COORDINATION continuation……

VI. HORMONAL COORDINATION IN ANIMALS

The endocrine system is made of a number of glands called **endocrine glands**. A gland is a structure which secretes a specific chemical substance. There are two types,

(i) Exocrine gland.

Is a gland which secretes its product into a duct. For example sweat gland, pancreas etc.

(ii) Endocrine gland.

Is a gland that secretes chemical substances called hormones. Endocrine gland has the following characteristics,

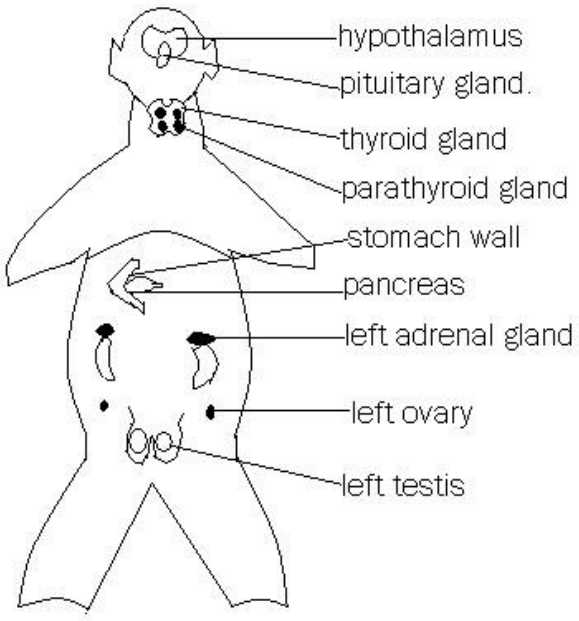
- It secretes chemicals called hormones.
- It has no duct (a ductless gland)
- It has a rich supply of blood with a relatively large number of blood vessels.

-Some glands can possess both exocrine and endocrine functions for example pancreas.

A hormone is a chemical messenger or a substance that causes a response in specific cells or organs called target cells or organs. Hormones have the following properties,

- It is carried in blood.
- It has its effect on the site different from the site where they are secreted that is they exert their effects on target cells at a site different from where they are secreted.
- They are specific in their actions. This is because they have active sites that fit precisely into specific receptor molecules on the target cells.
- It is small soluble organic molecule.
- It works best in minute or low concentrations.

DIAGRAM SHOWING THE LOCATION OF THE MAJOR ENDOCRINE GLANDS IN MAN.



GENERAL FUNCTIONS OF HORMONES (SIGNIFICANCE OF HORMONE ACTION)

i. Regulation of growth and development.
ii. Controls homeostasis e.g. in osmoregulation/thermo regulation etc.
iii. Regulation of metabolism e.g. digestion storage and utilization of food substances.
iv. Development of the skin coloration.
v. Enabling the body to withstand shock, tension, wounding etc and to recover from it.
vi. Together with the nervous system it provides for effective responses to all kinds of stimuli both internal and external.

MECHANISM OF HORMONE ACTION (HOW HORMONES WORK)

There are two mechanisms which describe how hormones work,

- Use of a second messenger mechanism/Peptide hormone mechanism.
- Steroid hormone mechanism.

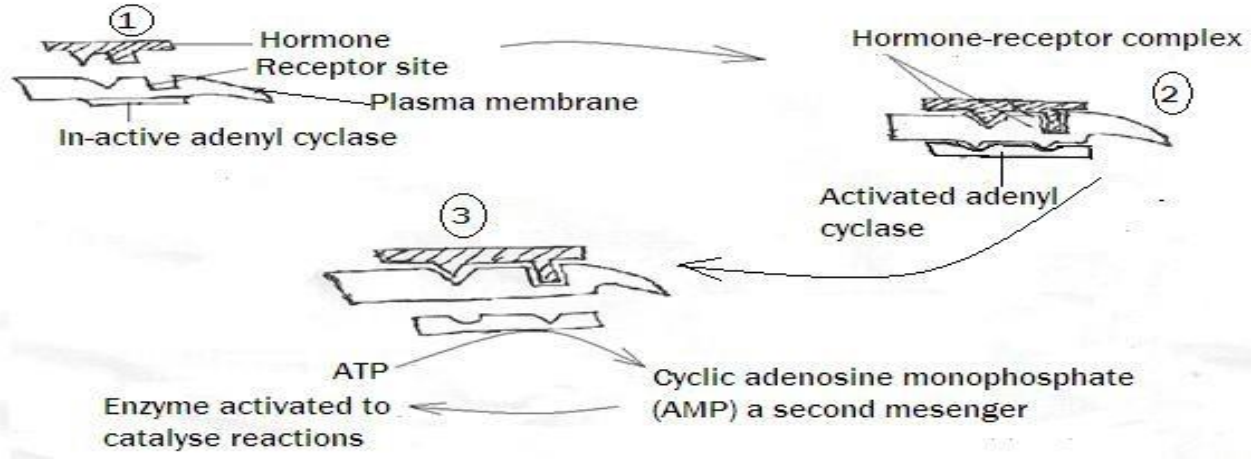
USE OF A SECOND MESSENGER (PEPTIDE) HORMONE MECHANISM.

