Model Answer

Department of Botany

Guru Ghasidas University, Bilaspur

M. Sc. Semester- II

LBT 203: PLANT PHYSIOLOGY and METABOLISM

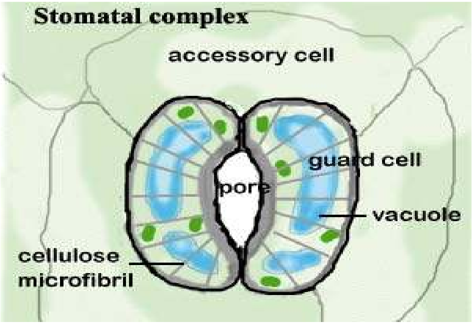
Answer 1: Objective types:

1. **C** (Evaporation**)**
2. **A (**Hydathodes**)**
3. **B (** 36 **)**
4. **A (**Mitochondria)
5. **D (**None of above**)**
6. **A (**Rhizobium**)**
7. **B (**Heavy metal stress**)**
8. **D** (None of above)
9. **A (**Garner and Allard)
10. **B (** Gibberelin)

Answer 2:

Stomata is a pore, found in the epidermis of leaves, stems and other organs that is used to control gas exchange. The pore is bordered by a pair of specialized parenchyma cells known as guard cells that are responsible for regulating the size of the opening. The term is also used collectively to refer to an entire stomatal complex, both the pore itself and its accompanying guard cells. Air containing carbon dioxide and oxygen enters the plant through these openings and is used in photosynthesis in the mesophyll cells (parenchyma cells with chloroplasts) and respiration, respectively. Oxygen produced as a by-product of photosynthesis diffuses out to the atmosphere through these same openings. Also, water vapor is released into the atmosphere through these pores in a process called transpiration.

Stomata are present in the sporophyte generation of all land plant groups except liverworts. Dicotyledons usually have more stomata on the lower epidermis than the upper epidermis.Monocotyledons, on the other hand, usually have the same number of stomata on the two epidermes. In plants with floating leaves, stomata may be found only on the upper epidermis; submerged leaves may lack stomata entirely.



Two important theories have been given. (Note: Others theories for the historical importance can be written).

1.Photosynthetic theory:
For stomata to Open:

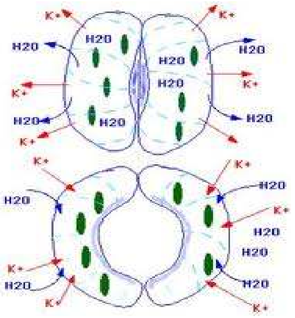
The guard cells have chloroplasts which carry out photosynthesis in the presence of sunlight.

Photosynthesis manufactures glucose which increases the osmotic pressure in the guard cells as compared to the epidermal cells. Water moves into the guard cells by osmosis hence increasing its turgidity. The inner walls of the guard cells are thicker than the hence the outer walls stretch more than the inner wall causing the inner wall to bulge outwards. In this process, the stomata opens.

For stomata to close:

In absence of light (at night), no photosynthesis takes place in the guard cells of the leafs.

The glucose in the cells that was manufactures in the day is converted into starch; which lowers the osmotic pressure of the guard cells than that of the epidermal cells. The epidermal cells withdraws water from the guard cells through osmosis, making the guard cell flaccid. The thinner outer wall shrinks and the curvature of the inner wall reduces; then the stomata close.



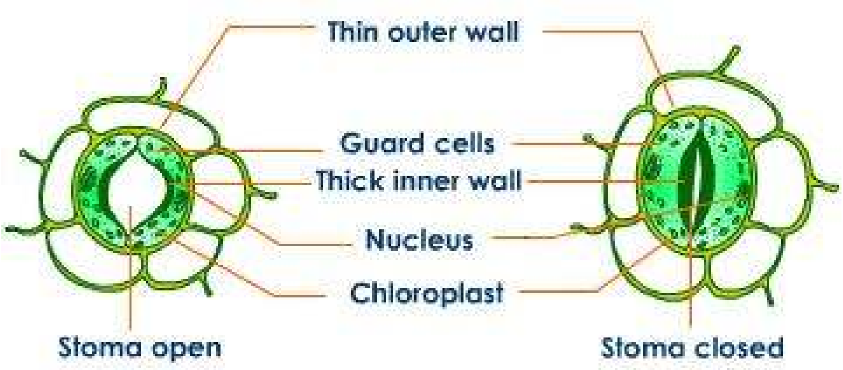
2. Starch-sugar inter-conversion theory:

During opening:

Photosynthesis occurs during the day due to the presence of light. This lowers the concentration of Carbon dioxide which is a raw material for the above process. This reduces the acidity of the guard. This condition favours conversion of starch to glucose (sugar); which then increases the guard cells' osmotic pressure; water from the nearby epidermal cells will move by osmosis to the guard cell making it more turgid. The thinner outer walls stretches more causing the guard cells to bulge out hence opening the stomata.

