Model sample paper for Botany IRC

Total marks= 75 Total Time 3 hrs

Instruction: Answer questions of both group A and B as given instructions.

Group A

Answer all the questions. Each question carries equal (05) marks

Q. 1. Answer the following questions in one or two sentences (1x5= 05 marks)

i. What do you mean by Crossing over?

Ans- The exchange of genetic material or chromosomal segments between non- sister chromatids of homologous chromosomes is known as crossing over. It occurs during pachytene stage of prophase I of meiosis I during a process called synapsis.

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ii. What are algae?

Ans- Algae are thalloid, photosynthetic, eukaryotic and mostly aquatic organisms.

iii.- What is an algal bloom?

Ans- An algal bloom is a rapid increase or accumulation in the population of green algae on the surface of lakes or other water bodies due to abundance of nutrients (primarily phophorus).

iv.- What do you mean by species diversity?

Ans- Species diversity means diversity of plants, animals or microorganisms at species level. For example- The Western Ghats have a greater amphibian species diversity than the Eastern Ghats.

v. Define Guttation?

Ans- Guttation is the process of exudation of water droplets from the special openings or pores of some vascular plants like grass. These special pores are called hydathodes which lies on the margins of leaf blades or leaf tip of grasses or some herbaceous plants.

Q. 2. Differentiate between Prokaryotes and Eukaryotes (05 marks)

Ans- Differences between prokaryotes and eukaryotes is summarized as follows:

	Prokaryotes	**Eukaryotes**
Type of Cell	Always unicellular	Unicellular and multi-cellular
Cell size	Ranges in size from 0.2 μm – 2.0 μm in diameter	Size ranges from 10 μm – 100 μm in diameter
Cell wall	Usually present; chemically complex in nature	When present, chemically simple in nature

Nucleus	Absent. Instead, they have a nucleoid region in the cell	Present
Ribosomes	Present. Smaller in size and spherical in shape	Present. Comparatively larger in size and linear in shape
DNA arrangement	Circular	Linear
Mitochondria	Absent	Present
Cytoplasm	Present, but cell organelles absent	Present, cell organelles present
Endoplasmic reticulum	Absent	Present
Plasmids	Present	Very rarely found in eukaryotes
Ribosome	Small ribosomes	Large ribosomes
Lysosome	Lysosomes and centrosomes are absent	Lysosomes and centrosomes are present
Cell division	Through binary fission	Through mitosis
Flagella	The flagella are smaller in size	The flagella are larger in size
Reproduction	Asexual	Both asexual and sexual
Example	Bacteria and Archaea	Plant and Animal cell

Q. 3. Write down the botanical name, family and uses of the plant Amla. (05 marks)

Ans- Amla also known as Indian gooseberry tree belongs to the family Phyllanthaceae.

Botanical Name- *Phyllanthus emblica* or *Emblica officinalis*

Uses-

1. Relieving stress- Amla is a rich source of various antioxidants. It is a known antioxidant property to scavenge the free radicals produced by the human body during stress.

2. Regulating blood pressure- Amla contains a notable amount of potassium. Potassium regulate blood pressure by dilating blood vessels, which further reduces the chances of blood pressure.

3. Controlling diabetes- Amla is used as a home remedy to regulate or control diabetes. Amla's fibres can help absorb the excess sugar in the body to regulate blood sugar levels.

4. Digestion- Amla berries contain enough soluble dietary fibres. The fibre has a role in regulating bowel movements, which could help relieve irritable bowel syndrome. Due to the

higher amount of vitamin C in Amla, it also helps absorb a good amount of essential minerals.

5. Weight loss- Amla helps prevent the fat formation and helps in flushing out the toxins from the body. Generally, eating raw amla and amla powder with lukewarm water is recommended for weight loss.

6. Improve vision- Amla is also a good source of A, which is known to enhance eye health and improve vision. This can also reduce the risk of macular degeneration and conjunctivitis.

7. Hair growth- Amla oil is used for a long-time as a home remedy to enhance the growth of the hair.

Group B

Answer any **four** questions. Each Question carries equal (15) marks. (4 x 15 = 60 marks)

Q. 4. State Mendel's Law of dominance with example. Is there any exception to it? If so, please explain.

Ans- Gregor Mendel, conducted hybridisation experiments on garden peas for seven years (1856-1863) and based on his observations on monohybrid crosses Mendel proposed two general rules to consolidate his understanding of inheritance in monohybrid crosses. Today these rules are called the Principles or Laws of Inheritance: the First Law or Law of Dominance and the Second Law or Law of Segregation. Mendel's law of Dominance is the first Law of Inheritance. It states that-

a. Characters are controlled by discrete unit called factors.

b. Factors occur in pairs.