Most of these hormones affect their target cells by **a signal-transduction mechanism**. The hormone binds onto receptor molecules in the cell membrane, a hormone–receptor complex is formed, which activates a G-protein (Guanine nucleotide-binding protein) in the cell membrane, the G-proteins further activate the enzyme adenyl cyclase which is found within the cytoplasm of the cell. This enzyme formed catalyses conversion of ATP to a second messenger cyclic Adenine Monophosphate (cAMP). Hormone is the first messenger. The Cyclic Adenine monophosphate is a second messenger which activates an enzyme that that catalyses a reaction which ends with activation of another enzyme, resulting into a complex chain reaction known as **cascade effect** that amplifies the response to the first messenger the hormone that is few molecules of the hormones on the cell membrane triggers production of a very large response. In this reaction each enzyme molecule activates many molecules of its substrate into becoming the next enzymes in the chain catalyzing further reactions.

In the case of action of hormone Adrenaline, cyclic AMP activates the enzyme protein kinase which in turn activates a phosphorylase enzyme. Phosphorylase enzymes then catalyses break down of glycogen to glucose phosphate molecules. The later enters a glycolytic pathway and systematically broken down to release energy inform of ATP molecules.

Examples of hormones that work under peptide mechanism include Adrenaline, Glucagon, Parathyroid hormone, Noradrenaline and oxytocin. These hormones are small hydrophilic molecules.

DIAGRAM SHOWING THE SECOND MESSENGER MECHANISM



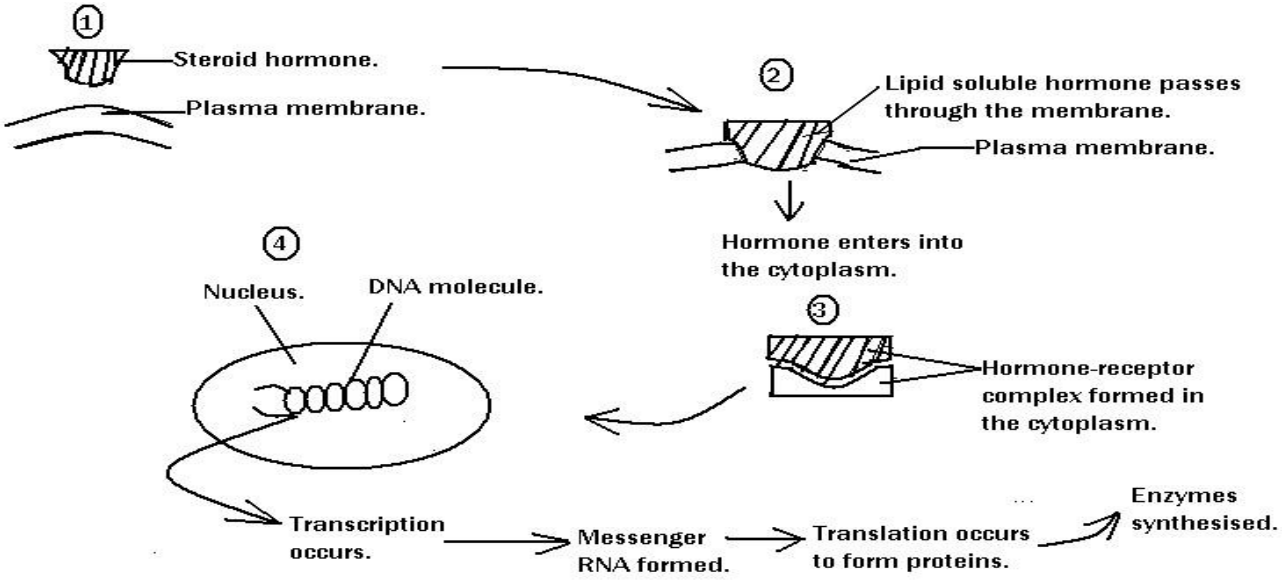
STEROID HORMONE MECHANISM.

The hormones are lipid soluble and enter the cell by passing through the cell membrane into the cytoplasm. While in the cytoplasm of the cell, the hormone combines with specific receptor proteins to form a hormone-receptor complex. The receptor protein moves the hormone into the nucleus. The hormone-receptor complex enters the nucleus, the hormone-receptor complex attaches on a DNA molecule of the target cell, triggering transcription of messenger RNA from specific gene. The target cell makes specific proteins such as enzymes and other hormones that produce a response.

