BLOCK 4

GLANDS AND BEHAVIOUR

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UNIT 6 THE ENDOCRINE SYSTEM*

Structure

6.0 LEARNING OBJECTIVES

After having read this Unit, you will be able to:

- explain the main characteristics of hormones;
- classify main types of hormones;
- describe general principles underlying hormone action;
- explain the regulation of hormone secretions;
- describe the working of hormones;
- identify the location and function of major endocrine glands; and
- discuss the impact of hormones on behaviour.

* Dr. Meetu Khosla, Associate Professor of Psychology, Daulat Ram College, University of Delhi, New Delhi.

6.1 INTRODUCTION

To introduce you to the functioning of endocrine glands in this Unit, we will first understand how the hormones work and then focus on the different endocrine glands in the body, the hormones they secrete and how they impact our behavior. The topic of hormones and their impact on behavior is very interesting as well as intriguing.The endocrine system along with the nervous system helps to maintain homeostasis. There are various endocrine glands in the body which secrete their hormones. A specific quantity of hormones is required for normal functioning of the body. If the secretion of the hormones is in excess of what is required by the body, that is, hyper (increased) secretion, it causes certain disorders. If the hormone is hypo (less) secreted, that is less than the quantity that is required by the body, then also it leads to deficiencies in the body, markedly influencing the functioning of the body.

6.2 UNDERSTANDING HORMONES

In Unit 2, we discussed about neurons and neurotransmitters and how they are released into synapse to communicate with the postsynaptic neurons. This mechanism is very fast and affects neurons that are in immediate proximity to the originating neuron. Similarly, there are other structures, like glands, that secrete chemicals. There are two types of glands, namely, *endocrine glands* and *exocrine glands*. The glands that affect behavior are known as endocrine glands, whereas, there are glands that do not affect behavior, like salivary gland and sweat gland, which fall in the category of exocrine glands. Exocrine glands are glands with ducts and chemicals are released into ducts. On the other hand, endocrine glands are ductless and secrete chemicals directly into the bloodstream when stimulated. Figure 6.1 illustrates the major endocrine glands (hormone-producing) in a human body.

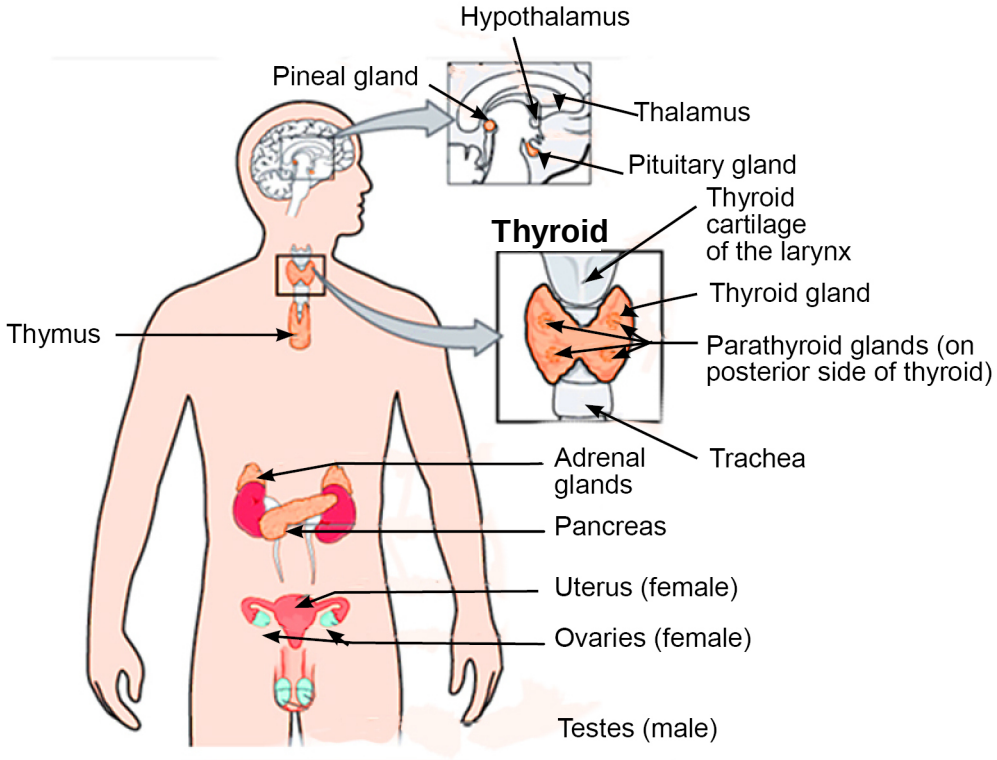

Figure 6.1: The major glands of the endocrine system

The chemicals secreted by endocrine glands are known as hormones. The word hormone is derived from the Greek word "hormaein" which means to excite. These are those chemicals that are secreted directly into the bloodstream by certain specialized