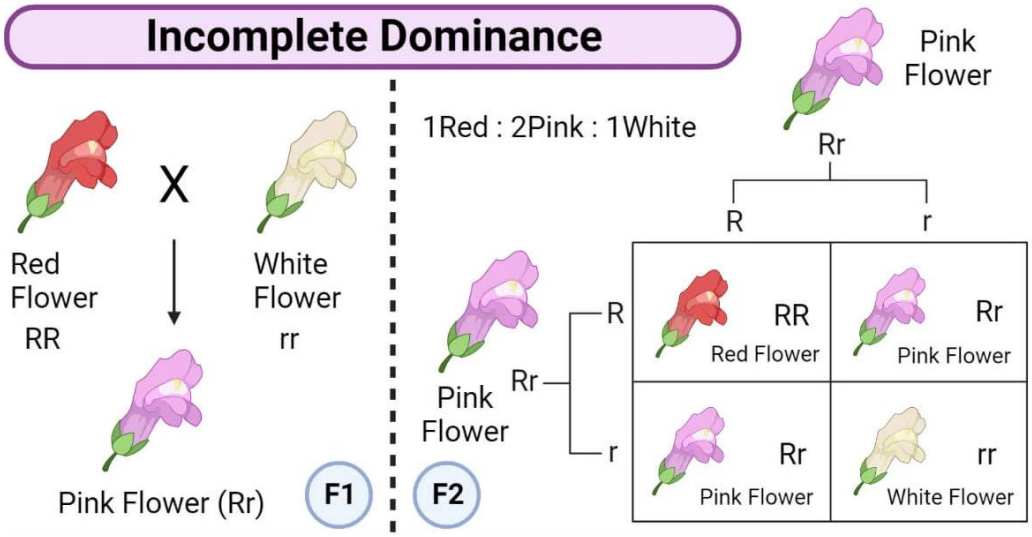
c. When two dissimilar pair of factor controls a trait, then one member of the pair expresses its character in F1generation called dominant , whereas the other one which do not expresses the character is called recessive.

The law of dominance is used to explain the expression of only one of the parental characters in a monohybrid cross in the F1 and the expression of both in the F2 . It also explains the proportion of 3:1 obtained at the F2 .

Exception- There are some exceptions of Mendel's Law of Dominance which are as follows.

a. Incomplete dominance- When experiments on peas were repeated using other traits in other plants, it was found that sometimes the F1 had a phenotype that did not resemble either of the two parents and was in between the two. The inheritance of flower colour in the dog flower (Snapdragon or *Antirrhinum* sp.) is a good example to understand incomplete dominance. In a cross between true-breeding red-flowered (RR) and truebreeding white-flowered plants (rr), the F1 (Rr) was pink (Figure 5.6). When the F1 was self-pollinated the F2 resulted in the following ratio 1 (RR) Red: 2 (Rr) Pink: 1 (rr) White. Here the genotype

ratios were exactly as in any mendelian monohybrid cross, but the phenotype ratios had changed from the 3:1 dominant : recessive ratio. Here R was not completely dominant over r and this made it possible to distinguish Rr as pink from RR (red) and rr (white) .



So, Incomplete dominance is when a dominant allele, or form of a gene, does not completely mask the effects of a recessive allele, and the organism's resulting physical appearance shows a blending of both alleles. It is also called semi-dominance or partial dominance. So it is an exception to Law of Dominance.

b. Co-dominance- Codominance is a heterozygous condition in which both alleles at a gene locus are fully expressed in the phenotype. Alleles which show an independent effect are called as Codominant alleles. In codominance, neither phenotype is completely dominant.