During closing:

At night when there is no light, no photosynthesis takes place that means the level of carbon dioxide in the guard cells increases increasing acidity. Acidic condition promotes conversion of glucose to starch; and the osmotic pressure of the guard cells reduces than that of the neighbouring cells hence loses water through osmosis. The cell thus become flaccid and the stomata has no choice than to close.



Answer 3:

Transpiration: Transpiration is the evaporation of water from plants. It occurs chiefly at the leaves while their stomata are open for the passage of CO_2 and O_2 during photosynthesis.

Mechanism of Transpiration:

Transpiration is the evaporation of water from aerial parts of plants, especially from leaves but also from stems and flowers. Leaf surfaces are dotted with openings which are collectively called stomata, and in most plants they are more numerous on the undersides of the foliage. The stomata are bordered by guard cells (together known as stomatal complex) that open and close the pore. Transpiration occurs through the stomatal apertures, and can be thought of as a necessary "cost" associated with the opening of the stomata to allow the diffusion of carbon dioxide gas from the air for photosynthesis. Transpiration also cools plants, changes osmotic pressure of cells, and enables mass flow of mineral nutrients and water from roots to shoots.

Mass flow of liquid water from the roots to the leaves is driven in part by capillary action, but primarily driven by water potential differences. In taller plants and trees, the force of gravity can only be overcome by the decrease in hydrostatic (water) pressure in the upper parts of the plants due to the diffusion of water out of stomata into the atmosphere. Water is absorbed at the roots by osmosis, and any dissolved mineral nutrients travel with it through the xylem.

Plants regulate the rate of transpiration by the degree of stomatal opening. The rate of transpiration is also influenced by the evaporative demand of the atmosphere surrounding the leaf such as humidity, temperature, wind and incident sunlight. Soil water supply and soil temperature can influence stomatal opening, and thus transpiration rate. The amount of water lost by a plant also depends on its size and the amount of water absorbed at the roots. Stomatic transpiration accounts for most of the water loss by a plant, but some direct evaporation also takes place through the cuticle of the leaves and young stems. Transpiration serves to evaporatively cool plants as the escaping water vapor carries away heat energy.

Environmental factors that affect the rate of transpiration

1. Light

Plants transpire more rapidly in the light than in the dark. This is largely because light stimulates the opening of the stomata (mechanism). Light also speeds up transpiration by warming the leaf.

2. Temperature

Plants transpire more rapidly at higher temperatures because water evaporates more rapidly as the temperature rises. At 30°C, a leaf may transpire three times as fast as it does at 20°C.

3. Humidity

The rate of diffusion of any substance increases as the difference in concentration of the substances in the two regions increases.When the surrounding air is dry, diffusion of water out of the leaf goes on more rapidly.

4. Wind

When there is no breeze, the air surrounding a leaf becomes increasingly humid thus reducing the rate of transpiration. When a breeze is present, the humid air is carried away and replaced by drier air.

5. Soil water

A plant cannot continue to transpire rapidly if its water loss is not made up by replacement from the soil. When absorption of water by the roots fails to keep up with the rate of transpiration, loss of turgor occurs, and the stomata close. This immediately reduces the rate of transpiration (as well as of photosynthesis). If the loss of turgor extends to the rest of the leaf and stem, the plant wilts.

The volume of water lost in transpiration can be very high. It has been estimated that over the growing season, one acre of corn (maize) plants may transpire 400,000 gallons (1.5 million liters) of water. As liquid water, this would cover the field with a lake 15 inches (38 cm) deep. An acre of forest probably does even better.

