SHORT QUESTIONS

2. What are carnivorous plants? Give examples.

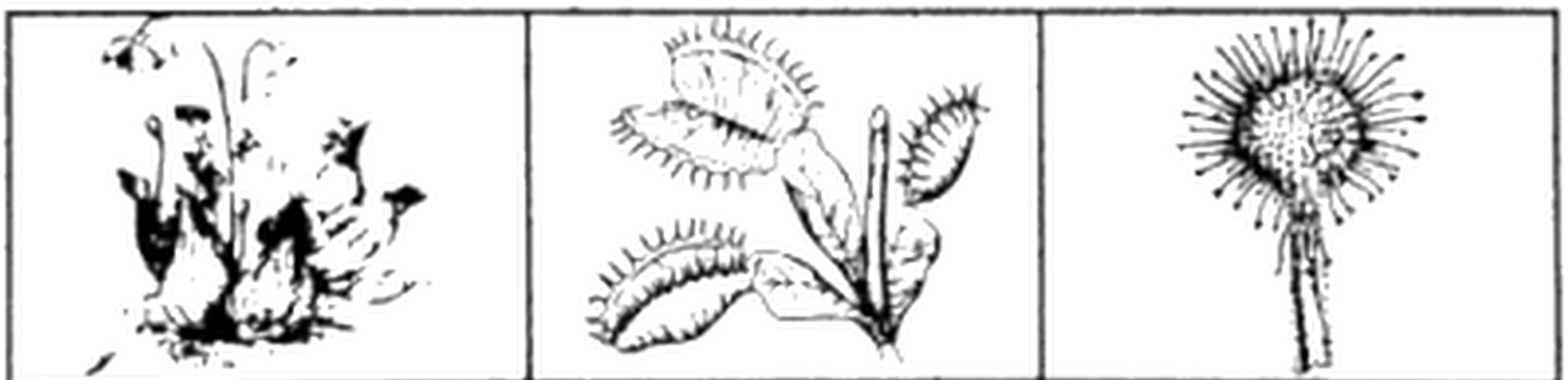
Ans: Carnivorous Plants:

Nutrition of Carnivorous Plants:

Carnivorous or insectivorous plants are true photosynthetic autotrophs but they also feed upon insects because they usually grow in places where nitrogenous salts are not readily available, e.g. marshy areas. Actually, they use insects and other small organ, ms as their source of nitrogen. Such plants have some modified leaves that are used to capture and digest insects. These plants also have certain symbiotic bacteria, which help them to digest insect proteins.

Examples:

The examples are Pitcher plant, (Nepenthes pupurea), Venus flytrap (Dionaea muscipula), Sundew (Drosera intermedia) etc.



Pitcher plant | Venus flytrap | Sundew

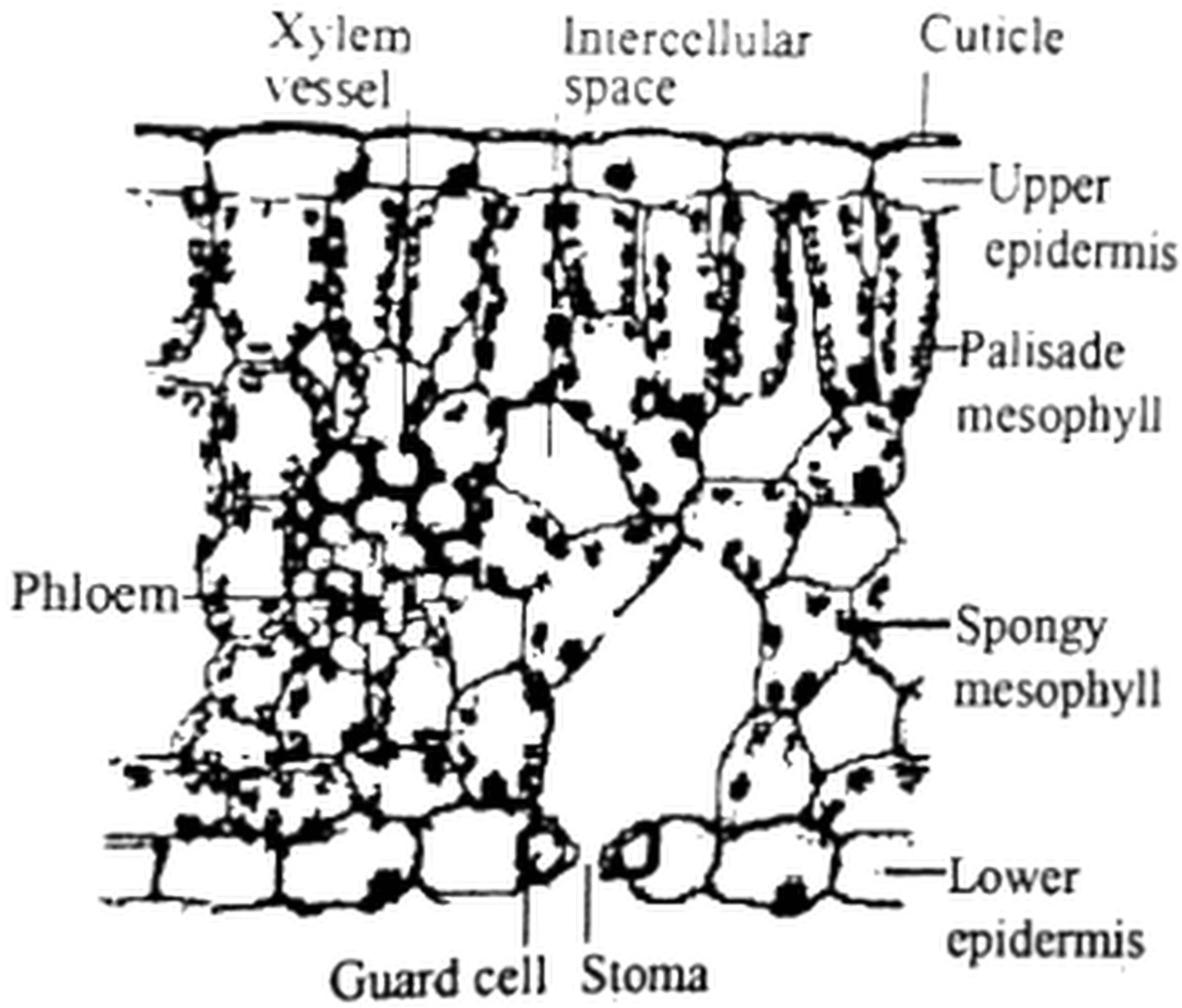
3. How exchange of gases takes place in plants? What is the purpose of gaseous exchange?

Ans: Gaseous Exchange in Plants:

In bioenergetics, you have studied that respiration occurs at two levels, i.e. organismic and cellular level. The respiration that occurs at organismic level is called **exchange of gases.**

The purpose of this gaseous exchange is to enable the organism to perform cellular respiration, which utilizes oxygen and releases carbon dioxide during the breakdown of complex organic compounds. Exchange of gases between organism and its environment is carried out by diffusion. In the absence of special organs, every cell of plant carries out the exchanges of oxygen and carbon dioxide according to its needs. This exchange of gases mainly occurs through two main openings, the stomata and lenticels.

4. Draw and label T.S. of bifacial leaf.
Ans:



T.S of Bifacial leaf

5. What is the role of transpiration in exchange of gases in plants?

Ans: Role of Transpiration in Exchange of Gases in Plants:

The transpiration is the loss of water in the form of vapours through serial (above the ground) parts of the plants mainly through the stomata. It is not only responsible for transportation of water and minerals but also plays a vital role in the exchange of gases. During day light the stomata are widely open and provide a wide passage for the exchange of gases.