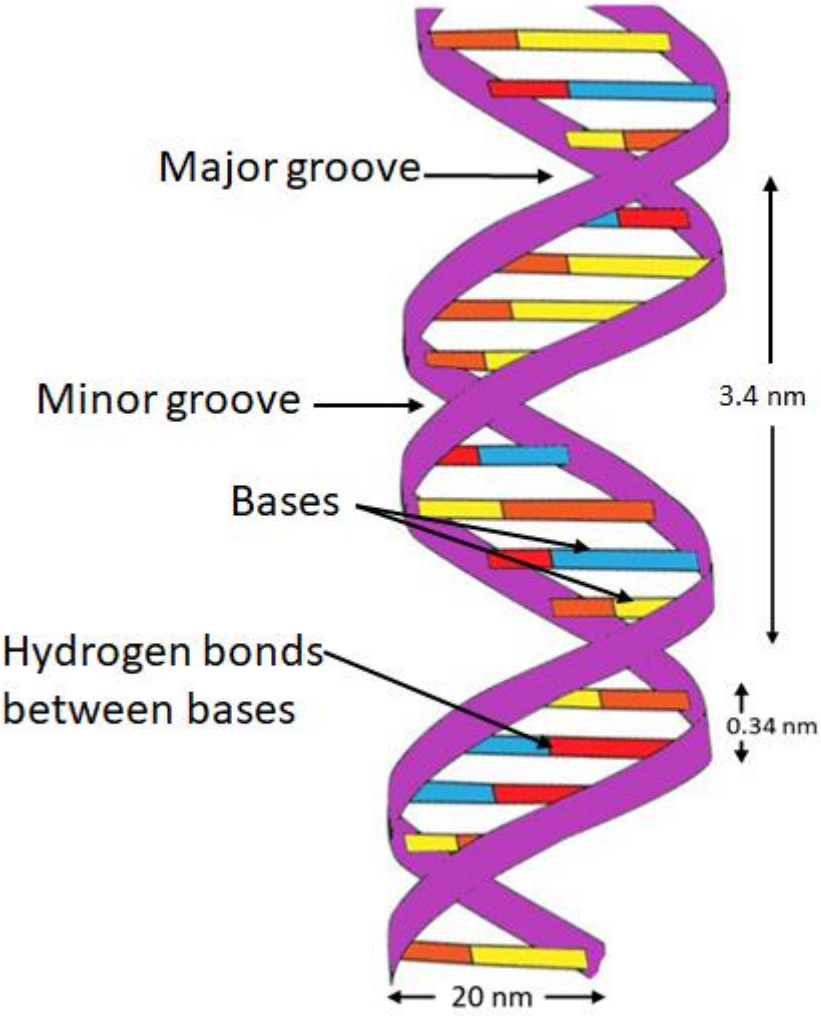
- Example-ABO blood group. ABO blood grouping is controlled by gene I which has three alleles A, B, and O and show codominance. An O allele is recessive to both A and B. The A and B alleles are codominant with each other. When a person has both A and B, they have type AB blood. In codominance, it does not matter whether the alleles in the homologous chromosomes are dominant or recessive. If the homologous chromosome consists of two alleles that can produce proteins, then both will be produced and forms a different phenotype or characteristics to that of a homozygote.

Blood Type	Genotype	
A	$i^A i$ $i^A i^A$	AA AO
B	$i^B i$ $i^B i^B$	BB BO
AB	$i^A i^B$	AB
O	$i\ i$	OO

So, in the case of co-dominance the F1 generation resembles both parents. So here none of the allele is dominant or recessive, but both expresses its character. So it is also an exception to Mendel's Law of Inheritance.

Q. 5. Explain with diagram the double helical structure of DNA.

Ans- DNA stands for Deoxyribonucleic acid, a molecule that contains the instructions an organism needs to develop, live and reproduce. It is a type of nucleic acid and is one of the four major types of macromolecules that are known to be essential for all forms of life.



DNA double helical Model

The three-dimensional structure of DNA, first proposed by James D. Watson and Francis H. C. Crick in 1953, consists of two long helical strands that are coiled around a common axis to form a double helix.

Each DNA molecule is comprised of two biopolymer strands coiling around each other. Each strand has a 5′end (with a phosphate group) and a 3′end (with a hydroxyl group). The

strands are antiparallel, meaning that one strand runs in a 5′to 3′direction, while the other strand runs in a 3′to 5′direction. The diameter of the double helix is 2nm and the double-helical structure repeats at an interval of 3.4nm which corresponds to ten base pairs. The two strands are held together by hydrogen bonds and are complementary to each other. The two DNA strands are called polynucleotides, as they are made of simpler monomer units called nucleotides. Basically, the DNA is composed of deoxyribonucleotides. The deoxyribonucleotides are linked together by 3′- 5′phosphodiester bonds. The nitrogenous bases that compose the deoxyribonucleotides include adenine, cytosine, thymine, and guanine.