cells. These chemicals travel in the body and bring about the physiological changes inside the body. There are target tissues or target organs with appropriate receptors to accept their specific hormones. The effect of hormones are slow and persist for a longer period of time. As compared to synaptic communication (uses electrical impulse), endocrine communication is slow (uses hormones). This is so because the hormones take time to travel to target organs. Endocrine glands are spread all over the body. There is quite a debate about which is the master gland? Whether it is the hypothalamus or the pituitary which regulates the functioning of the other endocrine glands as thyroid gland, adrenal glands, pancreas, gonads, pineal gland, etc.

The hormones can be classified as *tropic hormones* (tropic means able to stimulate or change something), when they have to perform a more generalized function. Tropic hormones act on other endocrine glands and stimulate them to secrete their hormones. Hormones can also be classified according to their chemical structure as steroids and non-steroids or protein hormones. The *steroid hormones* are made up of cholesterol (a type of fat molecule) and secreted from gonads (testes and ovaries) or adrenal cortex, for example corticoids. *Non-steroid hormones* are amino acids, peptides or complete proteins. An example is epinephrine. Among both the categories, steroid hormones have a long-lasting impact on cellular functioning.

The secretion of hormones is controlled by a negative feedback loop that tends to reverse any deviation from the set point value that maintains homeostasis. For example, when parathyroid hormone stimulates its target cells, it produces more calcium in the blood. However, when the level of calcium exceeds the set point value, this information is received by the parathyroid cells and they automatically reduce the secretion of parathyroid hormone. The information received from the nervous system also stimulates the glands to secrete their hormones.

6.3 FUNCTIONS OF THE HORMONES

There are certain general rules about the way the hormones function in the body. We must understand that hormones are not involved in any biological processes. Rather they tend to regulate the processes that are already going on in the body. They are produced in response to the changing internal bodily environment. Hormones act very slowly on the body. Various environmental or internal factors influence the release of hormones such that a reciprocal relationship exists between them. Hormones can be produced in varying amounts and can influence different tissues, organs and ultimately behavior. There are varying time periods during which the hormones work. For example, some are secreted regularly in 24 hours while some follow the lunar or 28-day cycle, others are secreted according to the demands of the body in response to internal or external stimuli. Hormones are involved as catalysts in metabolic processes in some cells. Each hormone has a specific effect. Hormones also influence the action of other hormones. In the following section, we will learn about the location of different endocrine glands and the effect of their hormones on human behavior.

Check Your Progress 1

1) Differentiate between endocrine and exocrine glands.

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2) Define and state two major functions of hormone.

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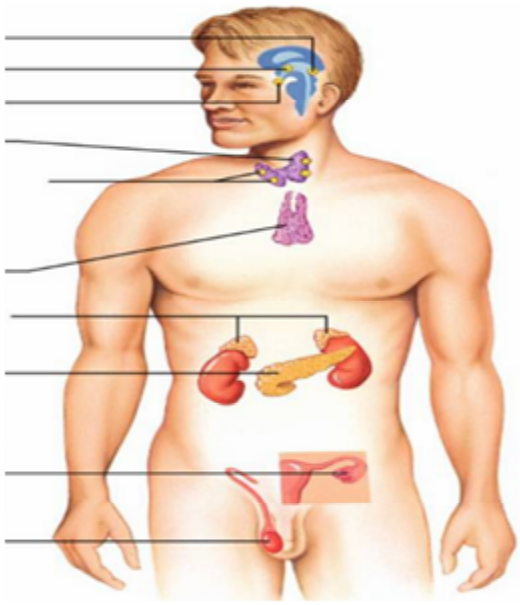
3) Label the endocrine glands in the diagram given below.



6.4 ENDOCRINE GLANDS

The previous section described the functioning and classification of hormones. In this section, you will learn about endocrine glands and their impact on behavior.You have a general idea of how endocrine system uses hormones in maintaining homeostasis of the body. Let us now see the structure, functions and role of each endocrine gland which are scattered all over the body.

6.4.1 Pituitary Gland

Structure: Pituitary gland is also referred as the master gland because it controls other glands and as well as other organs of the body. Most of its hormones are tropic hormones. The pituitary gland is a small structure weighing about 0.5 gms. It comes from the Latin word "pituita". It is located at the base of the skull, attached to the hypothalamus (you have learnt the functioning of hypothalamus in Unit 3). Another name for it is hypophysis. It has s small stalk known as infundibulum that connects it to the hypothalamus in the brain. It has two distinct glands, the adenohypophysis or anterior pituitary gland, and the neurohypophysis, or posterior pituitary gland, formed during embryonic development. Each gland secretes its own hormones which differ in functions.

