CHAPTER 9 PHOTOSYNTHESIS

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- BIOL. 1AB

LECTURE#1-PHOTOSYNTHESIS

I. PHOTOSYNTHESIS

- A. **DEFINITION- SERIES OF REACTIONS IN WHICH PLANTS CONVERT SOLAR ENERGY INTO GLUCOSE**

Trapping Energy from Sunlight

- The process that uses the sun's energy to make simple sugars is called photosynthesis.

B. **REQUIREMENTS**

- 1. LIGHT- IN THE VISIBLE LIGHT SPECTRUM
  2. CHLOROPHYLL- PHOTOSYNTHETIC PIGMENT
  3. RAW INORGANIC MATERIALS- WATER, NITROGEN ETC..

C. **CHEMICAL EQUATION**

- $CO2 + H20$ + SUNLIGHT →

  $C_6H_{12}0_6 + O_2$

D. STEPS IN PHOTOSYNTHESIS

- LIGHT REACTION
- DARK REACTION
- RESPIRATION

Trapping Energy from Sunlight

- Photosynthesis happens in two phases.
  1. The light-dependent reactions convert light energy into chemical energy.
  2. The molecules of ATP produced in the light-dependent reactions are then used to fuel the light-independent reactions that produce simple sugars.

1. LIGHT REACTION

- A. WHERE DOES IT OCCUR?
- IN THE LEAF, THE PALISADE MESOPHYLL
- MORE SPECIFICALLY THE THYLOKOID IN THE CHLOROPLAST

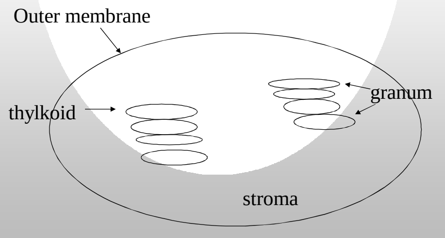
B. CHLOROPLAST

- SPECIALIZED PLANT CELL ORGANELLE THAT IS THE LOCATION OF PHOTOSYNTHESIS
- SHARES MANY OF THE SAME CHARACTERISTICS AS THE MITOCHONDRIA

The chloroplast and pigments

- To trap the energy in the sun's light, the thylakoid membranes contain pigments, molecules that absorb specific wavelengths of sunlight.
- Although a photosystem contains several kinds of pigments, the most common is chlorophyll.
- Chlorophyll absorbs most wavelengths of light except green.

1. STRUCTURE

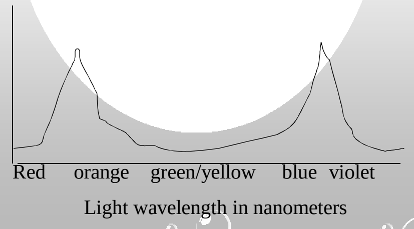


2. CHLOROPHYLL PIGMENT

- THIS IS THE MAJOR PHOTOSYNTHETIC PIGMENT OF PLANTS, IT ABSORBS LARGE AMOUNTS OF ALL VISIBLE LIGHT EXCEPT GREEN AND YELLOW

A. ABSORPTION SPECTRUM

- THE ACTION SPECTRUM CHARTS THE WAVELENGTHS OF LIGHT THAT CHLOROPHYLL WORKS BEST AT



3. ACCESSORY PIGMENTS

- THESE ARE PIGMENTS OTHER THAN CHLOROPHYLL
- THEY ARE DESIGNED TO ABSORB LIGHT WHERE CHLOROPHYLL DOES NOT
- XANTHOPHYLL AND CAROTENOIDS ARE THE MOST COMMON

A. CAROTENOIDS

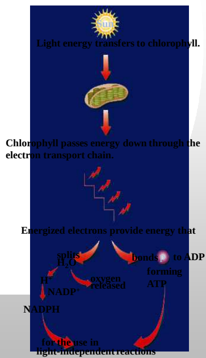
- ABSORB LIGHT AT THE YELLOW AND ORANGE SPECTRUM

Light-Dependent Reactions

- As sunlight strikes the chlorophyll molecules in a photosystem of the thylakoid membrane, the energy in the light is transferred to electrons.
- These highly energized, or excited, electrons are passed from chlorophyll to an electron transport chain, a series of proteins embedded in the thylakoid membrane.

Light-Dependent Reactions

- At each step along the transport chain, the electrons lose energy.



Light-Dependent Reactions

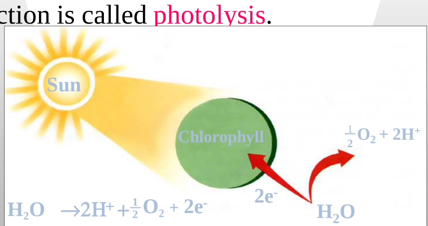
- This "lost" energy can be used to form ATP from ADP, or to pump hydrogen ions into the center of the thylakoid disc.
- Electrons are re-energized in a second photosystem and passed down a second electron transport chain.

Light-Dependent Reactions

- The electrons are transferred to the stroma of the chloroplast. To do this, an electron carrier molecule called NADP is used.
- NADP can combine with two excited electrons and a hydrogen ion (H^+) to become NADPH.
- NADPH will play an important role in the light-independent reactions.