Target cells are those cells whose response is caused by hormones.

Examples of hormones that work under the steroid hormone mechanism include Oestrogen, progesterone, testosterone, thyroxine, corticosteroids, etc.

STEROID HORMONE MECHANISM ACTION



Hormones exert their influence by acting on the molecular reactions in cells. They achieve this by one or more of the following cells processes.

i. Protein synthesis e.g. growth hormones.
ii. Enzyme activity e.g. Adrenaline.
iii. Exchange of materials across the cells membrane e.g. insulin.

FACTORS CAUSING RELEASE OF HORMONES

Hormones are released into the blood stream as a result of;

i. Stimulation of the endocrine gland directly by the nervous system e.g. the sympathetic nervous system causes secretion of adrenaline by the adrenal medulla.
ii. The levels of particular metabolites in the blood e.g. glucose levels trigger the release of insulin.
iii. Presence of other hormones called releasing hormones mostly produced in anterior pituitary e.g. TSH stimulates the release of thyroxin by the thyroid gland.
iv. Environmental changes such as high or low temperatures effects activities of the pituitary gland.
v. Animals' general mental states do affect the activity of the pituitary gland.

THE PITUITARY GLAND

It is also referred to as the master gland. This is because the larger number of hormones produced by pituitary gland directly stimulates other endocrines glands to secrete their hormones. The hormonal secretion by the pituitary glands intern depends upon the information received from the hypothalamus. The pituitary gland is further divided into two distinct portions and these include.

i. Anterior pituitary.
ii. The posterior pituitary.

The pituitary gland is closely influenced by the hypothalamus of the brain. In this ways, environmental changes, and the animals general mental state do influence hormonal activity. The hypothalamus communicates with the Pituitary by means of nerve impulses and chemical substances called impulses and chemical substances called releasing factors.

THE ANTERIOR PITUITARY

Is a region of glandular tissue which communicates with the hypothalamus by means of tiny blood vessels. It produces hormones which directly influences the activities of other endocrine glands. These hormones are called trophic hormones. The only non-trophic hormone is growth hormone which affects body tissues in general.

THE POSTERIOR PITUITARY.

This is an outgrowth of the hypothalamus and communicates with the hypothalamus by nerves. This portion of the pituitary gland stores two hormones.

- Anti-diuretic hormone (ADH) or vasopressin
- And oxytocin

Both hormones are secreted by the hypothalamus and stored in the posterior pituitary gland.

HORMONES SECRETED BY PITUITARY GLAND AND THEIR FUNCTIONS.

These include the following;

(i) Thyrotrophic hormones (thyroid stimulating hormone, (TSH)

- This causes thyroid glands to secrete thyroxine. Deficiency of TSH results into less thyroxine secreted and excess of TSH causes more thyroxine secreted. The secretion of TSH is controlled by levels of thyroxine in blood (-ve) feedback)
- Stimulates the growth of the thyroid gland

(ii) Adreno-corticotrophic hormone (ACTH)

- This causes the adrenal cortex to secrete adrenal cortical hormones.
- Regulates the growth of the adrenal cortex.

(iii) Human Growth hormone;

- Stimulates growth.
- Increases level of blood sugar.
- Promotes growth of skeleton and muscles.
- Controls protein synthesis and general body metabolism.

Deficiency of growth hormone causes dwarfism in young children and its excess causes gigantism in young children and acromegaly in adults.

(iv) Prolactin (luteotrophic hormone)

- Stimulates mammary glands to secrete milk in pregnant women.
- Maintains progesterone production from corpus luteum.
- Production is inhibited by high level of oestrogen and progesterone.

(v) Follicle stimulating hormone (FSH)

- Causes spermatogenesis in male.
- Causes development of Graafian follicle and secretion of oestrogen in female.
- Excess of FSH causes damage to seminiferous tubules.
- Its production is controlled by levels of oestrogen and progesterone (inhibition)

(vi) Leutenising hormone (LH) or interstitial cells stimulating hormone (ICSH)

- Causes secretion of androgens in males.
- Causes ovulation and developmental of corpus luteum in female.

Oestrogen stimulates production of LH and ICSH, while progesterone inhibits their production.

Note: Follicle stimulating hormone (FSH), Leutenising hormone (LH) or interstitial cells stimulating hormone are collectively referred to as Gonadotrophic hormones.

HORMONES FROM POSTERIOR LOBE OF PITUITARY GLAND

(a) Anti-Diuretic hormone (*ADH*) or vasopressin.

- Causes reabsorption of water in kidney with accompanying rise in blood pressure.
- Raises blood pressure by contracting arterioles.
- Deficiency of ADH causes diuresis and low blood pressure. The secretion of ADH is controlled by solute concentration of blood.

