Control and Coordination

Control & Co-ordination

Living organisms respond and react to various stimuli like heat, light, cold, touch, pressure etc.

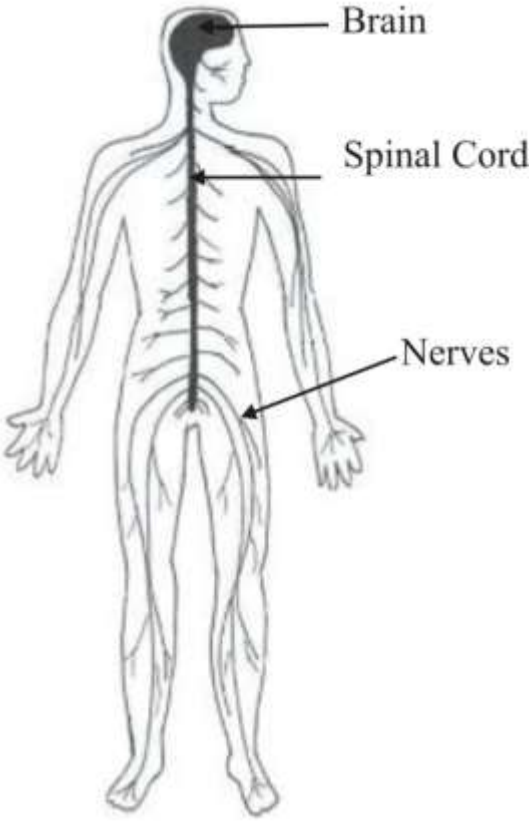
For example –

1. Take off the hand on touching a hot object.
2. Catching a ball by a fielder.

The response which a living being makes in relation to external stimuli is called control and coordination.

It is **Nervous System** which is mainly responsible for control and coordination in complex animals.

Nervous System



Nervous system is mainly composed of brain, spinal cord and nerves. Though five sense organs (nose, eyes, ears, tongue and skin) are also a part of nervous system and play a very important role in nervous system.

Functions of Nervous System

- Receive the information from environment by sense organs.
- Transportation of information to brain through spinal cord and nerves.
- After analyzing the information, it reacts accordingly through muscles and glands.

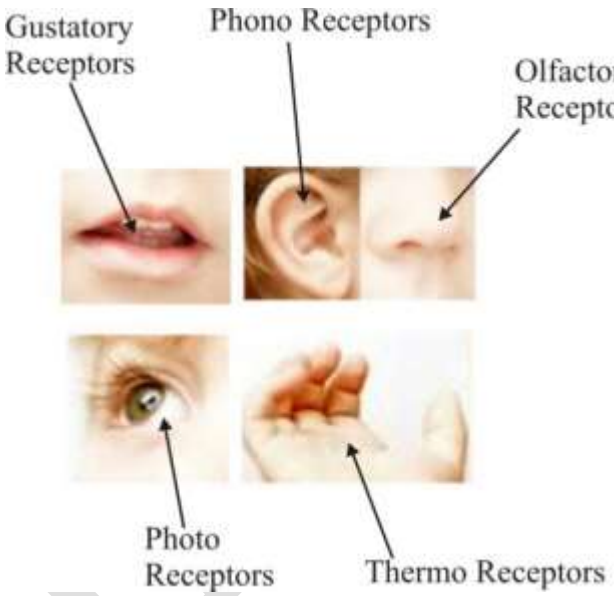
For example when we touch a hot object, our skin helps us to sense the heat, the nerves carry the impulse to the brain through spinal cord, and then the brain sends impulse to the muscles to contract and take off the hands.

Receptors

Receptors are group of cells present in sense organs which are sensitive to change in environment.