The structure of DNA -DNA is a double helix structure because it looks like a twisted ladder. The sides of the ladder are made of alternating sugar (deoxyribose) and phosphate molecules while the steps of the ladder are made up of a pair of nitrogen bases. As a result of the double-helical nature of DNA, the molecule has two asymmetric grooves. One groove is smaller than the other. This asymmetry is a result of the geometrical configuration of the bonds between the phosphate, sugar, and base groups that forces the base groups to attach at 120-degree angles instead of 180 degrees. The larger groove is called the major groove, occurs when the backbones are far apart; while the smaller one is called the minor groove, and occurs when they are close together.

The Nitrogen Bases or Nucleotides

DNA strands are composed of monomers called nucleotides. These monomers are often referred to as bases because they contain cyclic organic bases. Four different nucleotides, abbreviated A, T, C, and G, (adenine, thymine, cytosine, and guanine) are joined to form a DNA strand, with the base parts projecting inward from the backbone of the strand. Two strands bind together via the bases and twist to form a double helix. The nitrogen bases have a specific pairing pattern. This pairing pattern occurs because the amount of adenine equals the amount of thymine; the amount of guanine equals the amount of cytosine. The pairs are held together by hydrogen bonds. Each DNA double helix thus has a simple construction: wherever one strand has an A, the other strand has a T, and each C is matched with a G. The complementary strands are due to the nature of the nitrogenous bases. The base adenine always interacts with thymine (A-T) on the opposite strand via two hydrogen bonds and cytosine always interacts with guanine (C-G) via three hydrogen bonds on the opposite strand. The shape of the helix is stabilized by hydrogen bonding and hydrophobic interactions between bases.

Q.6. Give a brief account of Glycolyis.

The term glycolysis has originated from the Greek words, glycos means sugar, and lysis means splitting. The scheme of glycolysis was given by Gustav Embden, Otto Meyerhoff, and J. Parnas, and is often referred to as the EMP pathway. Glycolysis occurs in the cytoplasm of the cell and is present in all living organisms. In this process, glucose undergoes partial oxidation to form two molecules of pyruvic acid, ATP, NADH and water. In plants, this glucose is derived from sucrose, which is the end product of photosynthesis, or from storage carbohydrates.

Glycolysis, a chain of ten reactions, under the control of different enzymes, takes place to produce pyruvate from glucose.

In first and second stage, Glucose molecule reacts with ATP molecule in the presence of the enzyme *hexokinase* to form **glucose 6-phosphate** which is further isomerised into **fructose 6-phospahte** in the presence of *phosphohexose isomerase*.

Now in third and fourth stage, fructose 6-phosphate reacts with one mol. of **ATP** in the presence of *phosphohexose kinase* forming **fructose 1,6-diphosphate** which split into two **trioses - dihydroxyacetone phosphate** and **3- phosphoglceraldehyde** (PGAL) in the presence of enzyme aldolase. The two trioses may isomerise into each other in the presence of *phoshotriose isomerase*.

In fifth and sixth stage, the 3- phosphoglceraldehyde further reacts with phosphoric acid andforms **1,3- diphosphoglyceraldehyde**which is a non-enzymatic reaction. In the presence of *triose-phosphate dehydrogenase* and NAD it is further oxidised to form **1,3-diphosphoglyceric acid**. Nicotinamide adenine dinucleotide (NAD) is reduced.

