Our body is made up of billions of cells that get organized into different tissues. Different tissues constitute organs, and different organs constitute systems such as the digestive, respiratory and circulatory systems. In order to perform a particular function the component organs of each system depend on each other and work in harmony. In the absence of such working in harmony, an organism cannot do many things that it normally does. For example, when we run, our muscles require greater energy, which can be produced when there is a greater supply of oxygen. To increase the oxygen supply, the rate of breathing increases. When we stop running, our muscles do not need so much energy. Consequently, there is no need for extra oxygen and the rate of breathing comes down to the normal level. All these activities are coordinated and well organized. The working together of various systems in the body is called coordination.

Response and Coordination in Plants and Animals

The ability of an organism to detect changes and make appropriate responses is called sensitivity. Anything to which an organism responds and reacts is called a stimulus. In animals the responses are quicker and more obvious. Unicellular animals respond to stimuli either by moving towards them or away from them. In multicellular animals, the process of responding to stimuli is different. The responses occur within seconds, but through a complex network of communication which involves several life processes like movement, locomotion, transport, respiration, etc. For example, when you step out in bright sunlight, you partly close your eyes to keep out the bright light. You may start sweating as the temperature rises. These are coordinated responses to stimuli.

Response and coordination in animals involve the sense organs, nervous system and chemical messengers called hormones.

Plants also react to specific environmental conditions. However, they have no nervous system and their responses are in the form of slow modified growth or movements called turgor movements, caused due to the distension (swelling) of cells. Let us first examine the phenomena of response and coordination in plants.

RESPONSE AND COORDINATION IN PLANTS

Plants do not have nervous system or muscle tissue like animals, but they still show movement and response. This is because they use chemical means to convey information from one cell to another. The ability of a plant to detect change and respond to the same is termed as “sensitivity of the plant”. The movement of plants is broadly classified into two types:

1. Immediate response to stimulus: it does not involve any growth, rather plant moves its leaves in response to touch. Sensitive plants give immediate response to the stimulus. Movement of part of plant occurs at a point different from the point of touch. Plant communicates the information that a touch has occurred. This is done in the following:

a) Plants use electrochemical means to convey the information from cell to cell as there are no specialized tissue for the conduction of information.
b) Plant cells change their shape by changing the amount of water in them, resulting in either swelling or shrinking of cell and finally in shape.

2. Movement due to growth: plants respond to stimuli by growing in a particular direction. This growth is directional due to which the plant appears moving. Some plants like pea, pumpkin and cucumber plant climb up on other plants or fences by

means of tendrils, which are sensitive to touch. When these tendrils come in contact with any support, the part of tendril in contact with the object does not grow as rapidly as the part of the tendril away from the object. This causes the tendril to circle around the object and thus, cling to it. There are two types of movements shown by plants: Tropic movement and Nastic movements.

Movement related to growth	Movement other than growth
A germinating seed gives rise to a shoot and a root. The shoot moves upwards whereas the root has the tendency to move in the direction of gravity (downwards).	If you touch the leaves of Mimosa (chuimui) plant, the leaves droop inwards (movement). This has nothing to do with the growth.

Quick Movements of Plants: Rapid movements are uncommon in plants, but some plants do display such movements in response to stimuli.

Touch the tip of a sensistive plant (Mimosa pudica) gently. Only a few leaflets close. When you touch it roughly, all the leaflets close.

In Mimosa pudica (touch me not plant), the leaflets fold up quickly if any leaflet is touched. How does it happen? It happens because the touch triggers a sudden and rapid loss of water (turgor changes) from cells at the base of the leaflets. These movements of sensitive plants in response to touch are very quick. All quick movements are not so quick. For example, the leaves of many plants, including those of Mimosa pudica, remain open during day. When darkness falls, the leaves fold up. Many flowers open after sunrise and close after sunset. All these movements are directed neither towards nor away from the stimulus. Such movements are called **nastic movements**.

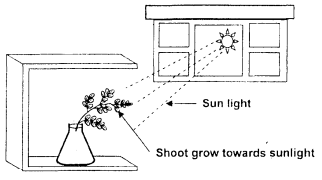
Types of nastic movements:

1. Photonasty (stimulus: light): e.g. opening and closing of petals of Oxalis
2. Thigmonasty (stimulus: contact of insect): e.g. bending of tentacles in Drosera
3. Thermonasty (stimulus: change in temperature): e.g.opening and closing of flower in Tulip
4. Seismonasty (stimulus: touch): drooping of leaves in Mimosa pudica (touch me not) plant

Stomatal Movements: The opening and closing of stomata is controlled by changes in the turgor pressure of guard cells and is coordinated with light and darkness.

Tropic Movements: The movement of an organism in the direction of a stimulus or away from it is called tropic movement, or tropism. A tropic movement is said to be positive if it is directed towards the source of stimulus and negative if directed away from the source of stimulus. The plant responds by growth or turgor changes, so that parts of the plant bend towards or away from the direction of stimulus. Tropic movements are of different types in response to different stimuli. Growth-related movement of plants is quite slow.

