

Lesson 4.2: Critical Reading

Name _____ Class _____ Date _____

Read these passages from the text and answer the questions that follow.

Photosynthesis Stage I: The Light Reactions

The first stage of photosynthesis is called the light reactions. During this stage, light is absorbed and transformed to chemical energy in the bonds of NADPH and ATP. You can read about this process below.

Steps of the Light Reactions

The light reactions occur in several steps, all of which take place in the thylakoid membrane.

- Step 1: Units of sunlight, called photons, strike a molecule of chlorophyll in photosystem II of the thylakoid membrane. The light energy is absorbed by two electrons ($2e^-$) in the chlorophyll molecule, giving them enough energy to leave the molecule.
- Step 2: At the same time, enzymes in the thylakoid membrane use light energy to split apart a water molecule. This produces:
 - two electrons ($2e^-$). These electrons replace the two electrons that were lost from the chlorophyll molecule in Step 1.
 - an atom of oxygen (O). This atom combines with another oxygen atom to produce a molecule of oxygen gas (O_2), which is released as a waste product.
 - two hydrogen ions ($2H^+$). The hydrogen ions, which are positively charged, are released inside the membrane in the thylakoid interior space.
- Step 3: The two excited electrons from Step 1 contain a great deal of energy, so, like hot potatoes, they need something to carry them. They are carried by a series of electron-transport molecules, which make up an **electron transport chain**. The two electrons are passed from molecule to molecule down the chain. As this happens, their energy is captured and used to pump more hydrogen ions into the thylakoid interior space.
- Step 4: When the two electrons reach photosystem I, they are no longer excited. Their energy has been captured and used, and they need more energy. They get energy from light, which is absorbed by chlorophyll in photosystem I. Then, the two re-energized electrons pass down another electron transport chain.
- Step 5: Enzymes in the thylakoid membrane transfer the newly re-energized electrons to a compound called $NADP^+$. Along with a hydrogen ion, this produces the energy-carrying molecule NADPH. This molecule is needed to make glucose in the Calvin cycle.
- Step 6: By now, there is a greater concentration of hydrogen ions — and positive charge — in the thylakoid interior space. This difference in concentration and charge creates what is called a chemiosmotic gradient. It causes hydrogen ions to flow back across the thylakoid membrane to the stroma, where their concentration is lower. Like water flowing through a hole in a dam, the hydrogen ions have energy as they flow down the chemiosmotic gradient. The enzyme ATP synthase acts as a channel protein and helps the ions cross the membrane. ATP synthase also uses their energy to add a phosphate group (Pi) to a molecule of ADP, producing a molecule of ATP. The energy in ATP is needed for the Calvin cycle.

Questions

1. In one sentence, describe what happens during the light reactions.

2. In which step(s) of the light reactions is sunlight absorbed?
3. Why is water “split” during the light reactions?
4. What is an electron transport chain? What is its role during these light reactions?
5. How is ATP made during the light reactions?