Control and Coordination

Chapter Out Line

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- Co-ordination in plants
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- Human nervous system
- Neuron
- Brain
- Spinal cord
- Sense Organs
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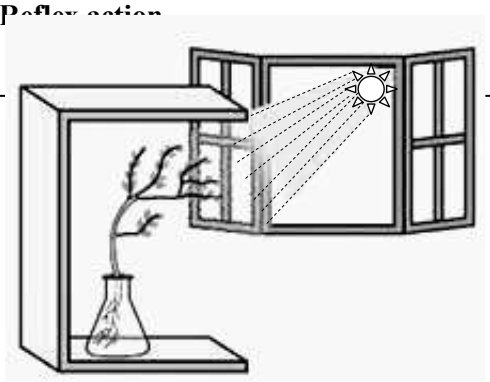


Figure : Response of the plant to the direction of light

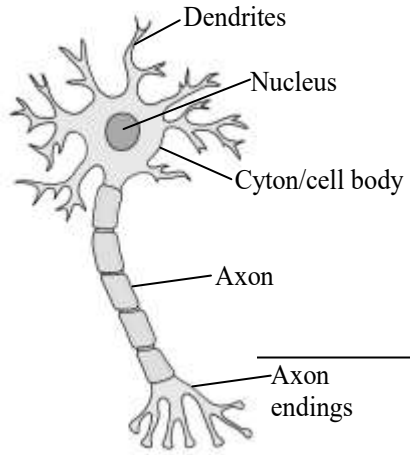


Figure : The neuron

Figure : Response of the *Mimosa pudica* plant to the touch (Thigmonasty)

INTRODUCTION

All living organisms including plants and animals respond and react to environmental factor or **stimuli**. There is necessity to develop some system for control and coordination of various body organs.

To carry out a simple function such as picking up an object from the ground there has to be coordination of the eyes, hands, legs and the vertebral column. The eyes have to focus on the object, the hands have to pick it up and grasp it, the legs have to bend and so does the back bone (vertebral column). All these actions have to be coordinated in such a manner that they follow a particular sequence and the action is completed. A similar mechanism is also needed for internal functions of the body.

The individuals also have to adjust to the changing conditions around them and vary their responses. At the same time, the internal conditions of the body should be maintained constant.

CONTROL

Control is the power of restrain & regulation by which a process can be started, slowed down or stopped.

CO-ORDINATION

Co-ordination is orderly working of different but inter-related parts to perform one or more activities very smoothly.

There are 2 modes of control & co-ordination, chemical & nervous. Plants do not have a nervous system. They possess only chemical control & co-ordination.

Animals have both chemical & nervous control & co-ordination. The two constitute neuroendocrine system.

Boost your knowledge

- The changes in the environment to which the organisms respond and react are called **stimuli**.
- The response of organisms to a stimulus is usually in the form of some movement of their body part.
- Nervous and chemical co-ordination are combinely called as **integrated system**.
- Nervous control is faster than chemical control.

CO-ORDINATION IN PLANTS

Plants do not have nervous system as in animals. Plants use only hormones for producing reaction to external stimulus. Thus plants react to stimuli in a very limited way.

PLANT MOVEMENTS

The plants are fixed at a place with their roots in the ground, so they cannot move from one place to another.

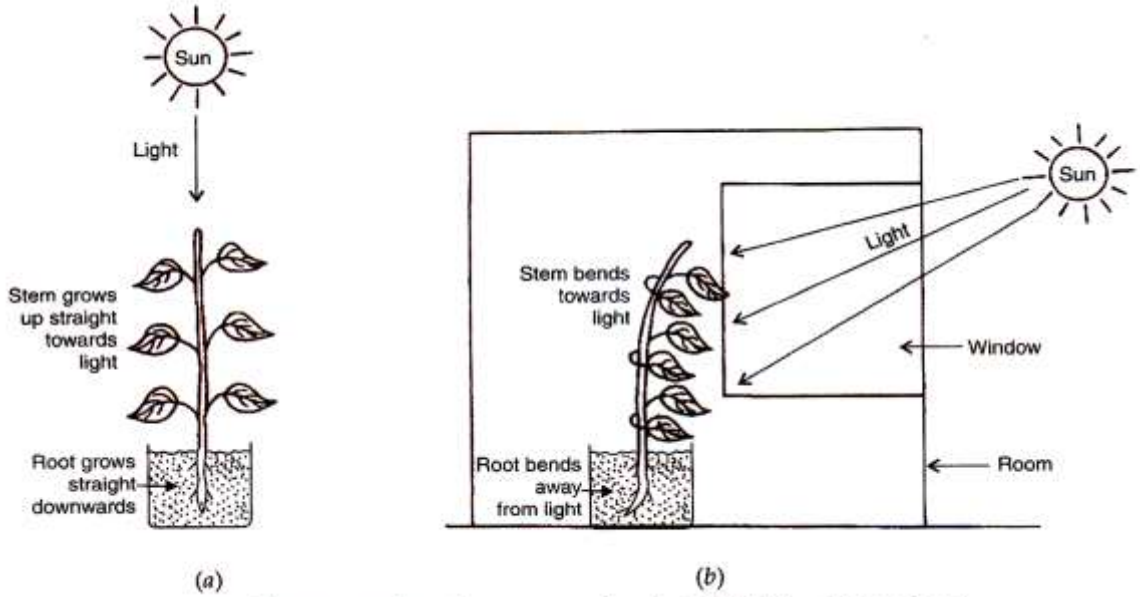
The plant movements made in response to external stimuli fall into two main categories : **tropism** and **nastic movements.**

◈ **Tropisms** – A growth movement of a plant part in response to an external stimulus in which the direction of stimulus determines the direction of response is called **tropism**.

- If the growth (or movement) of a plant part is towards the stimulus, it is called **positive tropism**.
- If the growth (or movement) of a plant part is away from the stimulus, then it is called **negative tropism**.

Based on the type of stimulus, there are five types of tropic movements.

