

SCIENCE

(Biology)

Chapter 7: Control and Coordination



Control and Coordination

For survival, an organism's body must respond correctly to various stimuli it receives.

Some important terms:

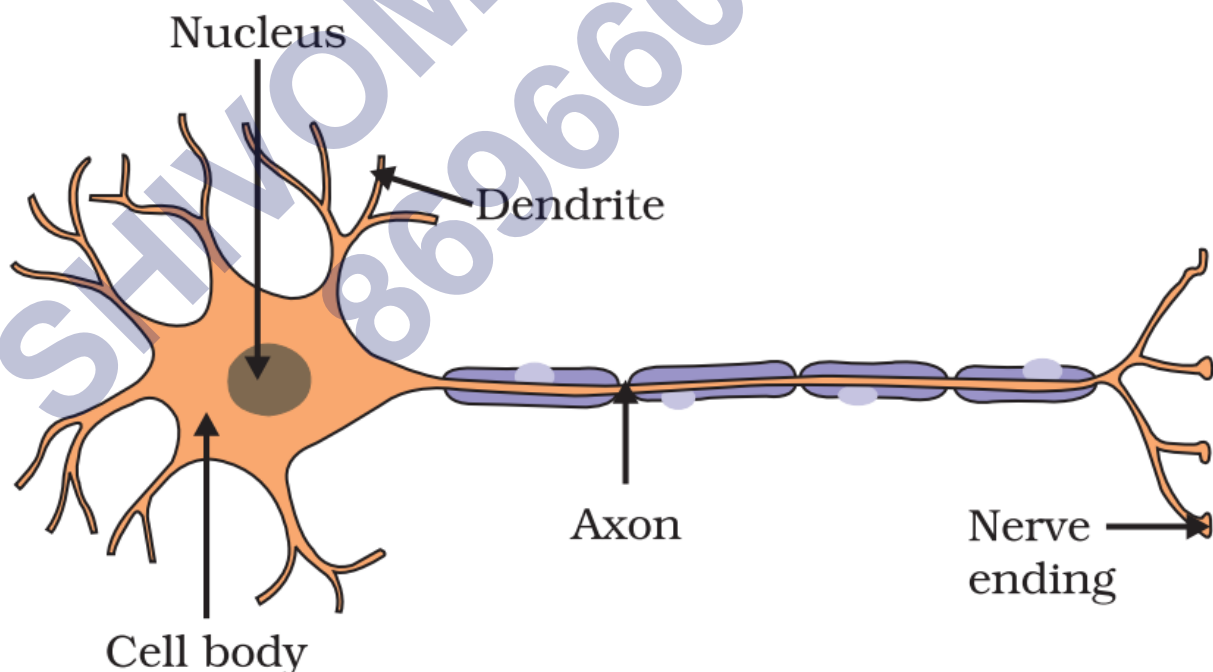
- **Stimulus:** An agent or sudden change in the external or internal environment which causes a change in an organism or any of its body parts.
- **Response:** The change in organisms resulting from a stimulus.
- **Receptors:** Nerve cells which initiate waves of impulses towards the central nervous system on receiving a stimulus.
- **Effectors:** Muscles or glands which contract or secrete substances on receiving an impulse from the brain or spinal cord.

Functions of the Nervous System

- Keeps us informed about the outside world through sensory organs.
- Controls and harmonises all voluntary muscular activities. Example- running and writing.
- Enables us to remember, think and reason.
- Regulates involuntary activities such as breathing and beating of the heart.

Neuron

A **neuron** is the structural and functional unit of the nervous system.



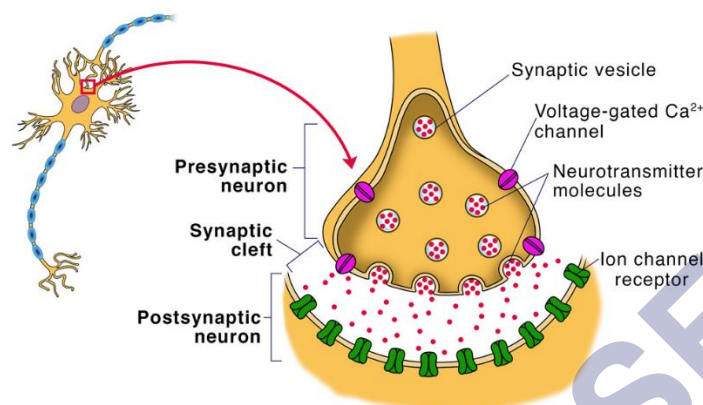
The three main parts of a neuron are:

- **Cell Body-** It has a well defined nucleus and granular cytoplasm.
- **Dendrites-** Dendrites are branched cytoplasmic projections of the cell body.
- **Axon-** It is a long process of the cell body. The end portions of the axons have swollen bulb-like structures which store neurotransmitters.