Answer 4:

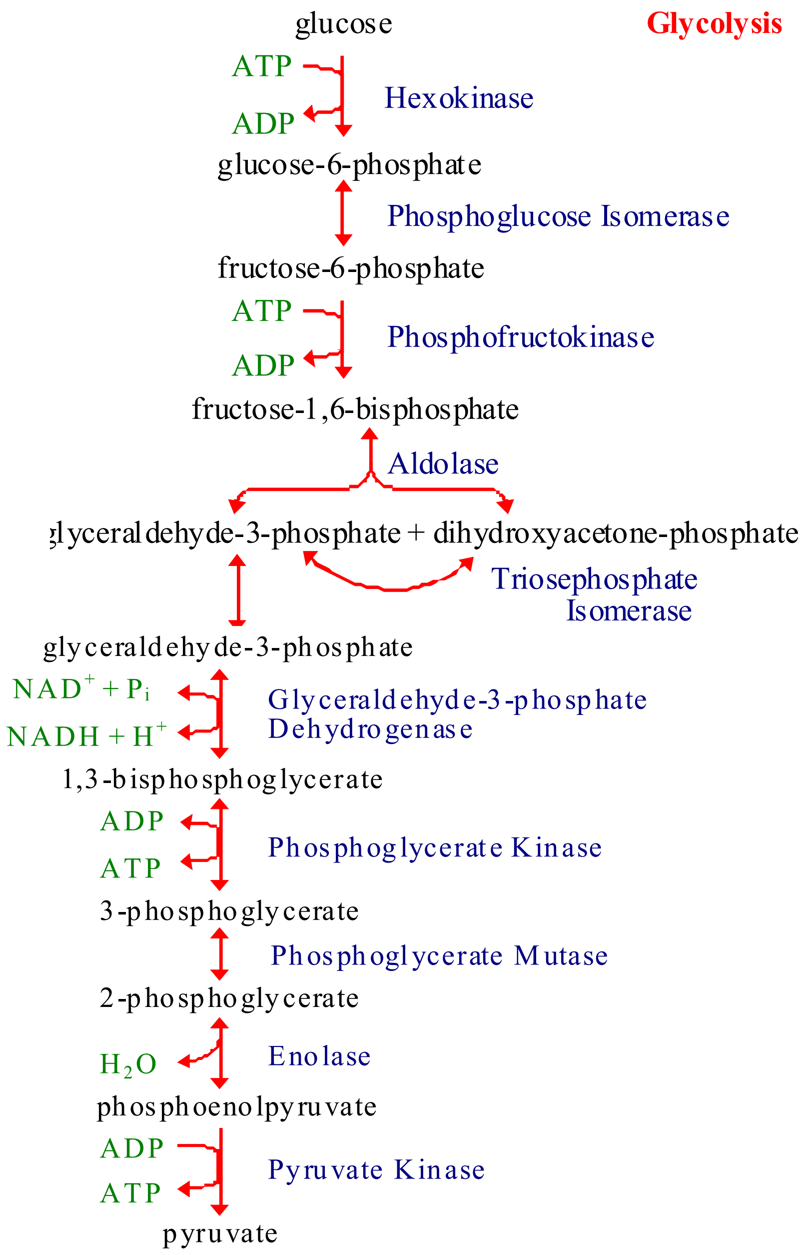
The glycolysis is ten step metabolic pathway to convert glucose into two molecules of pyruvate and two molecules each of *NADH* and *ATP.* All carbohydrates to be catabolized must enter the glycolytic pathway. Glycolysis is *central* in generating both energy and metabolic intermediaries. Essentially all cells carry out Glycolysis.

The *Pyruvate* can be further processed in to

a) *anaerobically* to lactate in muscle and in certain micro-organisms

b) *anaerobically* to ethanol (fermentation)

c) *aerobically* to CO2 and H2O via the citric acid cycle.



Balance sheet for ~P bonds of ATP:

2 ATP expended

4 ATP produced (2 from each of two 3C fragments from glucose)

Net production of 2 ~P bonds of ATP per glucose.