6. Write a shot note on:

(a) hydrophytes (b) mesophytes (c) xerophytes

Ans: (a) Hydrophytes:

The plants that are found in the area where abundant water is available, are called **hydrophytes.** Aquatic plants of freshwater habitats are example of such plants. These plants are exposed in hypotonic conditions so face problem of flooding (excess of water). Such plants show highest rate of transpiration due to broad leaves with large surface area and distribution of stomata on upper epidermis, which are kept open day and night. These plants do not store water and either have very thin cuticle or almost none, or their surface.

Features of Hydrophytes	
Habitat	Aquatic
Osmotic conditions	Hypotonic
Problems faced by plant	Flooding
Rate of transpiration	Very high rate

Stomatal distribution	On upper epidermis
Stomatal opening	Stomata remain open all the time
Thickness of cuticle	Very thin or none
Storage of water	None

(b) Mesophytes:

The plants that are found in the area where moderate supply of water is available are called **mesophytes.** Common crop plants such as wheat, rice corn is example of such plants. These plants are exposed in nearly isotonic conditions so face no drastic problem of flooding (excess of water) or dehydration (deficiency of water). Such plants show moderate rate of transpiration due to medium sized leaves with distribution of stomata on lower epidermis, which are generally open in day and close at night. However, these plants can close their stomata even in day. These plants store a very small amount water, have very thin cuticle on their surface;

Features of Mesophytes	
Habitat	Terrestrial (moderate)
Osmotic conditions of medium	Nearly isotonic
Problems faced by plant	No drastic problem
Rate of transpiration	Medium rate
Stomatal distribution	On lower epidermis

Stomatal opening	Open in day and close at night
Thickness of cuticle	Less thick
Storage of water	Little storage

(c) Xerophytes:

The plants that are found in the area where very little amount of water is available are called xerophytes. Desert plants such as cactus, opuntia are example of such plants. These plants are exposed to severely hypertonic conditions so face extreme degree of dehydration.

Such plants show very reduced rate of transpiration due to narrow needle like leaves or due to complete modification of leaves into spines. They have stomata in depressions (**sunken stomata)**, which are generally close in day and open at night. These plants store a very high amount of water therefore; they are also called **succulent plants.** They have very thought cuticle on their surface.

Features of Xerophytes	
Habitat	Terrestrial (severely dry)
Osmotic conditions of medium	Strong hypertonic
Problems faced by plant	Severe dehydration
Rate of transpiration	Very low rate
Stomatal distribution	Sunken stomata

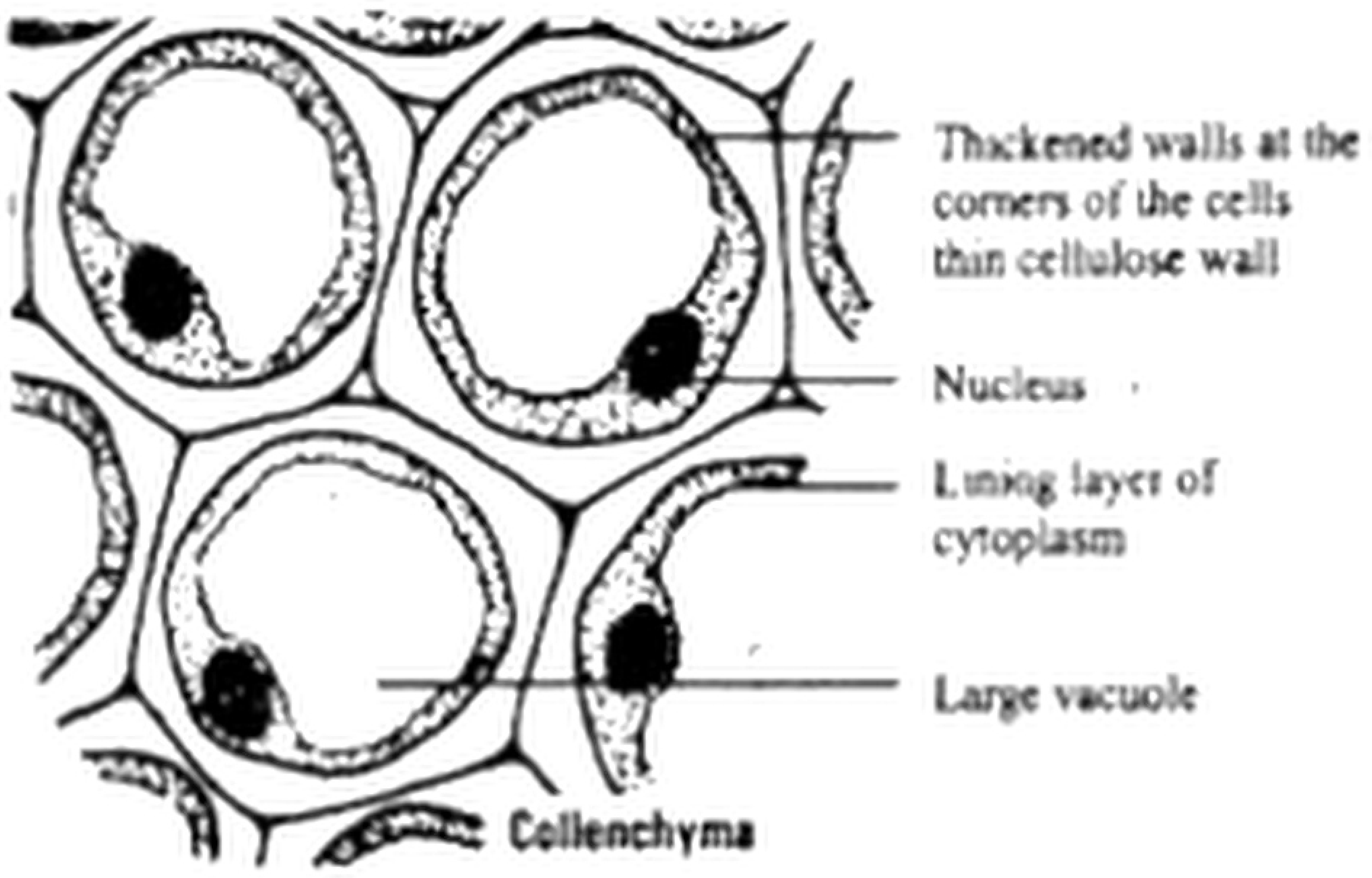
Stomatal opening	Close in day and open at night
Thickness of cuticle	Very thick
Storage of water	Succulent

7. What is the role of turgor mechanism for support in plants?

Ans: Role of turgor mechanism in support:

In plants the **parenchyma** cells have large central vacuoles, which are filled with water. The water causes pressure on the surrounding walls, when the cells are turgid. This pressure on the walls keeps the cells, stiff and hard and is called **turgor pressure.**

In herbaceous, plants where the specialized supporting tissues are not common, the turgidity of the cells provides support and strength and it grows uprightly. In these cases, the plant may wilt or collapse due to a decrease in turgidity (decrease in the internal hydrostatic pressure). Besides the hydrostatic pressure the plants specially shrubs and trees have some supporting tissues, like collenchymas, sclerenchyma, and conducting tissues.



8. Describe the types of plant growth.

Ans: Types of plant growth:

Based upon origin there are two types of plant growth: Primary growth and secondary growth.

Primary growth:

When a plant starts its life after germination of seed, it begins to increase its length first, this increase in length of root and shoot is therefore, called **primary growth.** It remains continue throughout the life of a plant (indeterminate growth) however the rate of grow may vary in different periods of life. Primary growth is carried out by the cell division in **apical meristem.**

Secondary growth:

The increase in thickness and diameter of a plant is called **secondary growth.** This is characteristic of stems and roots of Dicots and gymnosperms where it contributes a significant role in support of the plant body. All the tissues that are produced during secondary growth are called **secondary tissues.** Similarly, the tissues that are already present in plant before the onset of secondary growth are called **primary tissues.**

9. Classify plants based upon photoperiodism.

Ans: Classification of plants based upon photoperiodism:

Plants are classified into three main groups on the basis of how photoperiodism affects their flowering.

