

## Chapter :- Control and coordination

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### Introduction :-

- All living organism including plants and animals react to environmental factors called stimuli.
- They react to stimuli in different ways :-
  - Plants bends towards light but animals don't
- The working together of various organs of an organism in a systematic manner to produce proper response to the stimuli is called coordination.
- In multicellular organisms specialized tissue are used for control and coordination activities.
- Chemical coordination is seen in both plants and animals and is responsible for growth and development.

### Control and coordination in Animals :-

- In animals two kinds of coordination are present
  - Nervous (Brain)
  - chemical (hormone)
- The nerves coordination is brought by the nervous system.

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system and the chemical coordination by (endo)  $\times$  endocrine or hormonal system.

→ In lower animals like hydra and insects coordination is through the nervous system only. But in higher animals the coordination takes place through both Nervous and chemical means.

Nervous System :-

→ The main parts of the nervous system are brain, spinal cord and nerves.

→ Neurons are the structural and functional unit of the nervous system. It is the longest cell in the human body.

→ Synapse is the functional junction between the neurons. It is the point of contact between terminal branches of the axon of one neuron with the dendrites of another neuron. There is no cytoplasmic connection between the two neurons.

Types of Neuron :-

→ Neurons are of 3 types :-  
 - Sensory neuron (receptor)  
 - Motor neuron (effector)  
 - Relay neuron

Sensory Neuron :-

→ These often occur in the sense organ and stimuli by their dendrites.

Motor Neuron :-

→ This transmit impulse from central Nervous system (CNS) towards the effector organ.

Relay Neuron :-

→ These serve as a connecting link between sensory and motor neuron.

Sensory Receptors :-

→ There are 5 sense organ through which animals received the stimulus :-  
 - eyes  
 - ears  
 - nose  
 - tongue  
 - skin

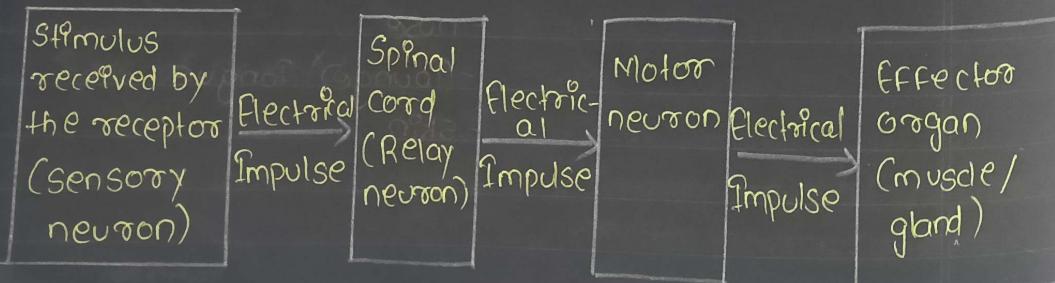
→ The receptors are photo receptors for light (eyes), phono receptor for sound (ears), gustato receptors (Tongue) for taste, Olfactory receptors for smell (nose) and thermo receptors for touch (skin).

### Reflex Action :-

→ These are spontaneous, automatic and involuntary response of effectors to a stimulus which is monitored through the spinal cord.

- Ex:- Blinking of the eyes in response to a foreign particle.  
 - Sneezing or coughing  
 - Watering of the mouth at the sight of tasty food  
 - Immediate withdrawal of hand on touching a hot object unknowingly.  
 - Withdrawal of the leg while walking bare feet if we step on a nail.

→ The pathway taken by the nerve impulse in a reflex action is called reflex arc.



### Parts of the nervous system :-

- Human nervous system consists of two main parts:
- Central Nervous System (CNS)
  - Peripheral Nervous System (PNS)

### Central Nervous System (CNS) :-

- This consists of brain and spinal cord.
- The brain and spinal cord are protected by a pair of skeleton called skull or cranium or brainbox and vertebral column respectively.

### Brain :-

- There are 3 layers of the brain :-
- Inner layer (Piamater)
  - Middle layer (Arachnoid)
  - Outer layer (Durameter)

→ It is the highest coordinating centre in our body.

→ It is surrounded by three membranes called meninges which provide protection to it.

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→ There is a space between these three meninges which is filled with a fluid called cerebro spinal fluid (CSF) which protect brain from mechanical shock.

→ The brain is broadly divided into 3 regions :-

- forebrain
- Midbrain
- Hindbrain

→ Forebrain :-

→ It is the main thinking part of the brain.

→ It includes :-

- Cerebrum
- Olfactory lobe
- Diencephalon

Cerebrum :-

→ It consists of two cerebral hemispheres (left and right).