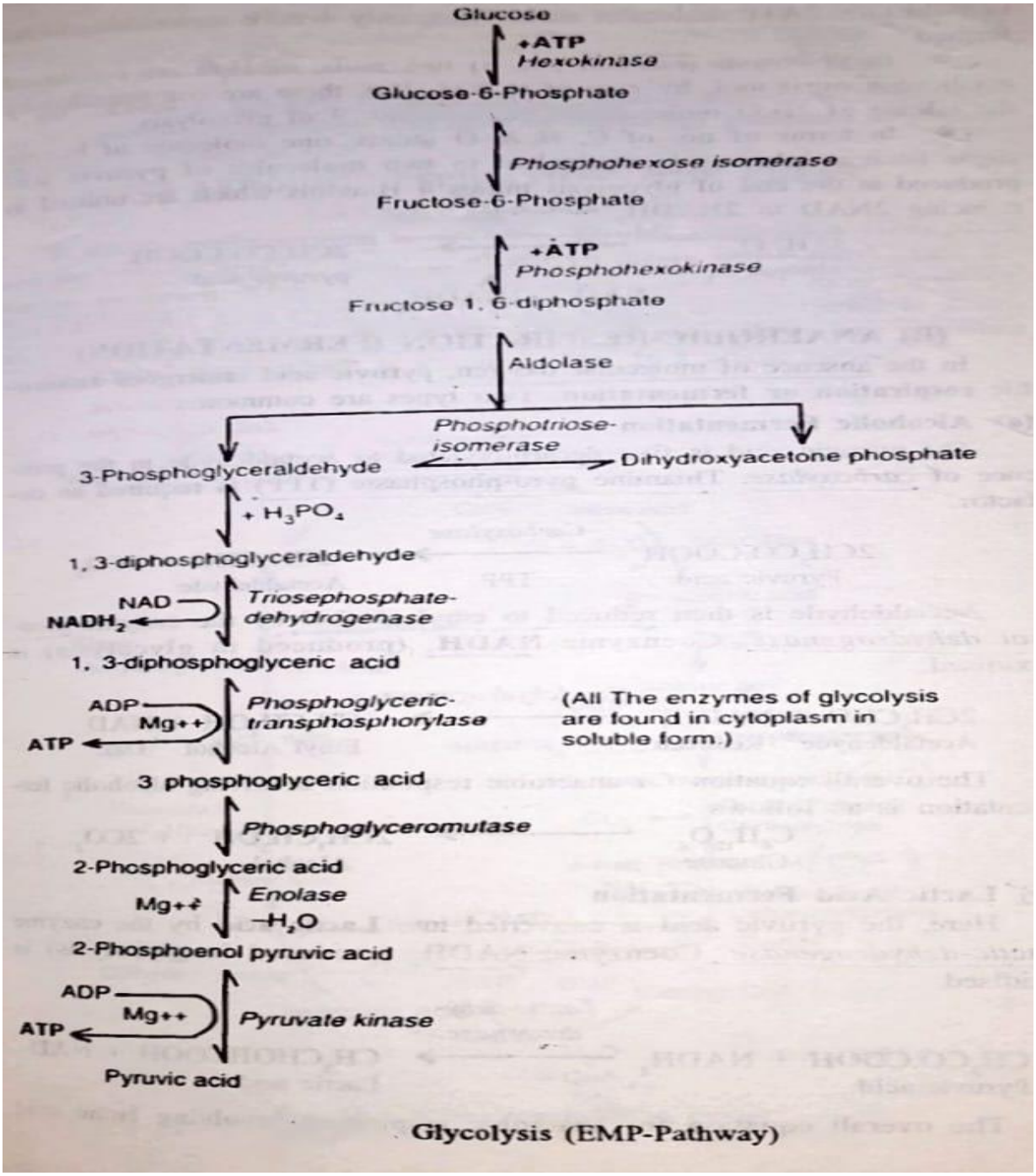
In seventh and eight stage, 1,3- diphosphoglyceric acid reacts with ADP in presence of *phosphoglyceric transphoshorylase* to form one mol. of **ATP** and **3-Phoshoglyceric acid**. This 3-Phoshoglyceric acid get isomerised into **2-Phosphoglyceric acid** in presence of enzyme *phoshoglyceromutase*.

In ninth and tenth stage, 2-Phosphoglyceric acid,in presence of enzyme *enolase*is converted into **2-phosphoenol pyruvic acid**(PEP)along with release of **$2H_2O$** molecules.It further reactswith ADP to form one molecule each of **ATP** and **Pyruvic acid**. The enzyme*pyruvate kinase* catalyses this reaction.