Short-day plants:

These plants flower when the photoperiod is less than a certain critical length, e.g. Maryland mammoth, cocklebur, chrysanthemum, tobacco etc.

Long-day plant:

These plants flower when the photoperiod exceeds from the critical length e.g. spinach, sugar beet, Henbane snapdragon, cabbage, spring wheat etc.

Day-neutral plants:

These plants can flower in any photoperiod after a considerable vegetative growth. The flowering is not affected by variation in day length or length or darkness in these plants, e.g. tomato, pansy, bean, sweet pea, rose, etc.

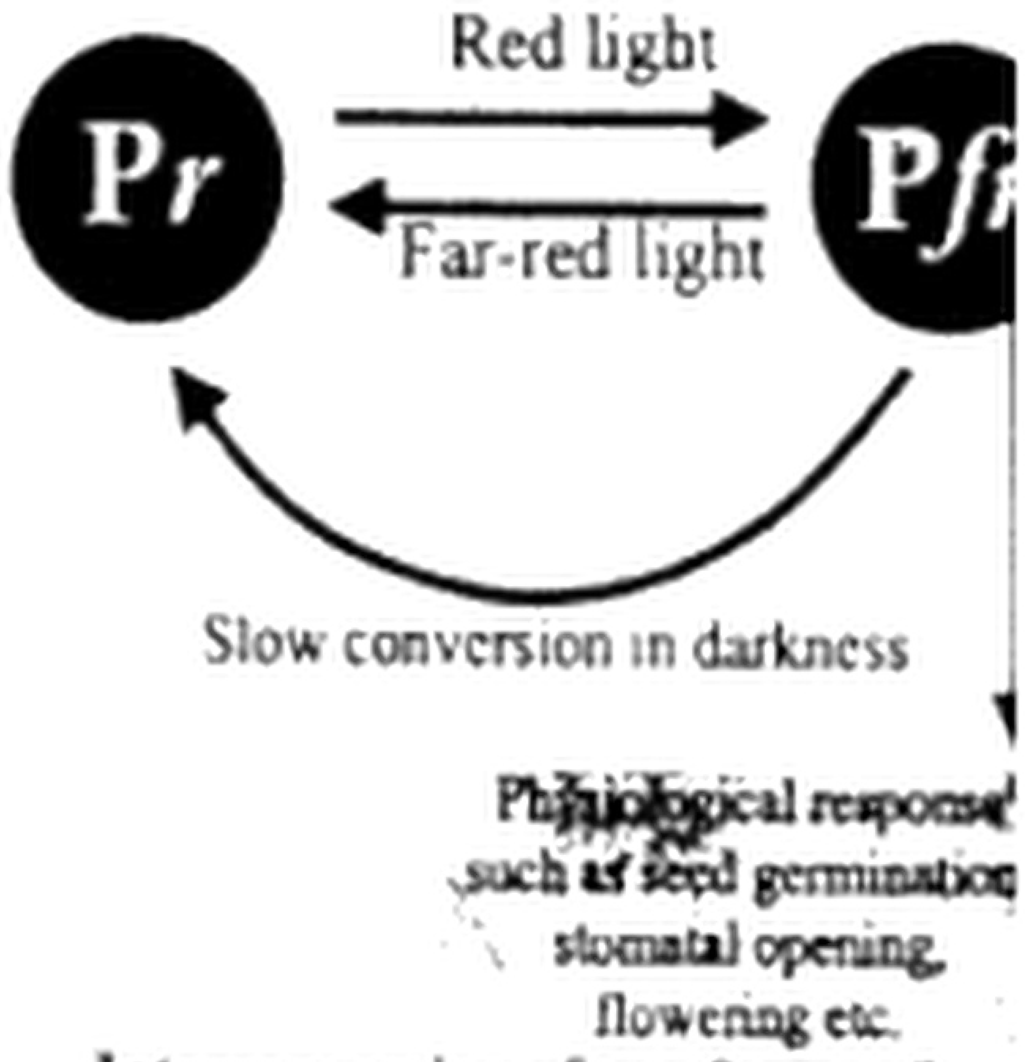
10. What is critical photoperiod?

Ans: Concept of Critical Photoperiods:

The concept of critical lengths of photoperiod for both long day and short-day plants different and its duration is also variable for every plant even they belong to the same group. For example, for **tobacco, 14 hours** photoperiod is seemed to be critical and for **cocklebur 15.5 hours** photoperiod is critical, however both are short day plants. Actually, length of critical photoperiod depends upon the level and relative proportion of two forms of phytochroes in plant body. Critical photoperiod for short day plant can be defined as the maximum length of day, which is required to simulate/induce flowering in short day plant". Similarly, "critical photoperiod for long day plant can be defined as the minimum length of day, which required to simulate/induce flowering in a long day plant". For example, for henbane 11 hours photoperiod is critical.

11. What are phytochromes?

Ans: Phoytochromes are found in two interconvertible forms. One form of phytochrome, designated as PR or P660 strongly observed red light (at 660 nm) and is converted into the second form phytochrome i.e. PFR or P730. When PFR (P730) absorbs far – red light, it reverts to the original form PR (P660). Since red light is available in day time so the conversation of PR (P660) to PFR (P730) occurs in day. Far-red light are invisible heat radiations that are present in both day and night but the conversation PFR (P730) to PR (P660) cannot stay in day time due to the presence of red light: in this way, the accumulation of either form phytochrome in day and night enable the plant to determine that weather it is present in day or night. The rate of conversation of PFR (P730) to PR (P660) that occurs at night also provides a biological clock to the plants to determine the length of their night.



Interconversion of two forms of phytochromes

12. What is vernalization?

Ans: Vernalization:

The promotion of flowering by exposure to low temperature is known as **vernalization.** The low temperature stimulus is received by the shoot apex of a mature plant or embryo (not by the leaves as in **photoperiodism)**. Although the exact **temperature** and amount of time required among species, most vernalization temperature occurs between 0^0C to 10^0C, but temperature around 4^0**C** is found to be most effective. Vernalization is the requirement of **biennial plants** (the plants that complete their life cycle during any months of two different calendar years).

Example:

For example, **winter whear** is biennial plant, which is swon in October or November and harvested in June or July of the next year. If it is sown in February of March like **spring wheat** (annual plant), it will show vegetative growth but will not flower. However, it can flower even it is sown in February or March, if its seeds are exposed to several weeks of low temperatures 4^0C stimulus.

In some pants, the requirement of **low temperature** period is absolute, meaning that they will not flower without vernalization. Low temperature stimulates production of **vernalin** hormone that transforms vegetative buds to the floral bud thus flower is produced. It has been now discovered that vernal in is actually **gibberellins.**

13. Why support is need in terrestrial life?

Ans: When the life started on land from water, one of the very important needs for the organisms was to gain some sort of support and strength for keeping their bodies in shapes. Plants also have variety of mechanism for support.

Such as, turgor mechanism in parenchyma cells, mechanical tissues (thick walled e.g, collenchymas and sclerenchyma), arrangement of vascular bundles and secondary growth.

In plant the **parenchyma** cell has large central vacuoles, which are filled with water.

The water causes pressure on the surrounding walls, when the cells are turgid. This pressure on the walls keeps the cells, stiff and hard and is called **turgor pressure**.

In herbaceous plants where the specialized supporting tissues are not common, the turgidity of the cells provides support and strength and it grows uprightly. In these cases, the plant may wilt or collapse due to a decrease in turgidity (decrease in the internal hydrostatic pressure).