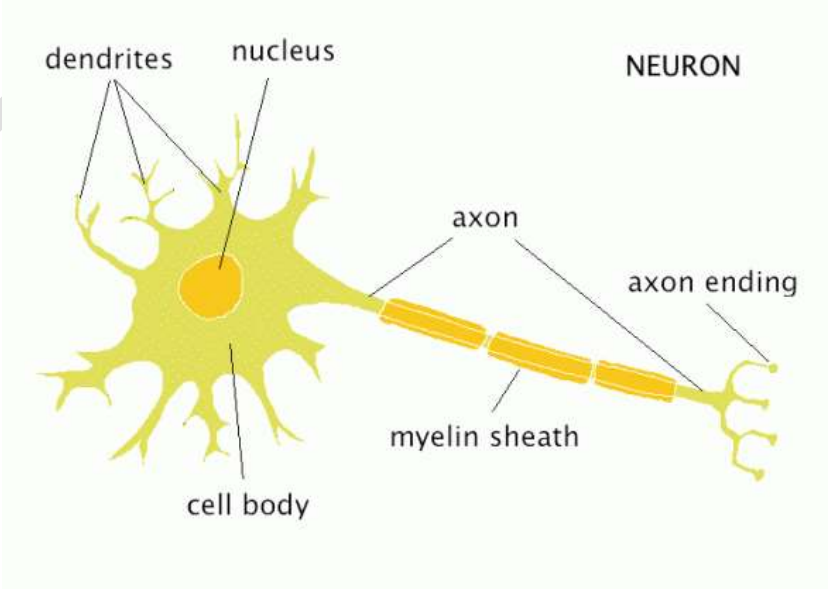
There are five types of receptors which are responsible for sensing the change in environment.

1. **Gustatory Receptors:** Responsible for taste detection.
2. **Phono Receptors:** Responsible for hearing.
3. **Olfactory Receptors:** Responsible for smell detection.
4. **Photo Receptors:** Responsible for detecting light.
5. **Thermo Receptors:** Responsible for feeling the touch of external stimuli.



Neuron

Neurons are specialized cells which are combined to form nerves of the nervous system. As nerves are emerged from brain and spinal cord and branch out to almost all parts of the body, so neuron is also called unit of nervous system.



The neuron consists of the following parts:

Cell Body: This main part has all of the necessary components of the cell, such as the nucleus, endoplasmic reticulum, ribosome and mitochondria. If the cell body dies, the neuron dies.

Axon: This is a long cable like projection of the cell along the length of the cell. It ends in several hair-like structures; called axon terminals/ axon endings. The axon terminals relay nerve impulses.

Dendrites: These small branch-like projections of the cell make connections to other neuron and receive the nerve impulses.

Synapse: The point of contact between the terminal branches of axon of one neuron with the dendrite of another neuron is called synapse.

Working of Neuron:

Neurons are responsible for transmitting message from brain to body parts and vice versa.
When receptors sense anything, a chemical reaction is triggered. This chemical reaction causes an electrical impulse in dendrites. This impulse travels through the body of neuron to axon endings. Tiny amount of chemical is released in synapse by axon endings when impulse reaches there. This chemical crosses the synapse and reach to tip of dendrites where it again produces electrical impulse. And then this impulse travels along neuron.

Types of Neuron:

1. **Sensory Neurons:** These neurons transmit message from body parts to central nervous system (which is composed of the brain and the spinal cord).
2. **Motor Neurons:** These neurons transmit message from central nervous system to body parts.
3. **Relay Neurons:** These neurons relay the signals within the central nervous system.

Nervous System in Humans

The nervous system in humans can be divided into two main parts,

1. **Peripheral nervous system**
2. **Central nervous system**

Peripheral Nervous System (PNS):

The peripheral nervous system is composed of the Cranial nerves, Spinal nerves and Visceral nerves.

Cranial Nerves: There are 12 pairs of cranial nerves. The cranial nerves come out of the brain and go to the sense organs and muscles in the head region.

Spinal Nerves: There are 31 pairs of spinal nerves. The spinal nerves come out of the spinal cord and go to the sense organs and muscles which are below the head region. These nerves carry message to brain through spinal cord.

Visceral Nerves: The visceral nerves come out of the brain and spinal cord and go to the internal organs (like heart, kidney etc.)