Glycolysis - total pathway, omitting H^+:

$$\text{glucose} + 2\ NAD^+ + 2\ ADP + 2\ P_i \rightarrow 2\ \text{pyruvate} + 2\ NADH + 2\ ATP$$

Answer 5:

a). Symptom of Zn and Mn deficiency

Zinc. This leaves show an advanced case of interveinal necrosis. In the early stages of zinc deficiency the younger leaves become yellow and pitting develops in the interveinal upper surfaces of the mature leaves. Guttation is also prevalent. As the deficiency progress these symptoms develop into an intense interveinal necrosis but the main veins remain green, as in the symptoms of recovering iron deficiency. In many plants, especially trees, the leaves become very small and the internodes shorten, producing a rosette like appearance

Manganese deficiency: These leaves show a light interveinal chlorosis developed under a limited supply of Mn. The early stages of the chlorosis induced by manganese deficiency are somewhat similar to iron deficiency. They begin with a light chlorosis of the young leaves and netted veins of the mature leaves especially when they are viewed through transmitted light. As the stress increases, the leaves take on a gray metallic sheen and develop dark freckled and necrotic areas along the veins. A purplish luster may also develop on the upper surface of the leaves.

b). Symptom of N, P. K deficiency

Phosphorus. These phosphorus-deficient leaves show some necrotic spots. As a rule, phosphorus deficiency symptoms are not very distinct and thus difficult to identify. A major visual symptom is that the plants are dwarfed or stunted. Phosphorus deficient plants develop very slowly in relation to other plants growing under similar environmental conditions but without phosphorus deficiency. Phosphorus deficient plants are often mistaken for unstressed but much younger plants. Under severe deficiency conditions there is also a tendency for leaves to develop a blue-gray luster. In older leaves under very severe deficiency conditions a brown netted veining of the leaves may develop.

Nitrogen. The chlorotic symptoms shown by this leaf resulted from nitrogen deficiency. A light red cast can also be seen on the veins and petioles. Under nitrogen deficiency, the older mature leaves gradually change from their normal characteristic green appearance to a much paler green. As the deficiency progresses these older leaves become uniformly yellow (chlorotic). Leaves approach a yellowish white color under extreme deficiency. The young leaves at the top of the plant maintain a green but paler color and tend to become smaller in size. Branching is reduced in nitrogen deficient plants resulting in short, spindly plants. The yellowing in nitrogen deficiency is uniform over the entire leaf including the veins. However in some instances, an interveinal necrosis replaces the chlorosis commonly found in many plants. In some plants the underside of the leaves and/or the petioles and midribs develop traces of a reddish or purple color. As the deficiency progresses, the older leaves also show more of a tendency to wilt under mild water stress and become senescent much earlier than usual.

Potassium. Some of these leaves show marginal necrosis (tip burn), others at a more advanced deficiency status show necrosis in the interveinal spaces between the main veins along with interveinal chlorosis. This group of symptoms is very characteristic of K deficiency symptoms. The onset of potassium deficiency is generally characterized by a marginal chlorosis progressing into a dry leathery tan scorch on recently matured leaves. This is followed by increasing interveinal scorching and/or necrosis progressing from the leaf edge to the midrib as the stress increases. As the deficiency progresses, most of the interveinal area becomes necrotic, the veins remain green and the leaves tend to curl and crinkle. In some plant such as legumes and potato, the initial symptom of deficiency is white speckling or freckling of the leaf blades. In contrast to nitrogen deficiency, chlorosis is irreversible in potassium deficiency, even if potassium is given to the plants.

c). Trace elements:

Mineral elements that are needed by plants in only trace amounts are known as microelements. These elements are as important to a plant's health as macroelements, but needed in lower quantities. Many of the microelements are enzyme cofactors, which are easily supplied through the soil since only trace amounts are needed. Examples of microelements are

Sulphur

This element has a general role in plant nutrition, it being difficult to explain its exact function. Sulphur is present initially in most soils and in addition in many fertilizers used, so its shortage is seldom, if ever, a problem.

Iron

This is an important element in greenhouse culture and is greatly concerned with photosynthesis. It is very insoluble and is rendered still more so by high pH figures. Symptoms of shortage are yellowing of the whole leaf, although in extreme cases the leaf can turn white, the older leaves usually being more affected than the younger ones. Deficiency usually arises from an excess of exchangeable calcium in the soil or growing medium..

Manganese

Like iron, this is much concerned with photosynthetic activity, which is why any shortage invariably produces a leaf-mottling effect. High pH figures usually spark off any deficiency of this element, although the mottling of the leaves of young plants caused by the invariably high pH figure of many growing composts usually disappears as the pH figure drops. Toxicity of manganese is a much more common problem.