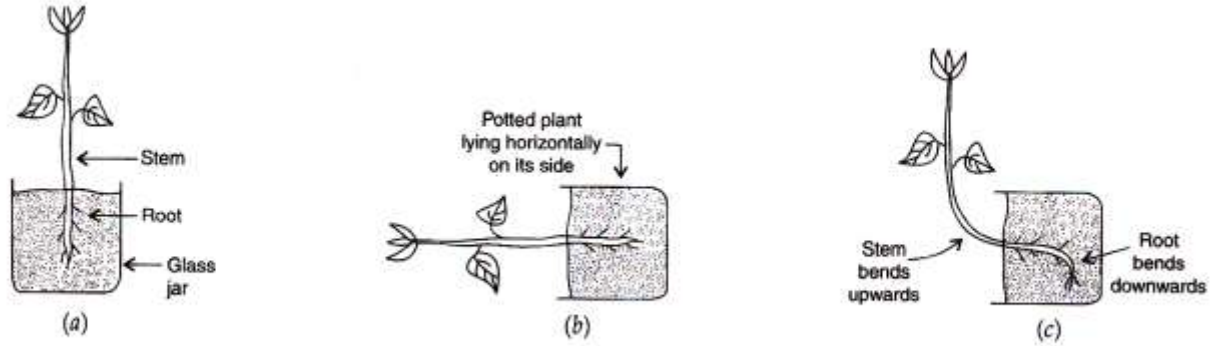
(i) Phototropism – It is the movement of plant part in response to light. Plants need sunligtht, so the stems (or shoots) respond to sunlight by growing towards it is due to **positive phototropism**. The root of plant, however, bends away from the direction from which the sunlight comes is due to **negative phototropism**.



Diagrams to show the response of a plant to light (or phototropism).

(ii) Geotropism – It is the movement of a plant part in response to gravity. The roots of plants always grow downward in response to gravity, this is due to **positive Geotropism**. The stems (or shoots) of plants always grow up, away from the pull of gravity, this is due to **negative Geotropism.**

Exception - Pneumatophores



Experiment to show the response of a plant to gravity (geotropism).

(iii) Chemotropism – It is the movement of plant part in response to chemical stimulus.

Ex.- The growth of the pollen tube in response to chemical substance produced by ovum during fertilisation.

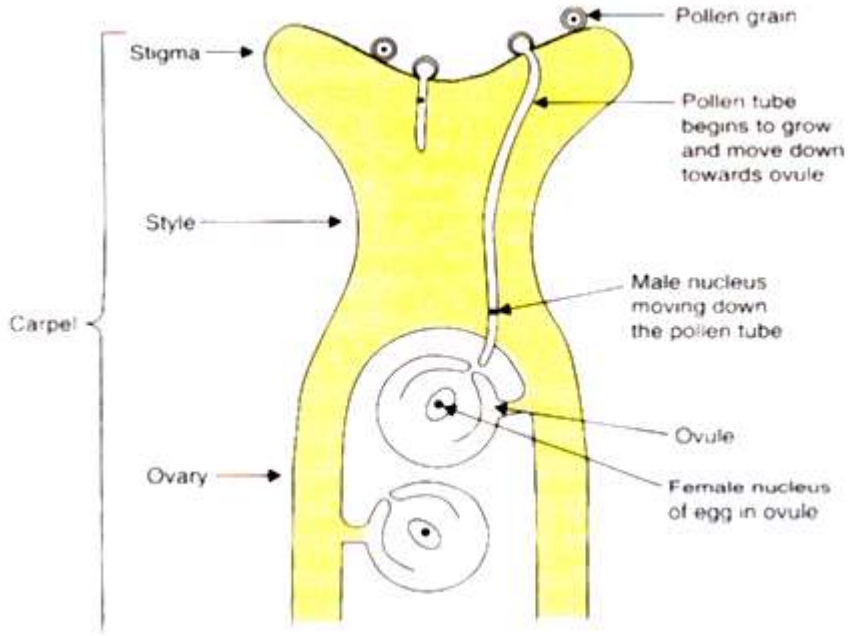
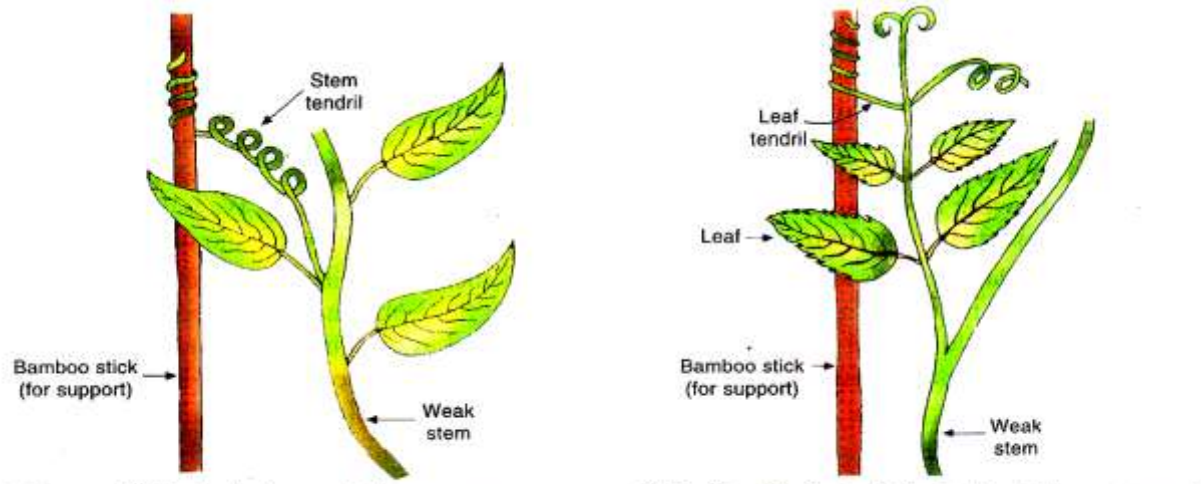


Diagram to show the response of a plant part 'pollen' to chemical secreted by stigma (or chemotropism)

(iv) Hydrotropism – It is the movement of plant part in response to water. The roots grow in the direction of source of water showing **positive Hydrotropism**.

(v) Thigmotropism – It is the directional growth movement of a plant part in response to the touch of an object. The climbing parts of the plants such as tendrils grow towards any support which they happen to touch and wind around that support. So, tendrils of plants are **positively Thigmotropic**.

STIMULUS	TYPE OF TROPISM
Light	Phototropism
Gravity	Geotropism
Chemical	Chemotropism
Water	Hydrotropism
Touch	Thigmotropism



(*a*) Stem tendrils help the plant to climb up a support (*b*) Leaf tendrils also help the plant to climb up a support

Diagrams to show the response of a plant part 'tendril' to the touch of an object (here a bamboo stick).

◈ **Nastic Movement** – The movement of a plant part in response to an external stimulus in which the direction of response is not determined by the direction of stimulus is called nastic movement.

