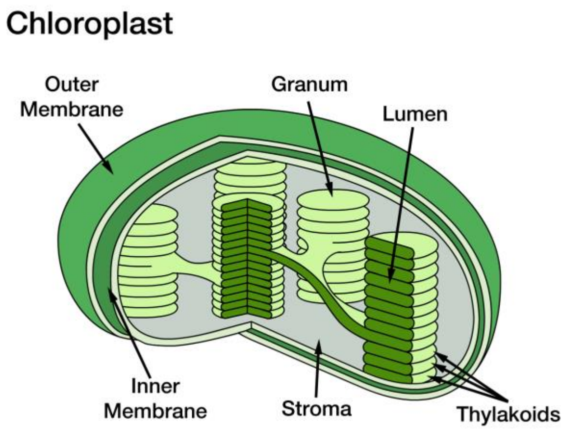
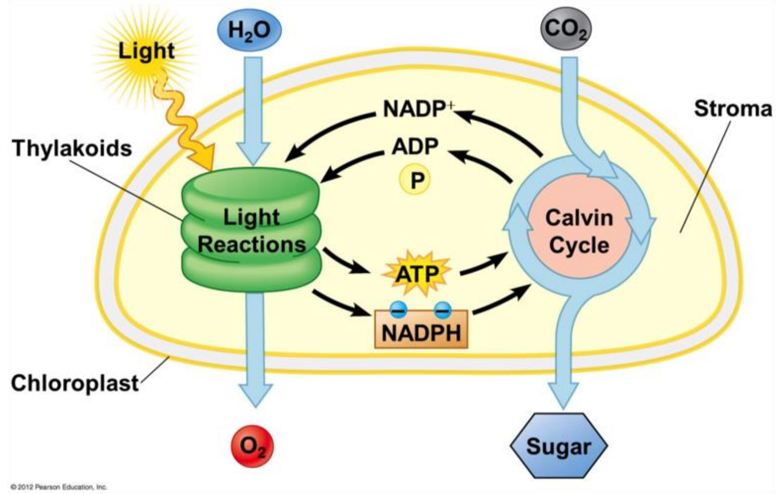
SBI4U: Photosynthesis & Comparisons Review Questions

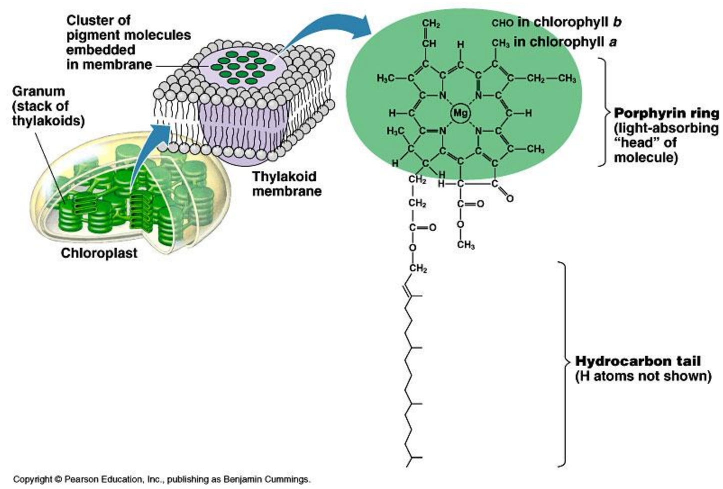
1. Sketch a diagram of a chloroplast and label it. Indicate where the processes of photosynthesis occur.





2. Describe a photosynthetic pigment (ie chlorophyll). Why do photosystems use groupings of more than one type of pigment?

Allows for more photons to be absorbed and increase the amount of light reactions occurring. Each pigment absorbs a certain wavelength of light, by combining them more of the light energy can be absorbed/used by the plant.