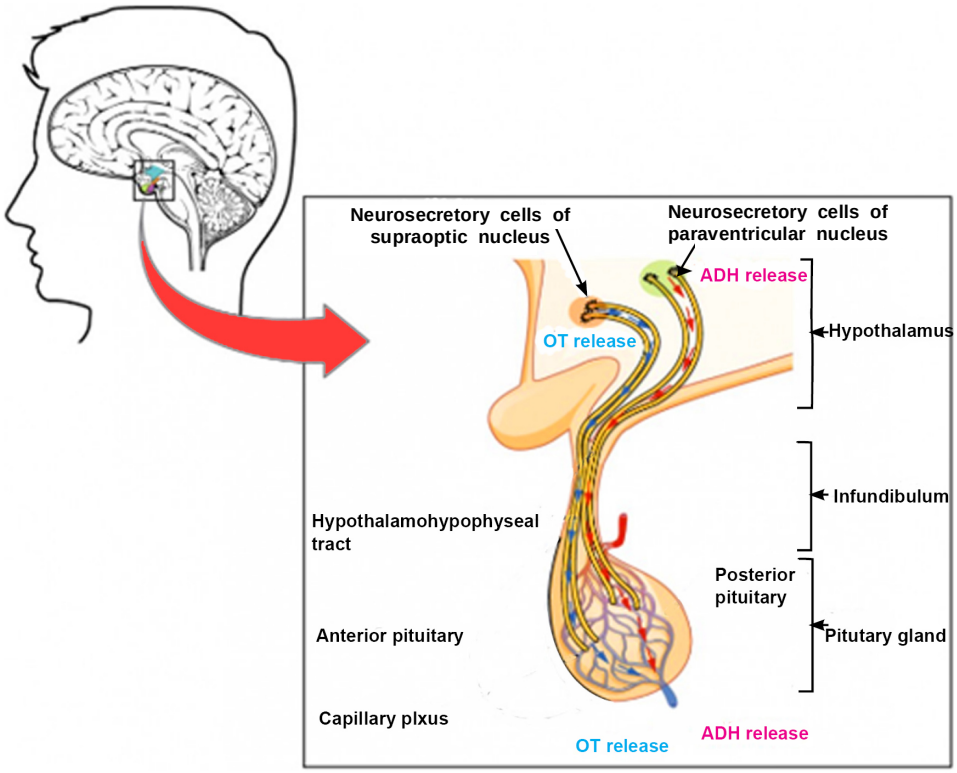


Figure 6.3: Pituitary Gland

6.4.1.1 Anterior (Adenohypophysis Pituitary)

The anterior part of pituitary gland is known as adenohypophysis. It is composed of glandular tissues. The hypothalamus regulates the secretions of the adenohypophysis. Hence, even though pituitary gland is known as the master gland, it is controlled by the hypothalamus. Hypothalamus secretes hormones into the hypothalamus-pituitary portal system and regulates the hormone secretion through the negative feedback mechanisms. Main secretions of the anterior pituitary, although the release is controlled by hypothalamus, are:

1) **Adrenocoticotropic hormone (ACTH)**: This controls the release of hormones of the adrenal cortex which releases steroid hormones. ACTH promotes and maintains growth and development of the cortex of the adrenal gland.

2) **Melanocyte-stimulating hormone (MSH)**: This stimulates the production of melanocytes in the skin which tends to darken the skin.

3) **Thyroid-stimulating Hormone (TSH):** Promotes the growth and development of thyroid gland and release of thyroid hormones known as **thyroxin**.

4) **Luteinizing stimulating hormone (LH)**: It stimulates the formation and activity of the corpus luteum of ovary. It stimulates the release of eggs from the ovary in females and prepares the uterine lining for the implantation of a fertilized egg. It increases the production of progesterone in females, while in males it stimulates interstitial cell to produce testosterone.

Box 6.1: Progesterone and Testosterone

Progesterone: It is produced primarily by the corpus luteum of the ovary in normally menstruating women and to a lesser extent by the adrenal cortex. The major functions of progesterone are in the preparation of the uterus for implantation and maintenance of pregnancy. - Source: http://www.ilexmedical.com

Testosterone: It is primarily male sex hormone however,women's ovaries also make testosterone but in much smaller amounts. It plays vital role in sex drive of males and development of their reproductive tissues such as testes and prostate.

5) **Follicle-stimulating hormone (FSH)** : FSH stimulates the secretion of estrogen and maturation of ovum in females and sperm production in males. It influences the growth and maintenance of the gonads (ovaries and testes).