The overall glycolytic process can be summarised as

$$C_6H_{12}O_6 + 2ATP + 2NAD + 4ADP + 2H_3PO_4 \downarrow$$

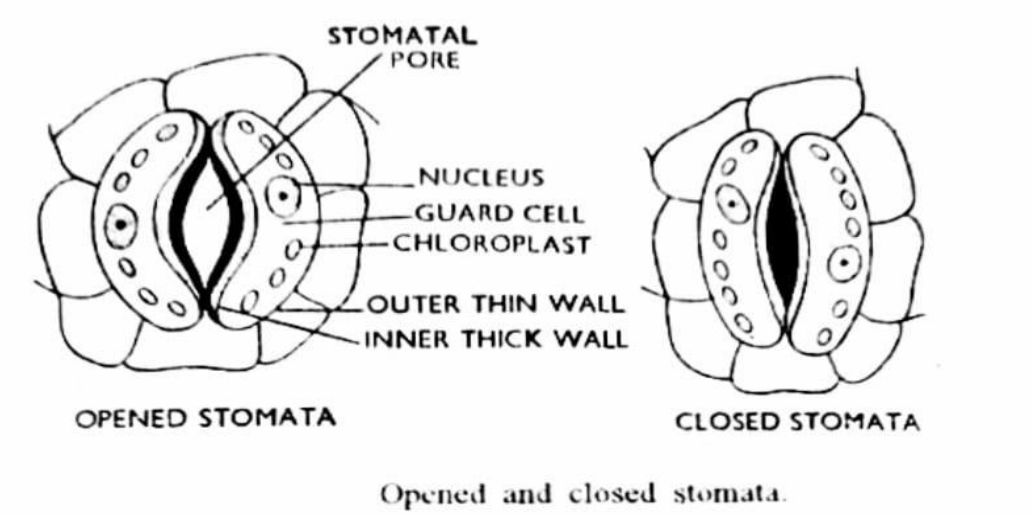
$$2CH_3CO.COOH + 2ADP + 2NADH_2 + 4ATP$$



Q. 7. What do you mean by stomatal opening and closing? Describe different theories related to it put forwarded by scientists from time to time.

Guard cell regulates the opening and closing of stomata. Sunlight is the main agent to induce the opening and closing of stomata. Stomata are the pores present in abundance at the lower epidermis of the leaf. They are also present in the stem. The gaseous exchange and transpiration occur through stomata. The stomata are surrounded by two guard cells which regulate its opening and closing. Stomata open during the day time for gaseous exchange and also releases water vapour through transpiration. The opening and closing of stomata is due to change in turgor pressure of the guard cell.

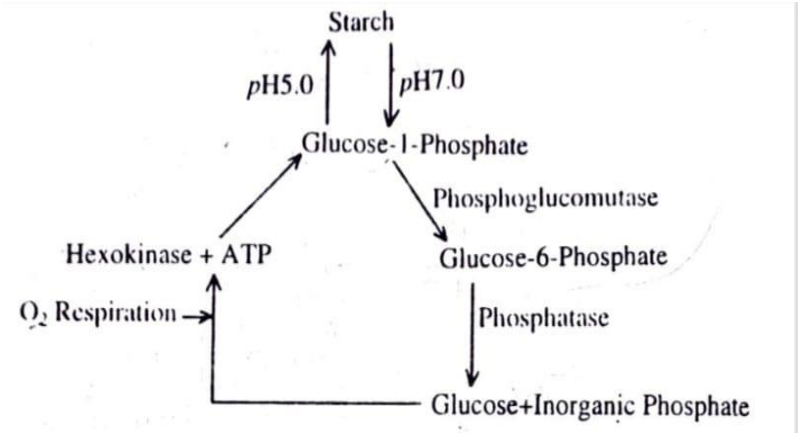
During the day the roots absorb water due to greater transpiration pull and it is transported to different parts of the plant through xylem. The guard cell on receiving this water swells and becomes turgid. As a result of which the stomatal opens. At night, the roots absorb less water, thus the guard cell becomes flaccid and shrinks. As a result of which stomatal pores closes.



Opened and closed stomata.

There are various theories related to opening and closing of stomata proposed from time to time by different scientists. Some of them are as follows:

1. **Starch-Sugar Interconversion Theory** : The classical theory is based on the effect of pH on starch phosphorylase enzyme which reversibly catalyses the conversion of starch and inorganic phosphate into glucose-1-phosphate. During the day, pH in guard cells is high which favours hydrolysis of starch (which is insoluble) into glucose-1-phosphate (which is soluble) so that osmotic potential becomes lower in guard cells. Consequently water enters into the guard cells by osmotic diffusion from the surrounding epidermal and mesophyll cells. Guard cells become turgid and the stomata open. During dark reverse process occurs. Glucose 1-phosphate is converted back into starch in the guard cells thereby increasing the osmotic potential. The guard cells release water, become flaccid and the stomata become closed.
   According to **Steward** (1964) the conversion of starch and inorganic phosphate into glucose- 1-phosphate does not cause any appreciable change in osmotic pressure because inorganic phosphate and glucose-1-phosphate are equally active osmotically. He suggested that (i) glucose-1-phosphate should be further converted into glucose and inorganic phosphate for opening of stomata, and (ii) metabolic energy in the form of ATP would be required for the closing of stomata which probably comes through respiration.