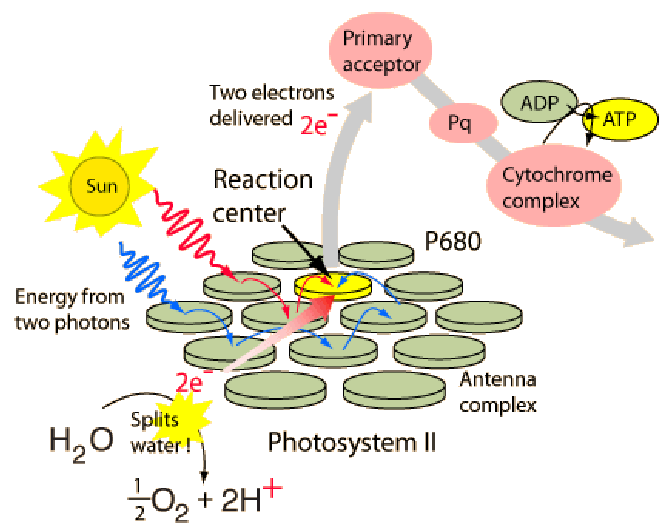
3. Define: complex/antenna complex, reaction centre, photosystem, primary electron acceptor.

antenna complex: an array of protein and chlorophyll molecules embedded in the thylakoid membrane of plants, which transfer light energy to one chlorophyll a molecule at the reaction center of a photosystem

reaction centre: is where the electrons are transferred from the photosystem to the primary electron acceptor.

photsystem: functional and structural units of protein complexes involved in the absorption of light and the transfer of energy and electrons.

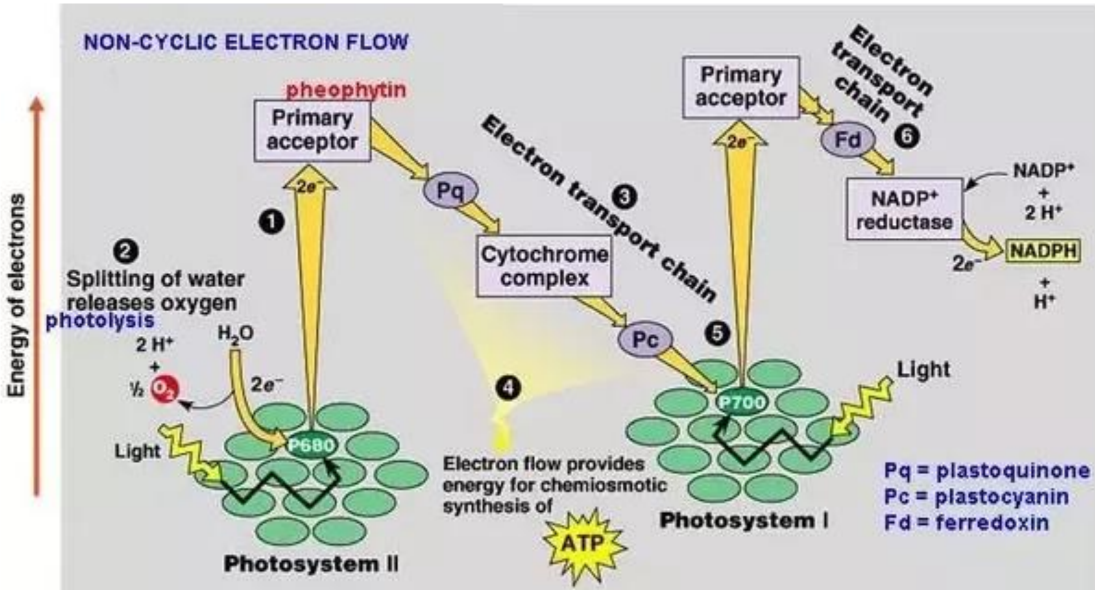
primary electron acceptor: absorbs high energy electrons that leave the photosystem.



4. Summarize the key events of Non-cyclic electron flow. Why is it so-called?

Uses both photosystems. Electrons finish in a different location than where they begin.