Box 6.2: Estrogen

"A female steroid hormone that is produced by the ovaries and, in lesser amounts, by the adrenal cortex, placenta, and male testes. Estrogen helps control and guide sexual development, including the physical changes associated with puberty. It also influences the course of ovulation in the monthly menstrual cycle, lactation after pregnancy, aspects of mood, and the aging process."

- Source: https://www.medicinenet.com

6) **Prolactin (PRL)**: It is also called as the lactogenic hormone as it initiates and promotes milk production in female mammals. It also helps to maintain the corpus luteum of the ovary during the menstrual cycle. Hypersecretion of PRL may cause non-nursing women to lactate and also disrupt the menstrual cycle. It can also cause impotence in men. Hyposecretion of PRL is generally of no significance.

7) **Growth Hormone (GH)**: This hormone is also known as somatotropin hormone (STH) or somatotropic hormone. It influences the growth of cells and tissues all over the body. GH is released during some stages of sleep. It promotes the growth of bones, muscles and other tissues. Thus, it controls and regulates the growth of a child from infancy to adulthood. During growing years, hypersecretion of GH causes an extraordinary skeletal growth producing a condition known as **gigantism**. This also causes the formation of new bones making the body disfigured with large hands, feet, jaw etc. This is known as **acromegaly**. If during growing years the GH is secreted in quantity that is less than what is desired, or hyposecreted it results in reduced cell growth of the body leading to **dwarfism**.

Figure 6.4 (a): Tallest man to ever live: Robert Waldow:8'11.1'', lived to age 22

Image Source: https://www.slideserve.com

Figure 6.4(b): Shortest women to ever live: Pauline Musters: 23inches tall, lived to age 19

Image Source: https://www.slideserve.com

6.4.1.2 The Posterior Pituitary (Neuro hypophysis)

The posterior pituitary is composed of neural tissue. The main hormones released are Antidiuretic Hormone (ADH) or Vasopressin and Oxytocin.

6.4.1.2.1 Antidiuretic Hormone (ADH)

ADH, also known as vasopressin, helps the body to retain water and regulates sodium level in the blood. In other words, it prevents the loss of water from the body through large urine volume. It helps the tubules of the kidney to reabsorb water from the excess amounts of urine that is formed to be excreted. The osmotic pressure in the body increases when the body dehydrates. This triggers the release of ADH, which in turn helps to reabsorb the water from the kidney and pour it into the blood. This restores the water level in the body and reduces the osmotic pressure. The hyposecretion of ADH causes the excretion of large quantity of urine from the body, thus leading to diabetes insipidus. This is generally taken care of by injecting ADH or vasopressin. ADH is also involved in learning and memory though, the exact role is yet to be understood.

Box 6.3: Diabetes Insipidus

Diabetes insipidus (die-uh-BEE-teze in-SIP-uh-dus) is an uncommon disorder that causes an imbalance of water in the body. This imbalance leads to intense thirst even after drinking fluids (polydipsia), and excretion of large amounts of urine (polyuria).There's no cure for diabetes insipidus, but treatments are available to relieve your thirst and normalize your urine output.

Symptoms

The most common signs and symptoms of diabetes insipidus are:

- Extreme thirst
- Excretion of an excessive amount of diluted urine

- Source: https://www.mayoclinic.org

6.4.1.2.2 Oxytocin

The word is derived from Greek words, *oxys* meaning 'rapid' and *tokos* that means

'childbirth'. Oxytocin (OT) initiates the contraction of uterine muscles. Injections of OT are given to induce labour and to speed-up childbirth. It also promotes lactation and ensures successful nursing. It also controls certain aspects of parental behavior and sexual behavior. Research is being conducted to find out the impact of oxytocin and vasopressin on social behavior.

6.4.2 Adrenal Gland

Structure: The adrenal glands are placed like a cover on top of each kidney. *Renal* is a Latin word that means 'kidney' and *ad* is a Latin word for 'to', which means to or on the kidney. They have two parts, the outer covering which is the major part of the gland is known as adrenal cortex and is made up of endocrine tissue. The inner part of the gland known as adrenal medulla is made up of neurosecretory tissue. 30 different hormones are secreted to regulate salt intake, deal with stress and also influences sexual changes during adolescence (along with gonads).

6.4.2.1 Adrenal Cortex

Adrenal cortex secretes corticosteroids as mineralocorticoids, glucocorticoids and gonado corticoids.

6.4.2.1.1 Mineralocorticoid

Mineralocorticoids regulate the processing of mineral salts (electrolytes) in the body. For example, aldosterone helps in the maintenance of sodium balance in the body by reabsorbing it from the kidney. This also leads to reabsorbing water in the body.

Box 6.4: Aldosterone

"Aldosterone is a hormone secreted by the Adrenal Cortex that regulates electrolyte and water balance by increasing the renal retention of sodium and the excretion of potassium."