Steward's scheme of metabolic reactions involved in the opening and closing of stomata.

2. **Synthesis of sugar or organic acids in guard cells** : During daylight photosynthesis occurs in guard cells as they contain chloroplasts. The soluble sugars formed in this process may contribute in decreasing the water potential of guard cells and hence resulting in stomatal opening. As a result of photosynthesis CO_2 concentration in guard cells decreases which lead to increased pH in them during daylight. There may be some build up of organic acids, chiefly malic acid during this period form malic acid in the presence of the enzyme PEP- carboxylase. The formation of malic acid would produce protons that would produce protons that could operate in an ATP – driven-proton-K+ exchange pump moving protons into the adjacent epidermal cells and K+ ions into the guard cells and thus may contribute in decreasing water potential of the guard cells and leading to stomatal opening. Reverse process would occur in darkness.
3. **ATP-driven Proton (H^+) – Potassium (K^+) exchange Pump Mechanism in Guard cells**: At present this is the most accepted theory for explaining the stomatal movement which was proposed by Japanese scientists, Imamura and Fujino (1959) and were modified by **Levitt** (1974). There is accumulation of K^+ ions in guard cells during daylight period. The protons (H^+) are 'pumped out' from guard cells into the adjacent epidermal (or subsidiary) cells and in exchange K^+ ions are 'pumped in' into them from adjacent epidermal cells. The exchange of H^+ and K^+ ions is followed by entry of Cl^- anions into guard cells which results in response to the electrical differential in the guard cells due to accumulation of K^+ ions in them. The accumulation of K^+ ions together with Cl^- and organic acid counter ions is sufficient enough to significantly decrease the water potential of guard cells during daylight. Consequently, water enters into them from the adjacent epidermal and mesophyll cells thereby increasing their turgor pressure and opening the stomatal pore. Reverse situation prevails during dark when stomata are closed. There is no accumulation of K^+ in guard cells in dark.

Q. 8. "Transpiration is a necessary evil" Justify

Transpiration is the process in which there is loss of water in form of water vapour from the aerial parts of the plant through stomatal openings. When there is a huge amount of transpiration that takes place, it leads to huge amount of water loss thus causing wilting of the plant. But transpiration is needed for the pull of water and minerals from the root to the other parts of the plant and is needed for stomatal opening for the purpose of photosynthesis and respiration.

The **advantages** of transpiration are:

1. It creates suction force and helps in the ascent of sap.
2. It affects the diffusion pressure deficit, thereby indirectly helping diffusion through cells.
3. It increases the rate of water absorption and mineral absorption.
4. It helps in evaporating excess of water.
5. It plays an indispensable role in the translocation of food from one part of the plant to the other.
6. It maintains suitable temperature for the leaves and also renders cooling effects to the plant body.
7. It brings about opening and closing of stomata which indirectly influence the process of photosynthesis and respiration.

The disadvantages of transpiration are:

1. Rapid transpiration causes loss in turgidity and general metabolism is affected.
2. It unnecessarily uses energy and create, water shortage which causes death by dessication.
3. Many xerophytes have to develop structural modifications to reduce transpiration which are extra burden on the plants.
4. Deciduous trees have to shed their leaves during autumn to check loss of water.
5. Excessive rate f transpiration leads to stunted growth of plants.

But, inspite of various disadvantages, the plants cannot avoid transpiration due to their peculiar internal structure of leaves which is meant for gaseous exchange for respiration and photosynthesis, thus it cannot check the evaporation of water. Therefore many workers like Curtis (1926) have called "Transpiration is a necessary evil".

