outlined, and it is hoped that the reader will attain a better view of personality physiology of the endocrine glands.

Thyroid Gland

The thyroid gland is perhaps the most important gland in the building of personality. Already mentioned is the fact that the thyroid secretes the hormone throxine, which is very important in the metabolic process. If this gland
is under-active and the condition of hypothyroidism prevails, the individual may be slow and sluggish, with little energy or initiative. He is characteristically sluggish in every thought and action. The derangement of metabolism causes deposits of adipose tissue to invade the muscles as well as the entire body. The fatty tissue further hampers the actions of the individual, and with an increase in size, extra work will be brought to bear on the circulatory system. In the cases of hypothyroidism the blood pressure and body temperature are lowered; in general, one may say that a hypothyroid condition tends to produce a person who is drowsy, unconcerned, disinterested, and such an individual is usually classified as being lazy. The hypothyroid individual shows no desire to participate in work or play, and he had much rather be left to rest and daydream.¹

The hyperthyroid individual usually exhibits personality and behavior patterns exactly opposite to those of the hypothyroid individual. The over-active thyroid and the over-secretion of throxine tend to cause one to be very excitable and dynamic. The increased basal metabolism causes the individual to be thin, and the body temperature and heart action are high. One suffering from hyperthyroidism is often mentally irritable, unreasonable, and unduly emotional. Such an individual may be compared with a machine that is set to

run at high speed; he uses his fuel fast, and the machinery of the body tends to wear out. Thus, the over-active thyroid may produce pre-mature old age. The restless, dynamic, and energetic individual, who is often called the "live-wire," is the one who learns easily and usually surprises the adults with his ability to acquire knowledge. Society often has a problem with this type of person, because the hyperthyroid individual has a difficult time in understanding why normal people become tired or fatigued. Thus, as a result of an over-active thyroid gland, a person may be easily excitable, under-weight, energetic, irritable, brilliant, and a perpetual doer and worker.2

Pineal Body

The pineal gland, located near the hypophysis, apparently primarily controls the sex and mental developments of the pre-adolescent. As has been previously mentioned, because of the gland's location in the head, little is actually known of its physiology; in recent years, however, typical abnormalities that can be attributed to the pineal body have been established. A typical example of one suffering from a pineal abnormality may be a boy of five years of age who has a burly figure, a low-pitched voice, a beard, and the sex organs of an adult. Behavior changes accompany the precocity of the sex organs, and characteristics of a

2Ibid., pp. 41-49.
more adult frame of mind may be exhibited. Acceleration of mental development has also been associated with the pineal gland. The child of six years may display the intelligence of a seventeen-year-old adolescent. In general it may be concluded that the purpose of the gland, as it is understood today, is to delay puberty. Thus, the secretions of the pineal gland simply act on the other glands of internal secretion to delay the appearance of adult characteristics until the age of adolescence.

Pituitary Gland

The hypophysis is referred to by Guyer as the leader of the "endocrine orchestra." When any gland is mal-functioning, it is wise always to consider its relationship to the pituitary. Investigations of the functions of the hypophysis have been difficult because of the inaccessible position of the hypophysis in the center of the head; it has been established, however, that it is an organ of vast importance. The gland is a controller and regulator of the entire endocrine system. The pituitary, together with the sex glands, appears to control much of man's behavior. It has been suggested that the hypophysis is the spring of activity, of energetic application, of interest, of the will to participate in action, and of the desire for great accomplishments.

Concerning the hypophysis, Mayers and Welton stated as follows:

These are the Babe Ruths, the Theodore Roosevelts, the Hills, the Harrimans, the pioneers, the pathfinders, whose ambition is without limits and who win their way to recognition whether success or failure accompanies it. No other gland approaches them for interest, for whatever sphere they act, they win notice and, not infrequently, deserve it.5

Truly, the hypophysis has many implications in the physical and personality development of the individual. The hypophysis has intimate relationships with the adrenals, with the thyroid, and with the gonads. Therefore, the hypophysis is often the very spring of life and activity. The many baffling and confusing behavior traits that may be betrayed, such as irritability, sluggishness, inability to concentrate, restlessness, fatigue, forgetfulness, and apathy, may be direct results of a pituitary syndrome.6

Parathyroid Glands

The parathyroid glands are located on the lobes of the thyroid. They are four in number, and each weighs about two grams. The primary function of these four minute glands is to control the calcium and phosphorous content of the blood. In controlling the calcium and phosphorous content of the blood, the parathyroid glands contribute both to the physical

5Mayers and Welton, op. cit., pp. 222-223.

and behavior traits of man. The calcium content of the blood and the metabolic action of the calcium undoubtedly have many implications in the behavior traits. The entire nervous system is thrown into a hyper-excitable condition when a low calcium content of the blood is present. The person with a low calcium content of the blood is irritable and is often very undesirable. Concerning this lack of calcium, E. V. McCollum, professor at Johns Hopkins University, made the following statement: "No one with a blood containing slightly too low a calcium content and markedly low phosphorous content has a wholesome attitude toward life."

