

Topic: Photosynthesis Activity

Summary: Students learn the chemistry by acting out the steps of photosynthesis.

Goals & Objectives: Students will be able to explain the three phases of photosynthesis. Students will be able to demonstrate how light, H₂O, and CO₂ is used to make sugar. Students will be able to explain the structure of the chloroplast.

Standards: CA Biology *If*. Students know usable energy is captured from sunlight by chloroplasts and is stored through the synthesis of sugar from carbon dioxide.

Time Length: 60 minutes

Prerequisite Knowledge: Structure of chloroplast and thylakoid, plasma membrane, active transport, passive transport, concentration gradients, ions and electrons

Materials:

- Student drawn poster of the structure of the thylakoid with an electron transport chain. Membrane must include the chlorophyll pigments, a proton pump, ATP synthase, and NADP reductase.
- One fan, surge protector with long chord and cart (small table works also)
- Light – lamp is best, flash light works
- Tape
- Chalk
- Candy (sugar) for each student
- Red, blue, and yellow construction paper – one of each
- Photocopy handouts and chlorophyll label - one per student.

Set-up:

1. In the front of the room, place the thylakoid poster on the chalk board.
2. On one side of the poster put the fan. The fan must be able to plug into the surge protector. The fan should point in the opposite direction of the poster.
3. On the other side of the fan, tape the label Glucose. Place the candy on top of the Glucose label.
4. On the cart, tape the Calvin cycle label.
5. Place the light on the cart so that it is shining on the thylakoid poster.
6. With the ADP label, cut a hole for where the 3rd phosphate should go. Tape the ADP label on top of the surge protector with the hole aligned with the plug outlet.
7. On the top of the thylakoid poster, tape the two photosystem labels.

8. On each student's desk, place two chlorophyll labels.
9. Crumple the red and blue colored papers into tight round balls.

Procedures:

1st Review with students about the purpose of photosynthesis, the structure of the chloroplast, light and dark reactions, and the visible light spectrum.

2nd Tell students the color that we see is reflected and the other colors are absorbed. Ask students why wearing a black shirt in the sun will make you hotter than wearing a white shirt. Hand out the color paper balls to three students close to the front of the room. Tell the students that you are pretending to be a plant. Ask them to gently throw the ball to you, one at a time. Catch all three of them. Ask the students what color if I would be as a pigment. Hand the papers out to three different students. Repeat, but this time, catch the red ball and deflect the other two balls back to the students. Now ask the students what color you would now be. Green of course, because red is absorbed and the reflected yellow and blue balls make green.

3rd Introduce to the students that they will pretend that the classroom is a giant chloroplast, their desks are the pigment chlorophyll, and the front of the classroom is the thylakoid membrane. Distribute the handouts and the two water molecules to each student. Select a well behaved student volunteer to throw the ball for you. He or she should not throw the ball hard and has to make sure the receiving student is looking and ready to catch the ball. You should be standing at the chalk board in front of the electron transport chain.

4th Demonstrate the activity with one student. The volunteer gently throws the red ball to a student in front of the class. The receiving student must say out loud "I am chlorophyll and the light I absorb splits water to form oxygen gas, electrons and hydrogen ions.

". That student then rips their water molecule paper and brings the blue or red ball to the volunteer and walks to the electron transport chain with their two electrons and four hydrogen ions.

5th Once arrived, the student must do a little dance and spins around once to show that they are excited. The student then says out loud "I am an excited electron that powers the electron transport chain".

6th The student slides their two electrons along the membrane from the green pigment to the proton pump and stops. The student then says out loud "In photosystem II, two protons are pumped into the thylakoid space. Two hydrogen ions diffuse out through ATP synthase, making ATP".

7th The student then pushes their two hydrogens through ATP synthase and plugs the fan into the surge protector. The fan turns on. The student then finishes sliding the electron to the end of the chain and says out loud “In photosystem I, the excited electron is stored in NADPH”.