- Source: https://www.ncbi.nlm.nih.gov

6.4.2.1.2 Glucocorticoids

The main glucocorticoid released by the adrenal cortex is known as cortisol along with cortisone and corticosterone. Glucocorticoids speed up the breakdown of proteins into amino acids. In liver, the amino acids are converted into glucose. Glucocorticoids are necessary to maintain normal blood pressure and working of the epinephrine and nor-epinephrine. If there is excess of glucocorticoids in the blood, it tends to initiate tissue loss or protein loss and causes *hyperglycemia*, when there is high level of blood glucose in the body. Glucocorticoids help in the mobilization of lipids. High concentration of glucocorticoids also causes a decrease in white blood cells, which reduces the formation of antibodies in the body. Hence, glucocorticoids help the body to cope with physical and psychological stress.

Box 6.5: Cortisol, Cortisone, and Corticosterone

Cortisol is the main glucocorticoid found in humans, while, corticosterone is most commonly found in rhodents. Cortisone is the synthetic version of cortisol, which is used as an important anti-inflammatory drug. Cortisol and corticosterone helps in metabolism of proteins and fats as well as stimulates liver to raise blood sugar.

6.4.2.1.3 Gonadocorticoids

The sex hormones released by the adrenal cortex are known as gonadocorticoids. Under normal conditions, adrenal cortex releases both male hormones **androgen** and female hormone **estrogen**. But the quantity in which they are released is very

small, so they do not produce any significant effects. That is, the level of androgens in females may only lead to the production of body hair but not produce any masculine characteristics.

6.4.2.2 Adrenal Medulla

The hormones secreted by adrenal medulla are known as **catecholamines**. They are non-steroid hormones. **Adrenalin** or **epinephrine** is the major hormone secreted. The other hormone secreted is **noradrenalin** or **norepinephrine**. Epinephrine and nor-epinephrine help to maintain the balance in the body (when people are under stress) by increasing their effects on the sympathetic system.

When the cortical hormones are hyper secreted it leads to **Cushing's Syndrome**.The fat gets deposited in the face, abdomen, shoulders instead of arms and legs.Face appears to be moon shaped. Hypersecretion of aldosterone causes aldosteronism which causes water retention in the body and loss of potassium causing muscle weakness. When there is hypersecretion of androgens, the level of male hormones in the blood increases in women.This causes male characteristics in women.

Hyposecretion of mineralocorticoids and glucocorticoids causes an increase in blood glucose and potassium levels, dehydration, weight loss, causing Addison's disease. Sometimes ointments containing hydrocortisone are used to treat symptoms of skin allergies.

Figure 6.5: Cushing syndrome

Left untreated, Cushing syndrome can result in exaggerated facial roundness, weight gain around the midsection and upper back, thinning of your arms and legs, and stretch marks.

Source: https://www.mayoclinic.org

Check Your Progress 2

1) Fill in the blanks.

   a) The hormones secreted by adrenal medulla are known as _____.

   b) The anterior part of pituitary gland is known as _____.

   c) The hyposecretion of _____ causes diabetes insipidus.

   d) The sex hormones released by the adrenal cortex are known as _____.

   e) When the cortical hormones are_____ it leads to Cushing's Syndrome.

2) State the important functions of growth hormone

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3) Identify the main functions of cortisol.

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Answers of fill in the blanks:

(a) Catecholamines, (b) adenohypophysis, (c) ADH, (d) gonadocorticoids, and (e) hyper secreted

6.4.3 Thyroid Gland

Structure: The thyroid gland is made up of two lobes that are connected by an isthmus in the neck region. It weighs about 30 gms in an average adult. The gland has follicles which are filled with thyroid fluid. It secretes hormones as **calcitonin**, **thyroxine** and **triiodothyronine** (T3).

Functions: Thyroid hormone regulates gene expression, metabolic processes, cell growth and tissue differentiation. The secretion of thyroxin depends upon the temperature of the environment. When it is cold then the secretion of thyroxin increases while when it is warm it reduces. Hypersecretion of thyroid hormone or **hyperthyroidism** produces a disease known as **Graves' disease**. This causes eyes to protrude, increased excitability, difficulty in sleeping, and inability to focus on a task. This condition may also cause lot of weight loss, nervousness, and enhanced heart beat. This condition can be taken care of by surgically removing a part of the gland so as to reduce the production of thyroxin. During growing years when there is deficiency of thyroxin i.e., hyposecretion in the body it causes a condition known as **cretinism**. Cretins suffer from low metabolic rate, CNS and other systems of the body are maldeveloped, with retarded growth. In severe conditions it leads to dwarfism. If hypothyroidism is detected early, then it can be rectified by injecting extra thyroxin and cretinism can be avoided. However, in adulthood, hypothyroidism causes myxedema. In myxedema, the metabolic rate reduces,mental and physical vigor also decreases, skin becomes yellowish, and there is gain in weight. When the level of iodine in the body is not sufficient, then there is a reduction in the release of thyroid hormones. This causes a swelling in the neck producing a condition known as **goitre**. This is very common in mountain areas where the diet lacks sufficient amount of iodine. Calcitonin is another hormone secreted by the thyroid gland. It controls the calcium content of the blood by increasing the formation of bones.

