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COORDINATION

This is the ability of an organism to detect and respond to changes in their internal and external environment. Living organisms integrate and harmonize functions of different parts, organs and organ systems to produce a response to stimuli, maintain homeostasis and achieve overall stability and control.

KEY DEFINITIONS

1. **Irritability/Sensitivity;** this is the ability of an organism to detect and respond to stimulus in the environment.
2. **Stimulus;** this is a change in the external or internal environment to which an organism responds.

For example;

EXTERNAL STIMULI; temperature, light, humidity, sound, touch, smell.

INTERNAL STIMULI; body temperature, blood sugar, carbon dioxide, salt concentration.

3. **Response;** this is a change in activity of an organism in reaction to a stimulus e.g. withdraw of a hand from a hot object.
4. **Impulse;** this is an electrical message transmitted along nerves in a nervous system.
5. **Effectors;** these are cells or organs in an organism that carry out a response to a stimulus e.g. muscles and glands.
6. **Receptors;** these are cells or organs that receive or detect a stimulus e.g. eyes, ears, nose, sensory endings in the skin etc.
7. **Internal environment;** this is the immediate surroundings of cells. In animals the internal environment is the blood and tissue fluid.
8. **External environment;** this is the surrounding of the entire organism.
9. **Sense organ;** is a group of sensitive cells/receptors that detect a given stimulus.
10. **Central nervous system;** this is the central part of the nervous system that consists of the brain and the spinal cord. It interprets and determines the nature of the response to the stimulus
11. **Hormone;** is an organic substance which is produced in small quantities and transported by blood to target organs where it exerts its effects. In animals, hormones regulate growth, development, reproduction and maintenance of Homeostasis.

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12. Neuron; is the basic structural and functional unit of a nervous system along which impulses are transmitted.

It is also called **nerve cell/nerve fibre**.

COORDINATION SYSTEMS IN ANIMALS

There are two main distinct coordination systems in mammals.

- 1. The nervous system;** This is a system of nerve cells and sensory organs that carry out coordination by transfer of impulses. It involves a network of message conducting cells called neuron cells connected to all body parts.
- 2. The endocrine system;** which is made up of a system of glands that produce chemical substances (hormones) for coordination.

CHEMICAL COORDINATION IN MAMMALS

COMPETENCY: the learner should be able to appreciate that there are organs in the body that secrete chemicals called hormones, which play vital roles in coordinating body functions.

LEARNING OUTCOMES: by the end of this chapter, the learner should be able to:

- ❖ Differentiate between hormones and enzymes.
- ❖ Know and understand the effects of various hormones in the human body.
- ❖ Know and describe the symptoms of common hormonal diseases in humans.
- ❖ Appreciate the role of diet in managing hormonal diseases in humans.

Chemical coordination in mammals involves the endocrine system of glands that secrete chemical substances called **hormones**.

A hormone is a specific chemical substance produced by glands and it is transported to a target organ to regulate the physiological activities in the body. It is an organic substance which is produced in small quantities and transported by blood to target organs where it exerts its effects

CHARACTERISTICS OF HORMONES

They are protein or steroid in nature.

They are produced and work best in small quantities.

Their effect on the target organ is either by stimulation or inhibition i.e. they regulate the activities of the target organs.

GLANDS

These are tissues or organs that produce and secrete chemical substances.

There are 2 types of glands i.e. **endocrine and exocrine**.

EXOCRINE GLANDS

These are glands that secrete their substances to their target organs through **ducts** i.e. these glands have ducts that connect and carry their chemical substances to their target organs hence they are called **duct glands**.

Examples:

- 1) Pancreas releases pancreatic juice.
- 2) Salivary gland has salivary duct that carries saliva into the mouth cavity.
- 3) Sweat glands
- 4) Tear glands

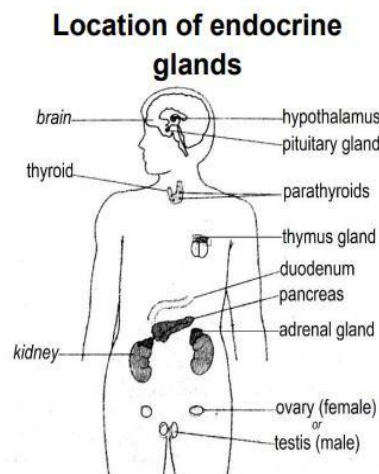
NOTE: The focus of this topic however is the endocrine glands.

ENDOCRINE GLANDS

These are **ductless glands** that secrete their hormones directly into the blood stream. The blood carries the hormones from the glands to their target organs hence endocrine glands are called ductless glands i.e. **have no ducts** e.g. **pituitary gland, thyroid gland, islets of Langerhans in pancreas** etc.

NB: The pituitary gland controls most though not all endocrine glands and is therefore known as the **MASTER GLAND**.