The main difference between tropic and nastic movements is that tropic movement is a directional movement of a plant part but nastic movement is not a directional movement.

(i) Thigmonasty – It is the non-directional movement of a plant part in response to the touch of an object is called **Thigmonasty or Seismonasty**. An example of this is touch-me-not plant (*Mimosa pudica*), if we touch the leaves of this plant with our fingers, then its leaves fold up and droop almost immediately.

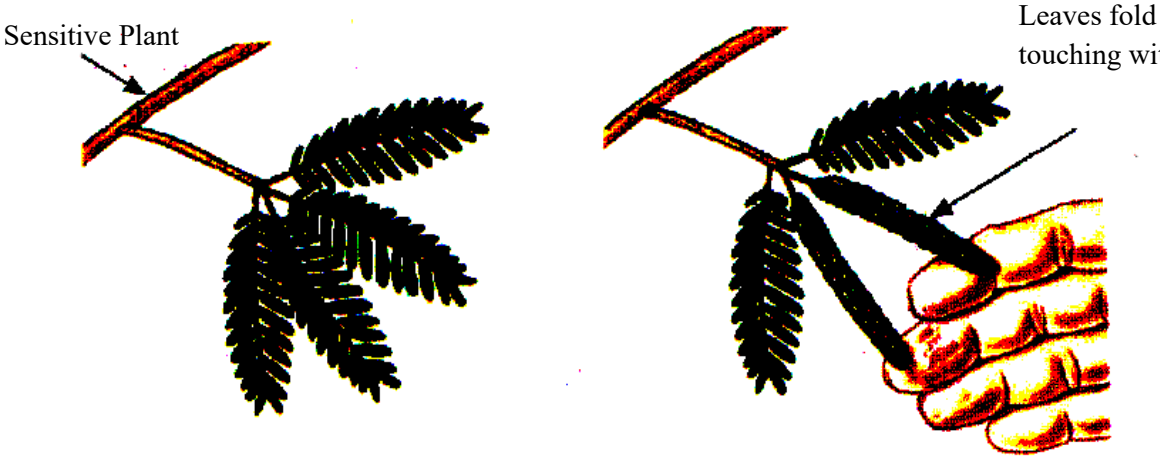
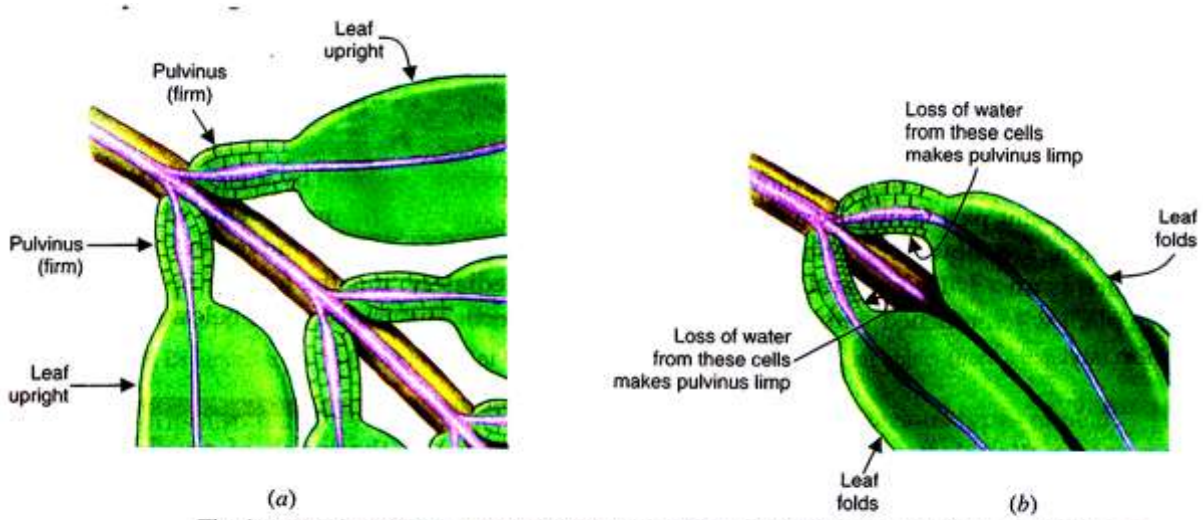


Diagram to show the nastic movements in the leaves of sensitive plant (Mimosa pudica) caused by "touch"



The leaves of sensitive plant fold due to the loss of water from pulvinus at their base.

(ii) Photonasty – It is the non –directional movement of a plant part in response to light. A dandelion flower opens up in the morning in bright light but closes in the evening when the light fades and it gets dark. Whereas the petals of moonflower close during the day when there is bright light but open up at night when it is dark and there is no light.

Boost your knowledge

- **Photoperiodism** – Flowering and germination of seeds in plants is controlled by duration of day light (photoperiod). This phenomenon is called photoperiodism.
  On the basis of length of photoperiod requirements of plants, they have been classified into.
  (i). Short day plants – Xanthium, Sugarcane.
  (ii). Long day plants – Spinach, Radish
  (iii). Day neutral plants – Cotton, Sunflower
  Response of plants to photoperiodic stimulus is due to a specialized pigment **phytochrome**.

PLANT HORMONES

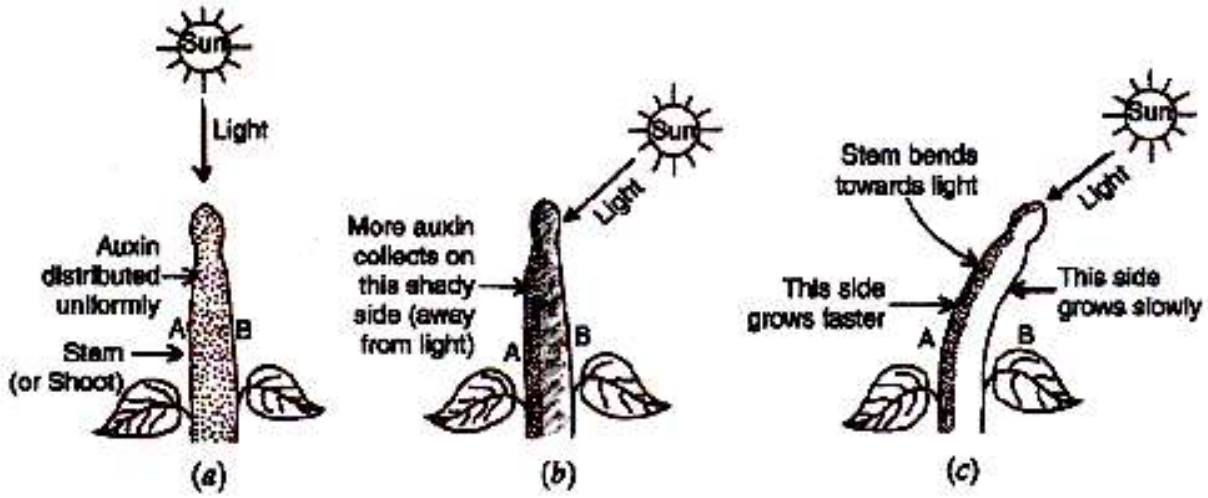
Plants do not have any special structure for perception of stimuli. In plants control and co-ordination is performed by chemical substances known as plant hormones or phytohormone.