→ They joint together by a broad curved thick band of nerve fibres called corpus callosum.

→ Each cerebral hemisphere is divided into 4 lobes.

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The name of 4 lobes are :-

- Occipital lobe (region of sight)
- Temporal lobe (region of hearing)
- Frontal lobe (region of speech, facial muscular activities and higher mental activities)
- Parietal lobe (for taste, smell, touch and consciousness)

→ cerebrum is the most important part of the brain as it is the seat of memory, mental activities, reasoning, speech, consciousness.

Olfactory lobes :-

→ These are paired, club shaped structures consisting of anterior olfactory bulb and posterior stalk each.

→ These are concerned with the sense of smell.

Diencephalon :-

→ It lies on the inferior side of the cerebrum.

→ Its roof is called Epithalamous; sides are called

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thalami and the floor is called hypothalamus.

- Hypothalamus has control centre for hunger, thirst, (fatigue) sleep, body temperature, sweating and emotions. It secretes neurohormones which regulates the secretion of (lobe) interior lobe of pituitary.

(Hind b) Mid brain :-

- These connects the forebrain to the hindbrain.
- It controls the movement of eye muscle, change in pupil size. as well as shape of eye lens, the head, the neck and the trunk.

Hindbrain :-

- These consist of 3 parts :-
  - cerebellum
  - Pons varolii
  - Medula oblongata

Cerebellum :-

- It lies at the roof the hind brain.
- This region controls the coordination of body movements and postures.

Pons varolii :-

- This lies just above the medulla oblongata and participate in regulating respiration.

Medulla oblongata :-

- This lies at the floor of the hind brain.
- It controls the heartbeat, breathing movements, expansion and contraction of blood vessels to regulate Blood pressure, swallowing, coughing, sneezing and vomiting.

Spinal cord :-

- It is a cylindrical structure that begins in continuation with the Medula oblongata of the hind brain and extend downward upto lumbar region.
- Spinal cord is surrounded by membrane called meninges.
- 31 pairs of nerves arises from the spinal cord.
- It performs two important functions that are :-

- It conducts sensory and motor impulse to and from the brain.
- It acts as a centre of reflex action.

→ Thus it reduces brain's work.

→ It has 5 regions that are :-

- Cervical cord (8 pairs, C<sub>1</sub> - C<sub>8</sub>)
- Thoracic cord (12 pairs, T<sub>1</sub> - T<sub>12</sub>)
- Lumbar cord (5 pairs, L<sub>1</sub> - L<sub>5</sub>)
- Sacral cord (5 pairs, S<sub>1</sub> - S<sub>5</sub>)
- Coccygeal cord (1 pair)

### Peripheral Nervous System (PNS) :-

→ It constitutes the cranial, spinal and visceral nerves.

→ Cranial nerves arise from the brain and spread throughout the head. There are 12 pairs of cranial nerves.

→ Cranial nerves I, II, VII are sensory nerves. Cranial nerves III, IV, VI, XI, XII are called motor nerves. Whereas, cranial nerves V, VII, IX, X are mixed nerves.

→ Spinal nerves arise from the spinal cord along its length and spread throughout the body except the head. There are 31 pairs of spinal nerves.

→ Spinal nerve in the neck region are of 8 pairs are called cervical nerves, 12 pairs in the chest region called thoracic nerves, 5 pairs in the hip region called sacral nerves and 1 pair in the coccyx region called coccygeal nerves.

→ Coccyx is the last bone of the vertebral column.

→ Visceral nerves arise mostly from the spinal cord but a few arises from the brain. Various activities of the internal organ like heart, kidney, lungs, urinary bladder, blood vessel, glands etc are controlled by these visceral nerves.

### Autonomic Nervous System :-

→ It means self governing nervous system.

→ It operates involuntarily or automatically.

→ It includes all the responses against the stimuli which

are not under the control of animal.

→ It is also called as visceral Nervous System.

→ It can be classify functionally into 2 systems

- Sympathetic Nervous System

- Parasympathetic Nervous System

→ Both the systems have involuntary opposing effects.

If one system exerts stimulatory effects on an organ then the other system exerts inhibitory effects.

Their effects are tabulated in the following table.