The irritability, lack of agreeableness, and lack of sincerity and cooperation are important factors in determining the attitudes toward home, school, and other associates of an environment. The parathyroids are involved in building these factors, and they may influence other behavior traits by their implications in the building of teeth, bones, muscle tone, and normal body growth.

Adrenal Glands

The adrenal glands, located on the top of each kidney, consist of two portions—the cortex and the medulla. The cortex of the gland secretes primarily the hormone cortin which has its implications in the behavior traits of man. The

7Hoskins, op. cit., p. 114.
8Ibid., pp. 101-117.
hormones of the cortex are suspected of functioning with the nervous system, and they are implicated with fatigue, with weak heart action, and with low blood pressure. All of these symptoms establish behavior characteristics of their own; the symptoms may be removed by injections of cortin. Due to these functions of the cortex it may be said that the adrenal gland may cause such behavior traits as insomnia, irritability, irrationality, poor judgment, and uncooperativeness.9

Scientists who have been doing research in schizophrenia, one of the most common mental disorders, believe that the answer to the mental disorder lies in the realm of organic disease and not in psychopathic behavior. Some authorities have advanced the theory that the adrenal glands have implications in schizophrenic behavior. Their logic is that when a normal person undergoes stress, his adrenal gland secretes a flow of hormones into the blood stream that will enable him to meet life situations. The schizophrenic's reaction to stress is different from that of a normal person, because the schizophrenic is not provided with the vital flow of hormones from the adrenal gland; thus, he does not have the power, energy, or initiative to meet many life problems, and a mental disorder will result.10

9Ibid., pp. 49-63.

10"Abnormal Adrenals," Newsweek, XXXIX (February 4, 1952), 45.
The adrenal gland is also involved in the development of the sexual apparatus. When a deficiency of the adrenal glands occurs, one of the first signs resulting from this deficiency is a depressing of the sex drive. The cortex deficiencies may influence the entire sexual development and maturation of an individual. On the other hand, one can exhibit an over-active gonad because of the over-activity of the adrenal cortex, thus accelerating the development of masculine characteristics.

The medulla of the adrenal gland appears to be a potent factor in the controlling of blood pressure and capillary tone. The over-active medulla, with its secretion of adrenalin, will cause behavior traits such as excitability, nervousness, and vigorous activity.\textsuperscript{11} If the medulla is under-active, a drop in blood pressure may cause such behavior patterns as rapid fatigue and exhaustion, loss of muscle tone, lack of energy, and lack of interest.\textsuperscript{12}

\textbf{Thymus Gland}

The thymus gland may have many implications in the forming of a pattern of behavior. In general, those individuals whose thymus glands remain active after puberty are child-like in character and appearance. They normally are self-centered, simple in mental processes, and unfitted for many

\textsuperscript{11}Hoskins, \textit{op. cit.}, pp. 49-63.

\textsuperscript{12}Timm, \textit{op. cit.}, pp. 92-94.
of life's struggles. The child-like personality dominates the behavior of the individual, and he continues to look for protection and care. He usually has a negative and obstinate outlook on life and his environment. In spite of the fact that this gland may not function properly, oftentimes the other endocrine glands will compensate, and although many developmental factors may have been delayed, the individual finally reaches maturity and becomes a useful and intelligent person.13

When the thymus gland becomes inactive at an early age, the behavior pattern is altered considerably. The individual is sometimes easily angered and is often resentful. He appears advanced in years when he is actually young; he never appears to mature psychically and usually retains the unreasonable characteristics.14

Ovaries

The ovary, as an organ of internal secretion, has many effects on the personality of the female. During early life the differentiation of sex is determined for the most part by the sex chromosomes, and this factor appears to continue to control sex differentiation for a short time after birth. The young girl is neutral as far as sex is concerned; even in early life, however, characteristics begin to appear that

14Ib ., pp. 241-256.
imply that the ovary does have early functions as an endocrine gland. In particular, the pelvis begins to take a shape much like that of the "winged" pelvis of the adult female. Many observers believe that the young female has an early differentiation of temperament; this may arise, however, through social conditioning.

When puberty arrives in the young female, the ovaries take on a more definite role in the establishment of personality patterns. Most of the information available concerning this was gathered from experiments on animals. In addition to reproductive functions, it has been found that two hormones are secreted primarily by the ovary. These two hormones aid in the regulation of growth, in the establishment and maintenance of the menstrual cycle, in establishing the necessary changes of pregnancy, and in the development of a normal psychic attitude toward life and the other sex.