(b) Oxytocin (Pitocin)

- Causes contraction of uterus at parturition (birth).
- Stimulates secretion of milk by mammary glands.
- Deficiency of oxytocin causes delayed parturition, while the excess results into the premature parturition.
- Secretion of oxytocin is controlled by levels of oestrogen and progesterone (inhibits).

(c) Melanophore-stimulating. (MSH)

- Causes expansion of melanin pigment in chromatophores (melanophores) in skin, particularly of amphibians etc.

THE HYPOTHALAMUS

It is found lying at the base of the brain; it is connected to numerous nerves. It performs many vital functions which include;-

(i) It regulates activities such as thirst, sleep, temperature control, hunger, feeding.
(ii) It monitors the level of hormones and other chemicals in the blood passing through it.
(iii) It controls the functioning of the anterior pituitary gland.
(iv) It produces anti-diuretic hormone and oxytocin which are stored in the posterior pituitary gland.

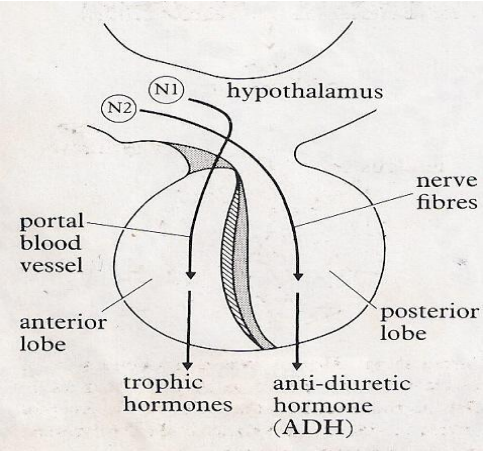
The hypothalamus is the link between the nervous and the endocrine system. By monitoring the level of hormones in the blood, the hypothalamus is able to exercise homeostatic controls of them. E.g. controls of thyroxine production by the thyroid gland.

CONNECTION BETWEEN THE PITUITARY GLAND AND THE HYPOTHALAMUS OF THE BRAIN

The anterior and the posterior parts of the pituitary project down the tween brain, the hypothalamus. In the hypothalamus there are two nerve centres referred to as N_1 and N_2. N_1 is connected to the anterior lobe of pituitary by the portal blood vessels which has capillaries at both ends when N_1 is stimulated hormones known as releasing factors are secreted into the portal vessels by cells in the hypothalamus. The releasing factors are then carried by the blood in the portal vessel to the anterior lobe where they regulate the secretion of its various hormones. There is specific releasing factor for each hormone produced by the anterior lobe of pituitary N_2 is connected to the posterior lobe by nerve fibres (axons) which perform two functions which are;

- They carry anti-duiretic hormone (ADH) from N_2 to the posterior lobe where it is stored and appropriately transmit nerve impulses from N_2 to the posterior lobe, causing the ADH to be released.

DIAGRAM SHOWING CLOSE CONNECTION BETWEEN PITUITARY AND HYPOTHTALAMUS OF THE BRAIN



NEURO-SECRETION

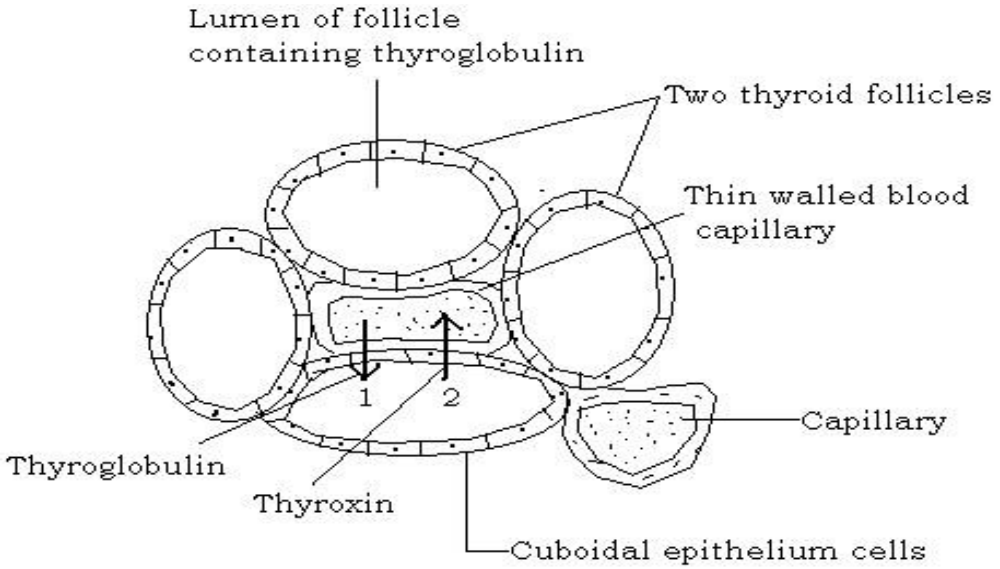
Is the release or production of specific hormones by nerve cells and the nerve cells that do it are called **neuro secretory cells**. For example the hormones shed from the posterior lobe of the pituitary gland such as the anti-diuretic hormone (ADH) and the oxytocin. Neuro-secretion also occurs in insects where the insects brain produce brain hormone called prothoracicotrophic hormone; neurones of sympathetic nervous system produce noradrenaline.