Phytohormones, which bring about control and co-ordination, in plants are broadly divided into two groups.

(1) Growth promoters : Chemicals that promote some or other aspect of growth (Auxins, Gibberellins and Cytokinins.)

(a) Auxin : Auxins are the growth hormones which were first discovered by Charles Darwin. Charles Darwin and his son Francis Darwin observed the coleoptiles of canary grass responded to unilateral illumination by growing towards the light source (phototropisms). Auxins was isolated by F.W. went from tips of coleoptiles of oat seedlings.

- Indole acetic acid is the principal naturally occurring auxin found in all plants including fungi.
- Auxin initiate as well as promote cell division, cell elongation, root formation.
- Causes apical dominance and prevents abscission layer formation.
- Initiation of flowering.
- Regulates Plant growth movements (e.g. phototropism and geotropism).



Diagrams to explain the bending of a plant stem (shoot) towards light by the action of "auxin" hormone.

(b) Gibberellins : The gibberellins were first discovered in Japan by yabuta and Sumuki. E.Kurosawa obtained from extracts of rice plants which were infected with fungus *Gibberella fujikuroi*. These rice plants were taller and sterile so called foolish seeding (Bakanae Disease).

- Elongation of internodes that leads to elongation of stem.
- Leaf expansion.
- Reversal of dwarfism.
- Breaking of dormancy.
- Promotes flowering and seed germination.

(c) Cytokinin : The cytokinins are chemically basic growth hormones which promote cell division in plants. This group of phytohormones were discovered when Carlos Miller isolated the crystalline substance from degraded DNA material. This substance was named as kinetin.

- Promote cell division and cell enlargement.
- Counteraction of apical dominance.
- Breaking of dormancy.

(2) Growth inhibitors : Chemicals that inhibit one or more aspects of growth (Ethylene and Abscissic Acid.)

(a) Ethylene : This is a gaseous plant hormone which is produced by almost all the fleshy fruits during ripening.

- Ethylene is a volatile gas.
- Has inhibitory effects on growth (prevents elongation of stem and roots).
- Promotes fruit growth and ripening.
- Promotes seed germination.
- Promotes abscission of leaves, flowers and fruits.

(b) Abscissic acid : Stress hormone of plants is called as abscisic acid. It is also known as dormin. Addicott and his co-workers isolated a substance from young cotton bolls and named it as Abscisic acid. This acid is now isolated from dormant seeds, buds and other parts of the plants.

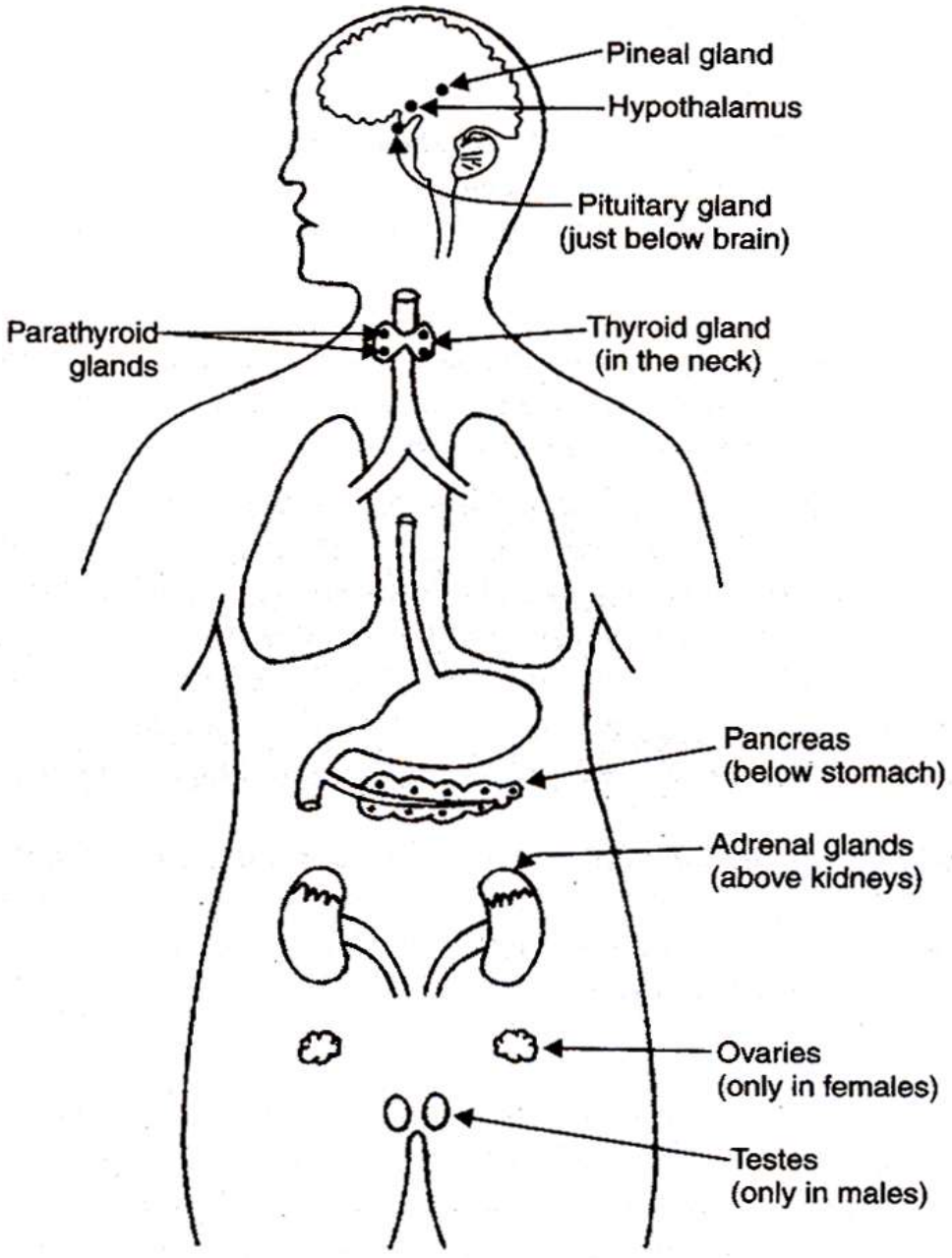
- Also known as stress hormone.
- Promotes abscission, senescence, bud dormancy.
- Causes growth inhibition.
- ABA suppresses the growth promoting effects of gibberellins and hence is also known as antigibberellins.