If the ovary is under-active in the pre-adolescent stage of development, the individual will grow taller, because the hormones of the ovaries retard the growth-producing substances of the anterior hypophysis. Removal of the ovary in the pre-adolescent stage of development will result in abnormal tallness, undeveloped sexual organs and sex characteristics, and an absence of the menstrual cycle. The reproductive instincts are also absent. The true psychological

changes which result from the removal or hypo-condition of the ovaries are exhibited by irritability, resentment, self-pity, and a critical and hostile attitude toward the environment. Experiments have shown that the ovary is a factor in the metabolic process; the ovary is important in the regulation of body activity and in the building of strength.\textsuperscript{16}

Testes

The major function of the testes is to produce and house the spermatozoan germ cell; like the ovary of the female, however, the testes exert a powerful influence on the behavior patterns of man. The physical and emotional characteristics of castrated animals have been observed for years by cattlemen. The cattlemen observed that castration caused the animals to grow larger and to gain weight, but they also noticed that behavior traits of the animals changed along with the metabolic processes. Removal or under-activity of the testes of man before puberty prevents the development of mature psychic attitudes, and the individual remains neutral in his sex development. He shows strong feelings of inferiority, mental depression, moodiness, and a sense of failure. With the removal of the growth-retarding hormones of the testes, the individual accelerates in growth. The effect of the testes upon the thyroid gland causes derangement of metabolism, and fat is deposited throughout the body, especially around the

\textsuperscript{16}Ibid.
hips and breast. The decline of the activity level becomes extremely noticeable because of the change in basal metabolism.

Thus, the person with a hypogonadal condition becomes slow and sluggish, with little energy. The normal aggressiveness fails to develop, and the hypogonadal condition causes an inactive social life because of the influence of the testes on the psychic area of development. The person who has a hypogonadal condition often feels that he is not like other people; he feels that others despise or pity him because of his plight.\textsuperscript{17}

In a study of the testes and their influence in the forming of a pattern of behavior, it should be remembered that the hypophysis, the pineal body, and the adrenal glands can cause the acceleration or inhibition of sexual development by their influence on the gonads.

In Chapter IV the personality traits established in man by the endocrine glands have been presented. Man's attitude toward life and his environment, his initiative, his interest, his judgment, his excitability, his activity level, his irritability, his ability to concentrate, his ability to meet the emergencies of life, and his will to participate with other associates of an environment are controlled by the ductless glands.

\textsuperscript{17}Laurence E. Cole, \textit{General Psychology}, pp. 156-157.
CHAPTER V

EFFECT OF THE ENDOCRINE GLANDS ON THE ABILITY OF THE STUDENTS TO PARTICIPATE IN AN EDUCATIONAL PROGRAM, WITH SPECIAL EMPHASIS ON INDUSTRIAL ARTS

The purpose of this chapter is twofold: to summarize briefly the information already presented about the endocrine glands and to show how these ductless glands affect an individual's ability to participate in a program of education, with special emphasis on industrial arts.

The glands of internal secretion have many implications in the ability of man to perform everyday tasks and to participate with other associates of an environment. In this chapter the information will be presented in a manner that will show the effects that the functions of the endocrine glands, mainly regulation of metabolism, regulation of physical growth and development, and regulation of mental development, have on an adolescent's ability to participate satisfactorily in an educational program.

Metabolism

Metabolism, which is present in all forms of life, may be defined as the sum total of chemical changes which occur in the tissues of the body. Metabolism is controlled by
physiological coordination of various agents in the body; hormones, vitamins, and enzymes are classified chiefly as such agents.\textsuperscript{1} In man there are six ductless glands which contribute significantly to the metabolic action. The hypophysis, the gonads, the thyroid, the adrenals, the pancreas, and the parathyroids all share in controlling the metabolism of food energy. In sharing with each other the control of metabolism, they all contribute to the activity of the organism.\textsuperscript{2}

The metabolism of food energy has implications concerning the ability of a student to participate in an educational program. The vitality of life, the interest in life, the initiative of life, the sex instinct of life, and the growth of life cannot be fully attained without the cooperation and aid of the endocrine glands. The student of industrial arts is influenced by metabolism in his actions. The foresight with which he approaches the problem of planning and making a shop project is undoubtedly influenced and controlled by the metabolism of food energy. The vigor, interest, initiative, and utilization of tools and materials used in an educational program are affected by the influence of the endocrine glands on metabolism, and the insight and initiative that are shown toward new ideals and new projects are due, probably to a large extent, to metabolic action, because the

\textsuperscript{1}Gregory Pincus and Kenneth V. Thimann, \textit{The Hormones}, p. 315.