THE THYROID GLAND.

The thyroid gland consists of numerous follicles in close association with thin walled blood capillaries. Iodine taken up into the follicles by active transport a cross the cells, is combined with tyrosine and stored in the follicle in combination with a protein as thyroglobulin. It is liberated into the blood streams as thyroxine.

The iodine required for the synthesis of the thyroxine is obtained from the diet and it's taken up into cells from blood stream by active transport. The follicles contain an in active precursor of the hormone, thyroglobulin which is thyroxine conjugated with a protein.

STRUCTURE OF THYROID GLAND



The thyroid gland produces three hormones triiodothyronine (I_3). Thyroxin (I_4) and calcitonin. Triiodothyronine and thyroxine are derivative of the amino acid tyrosin and both contain iodine. Thyroxine possesses four iodine molecules while triiodothyronine has only three. In shortage of iodine triiodothyronine is produced in preference to thyroxine.

HORMONES SECRETED FROM THYROID GLAND AND THEIR FUNCTIONS.

(i) Thyroxine/triiodothyronine
- Controls basal metabolic rate.
- Promotes metamorphosis in amphibians.
- Regulate the growth and development of cells.
- Increase the rate at which glucose is oxidized resulting to the generation of heat. The hormone thyroxine is produced when an organism is exposed to severe cold. Emotional stress, and hunger may elicit the similar production of the hormone. The overall effect is to control the metabolic rate of cells and as such the hormone thyroxine works in close connection with insulin, adrenaline and cortisone.

(ii) Calcitonin is concerned with calcium metabolism. It works with the parathormone to control the levels of calcium ions (Ca^{2+}) in blood. Calcitonin is produced in response to high levels of Ca^{2+} in blood and it causes reduction in the calcium ions concentration.

REGULATION OF THYROXINE PRODUCTION.

Thyroxine production is controlled by the hypothalamus of the brain by the process of the negative feedback. When the levels of Thyroxine is low in blood, it is detected by the hypothalamus, the hypothalamus is stimulated to secrete Thyrotropin releasing factor (TRF) The shedding of thyroxin into the blood stream is triggered by thyrotropin releasing factor. TRF passes to the pituitary gland along the portal blood vessels. The TRF stimulates the anterior pituitary gland to produce thyroid stimulating of hormones (TSH) or thyrotrophic hormone . TSH then stimulates the thyroid gland to produce thyroxin.

A slight excess of thyroxin in blood, inhibits the anterior lobe of the pituitary gland which responds by secreting less thyrotrophic hormone. (Thyroid stimulating hormones) This in turn reduces the activity of the thyroid gland, leading to decrease in the amount of thyroxine produced. This removes the inhibitory influence on the pituitary so that more thyroids stimulating hormone will be produced again.

Note: Thyroxine is responsible for controlling the basal metabolic rate and therefore important in growth.

Basal metabolic rate (BMR) Is the minimum amount of energy required to maintain basic body physiological functions such as blood circulation; breathing and the body temperature.

ABNORMALITIES OF THE THYROID GLAND

There are two main thyroid abnormalities and these are;

(i) Hyperthyroidism.
(ii) Hypothyroidism.

HYPERTHYROIDISM

Is an increased activity of the thyroid gland, producing in excess the hormone thyroxine. It is caused by the blood protein which stimulates the thyroid gland to increase its production of thyroxine and triiodothyronine.

Hyperthyroidism can have the following effect in an organism

- Increased metabolic rate, resulting into increased heart and ventilation rate and raised body temperature.
- Nervousness, restlessness and irritability occur.
- A goitre may become apparent.
- Heart failure may occur in extreme cases, a condition called thyrotoxicosis.

Control of hyperthyroidism is a achieved by the surgical removal of the thyroid gland or administration of radioactive iodine.

HYPOTHYROIDISM

Is the decreased rate of activity of the thyroid gland, produce less amounts of the hormone thyroxine. It is caused by insufficient supply of thyroid stimulating hormone. It has a marked effect in both young and adult individuals and these include;

In young, individuals the effects include;

- Mental and physical retardation and sluggishness occur, condition called **cretinism.** In adults, it has the following effects;
- Mental and physical sluggishness.
- Reduced metabolic rate which results into reduced heart and ventilation rate and lowered body temperature and obesity. A condition known as **myxoedema**.
- A swelling around the neck (throat) called goiter may arise. Hypothyroidism can be controlled by taking thyroxin orally.