Besides the hydrostatic pressure the plant specially shrubs and trees have some supporting tissues, like collenchymas, sclerenchyma, and conducting tissues.

14. Enlist the names of supporting tissue in plants.

Ans: **i.** Collenchyma
ii. Sclerenchyma
iii. Conducting tissues

15. What happens primary tissues of a stem when secondary growth occurs?

Ans: Lateral meristems are the dividing cells in **secondary growth**, and produce **secondary tissues. Secondary** xylem is the actual wood of the plant, and **secondary** phloem provides sugar transport. Lateral meristems are arranged into two cylinders that run through the roots and **stems,** the vascular cambium and the cork cambium.

16. Why does the wood of many tropical trees lack annual rings?

Ans: Rings occur where a tree grows more slowly during the winter (dark rings) vs rapidly during the summer (light rings). In places where there's not much seasonal change in growing conditions the plant grows steadily all year and from year to year so there are no rings.

17. Why are the types of movement in plants in response to stimuli?

Ans: The plants as their characteristics do not show locomotion, but the individual plant organs may show movements by change in differential growth in response of various stimuli (internal or external).

Tropic movements or **tropisms** that are either towards or away from certain external stimuli such as light, force of gravity, touch and chemical.

Depending upon the nature of stimuli, these movements are following types:

i. Phototropism **ii.** Geotropism

iii. Thigmotropism **iv.** Chemotropism

18. Define/Describe/Explain briefly:

Chlorosis, mesophyll, Mega pascal, water potential, solute potential, pressure potential, apoplast pathway, symplast pathway, vacuolar pathway, tracheophytes, transpiration mass flow theory, homeostasis, osmotic adjustment, hydrophytes, mesophytes, xerophytes, heat shock proteins, turgor pressure, meristem, annual growth, apical dominance, auxin, gibberellins, cytokinins, abscisic acid, ethane, phototropism, geotropism, thigmotropism, chemitropism, phytohrome.

Ans: Chlorosis:

Deficiency of nitrogen or magnesium causes yellowing of leaves called **chlorosis.**

OR

Chlorosis is a condition in which leaves produce insufficient chlorophyll. As chlorophyll is responsible for the green color of leaves, **chlorotic** leaves are pale, yellow, or yellow-white. **Mesophyll:**

Mesophylls are special types of parenchymatous cells (thin walled living cells) which are present between the two epidermal layers of leaves. These cells are modified to carry out photosynthesis.

Mega Pascal:

Potential or pressure is denoted by the Greek letter **Ψ(psi)** and is expressed in units of pressure (pressure is a form of energy) called **Mega Pascal (MPa)**.

Water potential:

Water potential is a measure of the potential energy in water that enables it to move from one place to another.

Solute Potential:

Solutes reduce water potential (resulting in a more negative Ψ_w) by consuming some of the potential energy available in the water. This measure of decrease in water potential of a medium due to the addition of solutes is called solute potential.

Pressure Potential:

If pressure greater than atmospheric pressure is applied to pure water or a solution, its water potential increases. It is equivalent to pumping water from one place to another such a situation may arise in living system. When water enters the plant cells by osmosis, pressure may be built up inside the cell making the cell turgid and increasing the water potential. This measure of increase in water potential of a medium due to the addition of water or due to the pressure greater than atmospheric pressure is called **pressure potential**.

Following example would help understand the concept of water potential. Two adjacent vacuolated cells are shown with Ψ_w, Ψ_s, and Ψ_p.

Apoplast Pathway:

The **apoplast** is the system of adjacent cell walls, which is continuous throughout the plant. When water moving through spaces in the cell walls reaches the endodermis, its progress is stopped by **casparian strips,** (a band of suberin and lignin bordering four sides of root endodermal cells). Therefore, water and solutes particularly salts in the form of ions must pass through the cell surface and into the cytoplasm of the cells of the endodermis. In this way the cells of the endodermis can control and regulate the movement of solutes through the xylem. This is called **apoplast pathway.**

Symplast pathway:

Movement of cell sap that involves cytoplasmic connection of adjacent cells is termed as **symplast pathway.** The **symplast** is the system of interconnected protoplast in the plant. The **cytoplasm** of neighboring **protoplast** linked by the **plasmodesmata.** Once water and any solutes it contains is taken into the cytoplasm of one cell it can move through the symplast without having to cross further membranes. Movement might be aided by cytoplasmic streaming. The simplest is an important pathway of water movement.

Vacuolar Pathway:

In the **vacuolar pathway** water moves from vacuole to vacuole through neighboring cells, crossing the symplast and apoplast in the process and moving through membranes and tonoplast by osmosis. It moves down water potential gradient.

Tracheophytes:

Tracheids are dead elongated cells with tapering and lignified walls. They have mechanical strength and give support and also involve in conduction of water and minerals. These cells are universally presenting in xylem tissue of all vascular plants, which are therefore, called **tracheophytes.**

Transpiration:

When stomata are open, the water molecules move from the region of high-water potential (intercellular spaces of leave) to a region of low potential (in the air). These evaporations of water are called **transpiration.**

Mass Flow Theory:

The most acceptable theory that explains the mechanism of translocation of organic solutes is the pressure flow or mass flow theory. According to this theory, the sugars produced in source region, such as photosynthesizing leaves or storage places are loaded into the phloem's sieve tube elements by the companion cells.

Homeostasis:

Homeostasis is the ability to maintain a steady state within a constantly changing environment that contributes towards the success of living systems. The outer environmental conditions such as water availability nutrients and temperature often show fluctuations that also affect these components within plant body. Plant have several adaptations to cope with these challenges.

Osmotic Adjustment:

The maintenance of water and solute level in the body is called osmotic adjustment or osmoregulation. Water and solute relations establish three kinds of osmotic situation such as hypertonic and isotonic.

Hydrophytes:

The plants that are found in the area where abundant water is available, are called **hydrophytes.** Aquatic plants of freshwater habitats are example of such plants. These plants are exposed in hypotonic conditions so face problem of flooding (excess of water). Such plants show highest rate of transpiration due to broad leaves with large surface area and distribution of stomata on upper epidermis, which are kept open day and night. These plants do not store water and either have very thin cuticle or almost none, on their surface.

Mesophytes:

The plants that are found in the area where moderate supply of water is available are called **mesophytes.** Common crop plants such as wheat, rice corn is example of plants. These plants are exposed in nearly isotonic conditions so face no drastic problem of flooding (excess of water) or dehydration (deficiency of water). Such plants show moderate rate of transpiration due to medium sized leaves with distribution of stomata on lower epidermis. Which are generally open in day and close at night? However, these plants can close their stomata even a day. These plants are store a very small amount of water, have very thin cuticle on their surface.

Xerophytes:

The plants that are found in the area where very little amount water is available are called **xerophytes.** Desert plants such as cactus, opuntia are example of such plants. These plants are exposed to severely hypertonic conditions so face extreme degree of dehydration.

Such plant shows reduced rate of transpiration due to narrow needle like leaves or due to complete modification of leaves into spines. They have stomata in depressions (**sunken stomata),** which are generally close in day and open at night. These plants store a very high amount of water therefore they are also called **succulent plants.** They have very thin cuticle on their surface.

Heat Shock Proteins:

Most plants have adapted to survive in such high temperature stress situations by synthesizing large quantities of special proteins called **heat shock proteins.**

Turgor Pressure:

In plants the **parenchyma cells** have large central vacuoles, which are filled with water. The water causes pressure on the surrounding walls, when the cells are turgid. This pressure on the walls keeps the cells, stiff and hard and is called **turgor pressure.**

Meristem:

In lower plants, the entire plant body is capable of growing, but in higher plants, growth is limited to certain regions known as growing points that possess specialized tissues for growth, the **meristematic tissues** or **meristems.**

Annual Growth:

In autumn and winter seasons, comparatively smaller sized cells are produced due to deficiency of water while in spring and summer seasons, larger sized cells are produced probably due to availability of water. Because of this differential growth pattern distinct rings of smaller and larger cells are formed, which represent the growth of one whole year, therefore these rings are called **growth rings** or **annual rings.** We can determine the age of plant by counting the number of these growth ring as each ring is form in one year.