\textsuperscript{2}Gregory, \textit{op. cit.}, p. 99.
Sufficient data are not available to determine the full implications of the pineal and thymus glands.\(^5\)

Fig. 4.—The endocrine glands that are concerned with metabolism and growth and development.

\(^3\)Ibid., p. 99. \(^4\)Ibid., p. 95. \(^5\)Ibid., p. 90.
literature has shown that persons suffering from mal-functioning and deranged metabolism of the endocrine are usually classified as lazy, drowsy, and unconcerned individuals, but actually these individuals, who are classified as lazy, drowsy, and unconcerned, are influenced by things over which they have no control. Therefore, when a teacher recognizes a student who exhibits these characteristics, the teacher must realize that an individual is many things that are not of his own doing.

The skills that an individual develops are due not only to the visual activity level of the student but also to the growth part of metabolism called anabolism. Due to the actions of some of the endocrine glands, mainly the hypophysis, the anabolic process in certain portions of the body will often become greatly accelerated, and the individual will grow at a rapid rate. The rapid growth of the extremities and body can have serious effects on the individual's ability to manipulate tools and equipment, because there is usually a lack of muscular coordination. The large hands and feet and the long arms and legs, which often result from an acceleration of the anabolic process, can cause the growing adolescent to be awkward and slow in physical and mental activity. The growing adolescent boy is conscious of his long and clumsy limbs, and he is often self-conscious when he

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attacks a problem that requires muscle and mental coordination.

The metabolism of food energy is also directly connected with mental alertness; therefore, each individual differs with respect to the rate of learning and the amount of information that he can gather, as well as in the use and application of the knowledge gained. The mentally-alert individual usually has a slight hyperthyroid condition or an over-active adrenal medulla. Both of these conditions increase the activity of the organism and provide an opportunity for mental alertness to develop. The active and mentally-alert student is characteristically thin and tall or medium in height, and he becomes fatigued quicker than a person who is not as mentally alert. As a result, the assignment should not always be the same for each student. The teacher should not set specific standards of quality and quantity of work to be completed, because if the teacher sets the same specific goals for each member of the class to achieve, some individuals cannot meet the requirements set by the teacher. Frustration will be the result of the inability of the student to achieve the goals set by the teacher.

In summary, with respect to metabolism it may be said that the endocrine glands and their influence in the regulation of metabolism have a significant influence on the individual's ability to plan and to execute plans, to visualize the reshaping of raw materials into the finished products,
to operate various machines and tools, to assemble the pieces of the reshaped materials into the finished project, and to alter articles already constructed so that they will be more usable. In exerting influence on these activities, the endocrine glands affect the student in his ability to participate in an educational program.

Physical Characteristics and Development of the Adolescent

The rate of growth and development of the adolescent undoubtedly have intimate relationship with the individual's ability to meet many of life's situations. One of the most important endocrine glands concerned with growth is the hypophysis. The pituitary, together with its association with general activity, growth, and development, exerts the dominating influence on man's ability to perform work. The rate of growth connected with the metabolic process has much to do with the activity of the organism. When the individual is growing rapidly, the hypophysis is causing the anabolic process to accelerate; thus, the building up of the cells (anabolism) is exceeding the destructive portion of the metabolic process (catabolism), and growth is occurring. When the anabolic process exceeds the catabolic process, growth occurs; usually when the growth accelerates, however, the catabolic process that produces physical activity declines in function. Therefore, a decline in physical activity accompanies rapid growth, and an individual exhibits
sluggish mental and physical action, awkward movements, and an unconcerned attitude toward problems in his environment.

The pituitary gland exerts a pronounced influence on the adrenals and their control of capillary tone and blood pressure, on the gonads and their implications in sex development, growth, and metabolism, and on the thyroid and its direct relationship to metabolism. Each of these aspects, whether it be the hypophysis and its secretion of growth-producing hormones or the adrenals and their hormone adrenalin that causes vaso constriction and increased heart activity and blood pressure, has an influence on the rate of metabolism and the growth process. In this intimate relationship to metabolism the pituitary gland and the growth process exert influence on the quality of work, the amount of work, the interest, the initiative, and the desire to participate in a program of education, because a student who is suffering from a disturbance of growth due to the functions of the endocrine glands may exhibit such behavior traits as irritability, sluggishness, inability to concentrate, restlessness, fatigue, and forgetfulness. An educational program must, therefore, provide for these individual differences created by the growth process.