Boron

Much more has been heard of boron in recent years, largely because its importance in tomato culture has been highlighted. It would appear to have a multifarious role to play in plant growth, as its shortage in many plants causes shrivelling of leaf tips and a blueing of stems and petioles. Tomato fruits develop a corky brown layer beneath the skin. In the majority of cases, and with properly formulated growing media, boron deficiency should not arise, although it is obviously an element which can cause considerable trouble.

Other elements

The other elements referred to earlier do not usually give cause for great concern unless present in excess, or rendered so by general soil imbalance. There can also be a degree of substitution where the micro-element replaces the macro-element, resulting in deficiency symptoms of the latter in some cases, although they may serve admirably; eg silicon can replace phosphorus, and sodium can substitute for potash.

Answer 6:

Stress is defined as the negative impact of non-living factors on the living organisms in a specific environment. The non-living variable must influence the environment beyond its normal range of variation to adversely affect the population performance or individual physiology of the organism in a significant way.

Salt Stress:

Salt stress is one of the most serious limiting factors for crop growth and production in the arid regions. Soil salinity in agriculture soils refers to the presence of high concentration of soluble salts in the soil moisture of the root zone. These concentrations of soluble salts through their high osmotic pressures affect plant growth by restricting the uptake of water by the roots. Salinity can also affect plant growth because the high concentration of salts in the soil solution interferes with balanced absorption of essential nutritional ions by plants.

Symptom of salt stress:

General symptoms of damage by salt stress are growth inhibition, accelerated development and senescence and death during prolonged exposure. Growth inhibition is the primary injury that leads to other symptoms although programmed cell death may also occur under severe salinity shock. Salt stress induces the synthesis of abscisic acid which closes stomata when transported to guard cells. As a result of stomatal closure, photosynthesis declines and photoinhibition and oxidative stress occur. An immediate effect of osmotic stress on plant growth is its inhibition of cell expansion either directly or indirectly through abscisic acid. Excessive sodium ions at the root surface disrupt plant potassium nutrition. Because of the similar chemical nature of sodium and potassium ions, sodium has a strong inhibitory effect on potassium uptake by the root. Plants use both low- and high-affinity systems for potassium uptake. Sodium ions have a more damaging effect on the low-affinity system which has low potassium/sodium selectivity. Under sodium stress, it is necessary for plants to operate the more selective high-affinity potassium uptake system in order to maintain adequate potassium nutrition. Potassium deficiency inevitably leads to growth inhibition because potassium, as the most abundant cellular cation, plays a critical role in maintaining cell turgor, membrane potential and enzyme activities.

Nutrient disturbances under salinity reduce plant growth by affecting the availability, transport, and partitioning of nutrients. However, salinity can differentially affect the mineral nutrition of plants. Salinity may cause nutrient deficiencies or imbalances, due to the competition of Na+ and Cl– with nutrients such as K+ , Ca2+ , and NO3– . Under saline conditions, a reduced plant growth due to specific ion toxicities (e.g. Na+ and Cl–) and ionic imbalances acting on biophysical and/or metabolic components of plant growth occurs.

Tolerance in plants:

During stress conditions plants need to maintain internal water potential below that of soil and maintain turgor and water uptake for growth. This requires an increase in osmotica, either by uptake of soil solutes or by synthesis of metabolic solutes. To accommodate the ionic balance in the vacuoles, cytoplasm accumulates low-molecularmass compounds, the compatible solutes because they do not interfere with normal biochemical reactions; rather, they replace water in biochemical reactions.

Drought stress:

With mild water deficiency, plants are usually slow growing and stunted. Some plant leaves turn from shiny to dull at first signs of stress. Grasses, which are the first to show the loss of water in the landscape, will show signs of wilt. Footprints in wilted grass persist instead of disappearing as grass blades spring upright.

Under long term water stress, plants might permanently wilt or stop growing; they may have diminished crops and discolored leaves, flower buds and flowers. Plants may eventually die. Bare spots will appear in ground covers. Water-stressed plantings may show the effects of weeds, insect pests, and diseases. Drought symptoms can be very confusing, and can vary with different types of plants. Woody plants under drought stress can have many symptoms including yellowing, wilting leaves that develop early fall color and burning or scorching on edges of leaves. Plants may drop some or all of their leaves and appear dead.