Q. 9. Write short notes on any **three** of the following (3 x 5 = 15 marks)

a. Photochemical smog

Photochemical smog is a mixture of pollutants that are formed when nitrogen oxides mostly from the vehicles smokes and volatile organic compounds (VOCs) in the atmosphere which are emitted as gases from certain solids or liquids products react to sunlight, which leaves airborne particles and ground level ozone. Photochemical smog depends on primary pollutants as well as the formation of secondary pollutants. These primary pollutants includes nitrogen oxides, mainly nitric oxide and nitrogen dioxide, and volatile organic compounds. The relevant

secondary pollutants include peroxyacetyl nitrates (PAN), tropospheric ozone and aldehydes creating a brown haze above cities. For examples, in Unites States, photochemical smog is most typically associated with the Los Angeles Basin of Southern California than any other cities in the world. It can have a tremendous impacts as compounds like PAN and ozone, produces irritation to the eyes and also in respiratory system to humans and animals. They also damage many materials such as metals, stones, building materials etc. The harmful substance can hinder photosynthesis, thus inhibiting plant growth.

b. Green house effect

The green house effect is the rise in temperature that the Earth experiences because certain gases in the atmosphere (water vapour, carbon dioxide, nitrous oxide, ozone, methane and synthetic fluorinated gases for example) trap energy that comes from the sun. The glass panels of greenhouse let in the light but keep heat from escaping and this similar to the effect these gases have on earth. Sunlight enters the Earth's atmosphere, passing through greenhouse gases. As it reaches the Earth's surface, land, water and biosphere absorb the sunlight's energy. Once absorbed, this energy is sent back into the atmosphere. Some of the energy passes back into space, but much of it remains trapped in the atmosphere by the greenhouse gases. This is the completely natural process and without these gases all heat would escape back into space and Earth's average temperature would be about 30 degree Celsius colder. The greenhouse effect is very important process, because without the greenhouse effect, the Earth would not be enough for human to live. But if the greenhouse effect becomes stronger, it could make the Earth warmer than usual. Even a little extra may cause problems for humans, plant and animals.

c. Ecological pyramid

The graphical representation of the relationship between various living beings at various trophic levels within a food chain is called an ecological pyramid. The pyramid formed is based on the number of organisms (Pyramid of number), energy (Pyramid of energy) and biomass (Pyramid of biomass) and just like the name suggests, these are shaped in the form of a pyramid. The theory of ecological pyramid was suggested by Raymond Linderman and G.Evylen Hutchinson. It is also often known as the energy pyramid. The bottom of the pyramid is broadest part having highest level of both biomass and number is occupied by the producers at the first trophic level. The next level of the pyramid is occupied by primary consumers. This is followed by the next level of the pyramid, belonging to the secondary and tertiary consumers. The ecological pyramid explains how various organisms in an ecosystem are related to one another which ideally shows who is consumed by whom, while also showing the order in which the energy flows from top to bottom. It means energy from autotrophs goes to the primary consumers. At the next step, the energy goes to the secondary consumers who eat the primary consumers. An ecological pyramid determines how efficiently energy is transferred from one level to the other,

highlights their food patterns, shows relationships between the various trophic levels, helps in restoring balance and also quantify energy in a food chain.

d. Biodiversity conservation

Biodiversity conservation is the practice of protecting and preserving the wealth and variety of species, habitats, ecosystems and genetic diversity on the planet for both current and future generations. It is vital for maintaining the Earth's environment and sustaining life on the planet. There are a number of ways in which richness of biodiversity helps in maintaining the ecological system. Conservation of biodiversity is important for the survival of living beings on Earth. Due to human activities, numerous varieties of flora and fauna go extinct each year. Western black rhinoceros, dodo, tasmanian tiger, gold Toad, woolly mammoth, caribbean monk seal, ivory-billed woodpecker, japanese sea lion are some of the species of animals that have gone extinct. Lemur, mountain gorilla, vaquita, sea turtles, amur leopard and tiger are some of the species that are on the verge of extinction. Apart from these many species of plants and trees including *Lepidodendron, Arauacaria mirabilis,* wood cycads and *kokia cookie* have gone extinct and many species are endangered.

Conservation of biodiversity is important in many ways such as it process the food chain and nutritional needs among the living organisms. Plants and trees purifies air and keep the environment clean, the fertility of soil maintained by insects, soil organisms and microorganisms provides better cultivation of crops and for making different medicines many species of trees and plants are used to cure various diseases.

Thus there is a serious need to conserve richness of biodiversity which can be done by checking control over population and pollution, reduce deforestation, avoid wastage and spread awareness at a bigger level.