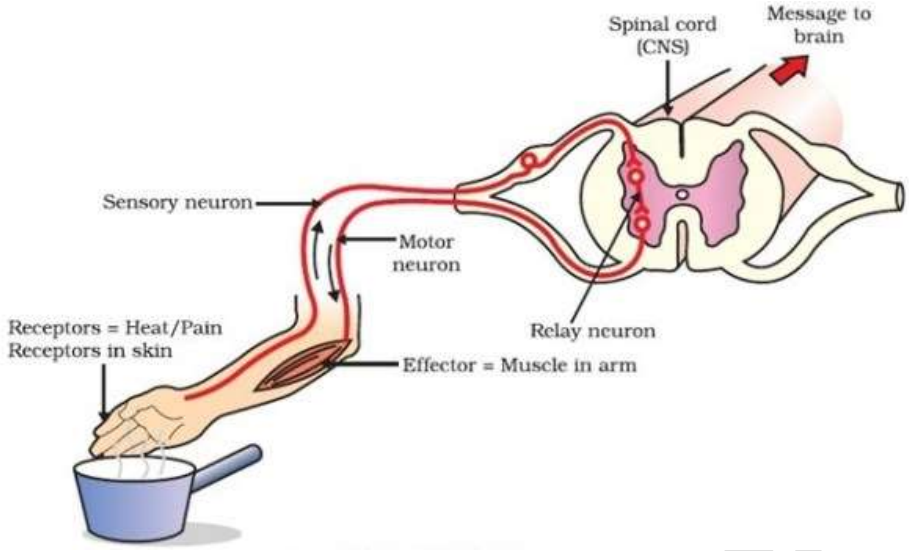
Voluntary and Involuntary Actions

Voluntary actions are actions which we do in conscious control of brain. For example: Writing, speaking, walking, kicking a ball, lifting an object etc.

Involuntary actions are those which occur without the conscious control of organisms or we can say they are not under the control of will. For example: beating of heart, breathing, sweating, working of kidney, digestion of food.

Reflex Action and Arc

Reflex action: It is a quick, automatic response to the change in environment (stimulus) that involves only spinal cord. Reflex actions occur within fractions of seconds.



Reflex arc: It is the pathway through which reflex action occurs.

Types of Reflexes / Reflex actions

1. Cerebral Reflex: A cerebral / cranial reflex is one that is controlled by one of the cranial nerves and tends to take place in the facial or head area. For ex. Change in size of pupil in bright light etc.

2. Spinal Reflex: A spinal reflex is a reflex that involves only the spinal nerves and spinal cord and is not processed by the brain. For ex. take off the hand on touching a hot object.

How Muscles (Effectors) cause Movement?

Muscles are made up of muscle cells which have special proteins. These proteins can change their arrangement on receiving message from brain. When they do so, shape of muscle changes. They can contract or expand. This contraction and expansion can cause movement in body parts.

Central Nervous System (CNS):

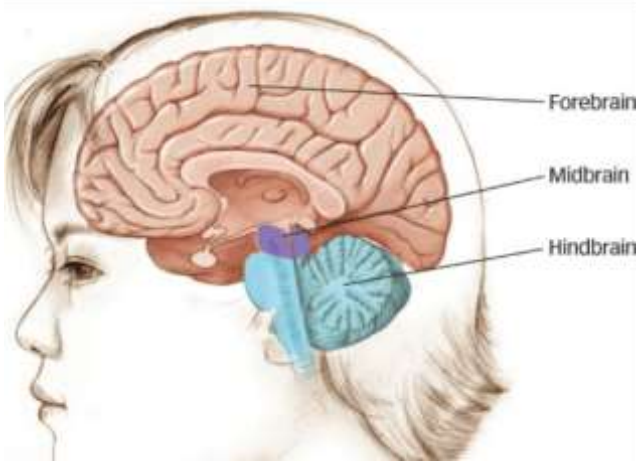
The central nervous system is composed of the **brain** and the **spinal cord**.

Brain

Brain controls all the functions in the human body. It is surrounded by a skull/ cranium. Cerebrospinal fluid is filled between the skull and the brain. Cranium and cerebrospinal fluid protect the brain from external shocks.

Human brain has three parts –

a. Forebrain (Cerebrum) **b. Mid brain** **c. Hind brain**



a. Forebrain/ Cerebrum: It is the most complex part of brain.

Functions –

1. Thinking part of the brain.
2. Memory (Store information).
3. Sensation.
4. Movement.
5. Feelings.

Thus cerebrum controls all the voluntary actions. Different parts of cerebrum are responsible for different jobs.

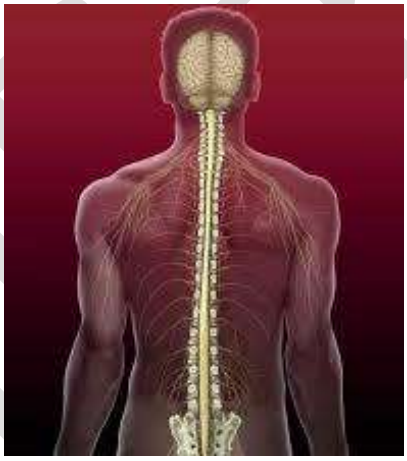
b. Mid brain: It controls cerebral reflexes like change in size of pupil, blinking of eye.

c. Hind brain: It controls all involuntary actions (beating of heart, breathing, sweating etc). Hind brain is mainly composed of three parts –

1. Pons – Regulate respiratory system.
2. Cerebellum – Controls posture, balance, motion, picking an object.
3. Medulla – Controls involuntary actions ex. digestion, heartbeat, blood pressure, vomiting, saliva in mouth, swallowing.