Effect of drought stress:

Drought stress symptom includes plant damage or death occurs from the top of the plant down and from the outside of the plant inward. One of the first symptoms of drought-stressed plants is the loss of turgidity. Plants or plant parts become limp and droopy. Plants show a decrease in growth or have no growth, both in girth and in length. A way to verify this on woody plants is to check the length of the growth increments, the amount of growth produced in each season. Beginning at the tip of a twig, move along the twig toward the trunk.

Other problems associated with drought stress are

- Tree canopy may be thin. (Can also be due to insect, disease.)
- Plants may leaf out, then die later in the growing season, a result of depleted food reserves. This may occur during or even a few years after, a drought event.
- A reduction in hardiness develops as the result of decreased food production, movement and storage that occurs during a drought.
- Gummy exudates appear on twigs, branches and trunks.
- Suckers develop on branches and trunk.
- Heavy seed production. This may also be a normal plant response to certain weather conditions. Some plants normally produce large amounts of seed every few years.
- Stems and twigs die, with the outermost and upper ones dying first.
- Leaves are smaller than normal.
- Evergreen needles brown from the tip downward.
- Evergreen needles turn yellow, red or red-purple.
- Leaves roll up and/or are misshapen.
- Leaves drop prematurely. They may or may not turn color prematurely before dropping.

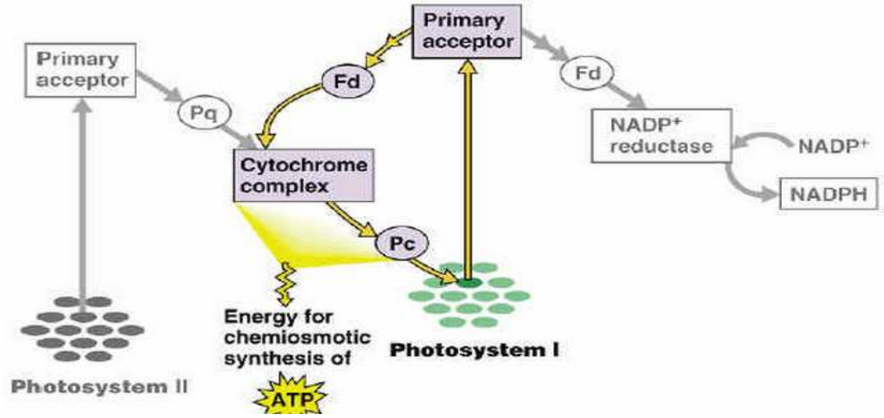
Answer 7:
Difference between Pigment system I and pigment system II

(Note: The answer can be written in Tabular difference or in paragraph)

Photosystems are an essential and functional part of the photosynthesis process. Photosynthesis is Greek for “composition of light”. It is a process used by plants and other organisms to convert light into food. It actually allows the plants and organisms to collect the light energy from the sun and turn it into chemical energy. This chemical energy can then be used to fuel the plant’s and organism's activities. The photosystem I was named “I” as it was discovered before photosystem II. However, during the process of photosynthesis, photosystem II comes into play before photosystem I. The main difference between the two is the wavelengths of light to which they respond. Photosystem I absorbs light with wavelengths shorter than 700 nm, whereas photosystem II absorbs light with wavelengths shorter than 680 nm. However, they are both equally important in the process of oxygenic photosynthesis.

Photosystem I

Photosystem I contains the chlorophyll-A molecule P700, which absorbs wavelengths shorter than 700 nm. It receives energy from photons, in addition to the associated accessory pigments in its antenna system, and from the electron transport chain from Photosystem II. It uses the energy from light to reduce NADP+ (nicotinamide adenine dinucleotide phosphate) to NADPH + H+, or simply to power a proton pump (plastoquinone, or PQ). Photosystem II, which is the first protein complex in the light-dependent photosynthesis, contains the chlorophyll-A molecule P680 that absorbs light with wavelengths shorter than 680 nm. It receives energy from photons and from associated accessory pigments in its antenna system and uses it to oxidize water molecules, producing protons (H+) and O2 as well as passing an electron to the electron transport chain.