Apical Dominance:

Apical dominance is a kind of negative growth correlation in which the presence of a growing apical bud inhibits growth of lateral buds. It is also found in roots where lateral root growth is inhibited by growth of the main root. The plants showing tall height with short side branches have very strong apical dominance and the plants showing short height and very dense growth of lateral branches have very little apical dominance.

Auxin:

An auxin or **indoie-3-acetic acid** (IAA), was the first plant hormone identified. It is manufactured primarily in the shoot tips (in leaf primordia and young leaves), in embryos, and in parts of developing flowers and seeds. They are mainly responsible for cell elongation.

Gibberellins:

The gibberellins are widespread throughout the plant kingdom, and more than 75 have been isolated, to date. Rather than giving each a specific name the compounds are numbered, for example GA1, GA2, and so on **Gibberellic acid 3 (GA3)** is the most widespread and most thoroughly studied. The gibberellins are especially abundant in seeds and young shoots where they control stem elongation by stimulating both cell division and elongation.

Cytokinins:

These are named because of their role in cell division (cytokinesis) the cytokinins have a molecula structure similar to adenine. Naturally occurring **zeetin,** isolated first from corn (zea mays) is the most active of the cytokinins. Cytokinins are found in sites of active cell division in plants, for example in root tips, seeds, fruits and leaves.

Abscisic Acid:

Abscisic acid (ABA) is synthesized in plastids from carotenoids during stress satiation and diffuses in all direction through vascular tissues and parenchyma. Its principal effect inhibition of cell growth. ABA increases in developing seeds and promotes dormancy. If leaves experience water stress ABA amount increase immediately causing the stomata to close.

Ethane:

Ethylene or ethane is a simple gaseous hydrocarbon produced from amino acid and appears in most plant tissues in large amounts when they are stressed. It diffuses from its sites of origin into the air and effects surrounding plants as well. Ethylene stimulates the ripening of fruit and initiates abscission of fruits and leaves.

Phototropism:

Phototropism is the movement of plants, either towards (positive) or away (negative) from light source. Such movements are found in shoots and roots. Shoots show positive phototropism (grow upward above the ground) and roots show negative geotropism (grow downward under the ground).

Geotropism:

Geotropism (gravitropism) is the movement of pants parts, either towards (positive) or away (negative) from force of gravity. Such movements are also found in shoots and roots. Shoots shows negative geotropism (grow upward above the ground) and roots show positive geotropism (grown downward under the ground).

Thigmotropism:

Thigmotropism is the movement due to the touch stimulus. Such movement is shown by climbing plants that require any supportive structure. Such as a wall, a wooden stick or rod or even a rope to climb over.

Chemotropism:

In chemotropism the stimulus is a chemical (nutrients). Such movement shows by fungal mycelium in which hyphae show more growth towards the nutrients.

Phytochrome:

Phytochromes are found into interconvertible forms. One form of phytochrome, designated as PR or P660 strongly absorbs red light (at 660 nm) and is converted into the second form of phytochrome i.e. PFR or P730. When PR or (P730) absorbs far-red light, it reverts to the original form PR (P660). Since red light available in day time so the conversion of PR or (P660) to PFR (P730) occurs in day. Far-red light is invisible heat radiation that are present in both day and night but they conversion of PFR (P730) to PR (P660) occurs at night prominently because PR (P660) cannot stay in day time due to the presence of red light. In this way the accumulation of either form of phytochrome in day and night enable the plant to determine that weather it is presence in day or night. The rate of conversion of PFH (P730) to PR or (P660) that occurs at night also provides a biological clock to the plants to determine the length of their night.

19. Write the differences between:

(a) Apoplast pathway and simplest pathway

(b) **Cohesion and adhesion**
(c) **Endosmosis and exosmosis**
(d) **Hypotonic and hypertonic solution**
(e) **Mesophytes and xerophytes**
(f) **Collenchyma and sclerenchyma**
(g) **Fibres and sclereids**
(h) **Primary meristem and lateral meristem**
(i) **Primary growth and secondary growth**
(j) **Wood and bark**
(k) **Phototropism and geotropism**
(l) **Phototropism and photoperiodism**
(m) **Red light and far red light**

Ans: (a) Apoplast pathway and simplest pathway:

Apoplast Pathway:

The apoplast is the system of adjacent cell walls, which is continues throughout the plant. When water moving through spaces in the cell walls reaches the endodermis its progress is stopped by **casparian strips,** (a band of suberin and lignin bordering four sides of fruit endodermal cells). Therefore, water and solutes particularly salts in the form of ions must pass through the cell surface and into the cytoplasm of the cell of the endodermis. In these ways the cells of the endodermis can control and regulate the movement of solutes through the xylem. This is called **Apoplast pathway.**

Symplast pathway:

Movement of cell sap that involves cytoplasmic connection of adjacent cell is termed as **simplest pathway.** The **simplest** is the system of interconnected protoplast in the plant. The cytoplasm of neighboring **protoplast** is linked by the **plasmodesmata.** Once water and any solutes it contains is taken into the cytoplasm of one cell it can move through the simplest without having to cross further membranes. Movement might be aided by cytoplasmic streaming. The simplest is an important pathway of water movement.

OR (Second Answer

Apoplast pathway	Simplest pathway
Definition:	
Apoplast refers to the no protoplasmic components of a plant, including the cell walls and the intracellular spaces	Simplest refers to the continuous network of protoplasts of a plant, which are interconnected by plasmodesmata.
Components:	
The apoplast consists of no protoplasmic components such as cell walls and intracellular spaces.	The symplast consists of protoplast.
Living/Non-living:	
The apoplast is composed of nonliving parts of a plant.	The simplest is composed of living parts of a plant.
Water Movement:	
The water movement occurs by passive diffusion.	The water movement occurs by osmosis.
Resistance to Water Movement:	

The apoplast shows less resistance to the water movement	The symplast shows some resistance to the water movement
Speed of the Water Movement:	
Water movement through the apoplast is rapid	Water movement the simplest is slower
Metabolic State of Roots:	
The metabolic rate of the cells in the root cortex does not affect the movement of water through the apoplastic route.	The metabolic state of the cells in the root cortex highly affect the water movement by the simplistic route.
Significance:	
With the secondary growth of the root, most of the water moves by the apoplastic route.	Beyond the cortex, water moves through the simplistic route

Conclusion:

Apoplast and symplast are two routes used by plants to transport water from root hair cells to the xylem of the root. Apoplast includes the non-living component of a plant such as cell walls and the intracellular spaces. Symplast includes the living components of a plant such as protoplasm. The water moves by the apoplastic pathway by passive diffusion. In contrast, in the simplistic pathway, water moves by the osmosis since water moves across the cell membranes. The main

difference between apoplast and symplast is their mechanism of the water movement.

OR (Second Answer)

Basis of Distinction	Apoplast Transport	Symplast Transport
Definition	The uptake of water that takes place between the non-living parts of the plant.	The absorption of water that takes place between the non-living parts of the plant.
Transport	Water reaches the endodermis through the process of apoplast.	Water moves out with the help of symplast transport.
Process	Takes place at faster speeds as the non-living parts do not have much happening within them.	Takes place at slower speeds at they do face some other entities during the process.
Problems	Does not face any resistance.	Faces little or more resistance
Flow	The metabolic state of root does not directly affect the pathway.	Roots are metabolically connected directly and

		has some effect on the passage of water flow.