Organs	Sympathetic Nervous System	Parasympathetic N.S.
Heart	Increase contraction and rate of heartbeat	Decreases contraction and rate of heartbeat
Blood vessels	Constriction of Blood vessels	Dilation of Blood vessels
Lungs	Dilates bronchi and bronchioles	Constricts bronchi and bronchioles
Eyes	Dilates pupil	Constrict pupil

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organs	S.N.S	P.S.N.S
Stomach	Inhibit secretion of gastric juice.	stimulate secretion of gastric juice
Salivary gland	Inhibits secretion of saliva	stimulates secretion of saliva
Urinary bladder	Induces relaxation	Induces contraction
Reproductive organs	Reduces blood flow	Increases blood flow

### Chemical coordination in Animals :-

→ Nerve impulse can reach only those animal cell which are connected by nervous tissue.

→ In others words cells can't continuously generate and transmit electrical impulses. This is the reason why most of the multicellular organism use another means of communication between cells known as chemical coordination / chemical system / endocrine system / hormonal system.

→ It is mediated by chemicals called hormones secreted by various endocrine glands.

→ The two systems (nervous and endocrine) operate in a

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coordinated manner on many occasions. Many important functions of endocrine system are in fact under the control of nervous system. Therefore, the two systems are collectively known as neuroendocrine system.

### Nervous Coordination

- It is sent as an electrical impulse along axons and as a chemical impulse across synapse.
- Information travels rapidly in mill second.
- Information is directed to specific receptors - one or few nerve fibres, gland cells or other neurons that is it is addressed by names.
- Responses immediate.
- Responses short lived.
- Responses generally more prolonged.

### Hormonal coordination

- It is sent as a chemical messenger through blood and lymph.

→ Information travels slowly.

→ Information is spread throughout the body by blood from which the target cells or organs pick it up. That is it is addressed to whom it may concern.

→ Responses usually slow.

- Endocrine gland are also known as ductless glands as they have no ducts and their secretion are poured directly into the blood.
- Hormones are effective to our body in trace amount. Excess or deficiency of hormones leads to serious diseases.
- i. Hormones secreted by Hypothalamus :-  
 (a) Releasing hormone :-  
 → These hormones stimulates anterior and intermediate lobe of pituitary gland.
- (b) Inhibitory hormone :-  
 → This hormone inhibits the secretion of anterior and intermediate lobe of pituitary gland.
- ii. Hormones secreted by anterior of pituitary :-  
 (a) Growth Hormone (GH) / Somatotrophic Hormone (STH) :-  
 → It controls overall development / growth of the body, muscle and tissue.

Disorders :- i) Hypersecretion - gigantism (long height)  
ii) Hyposecretion - dwarfism (short height)

### (b) Thyroid stimulating hormone (TSH) :-

→ This controls the growth and function of Thyroid gland.

→ It also stimulates the thyroid gland to produce thyroxine.  
Iodine is necessary for the production of thyroxine. Disorders -  
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### (c) Adrenocorticotropic Hormone (ACTH) :-

→ This stimulates the Adrenal cortex to secrete cortisol  
hormone.

### (d) Gonadotrophic Hormone :-

→ It stimulates the gonads

### (e) Follicle stimulating hormone (FSH) :-

→ In males it stimulates the process of spermatogenesis  
(Sperm formation).

→ In females it stimulates the follicle cells in the ovaries to develop into mature eggs and also stimulates to produce oestrogen.

### (f) Luteinizing Hormone (LH) :-

→ In males it stimulates the secretion of male hormone called testosterone.

→ In females it stimulates the secretion of oestrogen and progesterone.

### (g) Prolactin Hormone (PRC) :-

→ This hormone enhances the mammary gland development and milk production in the female.

### iii. Hormone secreted from the Intermediate lobe of pituitary gland :-

#### (a) Melanocyte stimulation hormone (MSH) :-

→ This hormone stimulates the synthesis of melanin in skin.

→ Hypersecretion causes hyperpigmentation.

IV Hormone secreted by the posterior lobe of pituitary gland:-

(a) Oxytocin :-

- This hormone stimulates the contraction of smooth muscle at the time of child birth.
- It also helps in milk ejection from the mammary gland.

(b) Vasopressin / Anti-diuretic hormone (ADH) :-

- This hormone regulates water and electrolyte balance in body fluid.

Disorders :- Hyposecretion causes over production of urine leading to diabetes insipidus hypersecretion causes excessive dilution of blood and decrease in sodium level in plasma.

V Hormone secreted by Thyroid gland :-

(a) Thyroxine :-

- This hormone stimulates the rate of cellular oxidation and metabolism.

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Disorders :- Hyposecretion in children causes cretinism (retarded growth and under developed sex organs)

- In adults, it leads to development of goitre.
- Hypersecretion results in Gravé's disease (exophthalmic goitre with bulging eyes)

(c) Calcitonin :-

- This hormone lowers calcium level by suppressing release of calcium ions from the bones when calcium level is high in blood.