Synapse

- The **synapse** is the point of contact between the terminal branches of the axons.

Synapse



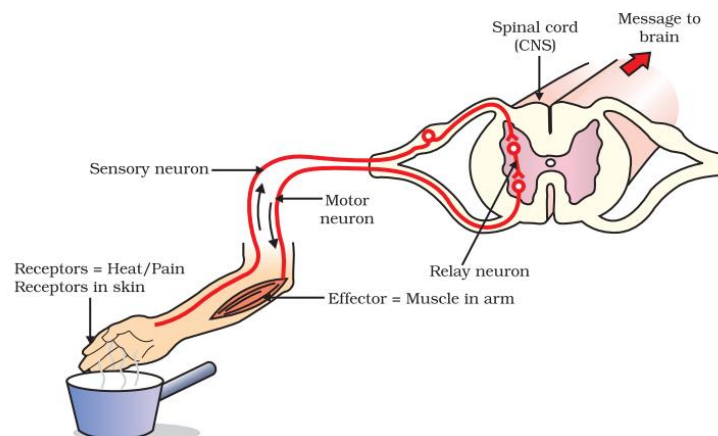
- Axon terminals of a neuron and the dendrites of another neuron are separated by a fine gap, i.e. a synaptic cleft.
- The nerve impulse is sent across the synaptic cleft with the help of the neurotransmitter acetylcholine.

Reflex Action

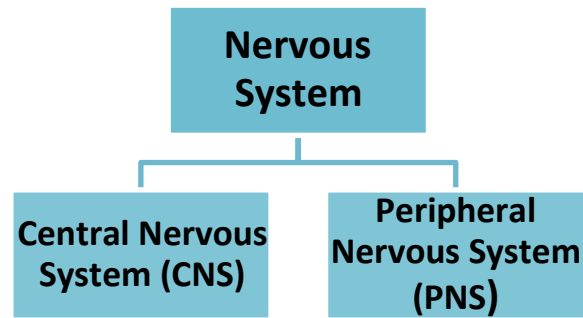
- Involuntary actions in response to external or internal stimuli are termed as **reflex actions**.
- The peripheral nervous system and spinal cord are involved in controlling reflex actions.
- The path travelled by the impulse during a reflex action is called a reflex arc.
- A reflex arc can be represented as follows:
Stimulus → Receptor in the sense organ → Afferent (sensory) nerve fibre → CNS (spinal cord) → Efferent (motor) nerve fibre → Muscle/Gland → Response

Examples of Reflex Arc

- When you touch a hot object, you withdraw your hand from it immediately.
- Shivering when it is too cold or sweating when it is too hot.
- Dilation of the pupils of the eye to look in the dark and *vice versa*.
- When you smell your favourite dish, your mouth waters.



Divisions of the Nervous System

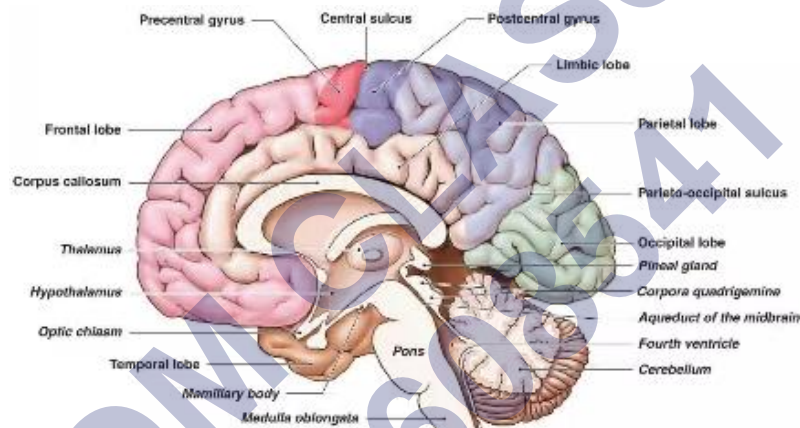


The Central Nervous System

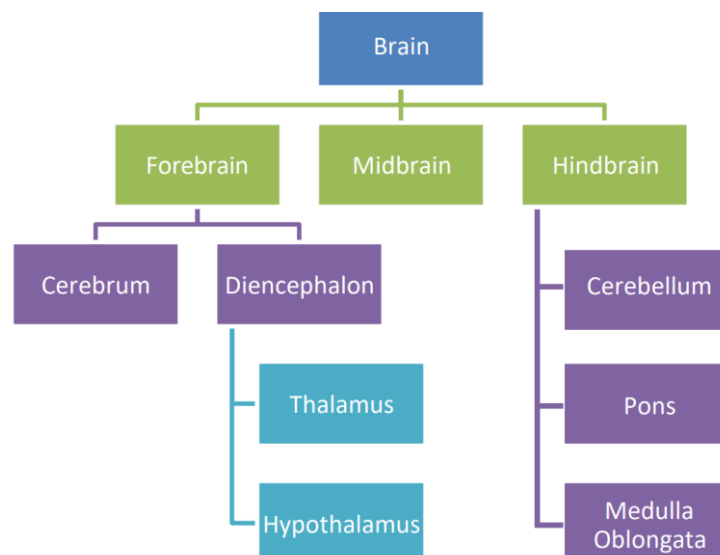
The central nervous system includes the brain and the spinal cord.