THE PARATHYROID GLANDS

They produce a single hormone parathormone. This hormone maintains the level of blood calcium at sufficiently high levels to permit normal muscle and nervous activity. It raises the levels of calcium ions in the blood in three ways;

- Increases the rate of calcium reabsorption by the kidney at the expense of phosphate ions.
- It increases the rate of calcium absorption from the gut.
- It causes the release of calcium reserves from the bones.
- Excess of parathormone leads to excessive removal of calcium from bones which thus becomes brittle and liable to fracture. Excessive calcium is removed by the kidneys causing the formation of kidney stones.

Under production of parathormone results in a low level of blood calcium, leading to nervous disorders and uncontrolled contraction of muscles known as tetany.

THE ADRENAL GLANDS

These are situated above each kidney. The size of the adrenal gland is closely linked to the out put of ACTH and the ability to withstand stress. They have two separate and independent parts and these are;

(I) The Adrenal cortex.

(II) The Adrenal medulla.

THE ADRENAL CORTEX

This is the outer region of the gland. It makes 80% of the gland. All the hormones are steroid hormones and are collectively called **corticoids (Adrenal cortical hormones)**. All steroid hormones are formed from a molecule called cholesterol which the cortex is able to synthesis and also take up from the blood circulation following absorption from the diet. Steroid hormones function under the steroid hormone mechanism. They are divided into two groups.

(i) Glucocorticoids.

(ii) Mineraloccarticoids.

GLUCOCORTICOIDS (CORTISOL)

They have the following functions,

- **In carbohydrate metabolism.**
  - (i) Promote gluconeogenesis, this is the breakdown of proteins and fats to glucose and conversion of lactic acid to glucose.
  - (ii) Promote liver glycogen formation.
  - (iii) Raise blood glucose level.
- **Protein metabolism.**
  - (i) Promote breakdown of plasma protein.
  - (ii) Increases availability of amino acids for enzyme synthesis in the liver.
- **Other functions,**
  - (i) Prevent inflammatory and allergic reactions.
  - (ii) Decrease antibody production.

Overactivity of the adrenal cortex can be caused by over production of Adrenocorticotrophic hormone (ACTH) by the anterior pituitary gland, resulting into higher concentration of the glucocorticoid (cortisol) hormones in the blood stream. It leads to Cushings' disease and the patients show the following,

- Abdominal obesity.
- Wasting of muscles.
- High blood pressure.
- Diabetes.
- And increased hair growth.

Underactivity of the adrenal cortex is caused by the low production of ACTH by the pituitary gland and results in low levels of the hormone glucocorticoid in blood and the victim suffers a condition called Addison's disease syndrome as shown by,

- Muscular weakness.
- Low blood pressure.
- Decreased resistance to infection.
- Fatigue.
- And darkening of the skin.

THE MINERALOCORTICOID HORMONE (EG. ALDOSTERONE).

This includes the hormone aldosterone which regulates water retention by controlling the relative concentration of sodium ions (Na^+) and potassium ions (K^+).

It controls water and salt content of the body by stimulating cations pumps in the membranes to conserve sodium and chloride ions and remove potassium ions. It prevents excessive sodium ion loss in sweat, saliva and urine and maintains concentration of body fluids at a steady state.
Low levels of sodium ions in blood or a reduction in the total volume of blood causes special cells in the kidney to produce renin, which activates a plasma protein called angiotensin. This stimulates production of aldosterone from the adrenal cortex. Both water and sodium ions are conserved. Angiotensin also affects centres in the brain creating a feeling of thirst and water is taken, which helps restore the blood volume to normal.
Over production of aldosterone is caused by tumour and leads to excessive sodium retention by tissues high blood pressure and head ache fall in levels of potassium ions arises causing weakness.
Under production of aldosterone leads to a fall in level of sodium in the tissues; retention of potassium ions water loss and fall in blood pressure.

SEXCORTICOIDS (ANDROGENS)

These are also steroid hormones, they promote development of testes and male secondary sexual characteristics. Their deficiency results into weakness; circulatory failure; addison's disease, etc while its excess causes sexual precosity in young male.

CONTROL OF CORTICAL HORMONE RELEASE.

- Mineralocorticoid (aldosterone) release is stimulated by the activity of the rennin and angiotensin as described above.
- Glucocorticoids are secreted in response to Adrenocorticotrophic hormone (ACTH). An example of the role of ACTH in regulating the release of the glucocorticoid hormone cortisol is an example of cascade effect.