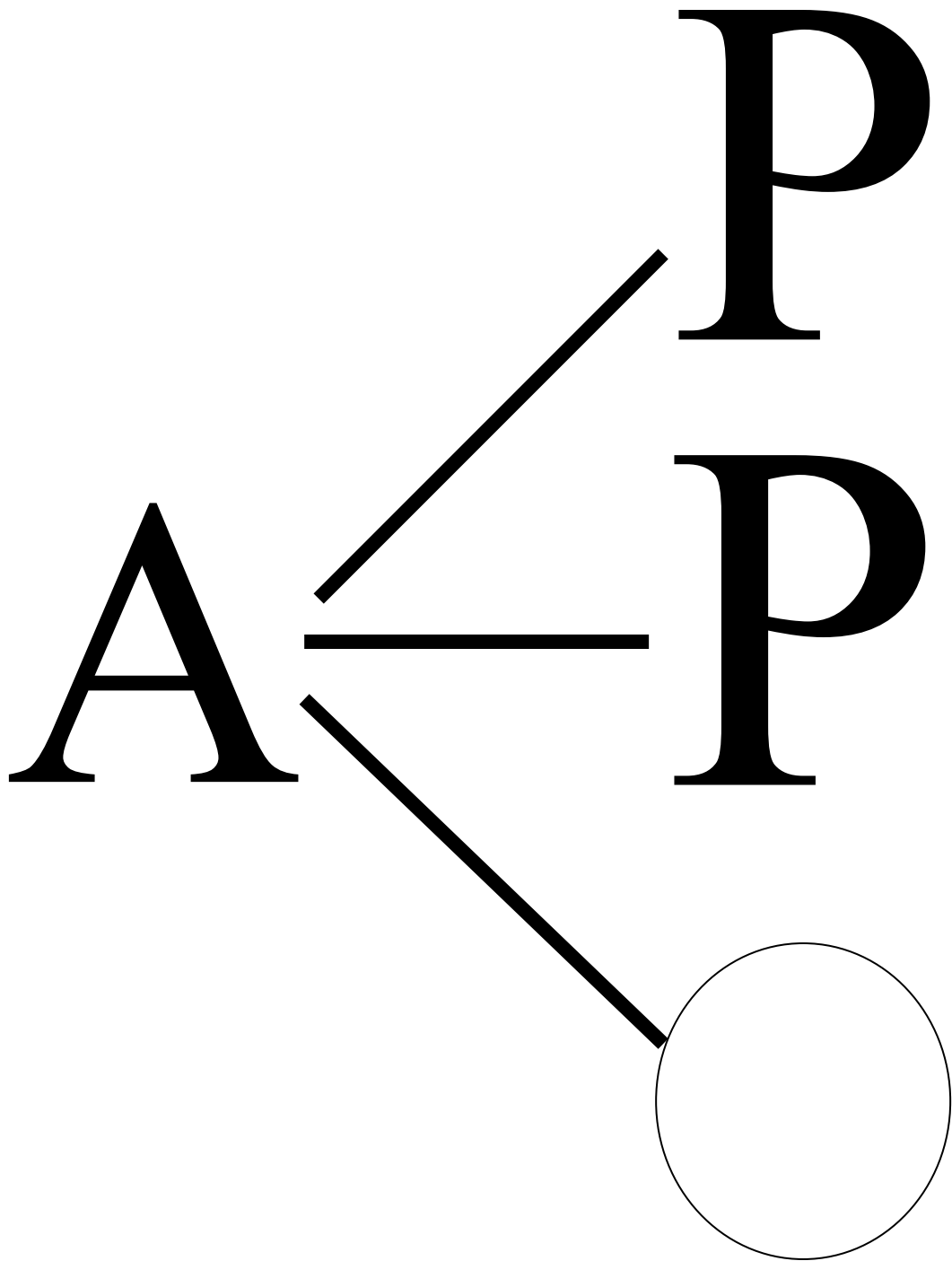
8th The student then blows through the fan and says “In the Calvin cycle, carbon dioxide is fixed into glucose from the energy provided by ATP and NADPH”. The student then walks back to their desk with the candy.