A. The Brain

- The human brain is the largest among all animals.



- It is well protected by the cranium or the skull.
- Three membranous coverings called meninges cover the brain.
- Inflammation of the meninges is called meningitis.
- The space between the covering membranes, central spaces of the brain and the central canal of the spinal cord is filled with **cerebrospinal fluid**.
- Three primary regions of the brain are forebrain, midbrain, and hindbrain.

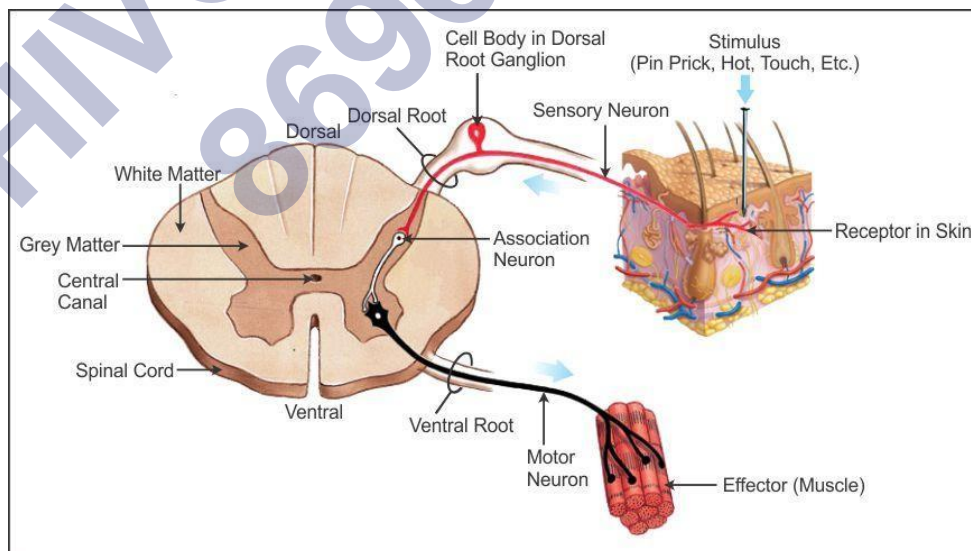


Parts of the Brain

1. Cerebrum	<ul style="list-style-type: none"> It is divided into two cerebral hemispheres connected to each other by the corpus callosum. The walls have an outer cortex and inner medulla. The cortex contains cell bodies of the neuron and is greyish in colour; hence, it is called grey matter. The medulla consists of axons of the nerve fibres and is called white matter.
2. Cerebellum	<ul style="list-style-type: none"> It is located at the base of the cerebrum. It has numerous furrows.
3. Medulla Oblongata	<ul style="list-style-type: none"> It is located at the base of the skull. It is roughly triangular. It continues behind the brain as the spinal cord. Injury to the medulla oblongata results in death.

B. The Spinal Cord

- Extends from the medulla oblongata down to almost the whole length of the backbone and ends at the second lumbar vertebra.
- The grey matter is on the inner side and white matter is on the outer side of the spinal cord.
- The spinal cord is responsible for reflexes below the neck.
- It conducts sensory impulses from the skin and muscles to the brain.
- It conducts motor responses from the brain to muscles of the trunk and limbs.



Peripheral Nervous System

- The Peripheral Nervous System consists of nerves which carry impulses to and from the central nervous system.
- The Somatic Nervous System is made up of 12 pairs of cranial nerves and 31 pairs of

spinal nerves.

- Cranial nerves emerge from the brain and spinal nerves originate from the dorsal and ventral roots of the spinal cord.

Coordination in Plants

Nastic Movements

- The movement of a plant in response to an external stimulus, in which the direction of response is not determined by the direction of stimulus, is called **nastic movement**.
- Nastic movements are shown by flat parts of the plants such as leaves and petals.
- Example: Daisy flowers close at dusk and open at daybreak; this may be referred to as sleep movements.
- This response however should not be confused with thigmotropism as the folding of leaves always occurs in the same direction irrespective of the direction of the stimulus.
- Two types of nastic movements are:
 - A. Photonasty** is a nastic movement to the light and dark phases of the day.
Example- Flowers of primrose blossom during the evening but close during the day.
 - B. Nyctinasty** is the movement in response to dark. Certain parts of a plant such as the leaves and flowers take up a different posture at night than that in the day.
Example- Leaves of the rain tree fold by nightfall.

