PHOTOSYNTHESIS KEY POINTS

- All animals including human beings depend on plants for their food.
- Green plants synthesise the food they need and all other organisms depend on them for their needs and are therefore called autotrophs.
- The autotrophic nutrition is found only in plants and all other organisms that depend on the green plants for food are heterotrophs.
- Green plants carry out 'photosynthesis', a physico-chemical process by which they use light energy to drive the synthesis of organic compounds. Ultimately, all living forms on earth depend on sunlight for energy.
- The use of energy from sunlight by plants doing photosynthesis
- is the basis of life on earth.
- Photosynthesis is important due to two reasons: it is the primary source of all food on earth.
- It is also responsible for the release of oxygen into the atmosphere by green plants.
- In green plants H2O is the hydrogen donor and is oxidised to O2 .
- Some organisms do not release O2 during photosynthesis.
- When H2 S, instead is the hydrogen donor for purple and green sulphur bacteria, the 'oxidation' product is sulphur or sulphate depending on the organism and not O2 .
- Hence the O2 evolved by the green plant comes from H2O, not from carbon dioxide.
- The membrane system is responsible for trapping the light energy and also for the synthesis of ATP and NADPH.
- In stroma, enzymatic reactions synthesise sugar, which in turn forms starch.

- The former set of reactions, since they are directly light driven are called light reactions (photochemical reactions).
- The latter are not directly light driven but are dependent on the products of light reactions (ATP and NADPH).
- Hence, to distinguish the latter they are called, by convention, as dark reactions (carbon reactions).
- However, this should not be construed to mean that they occur in darkness or that they are not light-dependent.
- Pigments are substances that have an ability to absorb light, at specific wavelengths.
- The wavelengths at which there is maximum absorption by chlorophyll a,
- i.e., in the blue and the red regions, also shows higher rate of photosynthesis.
- Hence, we can conclude that chlorophyll a is the chief pigment associated with photosynthesis.
- Though chlorophyll is the major pigment responsible for trapping light, other thylakoid pigments like
- chlorophyll b, xanthophylls and carotenoids, which are called accessory pigments, also absorb light and
- transfer the energy to chlorophyll a. Indeed, they not only enable a wider range of wavelength of
- incoming light to be utilised for photosyntesis but also protect chlorophyll a from photo-oxidation.
- Light reactions or the ‘Photochemical’ phase include light absorption, water splitting, oxygen release, and the formation of high-energy chemical intermediates, ATP and NADPH.
- Several protein complexes are involved in the process. T

- he pigments are organised into two discrete photochemical light harvesting complexes (LHC) within the Photosystem I (PS I) and Photosystem II (PS II).
- These are named in the sequence of their discovery, and not in the sequence in which they function during the light reaction.
- The LHC are made up of hundreds of pigment molecules bound to proteins. Each photosystem has all the pigments (except one molecule of chlorophyll a) forming a light harvesting system also called antennae.
- These pigments help to make photosynthesis more efficient by absorbing different wavelengths of light.
- The single chlorophyll a molecule forms the reaction centre. The reaction centre is different in both the photosystems.
- In PS I the reaction centre chlorophyll a has an absorption peak at 700 nm, hence is called P700, while in PS II it has absorption maxima at 680 nm, and is called P680.
- **The Electron Transport**
- In photosystem II the reaction centre chlorophyll a absorbs 680 nm wavelength of red light causing electrons to become excited and jump into an orbit farther from the atomic nucleus.
- These electrons are picked up by an electron acceptor which passes them to an electrons transport Photon Reaction centre
- Pigment molecules Primary acceptor system consisting of cytochromes .This movement of electrons is downhill, in terms of an oxidation-reduction or redox potential scale.
- The electrons are not used up as they pass through the electron transport chain, but are passed on to the pigments of photosystem PS I.

- Simultaneously, electrons in the reaction centre of PS I are also excited when they receive red light of wavelength 700 nm and are transferred to another accepter molecule that has a greater redox potential.
- These electrons then are moved downhill again, this time to a molecule of energy-rich NADP+ . The addition of these electrons reduces NADP+ to NADPH + H+ .
- This whole scheme of transfer of electrons, starting from the PS II, uphill to the acceptor, down the electron transport chain to PS I, excitation of electrons, transfer to another acceptor, and finally down hill to NADP+ reducing it to NADPH + H+ is called the Z scheme, due to its characterstic shape .
- This shape is formed when all the carriers are placed in a sequence on a redox potential scale.
- **Splitting of Water**
- The electrons that were moved from photosystem II must be replaced. This is achieved by electrons available due to splitting of water.
- The splitting of water is associated with the PS II; water is split into 2H+ , [O] and electrons. This creates oxygen, one of the net products of photosynthesis. The electrons needed to replace those removed from photosystem I are provided by photosystem II.