Spinal Cord

Spinal cord is started at medulla (Hind brain) and extends to downward. It is enclosed by a bony structure called Vertebral column at back centre of body.



Function –

- It carries message between brain and nerves.
- It controls spinal reflexes.

Endocrine System

The endocrine system is composed of several endocrine glands.

What are Glands?

Glands are organs in our body which excrete a liquid substance having some different chemicals. This liquid is called secretion of the gland.

Glands are of two types –

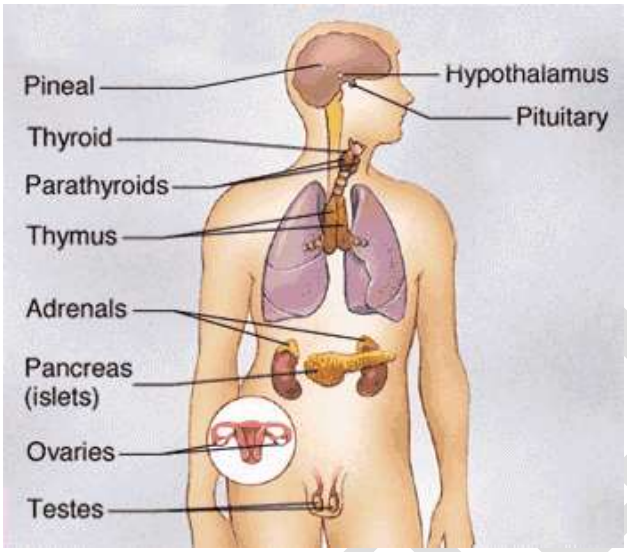
Exocrine Glands

Glands that have ducts are called **exocrine glands.** The secretions of exocrine glands reach their target by traveling through a duct (tube). Some examples of exocrine glands are sweat glands and salivary glands.

Endocrine Glands

The endocrine glands do not have ducts to carry their product to a surface. They are called ductless glands.
Hormones are the chemical substances produced by endocrine glands. These glands secrete their hormones directly into the blood vessels. Blood carries the secretion to different parts.

Thus **Endocrine System** is the system of endocrine glands in our body which secretes chemical substances called "**Hormones**". This system controls various activities of our body for example growth of body.