ENDOCRINE GLANDS



HORMONES OF THE ENDOCRINE GLANDS AND THEIR FUNCTIONS

1. PITUITARY GLAND:

It is found at the base of the brain immediately above roof of mouth. It's mainly controlled by the **hypothalamus**.

It controls activities of other glands thus called **master gland**.

It consists of two parts; **anterior pituitary** and **posterior pituitary**

It secretes two types of hormones i.e. **trophic hormones** and **non-trophic hormones**

Trophic hormones **control secretion of other hormones** by endocrine glands e.g. **thyroid stimulating hormone, follicle stimulating hormone** etc.

Non trophic hormones **affect activity of non-endocrine tissues**.

Gland	Hormone produced	Effects of the hormone
Anterior pituitary gland	Thyroid Stimulating Hormone (TSH)	It stimulates the thyroid gland to produce thyroxine hormone.
	Follicle Stimulating Hormone (FSH)	It stimulates egg development in females and sperm development in males. Stimulates the ovaries to produce oestrogen. Stimulates the ovary to produce progesterone.
	Luteinizing hormone (LH)	It induces ovulation in females. It causes the conversion of the Graafian follicle into corpus luteum in ovaries. It stimulates testosterone secretion in testes.
	Growth Hormone (GH) (somatotrophin)	It stimulates growth especially bones. Excess secretion in children results into gigantism and under secretion in children results into dwarfism characterized by stunted growth.
	Adrenocorticotrophic hormone (ACTH)	It stimulates the adrenal cortex to produce its hormones.

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		It stimulates lipid break down and release of fatty acids from fat cells.
Posterior pituitary gland	Anti-diuretic hormone (ADH)	It causes reabsorption of water in kidney nephrons (osmoregulation). Under secretion results into diabetes insipidus .
	Oxytocin	It brings about parturition (contraction of the uterus during birth). It stimulates milk flow from the mammary glands.

THE THYROID GLAND.

It is found in the neck region close to the larynx (voice box). This produces a hormone called **thyroxine**.

FUNCTION,

It controls the metabolic rate in organisms, being high when secreted and low when little quantity of hormone is present.

It also regulates tissue growth and development.

NB: among adults, too little secretion of thyroxine leads to overweight and sluggishness (Hypothyroidism) and too much secretion of it causes thinness and over activity (Hyperthyroidism).

Deficiency of thyroxine in infancy causes a type of mental deficiency known as cretinism which can be cured if identified early by administering thyroxine in the body. Cretinism is characterized by severe mental retardation, growth retardation, dry hair, short neck, arms and legs etc.

Thyroxine contains iodine. Lack of iodine results into little or no production of Thyroxine and causes the thyroid gland to increase in size a deficiency disease called **goiter**.

ADRENAL GLAND.

There are two adrenal glands, each situated above each kidney.

The gland is made up of two parts

A) ADRENAL CORTEX: This is the outer region of the adrenal gland.

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The adrenal cortex produces a hormone cortisone.

FUNCTION:

- ❖ Cortisone stimulates conversion of fats into glucose for cell respiration
- ❖ Cortisone stimulates conversion of amino acids into glucose for cell respiration.
- a) **ADRENAL MEDULLA:** this is the inner region of the adrenal gland. The adrenal medulla is stimulated by nervous impulses to produce a hormone known as **adrenaline**.

Adrenaline is produced in situations of **anxiety, excitement, feeling or when facing of danger**.

Adrenaline when secreted has the following **effects**;

- i) It increases the rate of heartbeat.
- ii) It increases the breathing rate.
- iii) It widens the pupils of the eyes.
- iv) It brings about conversion of glycogen to glucose in the liver.
- v) It increases the rate of respiration in order to ensure adequate supply of energy to body muscles.
- vi) Reduces blood supply to the skin and alimentary canal with more blood channeled to the muscles.

NB: Due to effects above, adrenaline is referred to as “**flight or fight**” hormone.

THE PANCREAS.

This consists of a tissue called **Islets of Langerhans** consisting of two groups of cells;

Alpha (α) cells and **beta (β) cells**.

The **α cells secrete Glucagon hormone while the β cells secrete Insulin hormone. These hormones regulate the levels of Glucose in the body.**

The normal level of Glucose in the body is about 90mg/100cm³.

When Glucose levels rise beyond normal e.g. after a meal:

- ✓ β cells secrete **insulin** hormone which stimulates the liver cells to; convert excess glucose into glycogen for storage, excess glucose to fats, increase metabolic rate.

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When Glucose levels in the body decrease below the normal e.g. during starvation:

- ✓ α Cells secrete **glucagon** hormone which stimulates the liver cells to; convert glycogen to glucose, fats to glucose, decrease metabolic rate

The glucose may be used during cell respiration to produce energy.

DIABETES MELITUS

Type 1 Diabetes (juvenile/ insulin-dependent diabetes).

