

Biology 10

8-3 notes (The Process of Photosynthesis)

p235-241

Objectives

- Describe the structure of a chloroplast.
- Be able to describe the inputs and outputs of the **light dependent reactions**
- Be able to explain how ATP is formed in the chloroplast (**chemiosmosis**)
- List the requirements and outputs of the **Calvin cycle**

Introduction

- **photosynthesis**- the conversion of solar energy to a usable chemical form of energy (glucose)
- products of photosynthesis are used as energy source, or as building blocks for other compounds (nucleic acids, proteins, lipids)
- Almost all other organisms (animals, heterotrophs) are dependent upon photosynthesis for their energy needs
 - almost _____ of food/year produced by plants, algae, and cyanobacteria!

Chlorophyll

- **chlorophyll**- the major pigment in plants that is used for photosynthesis
- **pigment**- a substance which absorbs certain wavelengths (colors) of light
- chlorophyll is green, because it absorbs _____ colors, and reflects back _____!
- There are two forms of chlorophyll in a plant, chlorophyll α and chlorophyll β
 - **carotenoids**- other pigments present in the plant which absorb other wavelengths (colors)

Arrangement of chlorophyll (see fig 8-7, p233)

- chlorophyll and other pigments wrapped in a double membrane
 - each pack of chlorophyll = _____
- thylakoids are then stacked up, similar to a stack of coins (= _____)
- Grana are then packed together inside the **chloroplast**

- Surrounding the grana is the _____ within the chloroplast

Diagram of a chloroplast

Light-dependent reactions (see fig. 8-10, p237)

- light is required in this phase
- Photosystems I and II
 - **photosystem**- a collection of about 400 _____ molecules and _____
 - within the thylakoid are two types of photosystems
 - photosystem I- absorbs light wavelengths of 700 nm (using P700 pigment)
 - photosystem II- absorbs light wavelengths of 680 nm (using P680 pigment)
 - light hits _____, and is passed from chlorophyll to chlorophyll until it reaches the _____ of the photosystem
 - the reaction center's electron becomes excited, and is passed from the photosystem, through a series of electron acceptors, and winds up at _____
 - the energy absorbed from light is also used to _____ (**photolysis**)
 - the split water has 3 parts:
 - H^+ : used to _____ (an electron-acceptor)
 - O: waste product _____ (some used by cell for respiration, some released into atmosphere)
 - e^- : _____ lost by photosystem II
 - Photosystem I passes the excited electron, received from photosystem II, to a waiting _____ molecule
 - NADP absorbs the electron from photosystem I, and H^+ to form $NADPH-H^+$
 - What is the point of this electron shuffle?
 - as the electrons are passed along, _____ absorbed from sunlight (i.e.- they return to ground state)
 - the energy lost from electrons is used to _____ (H^+) inside the thylakoid membrane
 - once inside, the protons want to _____ of the thylakoid
 - the protons are only allowed out of the thylakoid through _____ passages (similar to the electron transport chain of respiration!) = **chemiosmosis**
 - summary of light dependent reactions:
 - $12 H_2O + 12 NADP^+ + 18 ADP + 18 P_i \rightarrow 6 O_2 + 12 NADPH + 12 H^+ + 18 ATP$
 - Note: no glucose has been made yet, and no carbon dioxide is used yet!

Light-independent reactions (Calvin cycle) (see fig. 8-10, p238)

- light is **not** needed for this phase, although the products from the light-dependent reactions, and CO_2 are needed!

■ the Calvin cycle:

- ☐ starts with 3 _____ (5 C sugar w/ phosphate) (= _____)
- ☐ phosphate is added (from ATP from light-dependent rx) to form 3 X **ribulose biphosphate** (= _____)
- ☐ an enzyme (RuBP carboxylase, or **rubisco**) adds 1 molecule of CO_2 to each RuBP
 - note: now it is a _____ molecule
 - total of 3 CO_2 used
- ☐ the 6 C molecule splits into two 3 C molecules (**3-phosphoglycerate**, _____) (for a total of 6 PGA's, 2 for each CO_2)
- ☐ phosphate from ATP (light-dependent rx) and hydrogen from NADPH-H^+ added to the 2 PGA's to form 2 molecules of **glyceraldehyde 3-phosphate** (or _____)
 - total of 6 ATP needed, for a total of 6 G3P's
- ☐ of these 6 G3P's, 1 of them are used to form $\frac{1}{2}$ of a _____ (or fructose)
- ☐ the remaining 5 G3P's (15 C total), are rearranged into 3 molecules of _____ (each with 5 C), which completes the cycle
- ☐ glucose and fructose are either stored, combined to form other polysaccharides (sucrose, maltose, cellulose, et al), or used to form proteins, lipids, or nucleic acids
- ☐ summary of Calvin cycle:
 - ☐ $6\text{CO}_2 + 12\text{NADPH} + 12\text{H}^+ + 18\text{ATP} \text{ ----- } > \text{C}_6\text{H}_{12}\text{O}_6 + 12\text{NADP}^+ + 18\text{ADP} + 18\text{P}_i + 6\text{H}_2\text{O}$

Diagram of Calvin Cycle