Movement Due to Growth

The movement of plant organs towards or away from a stimulus is known as **tropism**.

Since the tropic movements are slow, the stimulus needs to be continued for a longer time for the effects to be noticed.

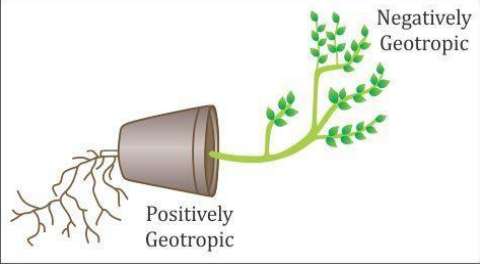
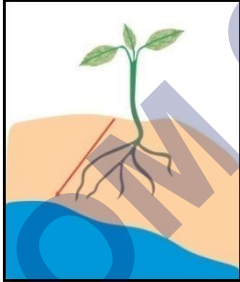

The different types of tropic movements in plants are:

1. Phototropism

- The movement of plant parts towards or away from light is termed as phototropism.



- Because shoots of most plants grow towards the source of light, it is termed as positive phototropism.
- Roots grow away from light and hence are negatively phototropic.

<p>2. Geotropism</p>	<ul style="list-style-type: none"> The movement of plant organs in response to gravity is termed as geotropism.  <ul style="list-style-type: none"> Roots are positively geotropic because they grow in the direction of gravity. The shoot grows upwards, i.e. against gravity, and hence is negatively geotropic.
<p>3. Thigmotropism</p>	<ul style="list-style-type: none"> The movement of plant organs in response to stimuli caused by physical contact with solid objects is termed thigmotropism. Weak-stemmed plants use twining stems and tendrils to climb on other plants/objects which provide them support. Hence, twining stems and tendrils are positively thigmotropic.
<p>4. Hydrotropism</p>	<ul style="list-style-type: none"> The movement of plant organs in response to water is termed hydrotropism.  <ul style="list-style-type: none"> Roots grow towards the source of moisture and hence are positively hydrotropic.
<p>5. Chemotropism</p>	<ul style="list-style-type: none"> The movement of plant organs in response to a chemical stimulus is called chemotropism.  <ul style="list-style-type: none"> When plant organs grow away from the chemical response it is called negative chemotropism. When plant parts grow towards the chemical response it is called positive chemotropism. For example, pollen tubes grow towards the sugary substance secreted by the stigma of the flower.

Plant Hormones (Phytohormones)

Plant hormones control some aspects of the growth of plants such as cell division, cell enlargement and cell differentiation.

Phytohormones	Description
1. Auxins	<ul style="list-style-type: none"> Promote growth of plants. They are secreted by the cells present in the tip of stems and roots. Synthetic auxins are used in horticulture.
2. Gibberellins	<ul style="list-style-type: none"> Promote cell differentiation in the presence of auxins. They break seed dormancy. Stimulate elongation of shoots.
3. Cytokinins	<ul style="list-style-type: none"> Promote cell division in plants. Delay ageing of leaves. Promote opening of stomata. Promote fruit growth.
4. Abscisic Acid	<ul style="list-style-type: none"> Acts as a growth inhibitor. It promotes dormancy in seeds and buds. Promotes closing of stomata. Promotes wilting and falling of leaves. Detachment of flowers and fruits from the plants is due to abscisic acid.

Hormones in Animals

Hormones	Functions	Disorders
1. Adrenaline Produced by the adrenal glands.	<ul style="list-style-type: none"> Adrenaline prepares the body for the fight and flight mechanism. 	
2. Thyroxine Secreted by the thyroid gland.	<ul style="list-style-type: none"> Regulates carbohydrate, protein and fat metabolism. It increases the basal metabolic rate (BMR). It regulates body growth such as ossification of bones and mental development. 	<ul style="list-style-type: none"> Simple goitre Ophthalmic Goitre Cretinism
3. Growth Hormone Secreted by the anterior lobe of the pituitary gland.	<ul style="list-style-type: none"> It is essential for normal growth. 	<ul style="list-style-type: none"> Dwarfism Gigantism
4. Insulin Secreted by pancreas	<ul style="list-style-type: none"> Regulates the blood glucose (sugar) level. 	<ul style="list-style-type: none"> Diabetes Mellitus High concentration of sugar in blood (hyperglycemia).