(b) Cohesion and adhesion:

Cohesion	Adhesion
Water is a polar molecule, with the oxygen carrying a slight negative charge while the hydrogen carries a slight positive charge. As a result, nearby water molecules attract one another forming weak hydrogen bonds. This attraction among water molecules is called **cohesion** and the hydrogen bonds formed between them are termed as **tension.**	**Adhesion** is the attractive force between water molecules and other substances. Because both water and cellulose are polar molecules so there is a strong attraction for water within the hollow capillaries of the xylem. Adhesion of the string of water molecules to the wall of the xylem cells assists upward movement of the xylem sap counteracting the downward gravity. Adhesion also helps, hold water in the xylem when transpiration is not occurring.

OR (Second Answer)

Cohesion is the attraction among the water molecules which enables the water molecules to stick together.

Water flows freely due to cohesion. Water molecules also have attraction to polar surfaces. This attraction is called **adhesion.** Both cohesion and adhesion are due to hydrogen bonds among water molecules. These properties of water enable it to circulate in living bodies and to act as transport medium.

OR (Second Answer)

Cohesion	Adhesion
Definition:	
Cohesion is the attraction force between molecules of the same substance.	Adhesion is the attraction force between different molecules.
Type of Attraction:	
Cohesion is an intermolecular attraction	Adhesion is an intermolecular attraction
Attraction Forces:	
Cohesion includes Van Der Waal forces and hydrogen bonding.	Adhesion includes electrostatic attractions.
Examples:	
Cohesion is the cause for the formation of water droplets on the surface tension of a liquid.	Adhesion is the cause for the spreading of a liquid on a solid surface.
Conclusion: Adhesion and cohesion are two types of attraction forces that occur between molecules. These forces act on a substance	

at the same time. Therefore, the effects that arise from these forces are caused by both adhesion and cohesion. The main difference between cohesion and adhesion is that cohesion is the attraction force between molecules of the same substance whereas adhesion is the attraction force between molecules of different substance.

(c) Endosmosis and exosmosis:

Different osmotic conditions cause different effects upon net movement of water in and out of the cells. If a cell is kept in a medium which has higher water potential and lower solute concentration than cell sap, the water begins to move from medium to the cell (**endosmosis)** and cell become turgid. Such medium is called **hypotonic medium.** On the other hand, if a cell is kept in a medium which has lower water potential and higher solute concentration than cell sap, the water begins to move from cell to the medium (**exosmosis)** and cell become flaccid. Such medium is called **hypertonic medium.** Both hypotonic and hypertonic type of osmotic conditions compel for osmotic adjustment. The ideal situation for a cell is **isotonic** in which water potential of both cell and outer environment is equal, therefore, there is o et movement of water in and out of the cell. However, this situation is rarely available to the plants in natural environment.

OR (Second Answer)

Endosmosis	Exosmosis
Endosmosis refers to the osmosis toward the inside of a cell or vessel.	Exosmosis refers to the osmosis toward the outside of a cell or vessel.
Water moves into the cell.	Water moves out the cell.

Occurs when cells are placed in hypotonic solutions	Occurs when cells are placed in hypotonic solutions.
Occurs when the solute concentration of the surroundings is less than the solute concentration inside the cell.	Occurs when the solute concentration of the surroundings is higher than the solute concentration inside the cell.
Water potential of the surroundings is higher than that of the cytosol.	Water potential of the surroundings is less than that of the cytosol.
Cell may swell.	Cell may shrink.
Example: Absorption of capillary water from the soil by roots and the entrance of water into the xylem vessels.	Example: Movement of water from the root hair cells to the cortical cells of the root.

OR (Second Answer)

Endosmosis	Exosmosis
Definition:	
Endosmosis refers to the osmosis toward the inside of a cell or vessel.	Exosmosis refers to the osmosis toward the outside of a cell or vessel.

Water Movement:	
Water moves into the cell during endosmosis.	Water moves out the cell during exosmosis.
Type of Solutions:	
Endosmosis occurs when cells are placed in hypotonic solutions	Endosmosis occurs when cells are placed in hypotonic solutions
Solute Concentration in the Surroundings:	
Endosmosis occurs when the solute concentration of the surroundings is less than the solute concentration inside the cell.	Endosmosis occurs when the solute concentration of the surroundings is higher than the solute concentration inside the cell.
Water Potential:	
The water potential of the surroundings is higher than that of the cytosol in endosmosis.	The water potential of the surroundings is less than that of the cytosol in endosmosis.
Result:	
The cells may swell as a result of endosmosis.	The cells shrink as a result of exosmosis.
Examples:	

The absorption of capillary water from the soil by roots and the entrance of water into the xylem vessels are the examples of endosmosis in plants.	The movement of water from the root hair cells to the cortical cells of the root is an example of exosmosis.
Conclusion: Endosmosis and exosmosis are the two types of osmosis in which the movement of water occurs across the cell membrane. Endosmosis is the movement of water into the cell when the cells are placed in a hypotonic solution. Exosmosis is the movement of water out of the cell when the cells are placed in a hypotonic solution. The main difference between endosmosis and exosmosis is the direction of the movement of water in each of process.	

(d) Hypotonic and hypertonic solution:

Hypotonic Solution	Hypertonic Solution
Definition:	
Hypotonic solutions are solutions having lower osmotic pressures.	Hypertonic solutions are solutions having comparatively higher osmotic pressures.
Solution Concentration:	
Hypotonic solutions have a low concentration.	Hypertonic solutions have a higher concentration.

Effect on cells:	
Hypotonic environments cause cells to swell.	Hypertonic environments cause cells to shrink.
Food preservation:	
Hypotonic solution are not help in food preservation.	Hypertonic solutions are helpful in food preservation since they kill microbes in the food package.
Conclusion: Tonicity is the relative concentration of solutes dissolved in a solution which determines the direction and extend of the movement of molecules across a semipermeable membrane. There are three types of solutions based on the tonicity; isotonic solutions, hypertonic solutions and hypotonic solutions. The main difference between isotonic hypotonic and hypertonic solutions is that isotonic solutions are solutions having equal osmotic pressures while hypotonic solutions are solutions having a lower osmotic pressure and hypertonic solutions are solutions with a high osmotic pressure.	

OR (Second Answer)

Difference between Hypotonic and Hypertonic Solutions:

- The solution (water) concentration is high in hypotonic solutions while the solution concentration is low in hypertonic solutions.
- Solute concentration of hypertonic solution is high while that of hypotonic solution is low.

- Water molecules move into the cell when the cell is bathed in a hypotonic solution. In contrast, water molecules leave the cell (water inside the cell itself) when it is bathed in a hypertonic solution.
- When a cell with a cytoplasm is immersed in a hypotonic solution, endosmosis takes place. On the other hand, a cell immersed in a hypertonic solution, exosmosis takes place.
- Hypertonic solution causes the cell to shrink while hypotonic solution causes the cell to swell.
- Cytolysis may occur in cells due to hypotonic solutions whereas plasmolysis may occur in plant cells due to hypertonic solutions.
- For dehydration, hypotonic solutions can be used while hypertonic solutions can be used for hemorrhage.

(e) Mesophytes and xerophytes

Comparison of osmotic adjustment in different groups plant:

Features	Mesophytes	Xerophytes
Habitat	Terrestrial (moderate)	Terrestrial (severely dry)
Osmotic conditions of medium	Nearly isotonic	Strong hypertonic
Problems faced by plant	No drastic problem	Severe dehydration
Rate of transpiration	Medium rate	Very low rate
Stomatal distribution	On lower epidermis	Sunken stomata

Stomatal opening	Open in day and close at night	Close in day and open at night
Thickness of cuticle	Less thick	Very thick
Storage of water	Little storage	Succulent

(f) Collenchyma and sclerenchyma:

Role of mechanical tissues in support:

The term mechanical tissues is used for the tissues of thick walled cells i.e. collenchyma and sclerenchyma.