Photosystem I

In the process of photosynthesis, the photosystem II absorbs light, using which the electrons in the reaction-center chlorophyll are excited to a higher energy level and are trapped by the primary electron acceptors. In photosystem II, cluster of four Manganese ions extract electrons from water, which are then supplied to the chlorophyll via a redox-active tyrosine. The electrons are then photoexcited, which travel through the cytochrome b6f complex to photosystem I through an electron transport chain set in the thylakoid membrane. The energy of the electrons is then harnessed through a process called chemiosmosis. The energy is used to transport hydrogen (H+) through the membrane, to the lumen, in order to provide a proton-motive force to generate ATP. ATP is generated when the ATP synthase transports the protons present in the lumen to the stroma, through the membrane. The protons are transported by the plastoquinone. If electrons only pass through once, the process is termed noncyclic photophosphorylation. After the electron reaches photosystem I, it fills the reaction-center chlorophyll of photosystem I. The electrons are then photoexcited and are trapped in an electron acceptor molecule of the photosystem I. The electrons may either continue to go through cyclic electron transport around PS I or pass through the ferredoxin to the enzyme NADP+ reductase. The electrons and hydrogen ions are added to NADP+ to form NADPH, which is then transported to the Calvin cycle to react with glycerate 3-phosphate, along with ATP to form glyceraldehyde 3-phosphate. The glyceraldehyde 3-phosphate is the basic building-block which can be used by the plants to make a variety of substances.

Differences between C3 and C4 Plants:

C3 Plants

About 95% of the plants on earth are C3 plants. As the name indicates they carry out C3 photosynthetic mechanism. These plants are mostly woody and round leaf plants.

In these plants, carbon fixation is carried out in the mesophyll cells that are just beneath the epidermis.

Carbon dioxide from the atmosphere that enters through the stomata is accepted by Ribulose bisphosphate and is fixed in to phosphoglycerate by Ribulose bisphosphate carboxylase enzyme (Rubisco). This process is known as carboxylation. Phosphoglycerate molecules enter the Calvin cycle in the mesophyll cells. C3 plants are known to be inefficient in terms of their photosynthetic mechanism. This is because of the occurrence of photorespiration in C3 plants. This effect is caused by the oxygenase activity of Rubisco.

Oxygenation of Rubisco works in the opposite direction to carboxylation, effectively undoes photosynthesis by wasting large amounts of carbon originally fixed by the Calvin cycle at great expense, and results in loss of carbon dioxide from the cells that are fixing carbon dioxide. Interaction with oxygen and carbon dioxide occurs at the same site on Rubisco.

4 Plants

C4 plants are commonly seen in dry and high temperature areas. Approximately 1% of plant species have C4 biochemistry. Some examples for C4 plants are corn and sugarcane.

As the name indicates these plants carry out C4 photosynthetic mechanism.

C4 plants may be better adapted now, as carbon dioxide levels are much lower now than 100 million years ago. C4 plants are much more efficient at capturing carbon dioxide.

C4 photosynthesis is found in both monocot and dicot species. In contrast to C3 plants, the first stable product formed during photosynthesis is oxaloacetic, which is a C4 compound. The leaves of these plants show a special type of anatomy called “Kranz Anatomy”.

There is a circle of bundle sheath cells with chloroplasts around vascular bundles by which C4 plants can be identified. In this pathway, carbon dioxide is fixed twice. In the mesophyll cell cytoplasm, CO2 is fixed with phospho enol pyruvate (PEP), which acts as a primary acceptor. The reaction is catalyzed by PEP carboxylase enzyme. Then PEP is converted to malate and then to pyruvate liberating CO2. This CO2 is then fixed with Ribulose bisphosphate, to form 2 phosphoglycerate to carry out Calvin cycle.

Other Major Differences:

- C4 plants are more efficient than C3 plants
- C4 plant leaves show Kranz anatomy but C3 leaves do not.
- CO2 is fixed once in C3 plants and twice in C4 plants.
- RuBP accepts CO2 in C3 plants and PEP accepts CO2 in C4 plants.
- PEP carboxylase in C4 has a higher affinity for CO2 than RuBP carboxylase in C3 plants.
- Photorespiration present in C3 plants and it is absent in C4 plants.
- In C3 plants, photosynthesis does not take place efficiently under very high light concentrations or low CO2 concentrations but, in C4 plants, it does take place efficiently under very high light concentrations and low CO2 concentrations.

Answer 8:

Role of Auxin in Plants:

The term auxin is derived from the Greek word auxein which means to grow. Compounds are generally considered auxins if they can be characterized by their ability to induce cell elongation in stems and otherwise resemble indoleacetic acid (the first auxin isolated) in physiological activity. Auxins and their role in plant growth were first described by the Dutch scientist Frits Went. Kenneth n isolated this phytohormone and determined its chemical structure as indole-3-acetic acid.