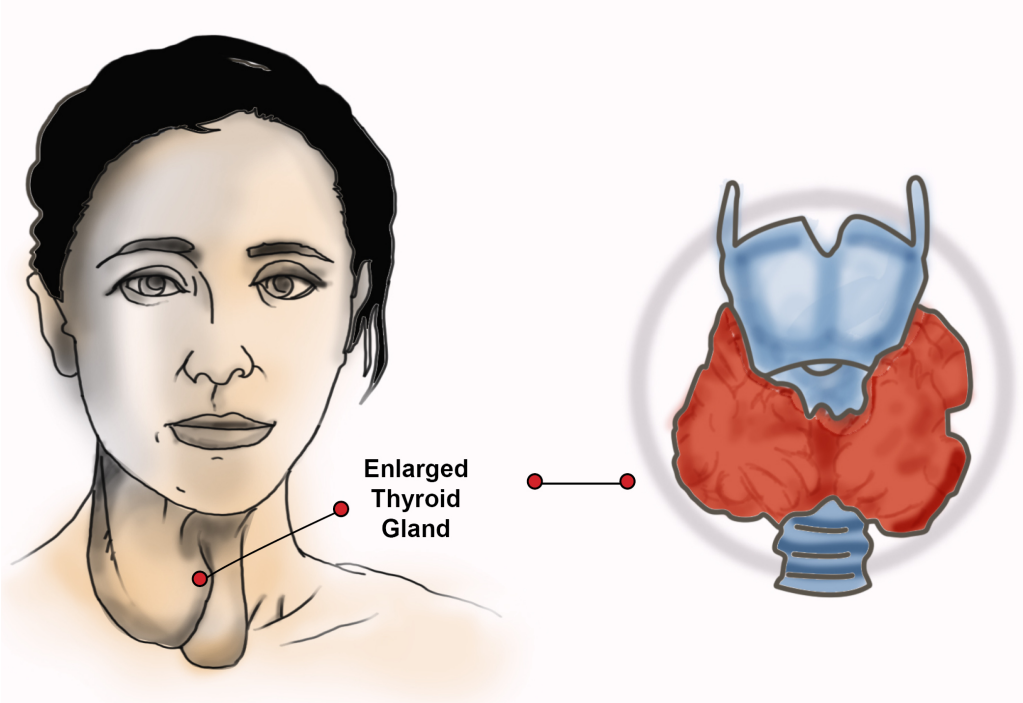

Figure 6.6: Goitre

6.4.4 Parathyroid Gland

Structure: Parathyroid glands lie above the thyroid gland.They are four of them and are round in shape. They secrete a hormone known as **parathyroid hormone (PTH)** or **parathormone**.

Functions: Parathormone regulates calcium, phosphorous and vitamin D in the blood. It works opposite to calcitonin. It regulates calcium homeostasis by acting on the bloodstream and maintains an optimal level of calcium in the body. This then facilitates the functions of neurons, skeletal muscles and acts on the bone, kidney and intestinal cells. When the level of calcium is low in the blood, parathyroid gland secretes parathormone which helps to increase the blood calcium. When the optimal level of calcium is reached, then parathormone is not produced by the gland. When the level of calcium drops, then the same cycle starts again. Parathyroid hormone activates Vitamin D in the body which helps in absorbing calcium that is available in the food we eat. There are many sources of Vitamin D, such as from the food we eat, or by exposing our skin to the sunlight which is in abundance in tropical countries, like India. The interaction between parathyroid hormone and calcium is important for healthy survival, neuro-muscular action, clotting of the blood, and permeability of the cell membrane.

Hyposecretion of parathyroid hormone causes hypocalcemia which produces irritability, muscle spasms and convulsions. In childhood, if there is an extreme deficiency of Vitamin D, then the calcium becomes very low. This causes **rickets**, a condition when bones begin to degenerate. On the other hand, when parathyroid hormone is produced in excess of what is required, that is there is hypersecretion, then it leads to too much calcium in the blood which causes a bone disease known as osteitis fibrosa cystica.

Box 6.6: Osteitis Fibrosa

"Osteitis fibrosa is a complication of hyperparathyroidism, a condition in which certain bones become abnormally weak and deformed."