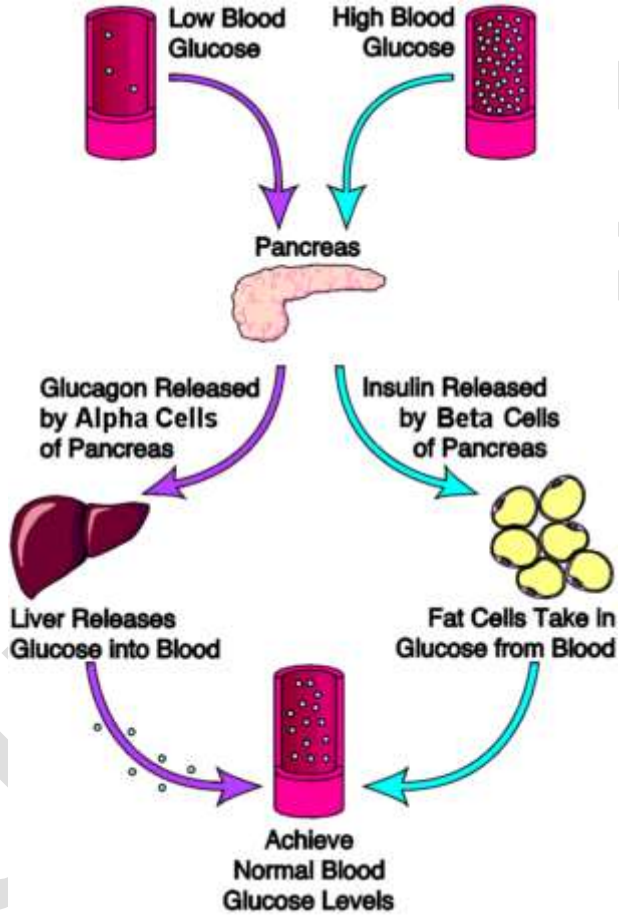
Endocrine Glands in Body

Endocrine Gland	Hormone	Location	Function
Pineal Gland	Melatonin	Close to centre of brain	Regulates sleep cycle
Hypothalamus	Secrete many hormones	Below mid brain	-Controls pituitary gland. -Controls secretion of many other glands.
Pituitary Gland	Secrete many hormones for ex. Growth hormones, thyroid stimulating hormone etc.	Below hypothalamus in brain	-Growth hormones stimulate growth of muscles, bones. -Regulates secretion of many other glands.
Thyroid Gland	Thyroxine (Iodine is necessary for secretion of thyroxine).	Around wind pipe in neck	-Regulates metabolism of carbohydrates, fats & proteins.
Parathyroid Gland	Parathormone	On thyroid gland	Regulates the level of calcium & phosphate in body.
Thymus Gland	Thymus hormone	In upper part of chest between lungs.	Plays important role in development of immune system.
Adrenal Gland	Adrenaline	On top of kidneys.	-Secretes in small amount all the time. -But sometimes for extra energy, more adrenaline hormone is secreted by it.

			-It prepares the body for emergency situations, excitement and anger.
Pancreas	Insulin	Below stomach	Regulates the amount of sugar in blood.
Testes (in males)	Testosterone	In scrotum	Sperm production, development of sex organs during puberty.
Ovary (in females)	Oestrogen & Progesterone	In the pelvis	Egg production, development of sex organs during puberty.

Feedback Mechanism

Feedback mechanism takes care that right amount of hormones are secreted by glands.



Regulation of blood glucose by pancreas Gland

Nervous System Vs Endocrine System

Nervous System	Endocrine System
1. Messages are in form of impulses over nerves.	Messages are in form of chemicals through blood.
2. Messages travel fast.	Messages travel slow.
3. Messages have short term effect.	Messages have long term effect.

Need for Endocrine System

- Nervous system is not very efficient in controlling large number of organs at the same time for a particular job. In such situations endocrine system is better.

- Nervous system is not meant for sending continuous messages for long time periods. But endocrine system can easily send continuous chemical messages in slow and steady manner. So endocrine system is better for controlling slow processes such as body growth.

Control and Coordination in Plants

Things to be coordinated:

1. Growth of plants
2. Germination of seeds
3. Flowering of plants
4. Ripening of fruits
5. Shedding of leaves
6. Movement of plants – Plants can do movement but can't do locomotion (moving from one place to another).

Animals Vs Plants

Animals	Plants
1. Control and coordination is more complicated in animals.	Simpler in plants.
1. Animals have nervous system and endocrine system (system of hormones) for control and coordination.	Plants do not have nervous system. Different hormones are responsible for control and coordination in plants.
1. Animals have specific glands to secrete hormones.	Plants do not have specific glands for secretion of hormones.

Some Important Plant Hormones

1. Auxin: It controls growth of stem, fruits and roots.
2. Gibberellins: It controls growth of stem, breaking dormancy of buds and seeds and growth of fruits.
3. Cytokinin: It controls growth of plants by cell division, functioning of stomata, breaking dormancy of seeds. These type of hormones present more in seeds and fruits.
4. Abscissic Acid (ABA): It controls inhibit growth, controls shedding of leaves, functioning of stomata and promote dormancy of seeds.

Movement in Plants

Movement in plants can be divided into two main types –
1. Tropic movement **2. Nastic movement**

Tropic movement/Tropism is the movement of plants in which direction of movement is guided by the direction of external stimulus causing the movement.

Nastic movement is the movement of plants in which direction of movement is **not** guided by the direction of any stimulus causing the movement.

Tropism/ Tropic movement

Tropic movements happen as a result of growth of a part of plant in a particular direction. Tropic movements can be of many types.

