SUBJECT:
HUMAN ANATOMY AND PHYSIOLOGY

TOPIC:
ENDOCRINE SYSTEM

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ENDOCRINE SYSTEM

• The endocrine system is a system in the body that plays an important role in hormones.

TYPES OF GLANDS

• **Endocrine glands** are ductless glands that secrete hormones directly into the bloodstream or surrounding tissues.
• In contrast, **exocrine glands**, or glands with ducts, such as salivary and sweat glands, secrete their products directly into ducts that open to specific areas.

FUNCTIONS OF ENDOCRINE SYSTEM

• Growth and development.
• Homeostasis (the internal balance of body systems).
• Metabolism (body energy levels).
• Reproduction.
• Response to stimuli (stress and/or injury).

HORMONES

• Hormones are chemicals that essentially function as messengers of the body.
• These chemicals are secreted by special glands known as the endocrine glands.
• These endocrine glands are distributed throughout the body.
• These messengers control many physiological functions as well as psychological health.
• They are also quite important in maintaining homeostasis in the body.

CHARACTERISTICS OF HORMONES

1. Action and low concentration
2. Storage, metabolism and excretion
3. Distant target organ

Functions of hormones:

• Food metabolism.
• Growth and development.
• Controlling thirst and hunger.
• Maintaining body temperature.
• Regulating mood and cognitive functions.
• Initiating and maintaining sexual development and reproduction.
Classification of hormones

- Amino acid derived – Examples include melatonin and thyroxine.
- Eicosanoids – hormones derived from lipids such as arachidonic acid, lipoxins and prostaglandins.
- Steroid – Hormones derived from cholesterol.

Some Important Hormones

1. **Estrogen** –

   This is the main sex hormone present in women which bring about puberty, prepares the uterus and body for pregnancy and even regulates the menstrual cycle. Estrogen level changes during menopause because of which women experience many uncomfortable symptoms.

2. **Progesterone** –

   It is a female sex hormone also responsible for menstrual cycle, pregnancy and embryo genesis.

3. **Cortisol** –

   It has been named as the “stress hormone” as it helps the body in responding to stress. This is done by
increasing the heart rate, elevating blood sugar levels etc.

4. **Melatonin** –

   It primarily controls the circadian rhythm or sleep cycles.

5. **Testosterone** –

   This is the main sex hormone present in men which cause puberty, muscle mass growth, and strength, increases bone density and handles facial hair growth.

**Mechanism of Hormone Action**

Each hormone has receptors that are found on the cell membrane of the target organ.

Once the hormones bind to its designated receptor, a series of actions are initiated to release secondary messengers inside the cell.

These secondary messengers are responsible for relaying information to the nucleus or other organelles. Based on their structure, receptors are of different types:
1. **Internal receptors**— they can be either nuclear or cytoplasmic. Nuclear receptors are found on the nuclear membrane while the cytoplasmic receptors are found in the cytoplasm of the cell. These receptors are for the steroid hormones.

2. **External receptors**— These are the transmembrane receptors which are embedded in the lipid layer of the cell membrane. These receptors are for the protein ones.

The mechanism of action hormone can be of two types: First, where the receptors are fixed and the second, where the receptors are mobile.

A. Fixed Receptor Mechanism
This mechanism of action hormone is seen in the protein hormones such as Adrenaline, insulin, ADH, TSH etc. As mentioned earlier, since they are water soluble, they cannot pass through the cell membrane as it is made up of a lipid layer. So, they bind to their extracellular receptors present on the membrane.

Once the protein hormone binds to the receptor, a series of reactions occur beginning with the production of adenyl cyclase enzyme. This enzyme leads to the production of cyclic AMP or cAMP which is the secondary messenger. This cAMP can now enter the cell and cause the effect it was meant to bring about.