Source: https://medlineplus.gov

6.4.5 Pineal Gland (Epiphysis)

Structure: Pineal gland is a very small structure and is in shape of a cone. It is placed on top of the brain stem. This gland is not a paired gland like other glands.

Function: The hormone released by pineal gland is known as **melatonin**. This regulates the biological clock of the body which controls our sleeping, waking, eating, reproductive cycle (menstrual cycle and onset of puberty) in women and behavior. Pineal gland does not secrete melatonin in sunlight, this tends to influence a persons' mood. It keeps track of length of days and seasons. For example, in seasonal affective disorder (SAD), patient suffers from severe depression during winters. As days are small in winters, so there is less daylight, and as a result reduction in the production of melatonin. When there is jet lag, then melatonin is also used to treat it.

6.4.6 Pancreas

Structure: Pancreas lies near the stomach and the small intestine.It is a long gland, about 12 cms long and weighs about 100 gms. It is made up of small cells known as islets of langerhans. These cells are joined together by gap junctions. There are different kinds of pancreatic cells. The A cell or alpha cells secrete the hormone **glucagon,** the Beta cells (B cells) produce **insulin** and Delta cells (D cells) secrete **somatostatin**. The pancreatic polypeptide cells (F, or PP cells) secrete pancreatic polypeptide.

Function: Alpha cells produce glucagon which converts the glycogen into glucose in the blood. It thus increases the blood glucose level. Somatostatin, that is produced by the delta cells regulates some cells of the pancreatic islets, inhibits the secretion of growth hormone, glucagon, insulin and pancreatic polypeptide. The beta cells produce insulin which helps to lower the blood glucose level and promotes metabolism.

When an inadequate or abnormally low level of insulin is produced, it causes diabetes. In hyperglycemia, glucose is unable to enter the cells normally this increases the level of glucose in the blood. Under normal conditions the tubules of the kidney reabsorb the glucose from the blood but when the bold glucose level is too high then the tubules are unable to reabsorb the excessive glucose. This produces a condition known as **glycosuria** and extra sugar is released out through urine. This may cause a condition where the frequency of urine production increases, that is **polyuria**. This happens because the body needs more water to throw out the excess glucose. When too much water is excreted, the body becomes dehydrated, and the person feels very thirsty all the time. This condition is known as **polydipsia**. When the blood sugar level is high, the body also feels hungrier, a condition known as **polyphagia**. Another name for diabetes is **diabetes mellitus**. When diabetes is not treated properly it may cause a condition known as diabetic ketoacidosis which leads to pain in the abdomen, nausea, coma and if not treated then it can also lead to death. Hereditary factors play a key role in the development of diabetes mellitus.

Type I diabetes mellitus is a serious disorder that occurs early in adolescence about 11 to 13 years. Since beta cells are destroyed, there is deficiency in insulin. This increases blood glucose level and body dehydrates. This effects the kidneys, eyes and there is reduced functioning of the peripheral nerves (Powell, 1987). The patient has to take injections of insulin to prevent ketosis and control hyper glycemia. About 10% of the diabetics suffer from this disorder.

Type II diabetes mellitus is little is less serious form of diabetes that occurs after the age 40.The insulin produced by the body is adequate but somehow it is not able to maintain the blood glucose level. The treatment involves changes in eating behaviors, diet and regular exercise. About 90% of all diabetics suffer from this disorder. Gain in body weight makes one susceptible to it.

If diabetes is left untreated then it may cause heart attack, decreased blood circulation to the extremities causing tingling sensation, problems in vision and kidney disease.

6.4.7 Gonads

Structure: The primary sex organs are gonads. In males, they are testes and in females they are ovaries. Both have different structure and produce their own hormones. Testes are paired organs having a sac called as scrotum. It produces hormones known as **testosterone** and **androgens**. Ovaries are also a pair of glands that are located in the pelvis of a female. They produce sex hormones as **estrogens** and **progestins**.

Functions: The hormones secreted by gonads regulate sexual behavior and reproduction, along with the brain. Testosterone is involved in making physical changes during puberty as changes in voice, growth of facial hair, chest and pubic hair, promotes sperm production and male sexual characteristics. Estrogens are responsible for the sexual development of the female body such as shape of the body, development of the breast, and female reproductive cycle. Progesterone is secreted during pregnancy and helps in it.

Check Your Progress 3

1) Match the following

(a)	Pancreas	(1)	lies on top of the brain stem
(b)	Pineal gland	(2)	lies above the thyroid gland
(c)	Parathyroid gland	(3)	lies near the stomach and the small intestine
(d)	Thyroid gland	(4)	lies on the neck region

2) State two important functions of thyroid gland.

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3) Identify the functions of testosterone and progesterone.