1. Phototropism
2. Geotropism / Gravitropism
3. Hydrotropism
4. Chemotropism
5. Thigmotropism

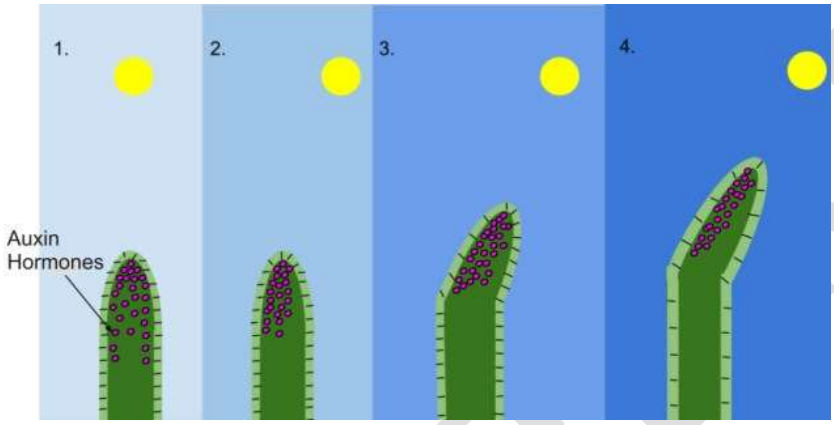
1. Phototropism

Phototropism is the growth movement of parts of plants in response to light. Growth towards a source of light is called positive phototropism. Growth away from the source of light is termed negative phototropism. Stems usually show positive phototropic movement, while roots usually show negative phototropic movement.

Mechanism of Phototropism

Auxin hormones cause growth in the part of stem where it is present in more amounts. But it prefers to accumulate more in regions of stem getting less light.

When light comes from top, all sides of stem get same light. Thus auxin is uniformaly distributed in stem and stem grows straight. But when light comes only from one side, auxin hormones gather on the other side and causing more growth on that side. This leads to bending of stem towards light.



2. Geotropism

When steam and root of plant move against and along the direction of gravity, it is called geotropism. Stems usually show negative geotropic movement to get light and air. Roots usually show positive geotropic movement i.e. towards the direction of the gravity to get water and nutrients from soil.

3. Hydrotropism

Movement of root towards water is called hydrotropism. This shows a positive hydrotropic movement. Growth hormones in root are responsible for bending of root towards the direction of water.

4. Thigmotropism

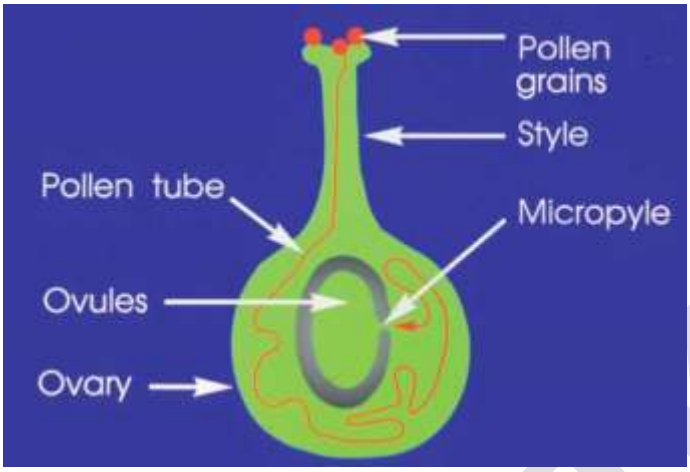
It is the growth movement of stem of some plants over a surface influenced by touch. The plant grows in a way so as it can coil around a support.

Such movements are seen in creepers for ex. Money plant.

The amount of auxin reduces in the portion of steam touching the stick. More auxin is present on the other side of stem which results in more growth on that side. This leads in the bending of stem around the contact surface.

5. Chemotropism

Movement of plant or parts of plant in response to a chemical stimulus is called chemotropism. In positive chemotropism, movement is toward the chemical. In negative chemotropism, movement is away from the chemical.
Growth of pollen tube from pollen to ovary under the influence of chemical released by ovary is an example of chemotropism.



Nastic movement (Nasty)

Nastic movements are the movements in which direction of the response is not dependent on the direction of the stimulus.

For example, when we touch the leaves of Mimosa pudica / touch-me-not plant, its leaves fold inward and droop. The drooping is independent of the direction from which the leaves are touched.

Such movements happen because when we touch the leaf, an electro-chemical signal travels to pulvinus. Pulvinus is a joint at the base of plant leaf which is tightly filled with water. Due to this, it remains firm and holds the leaf upright. When electro-chemical signal reaches to pulvinus, this signal makes pulvinus loose its water and thus firmness. So the leaf folds inward and droops.

If it is left for 15-20 minutes, water comes back to pulvinus and leaves become upright again.