B. Mobile Receptor Mechanism

(Image Source: stmary.ws)
This kind of mechanism is seen in the steroid hormone that is insoluble in water. They are made up of fats and therefore can freely cause the lipid layer of the cell membrane. Their receptors are intracellular and not extracellular like those for the protein ones. The intracellular receptors can be floating in the cytoplasm, on the nuclear membrane or inside the nucleus. For this reason, their receptors are known as mobile receptors.
ENDOCRINE GLANDS

Unlike exocrine glands (sweat, salivary), endocrine glands secrete their respective substances directly into the bloodstream rather than through a duct, that is they are ductless glands.

These endocrine glands belong to the body’s control system and they produce hormones which help to regulate the functions of cells and tissues.

Some glands are specific to either male (testes) or female (ovaries)

Endocrine glands include;

- Pituitary gland
- Thyroid gland
- Pancreas
- Adrenal glands
- Hypothalamus
- Parathyroid glands
- Pineal gland
- Ovaries

Pituitary Gland
• This gland has its location at the base of the brain.
• It is known as the master gland, because it is responsible to control the function of other glands to put forth their hormones.
• Growth, body metabolism, sexual development, and reproduction happen to be the elements which come under the domain of the pituitary gland.
• It develops the hormones that trigger growth and development.

**DIAGRAM OF PITUITARY GLAND**

**Functions of pituitary gland**

• Growth
• Blood pressure
• Sex organ functions
• Pain relief
• Temperature regulation
• Water and osmolarity regulations in the body

Hormones produced

- **Antidiuretic hormone (vasopressin)** – Its primary function is to help the kidneys to retain water in the body.

- **Corticotropin (ACTH)** – These hormones are there for regulating the hormones of the adrenal glands.

- **Human growth hormone** – it is associated with the growth and development of the body. It is also known to encourage the production of protein.

- **Luteinizing hormone and follicle-stimulating hormone** – Important functions like the production of sperm and semen, and menstruation, are looked after
by this particular hormone. Secondary sexual characteristics such as hair growth pattern, muscles, texture and thickness of the skin, nature of the voice, etc.

- **Oxytocin** – Helps contraction of the uterus muscles and mammary ducts in the breast.

- **Prolactin** – The process of milk production in the mammary glands is carried out by this hormone.

- **Thyroid-stimulating hormone** – Again, as the name suggests, this hormone is responsible for the functions of the hormones of the thyroid gland.

Disorders
- Gigantism and acromegaly caused by an excess of growth hormone in childhood and adult respectively.
- Hypothyroidism caused by a deficiency of thyroid-stimulating hormone.

**Thyroid Gland**

- Just below the Adam’s apple, is located what is known as the thyroid gland.
- The thyroid gland releases two main hormones, thyroxine and triiodothyronine.
- It produces hormones that affect the heart rate and how calories are burnt.
Functions

- Controls how quickly the body uses energy
- Hormones control growth rate and function of many system in the body
- These hormones play vital roles in regulating metabolism and organ function
Hormones produced

- **Thyroid hormone** – The body’s metabolic rate is controlled by this hormone.

- **Calcitonin** – It regulates calcium balance in species other than humans. Studies are still in progress to find its function in the human species.

Disorders

- Hyperthyroidism is characterized by excessive secretion of thyroid hormones

- Hypothyroidism is characterized by a deficient secretion of thyroid hormones

Pancreas
Pancreas, as most of us must be knowing, are the endocrine glands that are situated in the abdominal region, behind the stomach.

- Insulin and glucagons are known to be the important hormones produced by the glands.
• The hormones which get secreted into the bloodstream by these glands, serve to control proper digestion and blood sugar regulation
• Maintaining appropriate levels of sugar throughout the body.
• This gland produces insulin crucial to maintain blood sugar levels.

Hormones produced

• **Glucagon** – The blood sugar level raises with its help.

• **Insulin** – It helps in lowering the blood sugar level.

Apart from this, metabolism of sugar, protein, and fat are also carried out with its help.

Disorders

• Acute pancreatitis is a sudden attack causing inflammation of the pancreas and is usually associated with severe upper abdominal pain.
Chronic pancreatitis is the progressive disorder associated with the destruction of the pancreas.