The teacher in an educational program can observe growth disturbances of students without too much difficulty. When

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7Mayers and Welton, op. cit., pp. 57-63.
observing the differences in the structure of students, such as one who is small in stature, has small extremities, and small facial features, the teacher as a professional person should have an understanding of the causes of these characteristics and the types of behavior traits that an individual of this physique may exhibit. The behavior of an individual who is small in stature may be affected by the gonads, because the gonads secrete growth-retarding hormones, and if growth is retarded by the gonads, the individual may exhibit signs of aggressiveness caused by the over-active gonads. This is often true of the small, burly, and aggressive individual. The exact reverse, however, may occur when undergrowth occurs which is caused by mal-functioning of the thyroid, parathyroids, and pituitary, and an individual in this category may be timid and withdrawn from the class.

In summing up the influence of the endocrine glands on the physical characteristics and their implications with respect to one's ability to perform tasks related to education, it may be said that it is difficult for one to satisfactorily participate in an educational program without the cooperation of the ductless glands, because an educational program involves physical activity, mental activity, coordination of mind and body, a combination of skills, and the sharing of experiences. All of the factors affect the actions and the work of the individual.
Mental Manifestations

The mental manifestations of the influence of the endocrine glands on a student in an educational program can be divided into four areas: mental growth, mental activity, nervousness and psychosis, and emotions. Six glands are primarily involved in the psychic area of endocrinology. They are the pituitary, the gonads, the thyroid, the parathyroids, the pancreas, and the adrenals. The functions of the pineal body and of the thymus gland are not completely known.

The glands involved in mental growth are the pituitary, the gonads, the thyroid, and the adrenals. It should be kept in mind that all of these glands are connected with metabolism and the activity of the organism; thus, they produce traits that are conducive to mental growth. If any one of these glands is malfunctioning, a serious threat to mental growth may result, and such persons usually exhibit traits of restlessness, fatigue, irritability, inability to concentrate, lack of enthusiasm, lack of motor skill ability, and lack of initiative in meeting many of life's situations.

In mental activity, Gregory has added the pancreas gland to the list of ductless glands concerned with mental manifestations; however, he implies that the adrenals have no function in mental activity. Other authorities state that the adrenals, together with their control of heart activity,

9Gregory, op. cit., p. 103.
Sufficient data are not available to determine the full implications of the pineal and thymus glands.\textsuperscript{11}

Fig. 5.—The endocrine glands that are implicated with mental growth, mental activity, nervousness and psychoses, and emotions.

\textsuperscript{10}\textit{Ibid.} \hspace{1cm} \textsuperscript{11}\textit{Ibid.}, p. 90.
capillary tone, and blood pressure, are implicated with mental activity.\textsuperscript{12}

The third area of mental manifestations usually involves nervousness and psychosis. All six of the ductless glands, the pituitary, the gonads, the thyroid, the adrenals, the pancreas, and the parathyroids, are involved in this area. An over- or under-secretion of hormones from any one of these glands may have serious effects on the behavior of the student. The nervous student may display signs of fatigue and irritability, and he may not stay with one task long. If this is true, then those persons planning a program of education should design a program that will provide a variety of educational activities in order that the individual may be allowed to choose and participate in those activities that are interesting to him. The interest, desires, needs, and abilities of the student change from time to time; the program of education, therefore, should provide educational experiences that will coincide with the changes of the individual.

The nervousness caused by the endocrine glands is directly connected with metabolism and the activity of the organism. Therefore, industrial arts which involves activity may provide opportunities for the nervous student to work with his hands and in this way to release the nervous tension

\textsuperscript{12}Timme, \textit{op. cit.}, pp. 97-99.
caused by metabolism by permitting him to do work of a cre-
ative nature.

In the fourth area of mental manifestations are the
emotions. The five glands, the pituitary, the gonads, the
thyroid, the adrenals, and the pancreas, are involved in
this area. Some authorities on endocrinology include the
parathyroid glands in this area. These glands, the pitui-
tary, the thyroid, the adrenals, the pancreas, and the para-
thyroids, influence man in his every action, and all contrib-
ute to man's initiative, to his interest, and to his attitude
toward life and the opposite sex. 13

The implications of the mental manifestations of the en-
docrine glands for the student of industrial arts are many.
The mental growth of the individual will be determined in
part, whether or not he is able to comprehend the utiliza-
tion of plans, materials, and tools, and the effects that the
endocrine glands have on mental activity have some influence
on mental growth. The nervousness and psychoses connected
with the emotions will determine to a certain extent how se-
cure the individual feels in his environment. With the co-
operation of the endocrine glands the individual will be able
to participate more satisfactorily with other associates of
his environment.