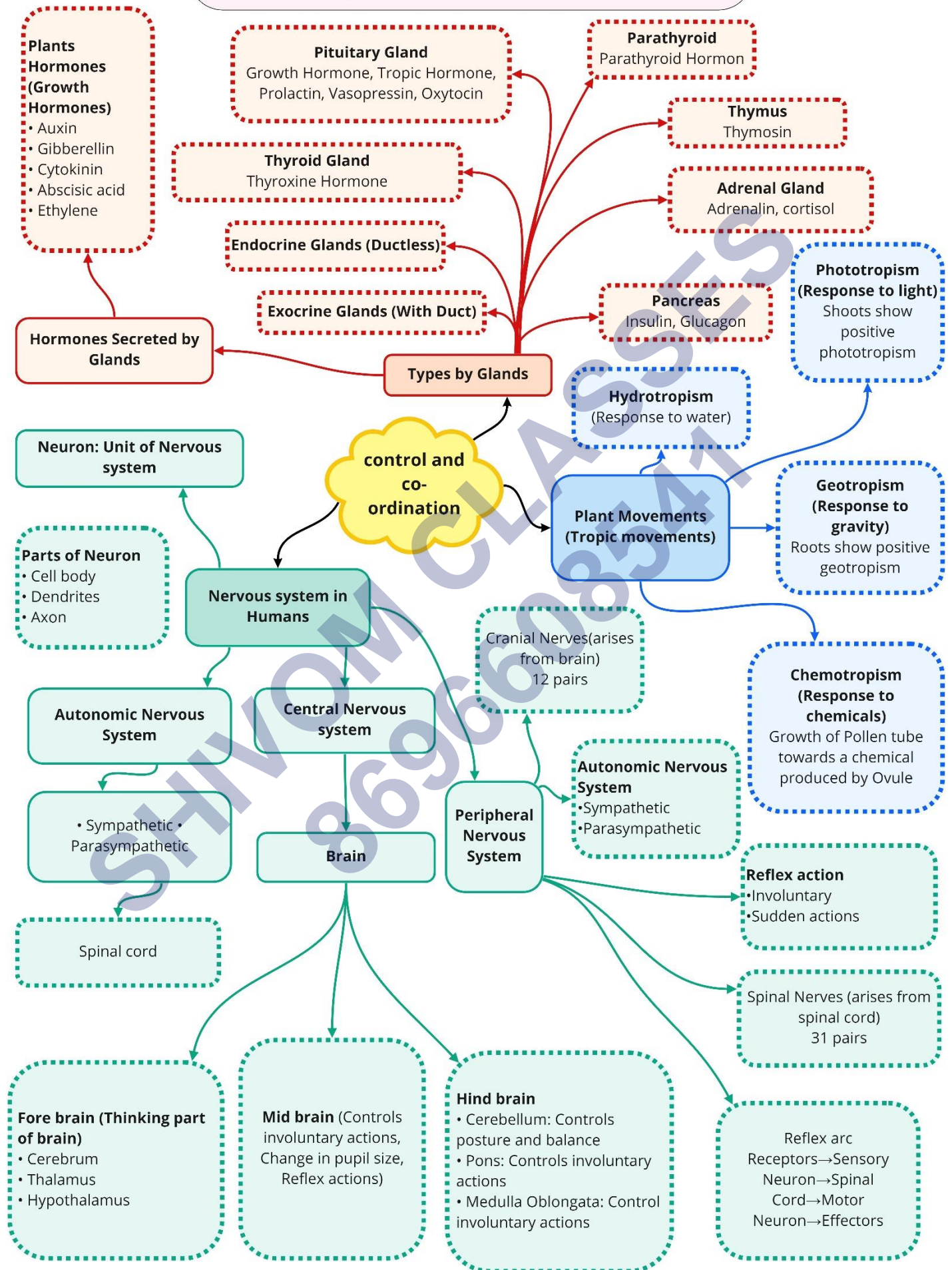
5. Testosterone Secreted by the testes in males.	<ul style="list-style-type: none"> • Controls the development of sex organs in males. • Controls the development of secondary sexual characters during puberty. 	
6. Oestrogen Secreted by the ovaries in females.	<ul style="list-style-type: none"> • Controls the development of female sex organs. • Controls the development of secondary sexual characters during puberty in females. 	

Feedback Mechanism

- The body has mechanisms to maintain its normal state.
- Whenever there is a change in the normal state, messages are sent to increase secretions if there is a fall below the normal levels or to decrease secretions if there is a rise above the normal levels to restore the normal body state. Such a mechanism is called **Negative Feedback Mechanism**.
- Example- Blood sugar level

The increase in blood sugar level stimulates the secretion of insulin so that the sugar level is maintained. If there is a fall in the blood sugar level below normal, it stimulates the secretion of glucagon. Glucagon stimulates the breakdown of glycogen to glucose, and thus the normal sugar level is maintained.