The **collenchymas** is characterized by the extra cellulose deposition at the corners of these cells. It is a mechanical tissue, providing support particularly in young plants, herbs and leaves etc, (where secondary growth does not occur) collenchyma is living so it can grow ad stretch freely. In stems and petioles, it plays ore important role in support because of its location in peripheral region near epidermis.

Sclerenchyma:

Sclerenchyma tissues are solely means for giving support and mechanical strength for the plants. The mature cells are dead due to the formation of very thick secondary lignified wall (lignin is a macromolecule that provide rigidness to the wall).

OR (Second Answer)

Collenchyma	**Sclerenchyma**
1. It is simple permanent tissue consisting of living cells.	**1.** It is also simple permanent tissue but consisting of dead cells.

2. In T. S. the cells are polygonal with localized thickening on their walls confined to the corners only Cells contains protoplasm when young.	**2.** In T S the cells are also polygonal with uniform thickening. Cells walls are very much thickened due to deposition of lignin leaving a narrow lumen.
3. In L. S. the cells are elongated with longitudinal strips of thickening.	**3.** In L. S. the cells are long, narrow and pointed.
4. It is elastic and also strong enough to provide mechanical support.	**4.** It is rigid and provide mechanical support to plant.

OR (Second Answer)

Difference between Collenchyma & Sclerenchyma:

Collenchyma	Sclerenchyma
1. Living cells contain cytoplasm.	Dead cells are empty.
2. Cell walls are cellulosic.	Cell walls are lignified.
3. Lumen of the cell is wide.	Lumen of the cell is narrow.
4. The thickening of the cell wall is not uniform.	Thickening of cell wall is uniform.

5. It provides mechanical support & elasticity to the plant body.	It is chiefly a mechanical tissue.

OR (Second Answer)

Difference Between Collenchyma & Sclerenchyma:

Collenchyma	Sclerenchyma
Found in:	
Collenchyma cells are found in petiole, leaves and young stems, appearing as a continuous ring beneath the epidermis.	Sclerenchyma is found in the mature parts of the plant like herbaceous perennials and woody plants.
Specialized/Unspecialized:	
Collenchyma cell are specialized cells	Sclerenchyma cells are specialized cells.
Cell Wall Thickness:	
Collenchyma consists of an unequally thin cell wall.	Sclerenchyma consists of a thick and rigid cell wall.
Cell wall constituents:	
Collenchyma cell wall is made up of cellulose and pectin.	Sclerenchyma cell wall is made up of waterproofing lignin.

Intercellular Space:	
No or little intercellular space is present between collenchymas cells.	No intercellular space is present between sclerenchyma calls.
Shape:	
Collenchyma cells are polygonal in shape	Sclerenchyma cells are tubular in shape.
Type:	
Collenchyma produces permanent tissues, which can achieve meristematic activity when stimulated.	Sclerenchyma also produces permanent tissues, eliminating the ability of diving.
Alive/Dead at Maturity:	
Collenchyma consists of living cells at maturity.	Sclerenchyma consists of dead cells at maturity. Hence, their protoplast is absent
Function:	
Providing mechanical support to the plant, resisting bending and	Providing mechanical support, protection and transportation of

stretching by the wind are the major functions of collenchymas.	water and nutrients are the major functions of sclerenchyma.

OR (Second Answer)

Collenchyma	Sclerenchyma
1. It is made up of living cells.	**1.** Sclerenchyma cells are generally dead.
2. The Cells are filled up with protoplasm.	**2.** The Cells are empty.
3. Wall thickening is not uniform.	**3.** Wall thickening is uniform.
4. The wall thickening consists of cellulose.	**4.** Wall thickening can be of cellulose lignin or both.
5. Lumen or cell cavity is wide.	**5.** Lumen or cell cavity is usually narrow.
6. Pits are simple and straight.	**6.** Pits are usually simple and oblique. They may be branched.
7. Collenchyma provides mechanical strength as well as elasticity.	**7.** It is only a mechanical tissue.
8. It allows plant organs to stretch and elongate.	**8.** Sclerenchyma occurs in areas which have stopped elongation.

9. It keeps the organ soft.	**9.** It provides hardness to the region where it occurs.
10. Collenchyma has a high refractive index.	**10.** Refractive index is comparatively low.
11. Being living the cells can store food and take part in photosynthesis.	**11.** Sclerenchyma has no such function.

(g) Fibers and sclereids:

The sclerenchyma is of two time, i.e, fibers and sclereids. Fibres are elongated cells and sclereids are roughly spherical or variously shaped cell otherwise both have heavily thickened wall with lignin and great tensile strength. **Fibres** are found in the pericycle of stems forming a solid rod of tissue. Fibres are found in xylem and phloem tissues. **Sclereids** are common in fruit wall and seed coats.

OR (Second Answer)

Difference Between Fibres and Sclereids:

Fibres	Sclereids
Sclerenchyma fibres are elongated cells which have long tapered ends and are present in most parts of the plant.	Sclerenchyma sclereids are cells which have a varying shape and are distributed in the cortex, pith, xylem and phloem of the plants.
Cell or rigin:	

Origin of the fibres is meristematic.	Sclereids origin from mature parenchymal cells.
Shape:	
Fibres are elongated.	Sclereids are broad and in varied shapes.
Cell endings:	
Fibres have tapering ends.	Sclereids have blunt ends.

OR (Second Answer)

Fibre	Sclereid
1. It is elongated and narrow like a thread.	**1.** It is usually broad.
2. End walls are tapering.	**2.** End walls are blunt in un-branched sclereids.
3. Fibres generally occur in bundles.	**3.** Sclereids occur singly or in loose groups.
4. Usually un-branched.	**4.** May be branced.
5. Pits narrow and un-branched.	**5.** Pits deep and commonly branched.

6. Pits are oblique.	**6.** Pits are straight.
7. Fibres are found directly from donatives of meristematic cells.	**7.** Sclereids arise by secondary thickening of parenchyma cells.
8. Fibres provide mechanical strength.	**8.** Sclereids provide stiffness only.

(h) Primary meristem and lateral meristem:

Primary Meristem:

These are located at opposite ends of the plant axis in the tips of roots and shoots. Cell divisions and subsequent cellular enlargement in these areas lengthen the above and below ground parts of the plant. Since, these meristems are present in plants right from embryonic life, therefore, they also known as **primary meristems.**

Secondary Meristem:

Lateral meristems are cylinders of dividing cells on lateral sides in stems and roots of dicots and gymnosperms and increase their thickness and diameter. These meristems are derived from apical meristem after embryonic life therefore, they are also called **secondary meristem**. Vascular cambium, cork cambium, and intercalary meristem are the type of lateral meristems. Some plants grow in diameter by producing new tissues laterally from a cylinder of tissue called the **vascular cambium,** which extends throughout the length of the plant from the tips of the shoots to the tips of the roots. **Cork cambium** also called **phellogen,** are found in the bark of roots and stems of woody plants where they contribute in width of plant body.

OR (Second Answer)

Primary Meristems	Secondary Meristems
1. It is present for the beginning.	**1.** Secondary meristem is formed later in the life.
2. It develops from another meristem.	**2.** Secondary meristem develops from the permanent cells due to dedifferentiation.
3. The cells are usually isodiametric (exception intra-fascicular cambium).	**3.** The calls are commonly elongated.
4. Central vacuoles are absent (exception intra-fascicular cambium).	**4.** The cells possess central vacuoles.
5. It usually gives rise to primary tissues (exception intra-fascicular cambium) that constitute primary growth.	**5.** Secondary meristem gives rise to secondary or supplementary tissues that constitute secondary growth. Secondary tissues either supplement or replace the primary tissues.
6. It usually produces growth in length (exception intra-fascicular cambium).	**6.** Secondary meristem produces growth in thickness.