Disorders :-

Hyposecretion increases calcium level in blood.

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vi. Hormone secreted by parathyroid gland :-

(a) parathyroid hormone / parathormone / cui's hormone :-

→ This hormone regulates calcium and phosphate level in the blood.

→ It has an opposite action with that of calcitonin.

Disorder :- Hyposecretion causes decrease in the calcium contained of the blood called Hypocalcemia.

- Hypersecretion causes demineralization of the bones and teeth leading to hypercalcemia.

vii. Hormone secreted by pancreas :-

(a) Insulin :-

→ This regulates the conversion of glucose to glycogen (decrease blood glucose level).

Disorder :- Hyposecretion causes diabetes mellitus in which sugar level in the blood increase.

- Hypersecretion leads to the decrease in blood sugar level resulting in a condition called insulin shock.

(b) Glucagon :-

→ This regulates the conversion of glycogen back to glucose results in increase in the blood sugar level.

Disorder :- Hyposecretion causes hypoglycemia

viii. Hormones secreted by Adrenal Gland :-

(a) Glucocorticoids (Cortisol)

→ This regulates the metabolism of proteins fats and carbohydrates in our body.

→ This also regulates heart rate and blood pressure.

Disorder :- Cushing's syndrome.

It is caused by excess of Glucocorticoids, which results in the high blood sugar, sugar in the urine rise in the blood volume and high blood pressure.

(b) Mineralocorticoids & Aldosterone :-

→ This regulates water and mineral balance in our body.

Disorder :- Addison's disease

- This is caused by deficiency of glucocorticoids and mineralocorticoids.

- Its symptoms are low blood sugar, vomiting, diarrhea and nausea.

- Aldosteronism (Conn's disease)

This cause by the excessive production of mineralcorticoids.

Its symptoms are high blood pressure, rise in blood volume and polyuria.

(c) Gonadocorticoids (Sex corticoids) :-

→ Sex corticoids means endrogenes and oestrogenes.

→ These hormones stimulate the development of secondary sexual characters both in males and females.

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Disorder :- Adrenal virilism - males

- Appearance of male characters in female called virilism.

- Excessive production of endrogenes produces male secondary sexual characters like beard, mustache and hoarse voice in women.

Gynaecomastia :-

Appearance of female character in males. It is the development of enlarged mammary gland in males. It is due to the excessive secretion of oestrogen in males.

ix. Hormone secreted by Adrenal Medulla :-

(a) Adrenalin and Non-adrenalin :-

→ Non-adrenalin regulates blood pressure under normal condition. It causes constriction of blood vessels, increase activity of heart, dilation of pupil etc.

→ Adrenalin is secreted at the time of emergency and almost same affects as non-adrenalin.

Disorder :- - hyposecretion causes low blood pressure :-

- hypersecretion causes high blood pressure.

x) Hormones secreted by Gonads (Ovaries and Testes) :-

(a) Ovaries :-

→ This secretes oestrogens and progesterone - role in ovulation.

→ Ovulation helps in preparation of uterus to receive the fertilised egg.

→ Progesterone helps in the maintenance of pregnancy.

→ Oestrogen is also responsible for development of secondary sexual characteristics in females.

Disorders of ovaries in females :-

→ Hyposecretion of oestrogen leads to failure of development of secondary sexual characters.

→ Hypersecretion of progesterone causes abortion in a pregnant female.

→ Hyposecretion of progesterone causes abortion in a pregnant female.

(b) Testes :-

→ This secretes the hormone called testosterone.

→ This regulates growth development and controls the secondary sexual characters in males.

Disorder :- Hyposecretion causes failure of development of secondary sexual characters.

x) Hormone secreted by pineal gland :-

(a) Serotonin :-

→ This helps in vasoconstriction of blood vessels.

(b) Melatonin :-

→ This reduces quantity of FSH and LH, acts as a anti-gonadotropic.

→ This also promotes sleep.

XII. Hormones secreted by Thymus gland :-

a) Thymosin :-

→ This stimulates development and differentiation of lymphocytes and also hastens sexual maturity.

Coordination in Plants :-

→ In plant control and coordination is not as highly developed as in animals. However, plants respond to external stimuli like light, touch, gravitational force and other stimuli.

→ Plants, in fact, show two different types of movement. On the basis of growth - one is dependent on growth and the other is independent of growth. Both these types of movements are affected by action of plant hormones called phyto hormones. Thus plant posses only chemical coordinates.