See outline posted in Edsby – "Circus script"



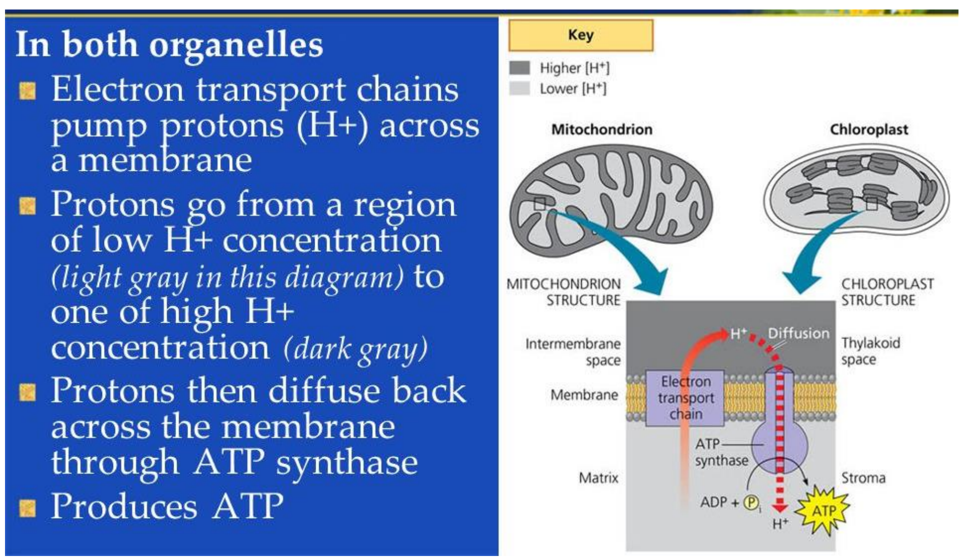
5. Explain the similarities and differences between the electron transport chains occurring in the mitochondria with the electron transport chain associated with photosystem II.

Mitochondria:

- always non-cyclic
- driven by Oxygen
- Oxidation of NADH & FADH2
- electrons come from NADH & FADH2
- Pumps multiple H+ per cycle

Chloroplast:

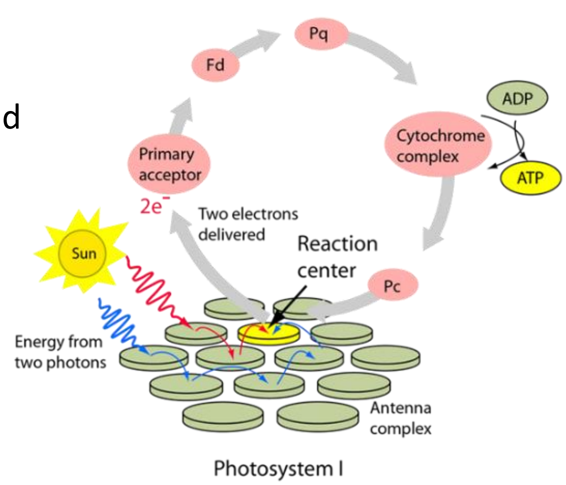
- cyclic & non-cyclic
- Non-cyclic produces ATP & NADPH
- Cyclic produces ATP only
- Driven by excitation of electrons by light
- electrons come from water
- reduction of NADP+ to NADPH
- produces water
- Uses photosystems



6. Summarize cyclic electron flow. Why does a plant need cyclic electron flow?

Needed to produce ATP as Calvin cycle needs more ATP than NADPH

Only uses photosystem I



7. Outline the 3 Phases of the Calvin Cycle. What is the end product of photosynthesis?
    1. Carbon fixation
    2. Reduction
    3. RuBP regeneration

    G3P molecule is the results of 1 turn of the Calvin cycle. Is used to make glucose and other carbohydrates needed by plants.

8. What forms can it (molecule from above) be in and what does the plant do with the different forms?
    2 G3P molecules can be combined to make glucose which is used in the mitochondria to make ATP energy for plants
    Several G3P molecules can be combined to make cellulose for structural support, starch for energy storage….