OR (Second Answer)

Apical (Primary Meristems)	Lateral (Secondary Meristems)
Sclerenchyma fibres are elongated cells which have long tapered ends and are present in most parts of the plant.	Sclerenchyma sclereids are cells which have a varying shape and are distributed in the cortex, pith, xylem and phloem of the plants.
Definition:	
A plant tissue with undifferentiated cells found at the tip of a shoot or root and is responsible for the primary growth.	A plant tissue with undifferentiated cells that is found along the length of stems and root and is responsible for the secondary growth.
Location:	
Apical meristems are positioned at the apices of stems, roots, and their lateral branches.	Lateral meristems are found along the entire length of stem and root except at apices.
Growth Type:	
Primary growth takes place at apical meristems.	Secondary growth takes place at lateral meristems.
Growth:	

Apical meristem increases the length of a plant along its vertical axis.	Lateral meristem increases the girth of a plant.
Content:	
Apical meristems give rise to lead primordia and bud primordial unlike later meristem.	Lateral meristems consist of vascular cambium and cork cambium unlike the apical meristem.
Tissue Type:	
Apical meristem gives rise to primary permanent tissue including epidermis xylem, phloem and ground tissues.	Lateral meristems give rise to wood inner bark and outer bark.

(i) Primary growth and secondary growth:

Types of plants growth:

Based upon origin there are two types of plant growth. Primary growth and secondary growth.

Primary Growth:

When a plant starts its life after germination of seed, it begins to increase its length first, this increase in length of root and shoot is therefore called **primary growth.** It remains continue throughout the life of a plant (indeterminate growth) however, the rate of growth may very indifferently period of life. Primary growth is carried out by the cell division in **apical** meristem. **Secondary Growth:**

The increase in thickness and diameter of a plant is called **secondary growth.** This is characteristic of stems and roots of dicots and gymnosperms where it contributes a significant role in support of the plant body. All the tissue that are produce during secondary growth are called **secondary tissues.** Similarly, the tissues that are already present in plants before the onset of secondary growth are called **primary tissues.**

OR (Second Answer)

Primary Meristems	Secondary Meristems
1. I takes place by the activities of primary meristematic tissues such as apical cell, apical meristems, etc.	**1.** It takes place by the activities of secondary meristematic tissues and some time by the joint activity of both primary and secondary meristematic tissues.
2. It results in growth in longitudinal axis mainly.	**2.** It results in radial growth.
3. It is the first growth of the plant and its parts	**3.**It is a later period of growth
4. It is for a short period and stops after complete tissue differentiation occurs in a part of the plant	**4.** It continues only in matured part and occurs after the part of organ has completely developed
5. It occurs in all plants and in all parts	**5.** It occurs in gymnosperms and angiosperms (except monocots)

6. Periderm and barks are not formed	**6.** It results in the formation of bark periderm, lenticels etc.
7. Tissue formed by this growth are various types and called primary tissue.	**7.** Tissues formed due to this growth are mainly secondary xylem and secondary phloem and are called secondary tissues.

OR (Second Answer)

Difference between Primary and Secondary Growth:

Primary Growth	Secondary Growth
Definition:	
Primary growth is the growth that occurs by the action of the primary meristem, which increases the length of the stem and adds appendages to the stem.	Secondary growth is the growth that occurs by the action of the cambium, which increases the diameter of the plant
Occur by:	
The primary growth occurs by the action of the apical meristem.	The secondary growth occurs by the action of the lateral meristem.
Growth:	

The primary growth results in the growth in the longitudinal axis.	The secondary growth results in the radial growth.
Order:	
The Primary growth of the plant occurs at the beginning.	The Secondary growth follows the primary growth.
Duration:	
The primary growth stops after complete of the tissue differentiation.	The secondary growth only occurs in the mature parts (parts that are completely developed)
Location:	
The primary growth occurs in all parts of all plants.	The secondary growth occurs in both angiosperms and gymnosperms (except monocots).
Development:	
The epidermis cortex, and the primary vascular tissues are developed during the primary growth.	The bark, periderm, lenticels secondary phloem, and secondary xylem are developed during the secondary growth

(j) Wood and bark:

Wood: During secondary growth, the bulk of tissues added laterally (inner to the vascular cambium) is mainly secondary xylem and is called **wood.**

(a) Heart Wood:

The inner region of wood (some secondary xylem, primary xylem and central most tissue, the pith) is blocked by the deposition of wastes in later life and therefore gives a dark appearance. It is called **heart wood.**

(b) Sap Wood:

However, the outer region of wood (consist of only secondary xylem) remain functional and therefore gives a light appearance. It is called **sap wood.**

Bark:

(a) Inner Bark:

The portion of bark inner to the cork cambium is called **inner bark** (secondary phloem, primary phloem, pericycle, endodermis, primary cortex and secondary cortex).

(b) Outer Bark:

The portion of bark outer to the cork cambium is called **outer bark** (cork and epidermis

(k) Phototropism and geotropism:

Phototropism	Geotropism
Phototropism is the movement of plants parts, either towards (positive) of away (negative) from light source. Such movements are found in shoots and roots. Shoots show positive phototropism (grow upward above the ground) and	**Geotropism (gravitropism)** is the movement of plants parts, either towards (positive) or away (negative) from force of gravity. Such movements are also found in shoots and roots. Shoots slow negative geotropism (grow

roots show negative geotropism (grow downward under the ground)	upward above the ground) and roots show positive geotropism (grow downward underground.

(l) Phototropism and photoperiodism:

Photoperiodism	Phototropism
Photoperiodism is the regulation of plant development in response to the length of day or night.	Phototropism is the growth response of a plant according to the direction of the light.
Site of Reaction:	
The stimulus of photoperiodism is the length of the day or night.	The direction of light is the stimulus of phototropism.
Hormones:	
Flowering is induced by cytokinin and GA in photoperiodism.	Phototropism is regulated by auxin.

(m) Red light and far red light:

Phytochromes are found in two interconvertible forms. One form of phytochrome, designated as PR or P660 strongly absorbs red light (at 660 nm) and is converted into the second form of phytochrome i.e. PFR or P730 when PFR or P730 absorbs far-red light, it reverts to the original form, PR (P660). Since red light is available is daytime so the conversion of PR (P660) to PFR (P730) occurs in day. Far-red-light are invisible hear radiations that are present in both day and night but the conversion of PFR (P730) to PR (P660) occurs at night prominently because PR (P660) cannot stay in daytime due to the presence of red light in this way, the accumulation of either form of phytochrome in day and night enable the plant to determine that weather, it is present in day or night. The rate of conversion of PFR (P730) to PR (P660) that occurs at night also provides a biological clock to the plants to determine the length of their night.

OR (Second Answer)

Difference between PR form and PFR form:

PR form:

1. It is an inactive form is phytochrome.

2. Being inactive, it does not show phytochrome mediated responses.

3. It has an absorption maximum in red region (about 680 nm).

4. It is found diffused throughout the cytosis.

5. It is converted into **PFR** from in presence of red light (660-665nm)

6. When the extract is centrifuged at 20000 x g, it remains present in the supernatant.

7. It shows activity in presence of urea, metal ions Cu^{2+}, C^{2+}, Zn^{2+} etc, and Nethyl maleimide.

8. Its original structure contains many double bounds in pyrrole rings

PFR form:

1. It is an active form is phytochromes.

2. Being active, it shows phytochrome mediated responses.

3. It has an absorption maximum in far red light (730 nm)

4. It is usually found in discrete areas of cytosol.

5. It converted into Pr from in presence of far red light 730-735 nm).

6. On centrifugation PFR form settles down in the form of pellets.

7. It shows comparatively more activity in presence of these chemicals.

8. The **PFR** form shows rearrangement of double in all four pyrrole rings.