In summary, with respect to the effects of the endocrine
glands upon an individual's ability to participate in an

13Gregory, op. cit., pp. 103-104.
educational program, it may be said that the ability of the endocrine glands to regulate the metabolic processes of the body is in direct relationship to a student's ability to participate in an educational program. In regulating the metabolic processes, the endocrine glands contribute to the physical growth and development and to the mental growth and development of the individual.
Chapter VI is concerned for the most part with the application of the information already presented in terms of what education, with special emphasis on industrial arts, can do to aid the individual who is suffering from malfunctioning of the ductless glands.

The nature of industrial arts is such that each individual may be allowed to express himself in the many activities of an industrial arts program. The activities engaged in industrial arts make a universal appeal to both boys and girls and are not limited by sex, race, intelligence, or aptitude. Thus, the nervous energy created in a situation of less activity may be released in part through some creative work in an industrial arts class. An industrial arts program can provide opportunities for the individual to gain self-reliance, self-confidence, and recognition through the planning and activity involved in the industrial arts classes. Evidence that industrial arts does involve an activity program and that it provides an opportunity for the development of self-reliance, self-confidence, and recognition is verified by the objectives of industrial arts as listed by Wilber.
They are as follows:

1. To explore industry and American industrial civilization in terms of its organization, raw materials, processes and operations, products, and occupations.
2. To develop recreational and avocational activities in the area of constructive work.
3. To increase an appreciation for good craftsmanship and design, both in the products of modern industry and in artifacts from the material cultures of the past.
4. To increase consumer knowledge to a point where students can select, buy, use, and maintain the products of industry intelligently.
5. To provide information about, and—so far as possible—experiences in, the basic processes of many industries, in order that students may be more competent to choose a future vocation.
6. To encourage creative expression in terms of industrial materials.
7. To develop desirable social relationships, such as cooperation, tolerance, leadership and followership, and tact.
8. To develop a certain amount of skill in a number of basic industrial processes.\(^1\)

The adventure into the areas of self-confidence and recognition can be very important for the individual who has not had opportunities sometimes afforded by the usual formal classroom activities. The young person needs purposeful activity in order to facilitate the development of the mind and of the body. Most authorities today agree that fatigued muscles have a growth-producing substance; that is, fatigued muscles have a greater ability to grow and develop than do muscles that are not used often. Some authorities believe that the muscles secrete the growth-producing substance;\(^2\)

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\(^1\)Gordon C. Wilber, Industrial Arts in General Education, pp. 42-43.

\(^2\)A. Franklin Shall, Principles of Animal Biology, p. 51.
it is more logical, however, to believe that the hypophysis secretes a growth hormone that is directly connected with metabolism of food energy in the muscles. Thus, when the muscles of the body become fatigued, the growth-producing substance connected with metabolism causes the muscles to accelerate in growth and development. The same activities that develop the body also develop the mind. Every student needs to develop a coordination of mind and body, and industrial arts can help the individual in establishing this coordination of soma and psychic through guided purposeful activities.

In an industrial arts class a variety of activities can be used to aid in the development of mind and body. These activities as a whole will consist of five manipulative activities: depicting, which involves drawing or writing; forming, which involves reshaping the form of materials; the operation of machines and tools; assembling of materials to put the project together, and altering, which involves the making of changes in articles already constructed. This variety of activities can aid in the development of mind and body and can also help the individual in contributing something to his family and to society. At the same time the individual can achieve a feeling of belonging, of acceptance, and of self-confidence. The problem as to what an industrial arts teacher can do to help the individuals who differ in ability, interests, needs, aptitude, initiative, and insight,
due to the actions of the endocrine glands, still remains, however.

First of all, in the planning of the regular class activities with the students, the industrial arts teacher should try to guide the students with respect to ability and activity in the correct positions of responsibility. Each student should have responsibilities that are challenging, but the responsibilities should lie in the area of his abilities so that he can perform them.

The activity level of the individual will have much to do with the student's ability to associate satisfactorily with other students of the class. If the teacher does not recognize differences in the activity level of his students, he will find students faced with projects and responsibilities which they cannot master, and frustrated students may be the outcome of such incidents. The teacher should realize that each person is limited in the amount and quality of work that he can produce; therefore, the teacher should aid the students in selecting projects, in planning projects, in carrying out plans, and in accepting class responsibilities. The teacher should help the student select the projects and responsibilities that are within his realm of ability.