- Hereditary pancreatitis
- Pancreatic cancer

**Adrenal Glands**

- On the upper side of the kidneys, are located these endocrine glands.
- In hormone production, there are two parts of these adrenal glands which comes into play.
- One is known as the adrenal cortex. It is known to steroid hormones, which are essential for digestion and sexual maturity.

The other is what is known as the adrenal medulla. Now the hormones that this part secretes, are although not essential to sustain life, but help the body to manage stress and improve the quality of life.
Functions

- Essential for digestion and sexual maturity

- This gland produces the hormones that control the sex drive, cortisol and stress hormone.
Hormones produced

- **Aldosterone** – Responsible for maintaining the salt and water balance in the body.

- **Cortisol** – The functions which regulate the blood sugar level, blood pressure, and muscle strength in the body is controlled by the cortisol.

- **Dehydroepiandrosterone (DHEA)** – It is related to the immune system, bones growth, and also to the mood of an individual.

- **Epinephrine and norepinephrine** – The nervous system is associated with it.

**Disorders**

- Cushing's syndrome
• Addison's disease.

Hypothalamus

• The hypothalamus gland is actually a part of the pituitary gland.
• The hormones that it secretes do the work of inducing the master gland, so that it can go on with its normal function.
• Growth-hormone-releasing hormone (GHRH), somatostatin, and dopamine, are the hormones which are released by this gland, which we discussed.

DIAGRAM OF HYPOTHALAMUS
Functions:

- Controls blood pressure
- Regulates body temperature, energy metabolism, and reproduction
- Directs responses to stress
- The hypothalamus also plays a role in the awareness of pleasure and pain, the expression of emotions, and sexual behaviors.

Hormones produced

- **Hormone-releasing hormone (GHRH)** – It is known as the growth hormone.
- **Somatostatin** – It works by regulating the endocrine system.
- **Dopamine** – It inhibits the release of prolactin from the anterior lobe of the pituitary gland.

Disorders
- Hypopituitarism.
- Hypothyroidism.
- Kallmann’s Syndrome.
- Neurogenic diabetes.

**Parathyroid Glands**

- These are located behind the thyroid gland, and that may be the reason they are known as parathyroid glands.
- They are there with the work of regulating the amount of calcium in the blood stream.

**Functions**

This gland helps in controlling the amount of calcium present in the body.

It helps the nervous and muscular system to function properly.
Hormones produced

- **Parathyroid hormone** – Calcium and phosphorus are eliminated from the body with the help of this hormone, which is also responsible for bone formation.

Disorders
- Hyperparathyroidism

**Pineal Gland.**

- It is at the base of the brain, and is responsible for alertness or consciousness of one’s self.
- Pineal is also known as the thalamus, it develops serotonin derivatives of melatonin, which can affect sleep.

*Diagram of Pineal Gland*

**Functions**
• The function of this endocrine gland is to secrete melatonin

Hormones produced

• **Melatonin** – Maintains the body’s circadian rhythm, apart from what has been mentioned in the earlier segment.

Disorders

• cancer,
• sexual dysfunction,
• hypertension,
• epilepsy,
• Paget's disease.
**Gonads**

Male gonads are known as the testes, and ovaries in case of females.

**Testes:**
- In men, the testes secrete the male sex hormone, testosterone.
- It also produces sperm.

**Ovaries:**
- In women, the ovaries secrete estrogen, progesterone, testosterone, and other female sex hormones.
Functions

- These glands produce hormones and cells that are vital to reproduction, in males and females.

Hormones produced

- **Estrogen** – The female sexual characteristics and the function of the reproductive system are influenced by the secretion of this hormone.

- **Progesterone** – It plays vital roles in pregnancy. For instance, it helps in preparing the lining of the uterus for the fertilized egg to get implanted.

- **Testosterone** – Men’s sexual characteristics and the nature of the reproductive system, involve the secretion of this hormones

Disorders
• Hypogonadism