Cortisol is mainly produced in response to stress. In stressful conditions like shock, pain, emotional distress, extreme cold or infection, the hypothalamus induces the anterior pituitary gland to secrete ACTH. This stimulates the adrenal cortex to increase secretion of glucocorticoid hormones including cortisol, where the stress is prolonged the size of the adrenal gland increases. The glucocorticoid hormones combat (reduce) stress in the following ways,

- Raise the blood sugar level by inhibiting insulin and increasing formation of glucose from fats and proteins.
- Increasing the rate of glycogen formation in the liver. Increase uptake of amino acids by the liver.

THE ADRENAL MEDULLA

Is the inner region of the adrenal gland. It produces two hormones, the adrenaline and noradrenaline. These hormones are also called "flight or fight hormones." The effects of both hormones are to prepare the body for exertion and heighten its response to stimuli.

THE EFFECTS OF ADRENALINE SECRETION TO THE BODY

Adrenaline is secreted only during times of excitement, fear or stress. The table below shows the importance of some of its effects in the body

Effects.	**Purpose.**
1. Dialates bronchioles.	- More air inhaled into the lungs and oxygen made available for respiration.
2. Dialates pupils of the eye.	- Increases range of vision and allows increased perception of visual stimuli.
3. Increases mental awareness	- Allows rapid response to stimuli and decision made faster.
4. Increases heart rate and stroke Volume	- Increases transport of metabolites and oxygen supply to cells and removal of wastes.
5. Vaso-constriction of most arterioles.	- Increased blood pressure.
6. Conversion of glycogen to glucose in liver	- More glucose available for cell metabolism
7. Peristalsis and digestion inhibited	- Allows blood to be delivered vital - organs e.g. brain, heart, muscle.
8. Hair erector-pili muscles contract.	- Hair stands upright, gives impression of increase size, frightens away enemies.

OTHER ENDOCRINE GLANDS,

These are,

- Pancreas.
- Testes.
- Ovaries.
- Stomach walls.
- Pineal body.
- Duodenal wall.
- Placenta.

THE PANCREAS

Alpha cells of the islets of langerhans produce the hormone glucagon. This raises blood sugar by stimulating the break down of glycogen to glucose. While the beta (β) cells of the islets of langerhans produce the hormone insulin. This lowers the levels of blood sugar by stimulating the conversion of glucose to glycogen and subsequent oxidation of glucose to provide energy.

TESTES

Produces the hormone testosterone. This produces male secondary sex characteristics and promote growth and activity of male reproductive organs.

OVARIES

The follicle cells of the ovary produce the hormone oestrogen. It has the following function.

- Promote development of female reproductive organs and secondary sexual characteristics.
- Repair uterus following menstruation.
- Promote development of mammary glands but prevent milk secretion. Its excess causes loss of appetite and feeling of nausea controlled by FSH.

Corpus luteum of the ovary produce the progesterone hormone. This hormone promotes proliferation and thickening of uterine wall and development of mammary glands. It inhibits ovulation and secretion.

PINEAL BODY

This produce the melatonin. It is thought to promote sexual development in males and causes concentration of melanin in pigment cells of frog.

WALLS OF STOMACH

Secrets the hormone gastrin which causes secretion of gastric juice by gastric glands in stomach wall.

WALL OF DUODENUM

- Secretin causes secretion of non-enzymatic component of pancreatic juice by pancreas and production of bile by liver.
- Cholecystokinin causes bile to flow from gall bladder to duodenum by causing contration of gall bladder and relaxation of sphincter muscles where bile duct joins duodenum, it also causes pancreas to produce enzymes.

Note:

- Cholecystokinin-pancreozymin has similar functions to cholecystokinin.

- The hormone enterogastrone; inhibits secretion of acid by the stomach wall.

PLACENTA

Produces Human chorionic gonadotrophin; it maintains the presence of the corpus luteum in the ovary. Corpus luteum secretes progesterone, a role which is taken over by placenta at later stage of gestation.

TABLE SHOWING CHEMICAL NATURE OF THE MAJOR HORMONES OF THE BODY.

CHEMICAL GROUP	HORMONES	MAJOR SOURCE.
(i) Peptides and proteins	• Growth hormones, oxytocin, ADH (vasopressin), • Parathormone • Calcitonin • Insulin, glucagon • Gastrin, • secretin	• Posterior pituitary gland. • Parathyroid gland. • Thyroid gland. • Islets of langerhans (pancreas) • Stomach mucosa. • Duodenal mucosa.
(ii) Amines.	• Adrenaline. • Noradrenaline • Thyroxine and Triiodothyronine. • Releasing and inhibiting hormones and factors of the hypothalamus. • Follicle stimulating hormone, Luteinising hormone, prolactin, Thyroid stimulating hormone and Adreocorticotrophic hormone.	• Adrenalin medulla •Sympathetic nervous system and adrenal medulla. • Thyroid gland. • Hypothalamus. • Anterior pituitary gland.