Class : 10th Biology
Chapter-7 control and co-ordination



Important Questions

➤ Multiple Choice Questions:

1. The gap between two neurons is called a:

- (a) dendrite
- (b) synapse
- (c) axon
- (d) impulse

2. The brain is responsible for:

- (a) thinking
- (b) regulating the heart beat
- (c) balancing the body
- (d) all of the above

3. Which of the following is a plant hormone:

- (a) insulin
- (b) thyroxin
- (c) oestrogen
- (d) cytokinin

4. Which endocrine gland is called master gland:

- (a) pituitary
- (b) adrenal
- (c) thyroid
- (d) pancreas

5. Cartisins are secreted by:

- (a) pancreatic gland
- (b) adrenal gland
- (c) thyroid gland
- (d) pituitary gland

6. Female sex hormone is:

- (a) estrogen
- (b) androgen
- (c) insulin
- (d) adrenalin

7. Insulin is secreted by:

- (a) stomach
- (b) liver
- (c) pancreas
- (d) kidney

8. In case of emergency which structure becomes very active:

- (a) adrenal medulla
- (b) adrenal cortex
- (c) thyroid gland
- (d) pancreas

9. Growth, mental development and tissue differentiation is controlled by:

- (a) glucagon
- (b) parathormone
- (c) thyroxine
- (d) cortisol

10. Heartbeat is increased by:

- (a) thyroxine
- (b) adrenalin
- (c) gastrin
- (d) glucagon

➤ **Very Short Question:**

1. Write the function of hormone thyroxine in our bodies.
2. Name the part of hind brain which takes part in regulation of respiration.
3. Which hormones helps in lowering the level of blood glucose in human beings?
4. We suddenly withdraw our hand when a pin pricks. Name the type of response involved in this action.
5. Which hormone is responsible for the development of moustache and beard in man?
6. Which type of glands in human body secrete hormones? State any one location for them.
7. Name the structural and functional units of human nervous system.
8. What is neuron?
9. What are phytohormones?
10. Name the largest cell present in human body.

➤ Short Questions:

1. Name two hormones secreted by pancreas. Write one function of each hormone named.
2. Name the hormone responsible for regulation of
 - Metabolism of carbohydrates, fats and proteins
 - Balance of calcium and phosphate
 - Blood pressure
 - Water and electrolyte balance.
3. What is reflex action? Explain the mechanism of reflex action with a suitable example.
4. Name the three major regions of human brain. Which part of brain maintains posture and equilibrium of the body?
5. Maintenance of Posture and Equilibrium. Cerebellum.

(a) Distinguish between voluntary and involuntary actions of our body.

(b) Choose involuntary actions, amongst the following:

Reading, Beating of heart, Salivation in the mouth on viewing tasty food, Talking.

6. Explain the cause of shoots of the plant bending towards light?

7. What are nastic and curvature movements? Give one example of each.

8. Draw a diagram of a nerve cell and label on it following:

(a) Nucleus

(b) Dendrites

➤ Long Questions:

1. (a) What is reflex action? Give its two examples. Illustrate the pathway followed by a message from the receptor in a reflex arc.

(b) Name the actions of sympathetic and parasympathetic systems on eye.

2. (a) What are "hormones"?

(b) List four characteristics of hormones

(c) Name the hormone required for the following:

Functioning of mammary glands

Regulation of calcium and phosphate

Lowering of blood glucose

Development of moustache and beard in human malc.

3. (a) What is
- Phototropism and
 - Geotropism?

With labelled diagrams describe an activity to show that light and gravity change the direction that plant parts grow in.

(b) Mention the role of each of the following plant hormones:

- Auxin
- Abscisic acid.

➤ Assertion Reason Questions:

1. Following questions consist of two statements – Assertion (A) and Reason (R). Answer these questions selecting the appropriate option given below:

- Both A and R are true, and R is the correct explanation of A.
- Both A and R are true, but R is not the correct explanation of A.
- A is true but R is false.
- A is false but R is true.

Assertion(A): Insulin regulates blood sugar level.

Reason (R): Insufficient secretion of insulin will cause diabetes.

2. Following questions consist of two statements – Assertion (A) and Reason (R). Answer these questions selecting the appropriate option given below:

- Both A and R are true, and R is the correct explanation of A.
- Both A and R are true, but R is not the correct explanation of A.
- A is true but R is false.
- A is false but R is true.

Assertion(A): Animals can react to stimuli in different ways.

Reason (R): All animals have a nervous system and an endocrine system involving hormones.