CHEMICAL CO-ORDINATION IN ANIMALS

The control and co-ordination in higher animals called vertebrates (including human beings) takes place through nervous system as well as hormonal system called endocrine system.

ENDOCRINE SYSTEM

Any chemical substance which is formed in the tissues of endocrine glands are carried by the blood to other parts of the body for its specific actions is termed as **hormone**.



The positions of endocrine glands in the human body

DIFFERENT ENDOCRINE GLANDS, THEIR LOCATION IN THE BODY & THE HORMONES SECRETED BY THEM.

S.NO.	DIFFERENT ENDOCRINE GLANDS	LOCATION	HORMONES SECRETED
(A)	Pituitary	Located below Hypothalamus	Anterior lobe → Somatotropic hormone(SH/GH) (Growth Hormone); Follicle stimulating hormone(FSH); Leutinizing hormone(LH); Adrenocorticotropic hormone(ACTH); Thyroid stimulating hormone(TSH); Prolactin Middle → Melanocyte stimulating hormone (MSH) Posterior lobe → Vasopressin/Anti Diuretic Hormone (ADH); Oxytocin
(B)	Pineal gland	Located between cerebral hemispheres.	Melatonin; Serotonin
(C)	Thyroid	It surrounds the larynx & upper part of the trachea in the neck	Thyroxine; Calcitonin
(D)	Parathyroid	Situated on lobes of the thyroid gland.	Parathormone
(E)	Thymus gland	Located in the upper part of the thorax near heart.	Thymosin
(F)	Pancreas	Pancreas lies below the stomach in a bend of the duodenum.	Insulin,Glucagon and Somatostatin (Islets of Langerhans)
(G)	Adrenal gland	Located on the top of kidneys.	Adrenal cortex → Mineralo corticoids; Sex hormones; Gluco corticoids Adrenal medulla → Adrenaline; Noradrenaline
(H)	Gonads	Ovaries (Female) - Located in pelvic cavity in abdomen. Testes (Male) extra-abdominal in position	Estrogen; Progesterone; Relaxin Testosterone

◈ **Hypothalamus :** It is present in the brain. The function of hypothalamus is to regulate the secretions of hormones from pituitary gland.

◈ **Pituitary gland** : It is a small ovoid structure attached to the base of brain (hypothalamus) by a short stalk called Infundibulum. Pituitary gland is also known as the master gland as it controls other endocrine glands.

(i) **Somatotropic hormone** (Growth hormone) (SH/GH) **:** Controls growth of somatic cells influences protein, carbohydrate and metabolisms. It's deficiency during childhood leads to dwarfism and over secretion leads to gigantism and acromegaly in adult.

(ii) **Follicle stimulating hormone** (FSH) **:** Stimulates growth of ovarian follicles in ovary of female and controls spermatogenesis in males.

(iii) **Leutinizing hormone** (LH) **:** Stimulates ovary to produce estrogen in female and testis to produce androgens in male.

(iv) **Adrenocorticotropic hormone** (ACTH) : Stimulates adrenal cortex to grow and secrete its hormones.

(v) **Thyroid stimulating hormone** (TSH) : Regulates the growth of thyroid gland and secretion of thyroxine.

(vi) **Prolactin :** Controls development of mammary glands and stimulates corpus luteum to secrete progesterone.

(vii) **Melanocyte stimulating hormone** (MSH) : Stimulate melanocytes which are responsible for skin colour.

(viii) **Vasopressin / Anti Diuretic Hormone** (ADH) : Controls tubular reabsorption of water in kidney, also increases blood pressure.

(ix) **Oxytocin :** Controls uterine contraction during parturition, stimulates lactation to increase milk secretion.

◈ **Pineal gland**

- It is a small gland reddish-grey in colour, about the size of a pea, attached to the roof of the third ventricle of the brain.
- It regulates the biological clock (circadian rhythm).
- It contributes in regulating gonadal development. It controls development & concentration of melanin. It secretes **melatonin** hormone.

◈ **Thyroid**

The thyroid gland consists of two lobes joined together by an isthmus.

It is situated in the lower part of the neck and when enlarged it forms goitre. Two hormones secreted by the thyroid gland are :

(i) **Thyroxine :** It is the principal hormone secreted by the thyroid gland.
Its main role is to increase the metabolic rate of the organs and tissues of the whole body.
Cretinism affects children and is due to congenital defect of either absence or defect of the gland.
Iodine deficiency causes simple goitre.

(ii) **Calcitonin :** This hormone lowers the calcium level in two ways :
By inhibiting renal tubular calcium reabsorption.
By inhibiting bone calcium reabsorption.

◈ **Parathyroid**

These are small ovoid pea shaped glands. They lie on the posterior surface of the thyroid gland.

Parathormone

(i) It regulates the balance between the calcium in bones and in extracellular tissue fluid, thus affecting the amount of calcium in the blood.

(ii) It also controls the excretion of phosphates in the urine, probably by reducing tubular reabsorption of phosphorus by the kidney tubule.

◈ **Thymus gland**

- This gland is situated in the thorax in midline under the sternum in front of trachea.
- It secretes a hormone namely **thymosin.**
- It is one of the sites of lymphocyte formation in children.
- It helps in producing antibodies.