The number of personal contacts may be a cause for consideration in planning. The number of personal contacts in industrial arts work has influence on one's ability to participate satisfactorily with other students. For example,
the tool checker in a certain class may exhibit signs of irritability which are caused by the number of human contacts, fatigue, and mal-functioning of the various tissues. The industrial arts teacher would certainly not want to place a person exhibiting signs of irritability in the tool room as tool checker or in the position as shop foreman, because unpleasant situations could arise if this kind of behavior were illustrated by a person who was in direct contact with each member of the class each class period. In order to help the individual who is irritable because of personal contact, fatigue, and mal-functioning of various tissues, the industrial arts teacher could give the individual some responsibilities that do not require too many personal contacts. The teacher could also aid the fatigued individual by helping him choose projects which do not require a great deal of time and by helping him develop better working habits.

The industrial arts teacher should be aware that when one stands for a period of time, the waste of metabolism accumulates in the legs, and they become tired or fatigued. If a person whose legs are fatigued from standing will simply contract the muscles of the legs a few times, the fatigued condition will improve, because when the muscles of the legs contract, they "squash" the blood up into the veins and increase the flow of blood to the heart. The veins have one-way valves; therefore, any of the blood that has been pumped upwards by the muscles cannot return immediately to the legs. This
phenomenon is commonly called the "milking action" of the muscles, and when one is standing, this is one of the most important ways of getting the blood from the legs back to the heart. Since this is true, the industrial arts teacher should not require the students to stand for an extended period of time at one table without having an opportunity to flex the muscles of the legs and "pump" the blood to the heart, thus removing the waste of metabolism from the muscles of the legs so that the waste can get to points of excretion.

The industrial arts teacher should be cognizant of the fact that when people become fatigued, they often become undesirable. The various working stations in the shop are closely related to the number of personal contacts. Therefore, the teacher should take notice of the pathways through the shop and should encourage those students who are bothered by personal contact to work at the stations near the pathways. The teacher can also rearrange the work benches and machines in such a way that the number of personal contacts will be reduced.

Each individual varies in the speed with which he accomplishes a given task; the metabolic action influences the industrial arts student's interests, desires, and initiative shown in the performance of the given or chosen tasks. Each student must accept responsibilities in the areas of his interest and ability. All of the students should not be given the same responsibilities, but each should be given those
responsibilities which he can perform in accordance with his ability and his interest.

In the planning of class activities the industrial arts teacher should design a program that will bring the withdrawn student into the group by giving him some responsibilities, and the selected projects should be the kind that will allow the withdrawn student an opportunity to exhibit and contribute his special abilities to the various student projects and class projects. The nature of industrial arts lends itself to many different kinds of creative work; therefore, many of the withdrawn students can have an opportunity to help other members of the class when the withdrawn student's special abilities are needed.

One of the primary duties of the public schools is to provide educational training for citizenship in a democracy; therefore, the organization of the industrial arts classes does provide an abundance of opportunities for the development of leadership. If the industrial arts teacher organizes a program that gives an opportunity for the development of leadership and of suggestions that arise from the group, he must be skilled in the group process method of working. The teacher should usually assume the role of group leader, resource person, or observer in this type of group activity. In any one of these roles he will not give the solutions to group problems, even though he knows the correct way to solve the problem. The teacher must give the group an
opportunity to solve its own problems, thus allowing leadership, suggestions, and a feeling of "we" instead of "I" to develop within the group.

The industrial arts teacher should assist the student in the selection of shop projects. The pupil should choose a project that is within his ability range and one that requires the skills that he can master. The teacher of industrial arts should have an insight into the many skills that are involved in the construction of various shop projects. The teacher should visualize the various tools and machines that are required in the making of shop projects, and he should know the students well enough to determine whether or not they are capable of using such tools and machines. The mental alertness, physical coordination, and self-confidence that an individual possesses can be important factors in the safe operation of high-speed machinery and in the safe use of tools. The mentally and physically slow and sluggish individual may become a definite safety hazard when he is operating a high-speed machine or when he is using certain tools. A student who is very active, alert, and energetic can work so fast that he, too, may neglect safety practices and become a safety hazard. The teacher should also visualize the muscle coordination that is required in the making of shop projects. It is important that an industrial arts teacher realize that individuals differ in their abilities to use the chisels,
the planes, the saws, and the many other tools that are often used in an industrial arts class.

The project that is chosen should be of interest to the student; students are usually interested in projects that have a personal value. If the projects are pre-determined by the teacher, they may have no personal value, and the student may lose interest in any required exercises or projects. If the teacher does require projects which are exercises in nature, the student should have a variety from which to choose. The maturity of the student and the amount of time that the student has to work should also be considered when he is selecting a shop project. The industrial arts teacher can provide a list of suggestions for projects and a book of drawings of projects that are designed for the proper maturity level; however, the students should not be confined to these sources alone when they choose a project. The teacher can encourage the student to bring in projects which will have personal value or something that the student may need at home.