✓ Answer Key-

➤ Multiple Choice Answers:

- (b) synapse
- (d) all of the above
- (d) cytokinin
- (a) pituitary
- (b) adrenal gland
- (a) estrogen
- (c) pancreas

8. (a) adrenal medulla
9. (c) thyroxine
10. (b) adrenalin

➤ Very Short Answers:

1. Answer: It controls basal metabolic rate and regulates metabolism of carbohydrates, fats and proteins.
2. Answer: Medulla oblongata.
3. Answer: Insulin.
4. Answer: Reflex action.
5. Answer: Testosterone.
6. Answer: Endocrine or ductless glands, e.g., thyroid in neck region around trachea.
7. Answer: Neuron.
8. Answer: Neuron or nerve cell is a structural and functional unit of nervous system that is specialized to receive, conduct and transmit impulses.
9. Answer: Phytohormones are chemical substances other than nutrients produced naturally in plants which regulate growth, development, differentiation and a number of physiological processes, e.g., auxin, gibberellins, abscisic acid, cytokinin's.
10. Answer: Neuron (length 90-100 cm).

➤ Short Answer:

1. Answer:
 Insulin (secreted by β -cells of islet of Langerhans)
 Recognition of glucose by cells for absorption and conversion of glucose into glycogen in liver and muscles.
 Glucagon (secreted by α -cells of islet of Langerhans)
 Formation of glucose from glycogen and other sources and its release into blood.
2. Answer:
 - Thyroxine
 - Parathormone (also calcitonin)
 - Adrenaline
 - ADH or vasopressin and aldosterone (a mineralocorticoid).
3. Answer:
 Reflex Action: It is an automatic nerve mediated response to a stimulus without consulting the will of the individual, e.g., withdrawal of hand on being pricked or coming in contact with hot surface.

Mechanism: The stimulus for reflex action is picked up by a receptor located in the organ on which stimulus is acting. One or more sensory neurons carry the impulse from receptor to the central nervous system (e.g., spinal cord). CNS functions as modulator. It transfers the sensory nerve impulse to one or more motor neurons. The motor neurons carry the impulse to effectors which provide a proper response to the stimulus.

Stimulus → Receptor → Sensory neurons → CNS → Motor neurons → Effectors → Response.

4. Answer: Major Regions of Brain

Fore Brain: Olfactory lobes (2), Cerebrum (2 cerebral hemispheres) and diencephalon.

Mid Brain: Cerebral peduncles (crura cerebri) and four quadrigemina.

Hind Brain: Cerebellum, pons and medulla oblongata.

5. Answer:

(a) Differences between Voluntary and Involuntary Actions

Voluntary Actions	Involuntary Actions
1. Will. They are under control of the will.	They are performed without consulting the will.
2. Muscles. The actions are performed with the help of striated muscles.	The actions are performed with the help of smooth muscles.
3. Activities. They are connected with the functioning of external organs.	They are connected with the functioning of internal organs.

(b) Beating of heart, salivation in the mouth on viewing of tasty food.

6. Answer: Stems are positively phototropic and bend towards the direction of light. The movement is due to occurrence of more auxin on the darker side and lesser auxin on the illuminated side. As a result, there is more growth on the darker side which causes the stem to bend towards light.

7. Answer:

(a) **Nastic Movements:** They are non-directional curvatures movements of turgor or growth where the movements are determined by the structure of the responding organ irrespective of the direction of stimulus which is generally diffuse. Ex. Drooping and folding of leaves in Sensitive Plant in response to shock (seismonasty).

(b) **Curvature Movements:** They are changes in orientation of some plant parts in relation to others caused by intrinsic or external stimuli. Ex. Sleep movement or nyctinasty of legume leaves, bending of stems towards light (or positive

phototropism of stems).