◈ **Pancreas**

- It is a heterocrine gland. Exocrine part produces pancreatic juice. The endocrine portion of the pancreas consists of about a million cells clustered together forming the Islets of Langerhans. Two kinds of cells are recognised in this area –
  - Alpha cells which secrete the hormone glucagon.
  - Beta cells which secrete the hormone insulin.
- Glucagon : Increases blood glucose levels.
  - If levels of blood glucose gets too low a-cells secrete glucagon.
  - This hormone activates the enzyme inside the cells which convert glycogen into glucose.
- Insulin : Decreases blood glucose levels.
  - Cells, tissues and organs recognize and absorb glucose only in the presence of insulin.
  - The pancreas detects change in the level of glucose in the blood. If the levels get too high, b-cells in the islets of Langerhans respond by releasing insulin.
  - This travels to all parts of the body in the blood, but mainly affects cells in muscles, liver and adipose (fat storage) tissue. Insulin lowers blood sugar by making cell membranes more permeable to glucose.
  - Deficiency of insulin in body leads to **diabetes mellitus**.

◈ **Adrenal gland**

These are two small semilunar structures lying one each on upper pole of the kidneys. That is why they are also known as supra renal glands.

Each gland consists of two structurally & physiologically separate parts known as cortex and medulla.

- Cortex secretes three different kinds of hormones known as corticosteroids. They are :
  - **(i) Mineralocorticoids :** These regulate sodium and potassium balance in the body.
  - **(ii) Glucocorticoids :** These derive their name from their influence on carbohydrate metabolism. e.g. Glycogenesis is promoted in liver.
  - **(iii) Sex hormones :** Small quantities of sex hormones as androgens and oestrogen are produced by adrenal glands which influence sexual development and growth.
- Adrenal medulla : It secretes two hormones.
  - **(i) Adrenaline :** It is a stress hormone causes increase in systolic blood pressure, dilation of coronary blood vessels, increased sweating and increase in metabolic rate.
    It brings restlessness, muscle fatigue and anxiety.
  - **(ii) Noradrenaline :** It is a general vasoconstrictor, increases both systolic and diastolic pressures.
    Both of these hormones are helpful in emergency conditions. Thus are called as **"fight fright or flight response"** or **3F's.**

◈ **Ovaries**

Ovaries secrete three hormone :

(i) Oestrogen : FSH from the anterior pituitary controls the secretion of oestrogen by acting on the Graffian follicles.

This hormone effects the development of female secondary sex characters.

- The oestrogen secretion influences the follicular phase.
- Its secretion is maximum during ovulation period. Moreover during pregnancy the oestrogen secretion by placenta keeps on increasing till full term.

(ii) Progesterone : It is secreted by corpus luteum.

- This hormone in contrast to oestrogen which is produced continuously during the reproductive years, is secreted only after ovulation.
- Progesterone prepares the uterus for receiving the embryo.
- If ovum gets fertilized, the corpus luteum continues to play a role in maintaining the pregnancy.
- This hormone is essential for the maintenance of pregnancy and is therefore called pregnancy hormone.

(iii) Relaxin : This hormone is secreted during later stages of pregnancy and leads to relaxation of muscles of the pelvic area to enable easy child birth and reduce the pressure on the foetus.

◈ **Testes**

Testosterone is the main testicular hormone secreted by interstitial cells of the testis.

It is mainly concerned with the development and maintenance of male sex characters and enhancing the process of spermatogenesis (sperm formation).

Boost your knowledge

- **Hypothyroidism :** Myxoedema is the condition caused by thyroid hormone deficiency in adults.
- **Hyperthyroidism :** Excessive amount of thyroxine is poured into the blood this condition being known as **toxic goitre** or exophthalamic goitre (grave's disease)
- The basal metabolic rate (B.M.R.) is increased in hyperthyroidism and reduced in hypothyroidism.
- **Feedback Mechanism :** The excess or deficiency of hormones has a harmful effect on our body. For example, the deficiency of insulin hormone results in a disease called diabetes whereas excess of insulin in the body can lead to coma. So, it is necessary that the hormones are secreted by the glands in our body in precise quantities which are required for the normal functioning of the body. This means that there should be some 'mechanism' to regulate the production and release of hormones in the body. **The timing and amount of hormones released by various glands are controlled by the 'feedback mechanism' which is in-built in our body.**

NERVOUS CO-ORDINATION IN HUMANS

The function of nervous system is to coordinate the activities of our body. It helps all other system of our body to work together.

HUMAN NERVOUS SYSTEM

Nervous system in vertebrates is highly evolved and comprises of

- **Central Nervous System (CNS) :** It lies along the main (longitudinal) axis of the body. In turn the CNS comprises of -
  - **(i)** Brain or encephalon situated in the head.
  - **(ii)** Spinal cord or myelon, which is a long and narrow structure located in the neck and trunk.
- **Peripheral nervous system :** It consists of nerves, which extend between the central nervous system and the sense organs or body's effectors (muscles, glands, etc.) or both. It carries information to and from the CNS. It mainly controls the voluntary activities of the body. Peripheral nervous system consists of two sets of nerves -
  - **(i) Cranial nerves :** 12 pairs of nerves (They arise from or join the brain.)
  - **(ii) Spinal nerves :** 31pairs of nerves (They arise from spinal cord).
- **Autonomic Nervous System :** It consists of nerves which connect the visceral receptors and effectors with the CNS through the cranial and spinal nerves. It controls involuntary activities of the body. It in turn has two components-

  (i) Sympathetic nervous system **(ii)** Parasympathetic nervous system

  The action of sympathetic & parasympathetic nervous system is antagonistic to each other. Both interact and maintain homeostasis inside the body.

NEURON

The nervous system is made of special cells called neurons. It is the largest cell in the body (which looks like an electric wire). The neurons carry messages in the form of electrical signals called electrical impulses or nerve impulses.

- Each neuron consists of a cell body called cyton and a number of branches (nerve fibres) arising from the cyton. Neuron does not divide.
- Cyton contains a nucleus within the cytoplasm & Nissl's granules (formed of RER with ribosomes) and fine thread like fibres, called neurofibrils.
  - **(i) Dendrites :** These are short, several, much branched & contain granules. They carry impulse towards the cyton.
  - **(ii) Axon :** It is a large, single and unbranched structure.
- It has no nissl's granules.
- It carries impulses from cyton to the effector organs like glands, muscles etc. or to the other nerve.
- Axis cylinder is enclosed in a thin permeable membrane called axolemma or nerve membrane.
- A layer of fatty material called myelin or medullary sheath is found outside the axolemma.
- Such fibres are called myelinated (medullated) fibres.