This is a chronic condition in which the pancreas **produces little or no insulin** because the body's immune system attacks the islet cells in the pancreas that make insulin

Type 2 Diabetes.

It occurs **when the cells in the body don't respond properly to the insulin** that is produced (insulin resistance). This means that blood glucose levels may become very high and this is known as **Hyperglycemia**. This can result from impaired glucose uptake and excessive glucose production.

Symptoms of Diabetes melitus

1. Feeling more thirsty than usual
2. Urinating often
3. Losing weight
4. Feeling tired and weak (fatigue)
5. Having blurry vision.

Prevention and treatment

1. Cut sugar and refined carbohydrates from the diet
2. Quit smoking (causes insulin resistance)
3. Exercising regularly.
4. Eating healthy foods rich in fiber such as tomatoes and peppers.

THE DUODENUM

The presence of food in the duodenum stimulates the lining of the duodenum to produce a hormone called **secretin**.

Secretin moves in blood to the pancreas and stimulates it to produce pancreatic enzymes.

This ensures that the enzymes are produced when food is present.

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THE REPRODUCTIVE ORGANS/ GONADS (TESTES AND OVARIES)

The ovary in females produces two major hormones.

These are **oestrogen** and **progesterone**.

Oestrogen controls **secondary sexual characteristics in females such as;**

- ✓ Development of breasts.
- ✓ Growth of pubic hairs.
- ✓ Widening of hips.
- ✓ Enlargement of reproductive organs.
- ✓ Softening of muscles.
- ✓ Softening of the voice.

NB: Deficiency of Oestrogen causes delay in the development of secondary sexual characteristics in females.

Oestrogen also brings about **repair of the uterine lining after menstruation.**

 **Progesterone hormone is produced by the corpus luteum and placenta after ovulation and it is responsible for:**

- ✓ Thickening the endometrium for implantation
- ✓ vascularization the endometrium for implantation
- ✓ maintaining the endometrium for implantation
- ✓ Prevents constriction of uterus until the baby is due to be born.

In males the testes produce a hormone known as **testosterone**. This hormone **controls male sex characteristics**, which include;

- i) Deepening of the voice.
- ii) Growth of beards.
- iii) Toughening of muscles.
- iv) Widening of the chest.
- v) Enlargement of reproductive organs.
- vi) Growth of pubic hairs.
- vii) Sperm production.

NOTE: deficiency of testosterone causes delay in development of secondary sexual characteristics and inhibition of spermatogenesis

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PARATHYROID GLAND

It secretes parathyroid hormone (parat hormone) which has the following functions:

- ✓ Raises blood calcium levels.
- ✓ Lowers blood phosphate levels which affects the development of bones.

COMMON HORMONAL DISORDERS/DISEASES

These include: **osteoporosis, diabetes and goiter.**

OSTEOPOROSIS

This is a condition in which bones become weak and brittle.

Osteoporosis is more likely to occur in people who have **low calcium intake.**

It also results from over secretion of parathyroid hormone.

Low calcium intake contributes to diminished bone density, early bone loss and increased risk of fractures.

SIGNS AND SYMPTOMS

1. Losing an inch or more on your height.
2. Changes in one's natural posture (bending forward more).
3. Shortness of breath (if disks in the spine are compressed to reduce lung capacity)
4. Lower back pain and neck pain.
5. Brittle finger nails
6. Bone fractures.

PREVENTION

1. Eat foods that support bone health for example fresh fruits (containing calcium, vitamin D and protein)
2. Get active i.e. do exercised e.g. hiking, jogging, tennis, dancing
3. Avoid smoking.
4. Limit alcohol consumption.
5. Avoid caffeine.

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THYMUS GLAND.

This gland is close to the heart and well developed in young mammals but greatly reduced in adults.

It's responsible for formation of lymphocytes which defend body against pathogens.

COMPARISON BETWEEN HORMONES AND ENZYMES

SIMILARITIES

- ✓ Both are required in small concentrations for action.
- ✓ Both are specific in action; enzymes work on specific substrate while hormones affect only target organs and tissues.
- ✓ Both affect the body metabolism.
- ✓ Both are protein in nature.
- ✓ Both act within particular PH ranges.

DIFFERENCES

Hormones	Enzymes
Are composed of proteins or steroids.	Are mainly composed of proteins.
They can be influenced by other hormones.	They are not influenced by other enzymes.
They can act on more than one site.	They act on one particular site.
Hormones act upon tissues or cells in the body.	Enzymes act on substrates.
They can diffuse easily through the cell membrane.	They cannot diffuse through the cell membrane.
They are carried to their target organs through blood.	They are carried to their target organs through specific ducts or sometimes produced at the site of action.

RESEARCH ASSIGNMENT

- ❖ Explain the role of diet in managing hormonal disorders or diseases in humans.