The teacher must also aid the student in outlining the methods and procedures to be followed in making the project. In the activities involved in the building of the project, the student should be allowed to progress at his own rate of speed and should receive encouragement from the teacher as the occasion demands. The teacher should keep in mind that the objective of the student is not necessarily to keep up
with the rest of the class, but rather to accomplish satisfactorily the task or project that he has selected for himself. Attention should be called to the progress that each student is making toward the completion of his project. This will cause a feeling of success and security; if the attention obtained by the individual’s work on his project is accompanied by student participation in a well-organized program, each student will feel that he is one of the group.

In summary it may be concluded that the industrial arts teacher can and should consider each person as a unique individual, because each student will differ in interest, initiative, and ability. The teacher should observe all of the individual differences that he can and should use them as a foundation from which to work.
CHAPTER VII

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary

This study of the endocrine glands and their influence on the physical characteristics and behavior patterns of man, as well as their influence on his ability to participate in a program of education, was based on the available data concerning the glands of internal secretion. In this study of the endocrine glands, the information concerning the shape and action of man's body, the development of man's mind, the coordination of soma and psychic, and the establishment of an equilibrium of activity and functions throughout the entire organism has been presented, with special emphasis on the relation of these glands to an industrial arts program.

Man has been slow to recognize the implications of the endocrine glands in his life. Concerning the endocrine glands, Berman stated as follows: "What the study of the internal secretions suffers from ... is insufficient appreciation of its meaning for man kind." ¹

The ductless glands and their changes in relationship at various periods in the life of man transform the individual from childhood to adolescence and from adolescence

¹Louis Berman, The Glands Regulating Personality, p. 255.
to adulthood. The many physical and mental traits that are established during these periods are related to these glands of internal secretion, and it has been established that the ductless glands contribute, either directly or indirectly, to all of man's activities.

The effects that the endocrine glands have on an individual's ability to participate in a program of education are as many as the various activities and incidents which occur in such a program. To summarize briefly the effects of the endocrine glands on one's ability to participate effectively in an educational program, one can divide the effects into three general areas: metabolism, growth and development, and mental development. These three areas are closely related to the many individual differences which the teacher in an educational program observes daily.

Conclusions

In view of the information presented in this study the following conclusions have been reached:

1. A better understanding of the different physical and psychic educational needs of students will be possible only after educators study the students as individuals.

2. Previous research indicates that behavior patterns are determined in part by secretions produced by the endocrine glands.

3. The growth and development, as well as other changes
desirable in childhood, adolescence, and adulthood, the coordination of soma and psychic, and the establishment of the activity level of the individual result from the functioning of the endocrine glands.

4. Endocrinology gives man a better understanding of how people are built, why they are built differently, and why they behave independently of each other.

5. Research indicates that the endocrine glands tend to make each person a unique individual.

6. The teacher of industrial arts should have a better understanding of the functions of the endocrine glands in order that he can better understand himself and his students in teaching-learning situations.

7. Research indicates that each individual will have different abilities which are due in part to the actions of the endocrine glands.

8. Research indicates that the ductless glands affect each individual with respect to the speed with which he accomplishes a given or a chosen task.

9. The glands of internal secretion are implicated with fatigue and irritability, which affect the teaching-learning process.

10. Research in the field of endocrinology indicates that for every change in the functioning of an endocrine gland there are accompanying changes in personality, as well as physical body changes.
Recommendations

Based on this study, the following recommendations are made:

1. When planning a program of education and when guiding learning experiences, educators should be more cognizant of the fact that each person is different and that each is an independent individual.

2. The educators should obtain the assistance of the chemist and the biologist on the subject of endocrinology with respect to education.

3. Institutions of higher learning which are preparing prospective teachers should provide greater opportunities for these prospective teachers to study the endocrine glands and their effects on and relationship to the teaching-learning process.

4. Teachers of industrial arts are concerned with a program which involves both mental and physical activities; therefore, they should have a better understanding of the physiology of the body so that they will be better prepared to counsel with students.

5. In an industrial arts class, all of the students should not be required to perform the same skills to the same degree of perfection, and the program should be organized so as to provide for individual interests and abilities.

6. Teaching-learning situations provided in industrial
arts should be of a nature that will allow for individual development.

7. The industrial arts class should be planned and conducted in a manner that will allow leadership, "followership," and suggestions to develop within the group.

8. The industrial arts teacher should help each individual student in choosing work and responsibilities that are challenging, but the work and responsibilities should be commensurate with the student's various abilities to perform the work and discharge the responsibilities.

9. Because of the limited amount of research which has been conducted with respect to the endocrine glands and their functions and because of the limitations of this study, it is recommended that further study be made in order to establish the implications of these glands in planning programs of education and in guiding teaching-learning situations.
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