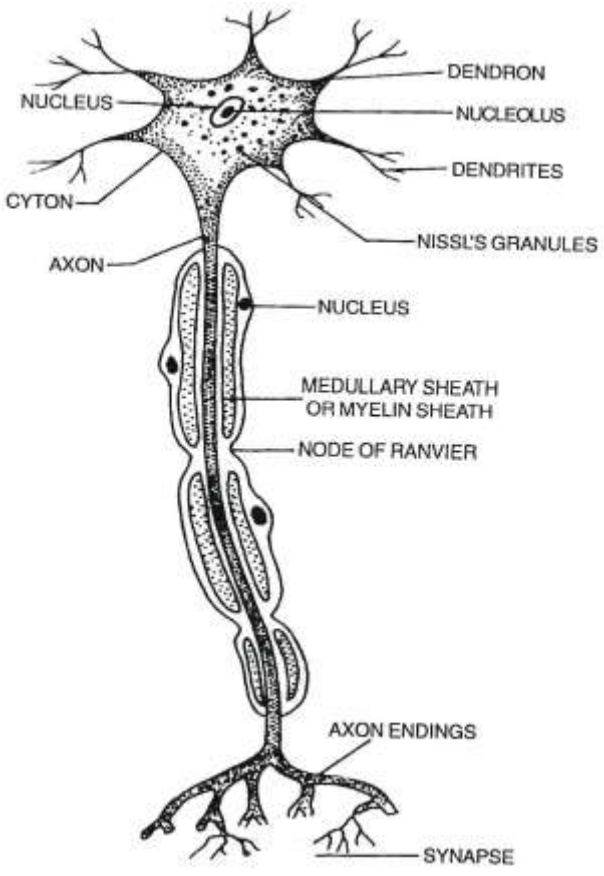


Fig. Neuron

- They seems to be white. Nerve fibres lacking myelin sheath are called non-myelinated & appear grey in colour.
- Myelin is interrupted at intervals by circular constrictions called **Nodes of Ranvier**.
- Each telodendron ends in a swollen knob called **synaptic knob** or terminal button.
- Synaptic knob of one nerve fibre (axon) forms synapse with the dendrites of another neuron.
- **Synaptic cleft** is a very fine gap between these two neurons. Thus, in the entire nervous system neurons are linked together.
- **Synapses** is a junction that ensure the nerve impulses to travel in only one direction.
- **Neurotransmitter** are those chemical substances which transmit impulse from one neuron to another neuron. Acetylcholine, serotonin, dopamine act as a neurotransmitter.
- **Types of Neurons or Nerve Fibres :**
  (i) Sensory : It transmits impulse from sensory organs to central nervous system.
  (ii) Motor : It carries impulses from brain and spinal cord to effector organs.
  (iii) Relay : They serve as links between other neurons.

Boost your knowledge
- For the conduction of nerve impulse, Na^+ is necessary.
- In human brain more than 100 billion neurons are present.

HUMAN BRAIN

- The brain is covered by cranium & spinal cord is covered by vertebral column.
- Both are also surrounded by three membranes of the connective tissues called meninges.
  1. Outer most - Duramater
  2. Middle - Arachnoidmater
  3. Inner most - Piamater.
- The space between the membranes is filled with a fluid called **cerebrospinal fluid(CSF)** that protects the brain from mechanical shocks.
- The brain can be differentiated into three main regions: Fore brain, Mid brain & Hind brain.

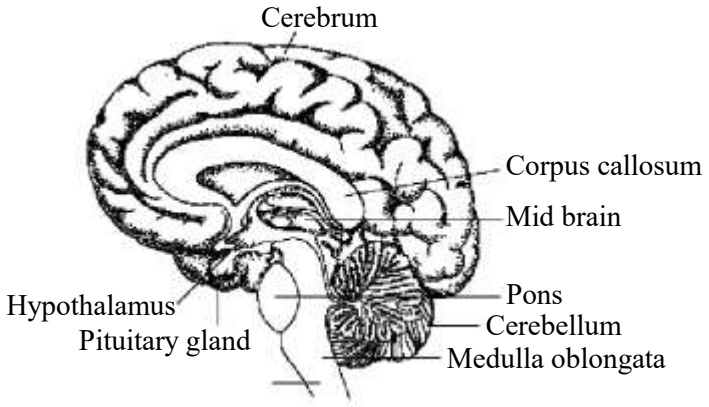


Fig. Brain

◈ **Fore brain :** It consists of olfactory lobes, cerebrum and diencephalon.

(A) Olfactory lobes : These are a pair of small, solid, cube shaped bodies. They are fully covered by cerebrum. They receive impulse for smell.

(B) Cerebrum : It is the largest part of the brain.
- It consists of two cerebral hemispheres joined by a band of nerve fibres called corpus callosum.
- Surface of cerebral hemisphere is made up of grey matter, called cerebral cortex.
- It becomes highly folded to increase area for accommodation of more neurons.
- Each cerebral hemisphere into four lobes
  (i) Occipital lobe : Region for visual perception
  (ii) Frontal lobe : For muscular activities
  (iii) Parietal lobe : For touch, smell, temperature and conscious association.
  (iv) Temporal lobe : For auditory reception.
- Cerebrum has sensory areas where impulses are received from sense organs (receptors). Similarly it has a general motor area from where impulses are sent to effector organs (Muscles & glands).

(C) Diencephalon : It encloses a cavity called third ventricle.

- It consists of thalamus and hypothalamus.
- Thalamus serves as a relay centre for sensory and motor impulses from spinal cord & medulla oblongata to cerebrum.
- It recognizes sensory impulses of heat, cold, pain, light & pressure.
- Floor of third ventricle is called hypothalamus.
- It possesses control centres for hunger, thirst, thermoregulation, sleep, sex, stress etc.

◈ **Mid Brain :** It consists of two parts :

(i) Cerebral peduncles :

- It consists of two heavy fibre tracts called Crura cerebri.
- These tracts connect fore brain to the hind brain.

(ii) Optic lobes

These are the centres for control of eye movement and hearing responses.

◈ **Hind brain :** It is divided into three parts.

(A) Cerebellum : Very large & well developed. It controls co-ordination and adjustment of movements (equilibrium) and posture.

(B) Pons varoli : It lies above the medulla oblongata. It controls some aspects of respiration.

(C) Medulla oblongata : It is the posterior most part of the brain and continues into the spinal cord. It controls involuntary functions of the body such as heart beat, rate of breathing, secretion of saliva, swallowing, coughing, sneezing, vomiting etc.