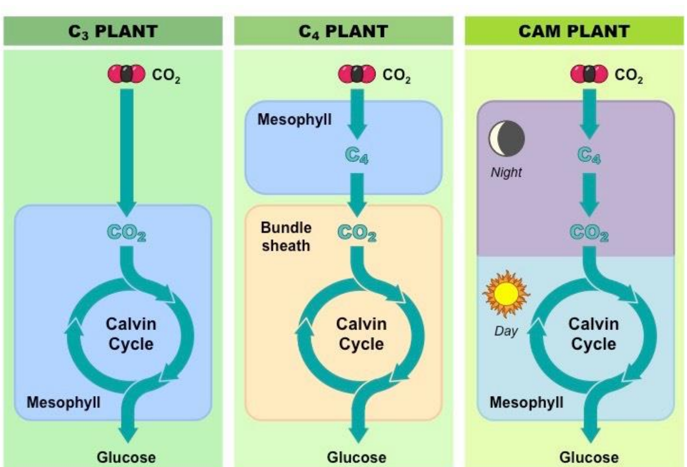
9. How are the Light reactions and the Calvin cycle linked?
    The products of one are the reactants for the other
    Light reactions produce ATP & NADPH, need ADP & NADP+
    Calvin cycle oxidized NADPH so it can be used in light reactions and dephosphorylates ATP into ADP to be used again in light reactions.

10. Why is the Calvin cycle called "dark reactions" or light independent reactions?
    It does not directly need light to proceed, but it does need the products from the light reactions to work.

11. Energy changes forms twice during photosynthesis. What are these changes?
    Photosynthesis converts **solar** energy into **chemical** energy using electrons and protons from water in the light reactions.
    Mechanical energy is also created in the chemiosmosis driving ATP synthase to create ATP.

12. What are 3 ways you could you limit the rate of photosynthetic activity?
    - decrease the amount of light
    - decrease the amount of CO2
    - decrease temperature

13. Explain the main differences between C3 and C4 plants. Explain the differences exhibited by CAM plants.



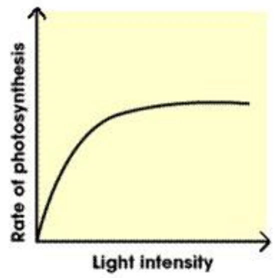
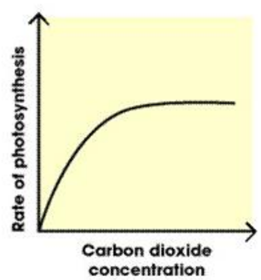
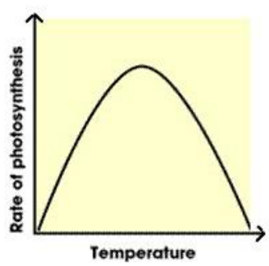
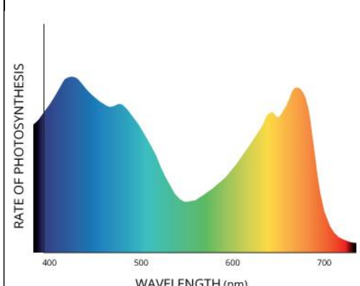
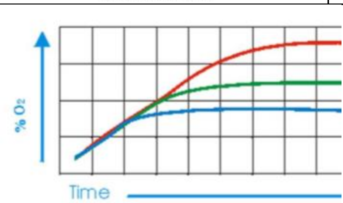
C3 plants	C4 plants	CAM plants
Most plants	Tropical grasses like corn, sugarcane	Succulents, pineapple, agave
Fix carbon in Calvin cycle - attach CO_2 to RuBP	Fix carbon in cytoplasm - attach CO_2 to PEP	Fix carbon at night only, fix it to organic molecules
Enzyme - Rubisco	Enzyme – PEP-ase	Enzyme – PEP-ase
Most energy efficient method	1/2 way between these two	Best water conservation
Loses water through photorespiration	Loses less water	Loses least water