8. Answer:

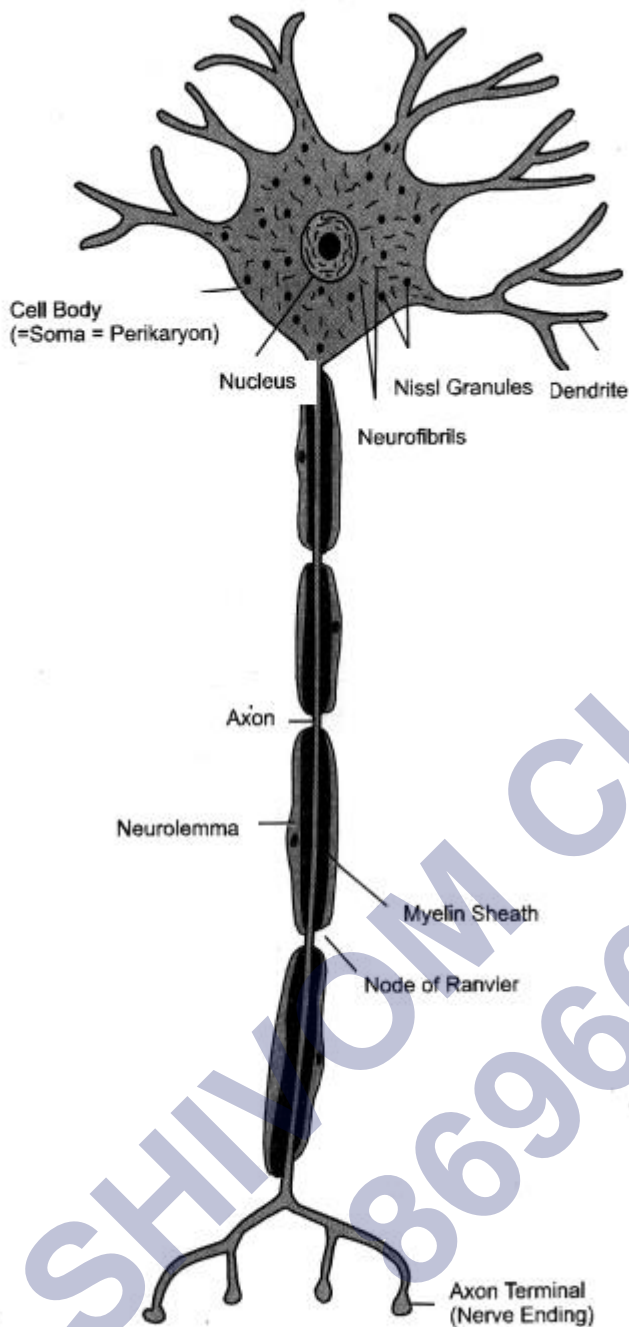


Fig. 2.1. Structure of a neuron.

➤ Long Answer:

1. Answer:

(a) Reflex Action: It is an automatic, spontaneous nerve mediated response to a stimulus without consulting the will of the individual.

e.g., withdrawal of hand on being pricked or coming in contact with hot surface.

(b) Effect on Pupil,

- Sympathetic - dilation

- Parasympathetic - constriction.

2. Answer:

(a) Definition: Hormones (Gk. hormein— to excite) are chemical messengers or informational molecules produced by ductless glands which are translocated by circulatory system to other body parts for inducing and coordinating their activities including growth. First hormone, secretin, was discovered by Bayliss and Starling (1902). The term hormone was coined by Starling (1905)

(b) Characteristics:

- Hormones are produced by endocrine or ductless glands.
- They are poured into circulatory system for passage to different body parts.
- Target Sites. Hormones act on specific cells, tissues and organs called target sites, generally away from the place of their synthesis.
- They function as chemical messengers or informational molecules that trigger specific chemical and physiological processes of target cells.
- Slow Action. Since hormones reach the target sites through blood, their effect appears after a lag period. They are slow acting with the exception of adrenaline.
- Chemical Nature. Hormones are small sized organic molecules which are of diverse origin— proteins, peptides, amino acids, amines and steroids.
- Non-nutrient Nature. Hormones are nonnutrient in nature. They have no role in providing energy or body building materials. Hormones take part in stimulation or inhibition of physiological processes.
- The hormones are effective in very low concentration, e.g., adrenaline one in 300 million parts.
- It is very specific. TSH acts only on thyroid while thyroxine affects all body parts.
- Hormones are generally produced in response to specific stimuli.
- Hormones are ultimately broken down or consumed during their activity in target cells.
- Deficiency or Excess. Both deficiency and excess of hormone are harmful, often leading to serious disorders.

(c) The Hormone are Required:

- Functioning of Mammary Glands. Prolactin.
- Regulation of Calcium and Phosphate in Blood. Parathormone.
- Lowering of Blood Glucose. Insulin.
- Development of Moustache and Beard in Human Male. Testosterone.

3. Answer:

(a) Definition of Phototropism: It is directional growth movement of curvature which occurs in plants in response to stimulus of unilateral light.

Definition of Geotropism: It is directional growth movement of curvature which occurs in response to force of gravity. Main root shows positive geotropism while main stem shows negative geotropism.

Activity: Phototropism and Geotropism- Take two potted plants. Place one plant near a window. Keep the other pot tilted horizontally in the open. Water the plants on alternate days. Observe after a week. Potted plant kept near the window shows bending of young stems towards the window. They are positively phototropic. In the horizontal pot, the stem bends upward as it is negatively geotropic. Its root if taken out, shows downward bending indicating its positive geotropic nature.

(b)

- Role of Auxin. It promotes cell enlargement, fruit growth, apical dominance, rooting of cuttings, prevention of abscission and differential growth during tropic movements.
- Role of Abscisic Acid. It checks excessive activity of auxin and gibberellins, closes stomata in water deficiency, induces dormancy of buds and seeds.

➤ Assertion Reason Answer:

1. (a) Both A and R are true, and R is the correct explanation of A.
2. (a) Both A and R are true, and R is the correct explanation of A.