Boost your knowledge

☛ The weight of brain of an adult man is 1350 g and of a female is 1250 g.

DIFFERENT PARTS OF BRAIN AND THEIR FUNCTIONS

Parts of Brain	Sub-Divisions	Function
1. Fore Brain	(a) Olfactory lobes	Sense of smell
	(b) Cerebrum (largest and most complex part of brain).	Centre of memory and intelligence.
	(c) Diencephalon : Thalamus & Hypothalamus	Centre of emotions, sweating, fatigue, sleep, think pain, hunger, body temperature, fear etc.
2. Mid Brain	Cerebral peduncles or Crura cerebri (fibre tracts)	Receive sensory impulses from eyes, ears and muscles of head. Relay impulses back and forth between the cerebrum, cerebellum, pons and medulla.
3. Hind brain	(a) Cerebellum	Controls the rapid muscular activities such that as running typing etc.
	(b) Pons varolli	Relay impulse between medulla oblongata and upper parts of brain. It contains centres that work with those of medulla oblongata to regulate respiratory rate.
	(c) Medulla oblongata	(i) It controls various involuntary movements of the body. (ii) It has a respiratory centre of regulate respiration. (iii) It has reflex centre of swallowing, vomiting, peristalsis, salivation, coughing, sneezing etc.

SPINAL CORD

Spinal cord is a cylindrical structure. The spinal cord begins in continuation with medulla and extends downwards. It is enclosed in a bony cage called vertebral column. Spinal cord is also surrounded by membranes called meninges. As many as 31 pairs of nerves arise from the spinal cord . The spinal cord is concerned with spinal reflex actions and the conductions of nerve impulses to and from the brain.

The region between the thalamus and spinal cord is referred to as **brain stem**.

Spinal cord controls reflex actions such as moving our hand away on touching a hot plate.

SENSE ORGAN

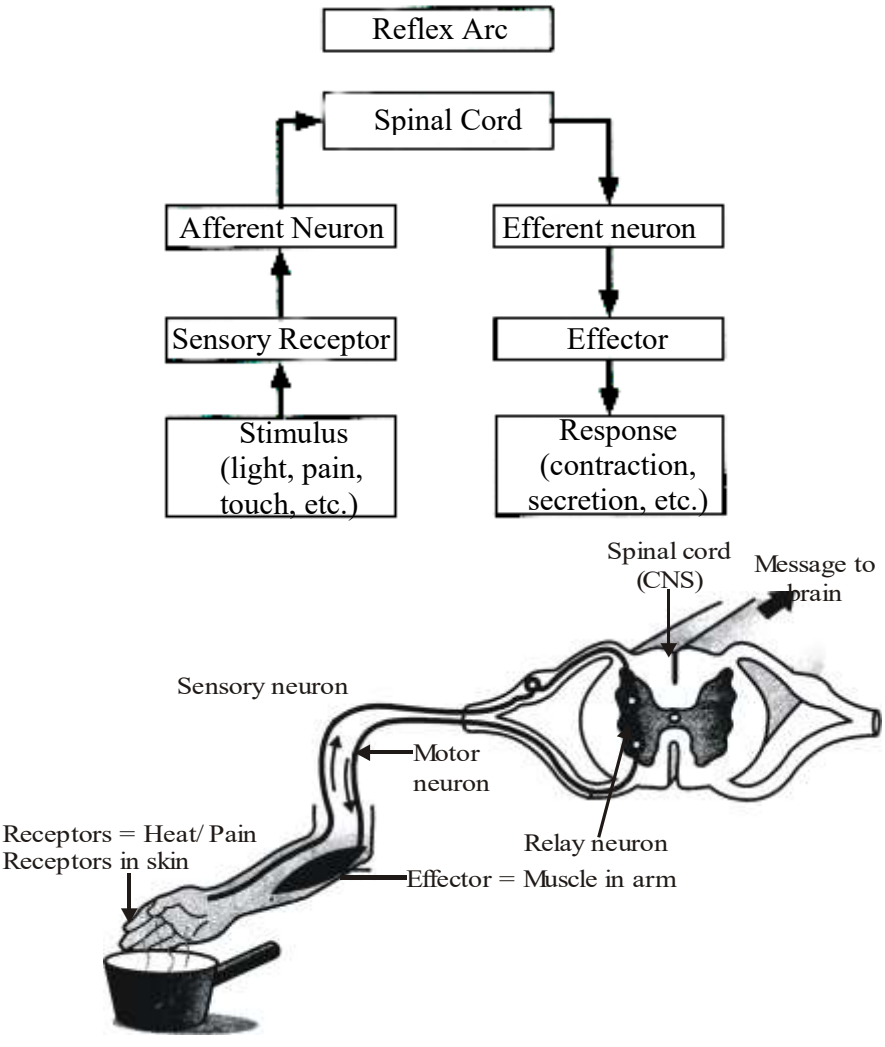
Every organism has little or more awareness to the different factors of the environment mainly due to the presence of certain sensitive structures in the body called sense organs or receptors.

The sense organs are generally destined to receive only one kind of stimulus and not any other. The most common receptors are

- Photoreceptor : Eye
- Phonoreceptor : Ear
- Guastatoreceptor : Tongue
- Tangoreceptor : Skin
- Olfactoreceptor : Nose

REFLEX ACTION

A reflex may be defined as an immediate and rapid response given without our awarness by an effector organ on the arrival of some external or internal stimulus.



Reflex Arc

- A reflex action is an unconscious (without will) and involuntary response of effectors (muscles or glands) to a stimulus. The pathway taken by nerve impulses in a reflex action is called the **reflex arc.**

  Examples of reflex actions :

  (i) Withdrawal of hand when pricked with a needle.

  (ii) Closing of eyes when flashed with strong light.

- Reflex action may be of two types :-

(i) Simple Reflex :

It is an in born, inherited or unlearned response to a stimulus.

Where learning is not required.

Mostly protective in function.

Ex.- Quick closing of eyelid when an object suddenly comes in front of eyes.

(ii) Conditioned Reflex :

It is the response acquired as a result of training or experience to a stimulus that originally failed to evoke the reaction. They are acquired by experience, training and learning. Father is **I.P. Pavlov** Ex. Writing , Driving of scooter etc.

Boost your knowledge

- **Cranial Reflex :** These actions are completed by brain. They are slow actions E.g. watering of mouth.
- **Spinal Reflex :** These actions are completed by spinal cord. They are quick actions. E.g. Displacement of leg at the time of pinching by needle.