Auxins were the first plant hormones discovered. Salkowski discovered indole-3-acetic acid (IAA) in fermentation media. The isolation of the same product from plant tissues would not be found in plant tissues for several years. IAA is the major auxin involved in many of the physiological processes in plants. His results were aimed at understanding if translocation of the signal occurred on a particular side of the plant but his results were inconclusive because the signal was capable of crossing or going around the incision. Went reported Avena colopltile by placing agar blocks under coleoptile tips for a period of time then removing them and placing them on decapitated Avena stems. After placement of the agar, the stems resumed growth. Went developed a method of quantifying this plant growth substance. His results suggested that the curvatures of stems were proportional to the amount of growth substance in the agar. This test was called the avena curvature test.

IAA is chemically similar to the amino acid tryptophan which is generally accepted to be the molecule from which IAA is derived. Tryptophan is converted to indolepyruvic acid through a transamination reaction. Indolepyruvic acid is then converted to indoleacetaldehyde by a decarboxylation reaction. The final step involves oxidation of indoleacetaldehyde resulting in indoleacetic acid. Auxin molecules present in cells may trigger responses directly through stimulation or inhibition of the expression of sets of certain genes or by means independent of gene expression. Auxin transcriptionally activates four different families of *early genes* (aka *primary response genes*), so-called because the components required for the activation are preexisting, leading to a rapid response.

Functions of Auxin

The following are some of the responses that auxin is known to cause

- Stimulates cell elongation

- Stimulates cell division in the cambium and, in combination with cytokinins in tissue culture
- Stimulates differentiation of phloem and xylem
- Stimulates root initiation on stem cuttings and lateral root development in tissue culture
- Mediates the tropistic response of bending in response to gravity and light
- The auxin supply from the apical bud suppresses growth of lateral buds
- Delays leaf senescence
- Can inhibit or promote (via ethylene stimulation) leaf and fruit abscission
- Can induce fruit setting and growth in some plants
- Involved in assimilate movement toward auxin possibly by an effect on phloem transport
- Delays fruit ripening
- Promotes flowering in Bromeliads
- Stimulates growth of flower parts
- Promotes (via ethylene production) femaleness in dioecious flowers
- Stimulates the production of ethylene at high concentrations

Role of Gibberelin in Plants:

Gibberellins (GAs) are plant hormones that regulate growth and influence various developmental processes, including stem elongation, germination, dormancy, flowering, and leaf and fruit senescence. Gibberellin was first recognized in 1926 by a Japanese scientist, Eiichi Kurosawa, studying *bakanae*, the "foolish seedling" disease in rice.

Gibberellins are involved in the natural process of breaking dormancy and various other aspects of germination. Before the photosynthetic apparatus develops sufficiently in the early stages of germination, the stored energy reserves of starch nourish the seedling. Usually in germination, the breakdown of starch to glucose in the endosperm begins shortly after the seed is exposed to water. Gibberellins in the seed embryo are believed to signal starch hydrolysis through inducing the synthesis of the enzyme α-amylase in the aleurone cells. In the model for gibberellin-induced production of α-amylase, it is demonstrated that gibberellins (denoted by GA) produced in the scutellum diffuse to the aleurone cells, where they stimulate the secretion α-amylase. α-Amylase then hydrolyses starch, which is abundant in many seeds, into glucose that can be used in cellular respiration to produce energy for the seed embryo. Studies of this process have indicated gibberellins cause higher levels of transcription of the gene coding for the α-amylase enzyme, to stimulate the synthesis of α-amylase.

Gibberellic acid, which was the first gibberellin to be structurally characterised , is GA_3. There are currently 136 GAs identified from plants, fungi and bacteria.

Functions of Gibberellins

Active gibberellins show many physiological effects, each depending on the type of gibberellin present as well as the species of plant. Some of the physiological processes stimulated by gibberellins are outlined.

- Stimulate stem elongation by stimulating cell division and elongation.
- Stimulates bolting/flowering in response to long days.

- Breaks seed dormancy in some plants which require stratification or light to induce germination.
- Stimulates enzyme production (a-amylase) in germinating cereal grains for mobilization of seed reserves.
- Induces maleness in dioecious flowers (sex expression).
- Can cause parthenocarpic (seedless) fruit development.
- Can delay senescence in leaves and citrus fruits.