Restoring electrons

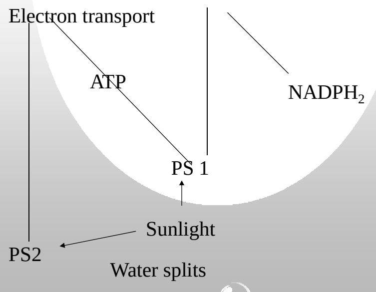
- To replace the lost electrons, molecules of water are split in the first photosystem. This reaction is called photolysis.



Restoring electrons

- The oxygen produced by photolysis is released into the air and supplies the oxygen we breathe.
- The electrons are returned to chlorophyll.
- The hydrogen ions are pumped into the thylakoid, where they accumulate in high concentration.

C. DIAGRAM OF THE LIGHT REACTION



1. PRODUCTS OF THE LIGHT REACTION

- THE LIGHT REACTION PRODUCES ATP AND $NADPH_2$

2. **DARK REACTION (CALVIN CYCLE)**

- OCCURS WITHOUT LIGHT IN THE STROMA OF THE CHLOROPLAST
- FIRST DESCRIBED MELVIN CALVIN IN 1961

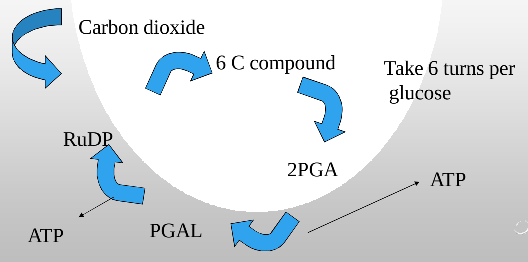
A. WHERE DOES IT OCCUR?

- OCCURS IN THE STROMA OF THE CHLOROPLAST
- SUPPORTS THE THEORY OF ENDOSYMBIOSIS

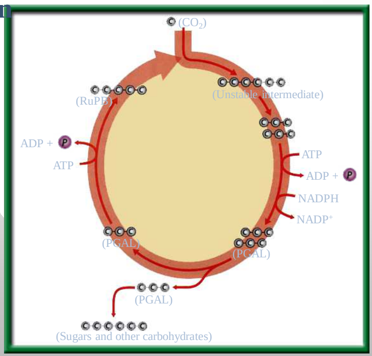
B. WHY IS THE TERM DARK REACTION MISLEADING?

- THE TERM DARK REACTION IS MISLEADING BECAUSE THIS REACTION CAN ALSO OCCUR DURING THE DAY
- DARK REACTION JUST REFERS TO THE FACT THAT LIGHT IS NOT NEEDED FOR THE REACTION TO OCCUR

C. DIAGRAM OF THE DARK REACTION

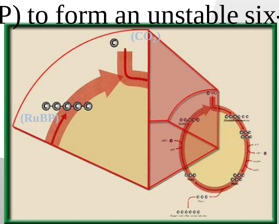


The Calvin Cycle



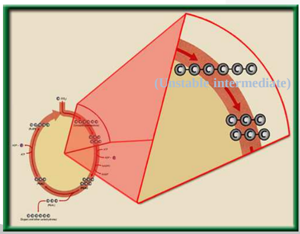
The Calvin Cycle

- Carbon fixation The carbon atom from CO_2 bonds with a five-carbon sugar called ribulose biphosphate (RuBP) to form an unstable six-carbon sugar.
- The stroma in chloroplasts hosts the Calvin cycle.



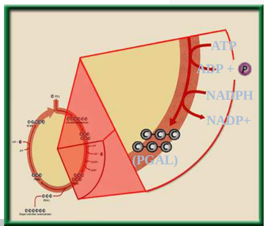
The Calvin Cycle

- Formation of 3-carbon molecules The six-carbon sugar formed in Step A immediately splits to form two three-carbon molecules.



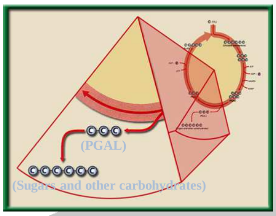
The Calvin Cycle

- Use of ATP and NADPH A series of reactions involving ATP and NADPH from the light-dependent reactions converts the three-carbon molecules into phosphoglyceraldehyde (PGAL), three-carbon sugars with higher energy bonds.



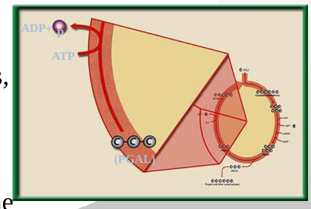
The Calvin Cycle

- Sugar production One out of every six molecules of PGAL is transferred to the cytoplasm and used in the synthesis of sugars and other carbohydrates. After three rounds of the cycle, six molecules of PGAL are produced.



The Calvin Cycle

- RuBP is replenished Five molecules of PGAL, each with three carbon atoms, produce three molecules of the five-carbon RuBP. This replenishes the RuBP that was used up, and the cycle can continue.



1. PRODUCTS OF THE DARK REACTION

- THE DARK REACTION MAKES GLUCOSE, ATP, OR OTHER CARBOHYDRATES

3.C4 AND CAM PATHWAYS

- **DIFFERENT PHOTOSYNTHETIC PATHWAYS TO MAKE PLANTS MORE EFFICIENT**
- **MAKES IT POSSIBLE FOR PLANTS TO LIVE IN EXTREME ENVIRONMENTS**
- **BOTH INVOLVE FIXING CARBON DIOXIDE TO BE USED IN PHOTOSYNTHESIS**