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Answers of match the following exercise:

(a) and (3),
(b) and (1),
(c) and (2),
(d) and (4)

6.5 SUMMARY

Now that we have come to the end of this unit, let us recapitulate all the major points that we have covered.

- There are two types of glands: endocrine glands and exocrine glands.
- Endocrine glands are ductless and secrete chemicals directly into the bloodstream when stimulated. Further, they affect our behavior. Whereas, exocrine glands are with ducts and they do not affect behavior.
- Pituitary gland also known as the master gland because it controls other glands and other organs of the body. It is located at the base of the skull, attached to the hypothalamus. It has two distinct glands, the adenohypophysis or anterior pituitary gland, and the neurohypophysis, or posterior pituitary gland. Each gland secretes its own hormones which differ in functions.
- Anterior Pituitary gland secrets Adrenocoticotropic hormone (ACTH), Melanocyte-stimulating hormone (MSH), Thyroid-stimulating Hormone (TSH), Luteinizing stimulating hormone (LH), Follicle-stimulating hormone (FSH), Prolactin (PRL), and Growth Hormone (GH).
- Posterior Pituitary gland secretes Neurohypophysis, Antidiuretic Hormone (ADH), and Oxytocin
- The adrenal glands are situated on top of each kidney. The outer part of adrenal gland is known as adrenal cortex and the inner part of the gland known as adrenal medulla.
- Thyroid gland is made up of two lobes that are connected by an isthmus in the neck region. It weighs about 30 gms in an average adult. The gland has follicles which are filled with thyroid fluid. It secretes hormones as calcitonin, thyroxine and triiodothyronine (T3).
- Pineal gland is a very small structure in shape of a cone. It is placed on top of the brain stem. The hormone released by pineal gland is known as melatonin. It is responsible for regulating the biological clock of the body.
- Gonads are primary sex organs. In males, they are testes and in females they are ovaries. Both have different structure and produce their own hormones.

6.6 KEY WORDS

Endocrine Glands : It is a group of glands that secrete chemical substance known as hormones directly into our bloodstream.

Hormones : These are naturally occurring chemical substance released by our glands and transported by our circulatory system to different parts of the body.

Hypersecretion : Excessive production of hormones by any of our glands. It may lead to a medical condition.

Hyposecretion : It refers to a medical condition in which no or too little production of a hormone takes place.

Thyroid gland : It is a part of endocrine gland, located in the front of the neck. It is responsible for secreting

hormones that control metabolism, growth and development.

Adrenal gland : This gland is located at the top of the kidney and it secrets steroids as one of the main hormones.

6.7 REVIEW QUESTIONS

1) The two major hormones secreted from the pancreas are:
   a) Estrogen and progesterone
   b) Norepinephrine and epinephrine
   c) Thyroxine and oxytocin
   d) Glucagon and insulin
2) The ..... secretes messenger hormones that direct the function of the rest of the endocrine glands.
   a) Ovary
   b) Thyroid
   c) Pituitary
   d) Pancreas
3) The ..... glands secretes hormones that regulate the body's fluid levels.
   a) Adrenal
   b) Pituitary
   c) Testes
   d) master
4) The ..... secrets hormones that regulate the body's fluid levels.
   a) Adrenal
   b) Pituitary
   c) Testes
   d) Thyroid
5) What do you understand by hormones?
6) Define pancreas and discuss its function.
7) Explain the structure and function of Gonads.
8) Differentiate between hyper secretion and hypo secretion of growth hormones.
9) Explain the role of adrenal cortex.

6.8 REFERENCES & FURTHER READING

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6.9 REFERENCES FOR FIGURE

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6.10 ONLINE RESOURCES

To learn more about Endocrine system, visit;

– https://courses.lumenlearning.com/suny-ap2/chapter/an-overview-of-the-endocrine-system/

– http://www2.centralcatholichs.com/APbiologysite/Hormone/more%20hormone%20notes.PDF

For more understanding on pituitary glands and hypothalamus, visit

– https://courses.lumenlearning.com/suny-ap2/chapter/the-pituitary-gland-and-hypothalamus/

– https://www.visiblebody.com/blog/endocrine-system-hypothalamus-and-pituitary

For more on adrenal gland, visit;

– https://courses.lumenlearning.com/suny-ap2/chapter/the-adrenal-glands/

– https://www.aagbi.org/sites/default/files/216-The-Adrenal-Glands.pdf

For more information on disorders of glands and their hormones, visit;

– http://www.patfyz.sk/ANGL/endocr1.pdf

– http://samples.jbpub.com/9781284040920/9781284040920_ CH07_ Pass4.pdf

– https://media.asrt.org/pdf/drpubs/RTT15_S_PituitaryDR_F.pdf

Answers for Multiple Choice Questions

1) (d), 2) (c), 3) (a), 4) (b)