(ii) Steroids	• Testosterone. • Oestrogen, progesterone • Corticosteroids.	• Testis. • Ovary and placenta. • Adrenal cortex.
(iii) Fatty acids.	• Prostaglandins.	• Many tissues.

INSECT HORMONES

Most invertebrate hormones are neurosecretory substances. In insects they are important in the control of ecdysis (moulting). These are two main hormones

- Ecdysone (moulting hormone)
- and neotinin (Juvenile) hormone.

The production of ecdysone and neotinin is controlled by the brain of the insects as follows;-

The brain produces brain hormone called **prothoracicotropic hormone** which passes to a pair of bodies called the corpora cardiaca which lie next to the brain. This is where the hormone is stored.

In response to external stimuli e.g. day length, temperature, food supply, the brain sends nerve impulses to the corpora cardiaca stimulating them to release their stored brain hormone.

The prothoracicotropic hormone released, passes to the prothoracic glands, which are stimulated to produce ecdysone (moulting hormone).

Neotinin (Juvenile hormone) is produced by a region behind the brain called **corpus allatum**.

In insects with complete metamorphosis (holometabolous) all moults require ecdysone. But if neotinin is also present in high concentration the larval moult produces larval stage. At low concentration of neotinin, the ecdysone causes the larva to moult into pupa.

In the absence of neotinin; ecdysone causes the pupa to moult into an imago (adult)

The production of neotinin diminishes during the insects development but is resumed in the adult.

COMPARISON BETWEEN HORMONAL AND NERVOUS COORDINATION

SIMILARITIES:

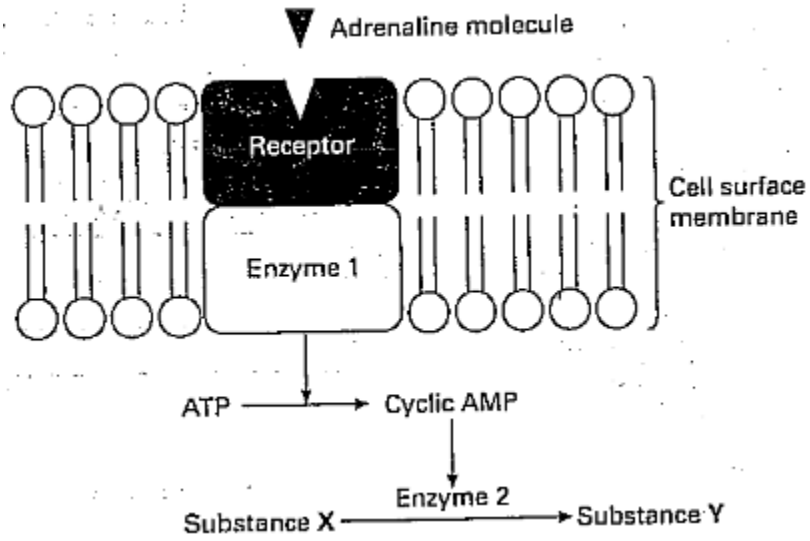
- Both provide a means of communication and coordination in the body.
- In both the information transmitted is triggered by a stimulus and produces a response.
- Both involve chemical transmission.
- Both are controlled by the brain.

DIFFERENCES

HORMONAL COORDINATION	NERVOUS COORDINATION
1. The speed of transmission is slower.	1. The speed of transmission is more rapid.
2. The duration of effect is long lasting.	2. Is short lived.
3. The message is chemical in nature.	3. The transmission of message is electrical in nature.
4. Hormones are transmitted in blood.	4. Impulses are transmitted in nerves (neurones)
5. The site of origin of message is specific endocrine gland.	5. The site of origin of the message is all over the body.

Exercise 6

1. The diagram summarises the way in which adrenaline can control a chemical reaction in a liver cell



(a) Describe the function of cyclic AMP in this process

(b) Give one example of a chemical reaction in a liver cell which is controlled by adrenalin by naming

(i) Substance X

(ii) Substance Y

(c) **Use** the diagram to explain

(i) Why adrenaline may affect some cells and not others

(ii) How a single molecule of adrenalin may cause this cell to produce a large amount of substance Y

2. Discuss the

(i) principles and functions of chemical coordination in living organisms

(ii) role of hormones in the life of mammals

3. (a)Describe what is meant by the term endocrine system (03 marks)

(b) explain why the pancreas is described as both exocrine and an endocrine organ (03 marks)

(c) In each case, state two likely effects on a mammal of

(i) over-production of thyroxine (02 marks)

(ii) under -production of insulin (02 marks)

4. (a) Define the term hormone

(b) Describe how hormones released by the hypothalamus and pituitary gland affect the functions of the;

(i) thyroid gland

(ii) ovaries

(iii) Kidney

(c) suggest reasons why hormonal rather than nervous stimuli are used to control these processes.