14. What is the significance of stomata?

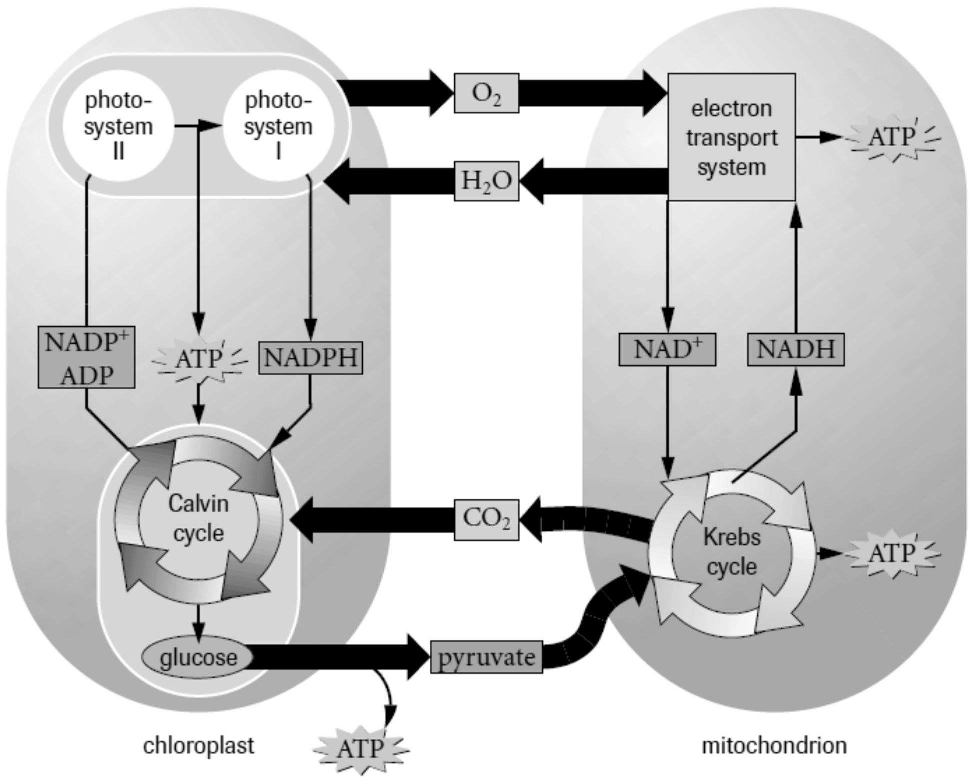
Stomata allow for gas exchange in the leaves – CO_2 into the leaf & O_2 out

They close to conserve water when it is too hot – this can cause an increase in photorespiration which is not desired.

15. How do various environmental conditions such as temperature, light colour, light intensity, CO_2 and O_2 concentration levels affect the rate of photosynthesis? Explain why each affects photosynthesis the way it does.

