Advanced Biology Photosynthesis

Learning Objectives:
Photosynthesis converts light energy to the chemical energy of food.
The light reactions convert solar energy to the chemical energy of ATP and NADPH.
The Calvin Cycle uses ATP and NADPH to convert CO_2 to sugar.
Alternative mechanisms of carbon fixation have evolved in hot, arid climates

Major Terms:

ATP synthase	Calvin Cycle	Chlorophyll	Light reaction	Photosynthesis	Visible light
Autotrophic	CAM	Chloroplast	Light Independent Reaction	Photosystem	
Bundle Sheath cells	CO_2 Fixation	Cyclic electron pathway	Noncyclic electron Pathway	Pigment	
C3 Plant	Carotenoid	ETC	Photons	Stomata	
C4 Plant	Chemiosmosis	Grana		Stroma	
				Thylakoid	

Read: Chapter 7

Lecture:

Photosynthesis

I. Overview

A. Photosynthesis: The process by which _____ (free energy) is converted by _____ (self-feeding) organisms (like green plants) into the _____ of a carbohydrate.

B. Light _____ are captured by specialized _____ molecules and excite the _____ of those molecules to high energy states.

C. An electron transport system transfers the energy from the electrons to _____ that serves as the energy reservoir for molecule biosynthesis.

D. The energy is then used to produce _____ which acts as long-term storage for the energy.

E. Photosynthesis is an _____ process where CO2 and H2O are utilized in the production of sugars and complex carbohydrates, eventually leading to the synthesis of nucleic acids, proteins and lipids.

F. Cellular respiration, on the other hand is an _____ process.

G. Overall Reaction

1. **$6CO_2+12\ H_2O \rightarrow C_6H_{12}O_6+ 6O_2+ 6H_2O$**
2. Water is written on both sides of the equation because the water represents _____ synthesized H_2O.
3. The O_2 produced has been traced (using radio-labeled substrates) to water, and **NOT** the CO_2 that the plant takes in.
4. Photosynthesis is a _____ process — H_2O is oxidized and CO_2 is reduced.

H. Generalized Equation

II. The Two Major Types of Reactions in Photosynthesis

A. Photosynthesis is divided into two reactions: The _____ (consisting of Photosystem I[PS I] and Photosystem II [PS II]) feeds ATP and NADPH into the _____ — the Calvin-Bensen Cycle, usually referred to as the _____.

III. Light Dependent Reaction

A. The visible light spectrum consists of light of 380-750 nm in wavelength.

B. Photosynthetic pigments (chlorophylls) absorb light at a maximum of about 400 (_____) and 600 (_____) nm.

C. Chlorophylls a and b
   1. The head of the chlorophyll is hydrophilic. The hydrophobic tail interacts with thylakoid membrane proteins.
   2. Absorption Spectrum of Chlorophyll
      a. Different pigments allow _____ of absorption.

D. Chloroplasts
   1. _____ is the liquid in the central compartment.
   2. The _____stacks contain _____ — the individual vesicles.
   3. The thylakoids are membrane bound interconnected vesicles that enclose a complete separate compartment — the thylakoid space. The photosensitive pigments are embedded in the thylakoid membrane.
   4. All the components of both PS I and PS II are located in close proximity to the _____, _____ and NADP reductase.

E. Photosystem II
   1. Chlorophylls absorb_____
   2. An _____absorbs energyand goes into a higher energy state.
   3. Electron is then transferred to an_____.
   4. To replace the electron that left, an enzyme splits an _____.
      a. The electrons go to _____
      b. _____ joins another one and _____ out
   5. The excited electron travels through an _____ (ETC) to Photosystem I.
   6. Energy from electron is used to pump _____ into Thylakoid space causing an electrochemical gradient.
   7. H+ leaves through _____ (produces ATP)

A. Photosytem I
   1. More Light energy _____ the electron.
   2. The electron goes to an acceptor and then down another _____
   3. It is transmitted to _____ to form _____

B. Cyclic Electron Flow
   1. Produces _____
   2. Uses photosystem I, but puts the electron back into the original _____

C. End Result is the production of _____ and _____

   Light+ADP+P+NADP+H2O◊ATP+NADPH+O2

IV. The Calvin-Bensen Cycle or _____

A. Uses ATP and NADPH to convert _____ into _____
B. The Calvin Cycle can be Divided into 3 phases
   1. Phase 1:_____ - C is added or “fixed” to beginning molecule (RuBP).
   2. Phase 2: _____- electrons are added to modify the molecule
   3. Phase 3: _____

V. Adaptations to Carbon Fixation

A. Plants in _____ have adapted to conditions both in morphology and metabolism.

B. The stomata are not only the main entry routes for _____, but are also the _____ routes for _____, which the plant must conserve.

C. ____ plants (standard Calvin cycle) use PS I and PS II to produce ATP and NADPH for further use in the Calvin-Bensen cycle.

D. _____ plants (carbon is "fixed" into the 4C compound, oxaloacetate).

1. In C4 plants such as _____, leaf structure includes the mesophyll and the bundle sheath cells.
   a. The bundle sheath cells _____ the leaf vasculature.
   b. Carbon is fixed into oxaloacetate in the mesophyll cells. Malate is then produced which crosses into the bundle sheath cells via plasmodesmata whereupon CO_2 is released and enters the Calvin cycle.

E. _____ (Crasulacean Acid Metabolism) plants are water-storing (succulant) plants. They open the stomata _____, and store the CO_2 as organic _____. During the day, the stomata are _____ and the CO_2 is released to enter the Calvin-Bensen cycle.

F. Overview

	C3	C4	CAM
Leaves			
Examples			
Other			

Review : Do Reviewing the Chapter and Testing Yourself on pgs 128-130