Plant Movements :-

→ Plant show 2 different type of movement  
- Nastic Movement (Independent of growth)  
- Tropic Movement (Dependent on growth)

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Nastic Movement :-

→ These movements are independent of growth directional movement.

Seismonastic Movements :-

→ The movements that occur in response to stimuli. These movements are very quick and seen in touch the plant.

→ As the touch me not plant responses me not to plant responses to touch stimuli. This phenomena is commonly called Thigmotaxis.

Nyctinastic Movement (Sleep movement) :-

→ This process involve the diurnal variation in the position of flowers and leaves of many plants in day and night. This movement include photonastic and thermo-nastic.

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### Phototactic Movements:-

→ If the diurnal movements in the position of plant parts like flower and leaves are caused by stimulus of light, such a non-directional movement is called phototactic movement.

E.g. Dandelions flowers which open in the morning in bright light and close in the evening when the light fades -

### Thermotactic Movements:-

→ If the diurnal variation in the position of plant parts like flower and leaves are caused by a change in temperature of the surrounding. Such a non-directional movement is called thermotactic movements.

E.g. The leaves of the Rhododendrons curl up and close during low temperature

### Tropic Movements:-

→ These directional movement occurs either towards the stimulus or (away from) away from stimulus.

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If the movement of the plant part is towards the stimulus it is called positive tropism. And if the movements of the plant parts is away from the stimulus, it is called negative tropism

### Phototropism:-

It is the movement of a plant part in response to light.

Shoots generally grow towards the light hence are called (+)ve phototropic while roots grow away from the light hence are called (-)ve phototropic.

### Geotropism:-

It is the upward and downward growth of shoots and roots respectively in response of earth or gravity. Roots are generally (+)ve geotropic. It moves in the direction of gravity while shoots are (-)ve geotropic which moves against the direction of gravity.

### Chemotropism:-

It is the movement of a plant part in response to

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chemical stimulus. The movement of plant parts towards the chemical is said to be (+ve) chemotropic while the movement of the plant parts away from the chemical is said to be (-ve) chemotropic.

E.g. The growth of the pollen tubes towards the ovule during fertilisation in a flower is the best example of (+ve) chemotropism.

Hydrotropism :-

→ It is the movement of the plant parts in response to water. Bending of the roots towards water shows (+ve) Hydrotropism.

Plant Hormones :-

→ Phytohormone is a chemical substance which is produced naturally in plants to regulate translocation and many physiological processes.

Types of plant hormone :-

→ These are synthesised in the shoot apex and developing seeds.

function :-

- This promotes cell enlargement and cell differentiation.
- They cause apical dominance (a phenomenon in which presence of apical bud doesn't allow growth of nearby lateral buds)
- This regulates important plant growth movements.
- This induces parthenocarpy (formation of seedless fruits without fertilisation).

E.g- Banana, pineapple

Gibberellins (Gibberellic acid) :-

These are synthesised in apical buds, root tips and developing seeds.

functions :-

- They overcome seed dormancy and helps during seed germination.
- This promotes growth in stem and fruit.
- This also induces parthenocarpy in many plants.

### Cytokinins -

→ These are synthesised in roots, endo-sperm regions of seeds, young fruits, etc.  
functions :-

- This promotes cell division in plants.
- This helps in breaking the dormancy of seeds.
- This delays the ageing in leaves.
- This also promotes fruit growth.

### Ethylene :-

These are synthesised in almost all parts of the plant.

#### functions :-

- + It promotes growth and ripening of fruits.
- It helps in breaking the dormancy in buds and seeds.
- It promotes the yellowing and senescence (loss of cell division and growth) of leaves.

### Abscisic Acid (ABA) / stress hormone (-ve regulates) :-

→ These are synthesised in many plant parts but abundantly inside chloroplast.

#### functions :-

- It promotes the dormancy in seeds and buds and thus inhibits (stop) the growth.
- It promotes the closing of stomata and thus affects (makes dry) the leaves.
- It also promotes the falling of leaves (abscission) and senescence in leaves.

\* opening of stomata is done by Auxin<sup>1</sup> and cytokinin<sup>2</sup> (more less).

### photoperiodism :-

→ The effect of photoperiod (day length) on germination of seeds and flowering plants is called photoperiodism.

Short day plants :-

→ Plants that flower on photoperiods shorter than critical day length

E.g. Tobacco plants

Long day plants :-

→ Plants that flower on photoperiods longer than the critical day length

E.g. wheat plant

Day neutral plants :-

→ These plants don't require specific photoperiods to flower.

E.g. Cucumber, Maize, Tomato