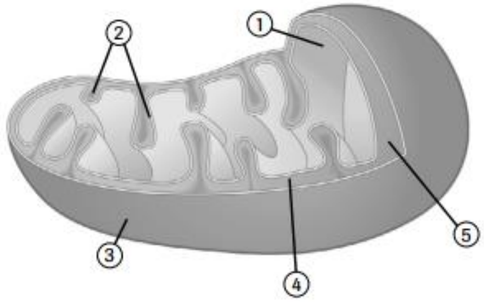
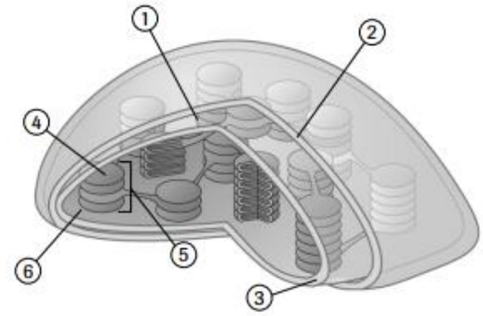
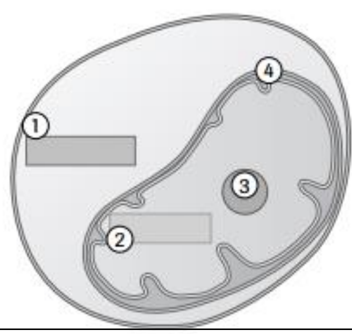
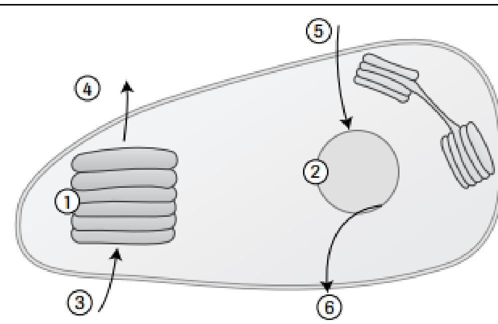
	The amount of light directly affects the speed at which the light reactions can occur. The more light the more electrons excited from the photosystems, the more reactions occur. Light saturation occurs when no more light can be absorbed as the processes are being limited by speed at which they can transfer electrons & the Z-proteins ability to split wate
	The amount of CO_2 directly affects the speed at which the Calvin cycle can occur. The more CO_2, the more can bind to Rubisco and the faster the cycle happens. However, like all enzymes it can reach substrate saturation so there is a maximum amount of CO_2 that can be fixed in the cycle.
	Temperature affects the cycle in 2 ways: 1- Both light reactions & Calvin cycle are enzyme driven and depend on molecule collisions. The lower the temperature the fewer collisions, the slower the reactions. Reaction speed will increase with temperature until enzymes begin to denature. 2- As temperature increase plants close their stomata to conserve water. The decreases the amount of photosynthesis and CO_2 cannot get into the leaf and O is still being produced in light reactions so plants begin to undergo more photorespiration rather than photosynthesis.
	Wavelengths affect the rate of photosynthesis as the pigments are responsible for absorbing light energy in the light reactions. Different pigments can absorb different wavelengths. Green is the least absorbed so it will have the slowest rate of photosynthesis.
	Amount of O_2 direction affects the rate of the Calvin cycle. Oxygen outcompetes CO_2 for binding to Rubisco. The more O_2 there is the more photorespiration and less photosynthesis occurring.

Comparing Cellular Respiration & Photosynthesis



	Criteria	Photosynthesis	Respiration
Overall	Reactants	H_2O & CO_2	Organic molecules (ex. glucose) & O_2
	Products	Organic molecule & O_2	H_2O & CO_2 & ATP
	Energy	Absorbed	Released
e-	Electron Source	H_2O	Organic molecule
	Electron Carriers	$NADP^+$/ NADPH	NAD^+/ NADH & FAD/$FADH_2$
ETC	Electron Profile	Z-pattern & Cyclic	Linear
	Electron Source	H_2O	NADH & $FADH_2$
	Electron Sink	NADPH	Oxygen
	Products	ATP & NADPH	ATP & H_2O
ATP Synthesis	Molecule pumped to create gradient	H^+	H^+
	Membrane-embedded molecule	ATP Synthase	ATP Synthase
	Location of H^+ reservoir	Thylakoid Interior	Intermembrane Space
	Location of ATP synthesis	Stroma	Matrix

Comparing Chloroplasts & Mitochondria

Criteria	Mitochondria	Chloroplast
Diagrams		
	1 Matrix	1 Intermembrane Space
	2 Cristae	2 Outer Membrane
	3 Outer Membrane	3 Inner Membrane
	4 Inner Membrane	4 Thylakoid
	5 Intermembrane Space	5 Granum / Grana
		6 Stroma
Structural Comparisons	- double phospholipid membrane - contain folding innermembrane (cristae) - matrix	- double phospholipid membrane - contain thylakoids with pair of membranes - stroma
Overview of Metabolic Process		
	1 Glycolysis	1 Light Reactions
	2 Pyruvate Oxidation	2 Light Independent Reactions (Calvin Cycle)
	3 Kreb Cycle	3 H_2O 4 O_2
	4 Electron Transport Chain	5 CO_2 6 Glucose / $[CH_2O]$
Reactants	Glucose & O_2 (if aerobic)	H_2O & CO_2
Products	H_2O & CO_2 & ATP	Glucose & O_2
Pathways / Location	Prokaryotes & Eukaryotes	Plants, algae, protists, cyanobacteria