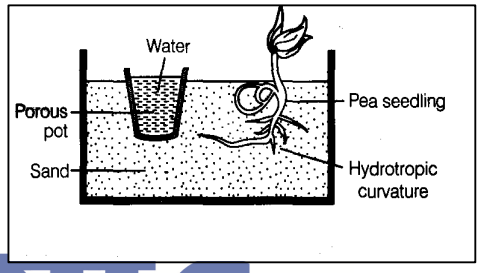
1. **Phototropism**: is the tropic response of organisms to light. When a young green plant receives light from one direction only, the stem grows towards the light source. The stem is said to be positively phototropic because the stem



2 GEOTROPISM

tip grows in the direction of light. Sunflower buds exhibit a special type of phototropism in which the buds turn slowly through the day so that they always face the sun. This movement is caused by turgor changes.

2. **Geotropism:** Geotropism is the tropic response of organisms to gravity. When a growing portion of a plant is placed horizontally, the stem tip grows away from the pull of gravity, while the root tip grows towards it. Thus, the stem is said to be negatively geotropic and the root positively geotropic.
Place a potted plant horizontally on the ground. After a week, you will see that the stem has bent upwards to grow away from gravity. And if you break the pot and remove some of the soil gently, you will notice that the root has bent downwards to grow in the direction of the pull of gravity.
3. **Hydrotropism:** The growth of plant parts towards or away from water is called hydrotropism. Roots are positively hydrotropic, i.e., they grow towards water in the soil.
Do you know that the positive hydrotropism of roots is stronger than their positive geotropism? Due to hydrotropism, the roots of roadside trees often block leaking sewage drains. To perform the experiment, take a plant (pea seeding) in ajar filled with sand. Place a porous pot filled with water in the wide jar. Roots of the plant will grow towards water and bend towards the water source showing positive hydrotropism.



4. **Chemotropism**: The tropic response of organisms to chemicals is known as chemotropism. For example, pollen tubes grow towards a chemical produced by the ovule during fertilization.
5. **Thigmotropism:** The tropic response of organisms to touch or contact with a solid surface is called thigmotropism. The climbing parts of a plant that twine around a support are positively thigmotropic. When such a plant part touches a support, the side of its apical meristem in contact with the support grows slower than the other side. This is how tendrils coil around a support.

Plant Hormones

Responses and growth in plants are controlled by chemical substances called plant hormones, or phytohormones. These substances are found in very minute quantities in plant tissues. A hormone is produced in specific cells of the plant and is transferred to another part where it influences a specific physiological process. While some plant hormones such as auxins, gibberellins and cytokinins stimulate growth, some others such as abscisic acid retard it.
Plant hormones control directional growth in plants and also bring about growth in carefully controlled ways. For example, they help plants to grow leaves only at the nodes and not at other parts of the body.
Auxins: Auxins are a group of plant hormones synthesized in the apical meristem of the root tips and shoot tips. When a shoot tip receives light, the hormone auxin is synthesized and diffuses towards the shady side of the shoot. This leads to enhanced growth on this side. Thus, the plant bends towards the light. The twining of a tendril around a support is also due to auxins.

In many plants, the apical meristem suppresses the growth of lateral, or axillary buds. The strong influence of the apical bud on the growth of the lateral buds can be seen by removing the apical bud from the plant.

Auxins promote cell elongation, root formation, cell division, respiration and other physiological processes like protein synthesis, water uptake, etc.

Gibberellins: Gibberellins stimulate stem elongation, seed germination and flowering. The maximum concentration of gibberellins is found in fruits and seeds. Gibberellins oppose the effect of abscisic acid, which inhibits growth.

Cytokinins: Cytokinins are chemicals which promote cytokinesis (cell division). They are produced in dividing cells throughout the plant. In mature plants, cytokinins are produced in the root tips and are transported to the shoots. They also help in breaking dormancy and regulating phloem transport.

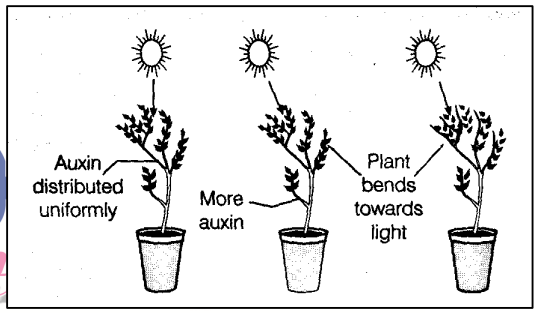
Abscisic acid: Abscisic acid is a growth inhibitor that reverses the growth-promoting effects of auxins and gibberellins. It causes dormancy of seeds, tubers and bulbs. It promotes leaf and fruit fall. It helps in the closure of the stomata to decrease the loss of water.

How phototropism occurs: It is the directional movement of a plant in response to light. The shoot responds by bending towards light and roots respond by bending away from light. This happens as;

a. When sunlight falls straight on the plant, the auxin hormone synthesized at the tip of the stem spreads uniformly down the stem and due to equal concentration of auxin, stem grows straight.

b. When sunlight falls on only one side of the plant, the auxin diffuses towards the shady side of shoot. The concentration of auxin stimulates the cells to grow longer.

Therefore, the stem appears to bend towards the source of light.



WORKSHEET

1. Plants neither have nervous tissues nor muscle cells, then how do they respond to stimuli?
2. Explain the mechanism that causes the leaves of touch me not plant droop when we touch them.
3. Give one example of plant hormone that promotes growth.
4. Design an experiment to demonstrate hydrotropism.
5. How does phototropism occur in plants?
6. How chemical composition does occurs in plants?
7. Write the main difference between auxins and cytokinins.
8. How do auxins help in the growth and the development of a plant?
9. Name the phytohormone, whose deficiency causes delay in seed germination.

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