9th The process repeats. You can usually have the two students doing the activity at one point in time. The volunteer can throw to the next student after the student does the excited dance. All other students who are waiting their turn or have finished the activity work on the handout individually. If students work as a group on the handout, it can disrupt a student who is supposed to catch the paper. The handout is collected at the end of the class.

Accommodations: Students who have difficulty walking can tell you everything from their seat and you perform the kinesthetic movements. Students with an IEP can say much simpler versions like “Plants get energy from sun light. Light energy is changed into chemical energy. ATP is made by adding a phosphate to ADP. Energy in ATP is use to make sugar from air.” If a student with an IEP needs extra time, they can take the assignment home.

Evaluation:

Complete participation in the activity is worth 15 points. Each question in the handout is worth 1 point. The labeling the drawing is worth 20 points. This assignment is worth a total of 55 points.



Photosystem II

In photosystem II, two protons are pumped into the thylakoid space.

Two hydrogen ions diffuse out through ATP synthase, making ATP

Photosystem I

In photosystem I, the excited electron is stored in NADPH.

Calvin Cycle

In the Calvin cycle, carbon dioxide is fixed into glucose from the energy provided by ATP and NADPH.

Electron Transport Chain

Glucose

Photosynthesis Activity

1. What is the chemical formula for photosynthesis?

6 _____ + 6 _____ → _____ + 6 _____

2. In what organelle does photosynthesis take place? _____

3. What is the disc like structure inside this organelle called? _____

4. What is the name of the pigment that absorbs light? _____

5. What color of light is reflected by this pigment? _____

6. Where does photosystem II and photosystem I take place in the organelle? _____

7. When light hits this pigment, what happens to water? _____

8. What is the gas produced when water is split? _____

9. What is the name of the particle that powers the electron transport chain? _____

10. In photosystem II, what is pumped into the thylakoid space through a proton pump?

11. In photosystem II, what is diffused out of the thylakoid through ATP synthase?

12. What is it called when you have more ions on one side of a membrane and fewer ions on the other side of the membrane? _____

13. When ATP synthase is activated, it adds a phosphate group to what molecule? _____

14. In photosystem I, sunlight hits a second pigment and excites what from photosystem II?

15. An enzyme then stores this excited particle in what molecule? _____

16. ATP and the energy carrier in question 15 are used to power what cycle? _____

17. What molecule from the air is broken down in this cycle? _____

18. What is the liquid called where this cycle takes place? _____

19. Is sun light used in this cycle? _____

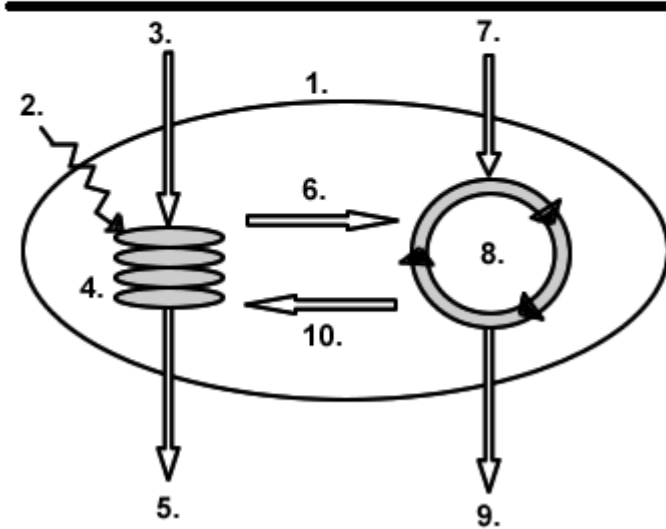
20. Name an organic molecule formed at the end of this cycle? _____

Label the drawings:

Photosynthesis Overview

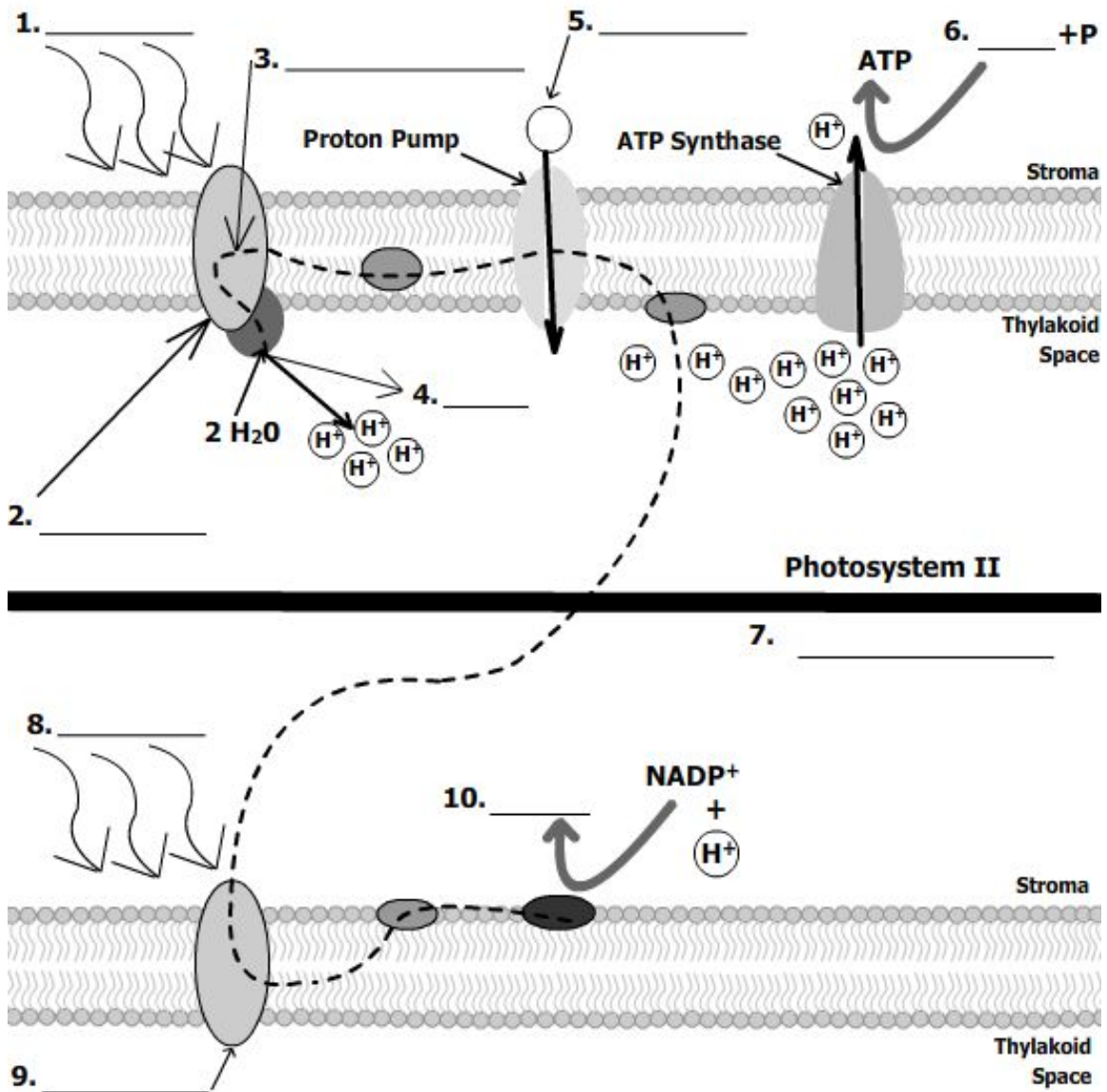
Word Bank

Calvin Cycle	CO ₂
H ₂ O	Light
C ₆ H ₁₂ O ₆	O ₂
Thylakoid	Chloroplast
NADPH and ATP	NADP ⁺ and ADP

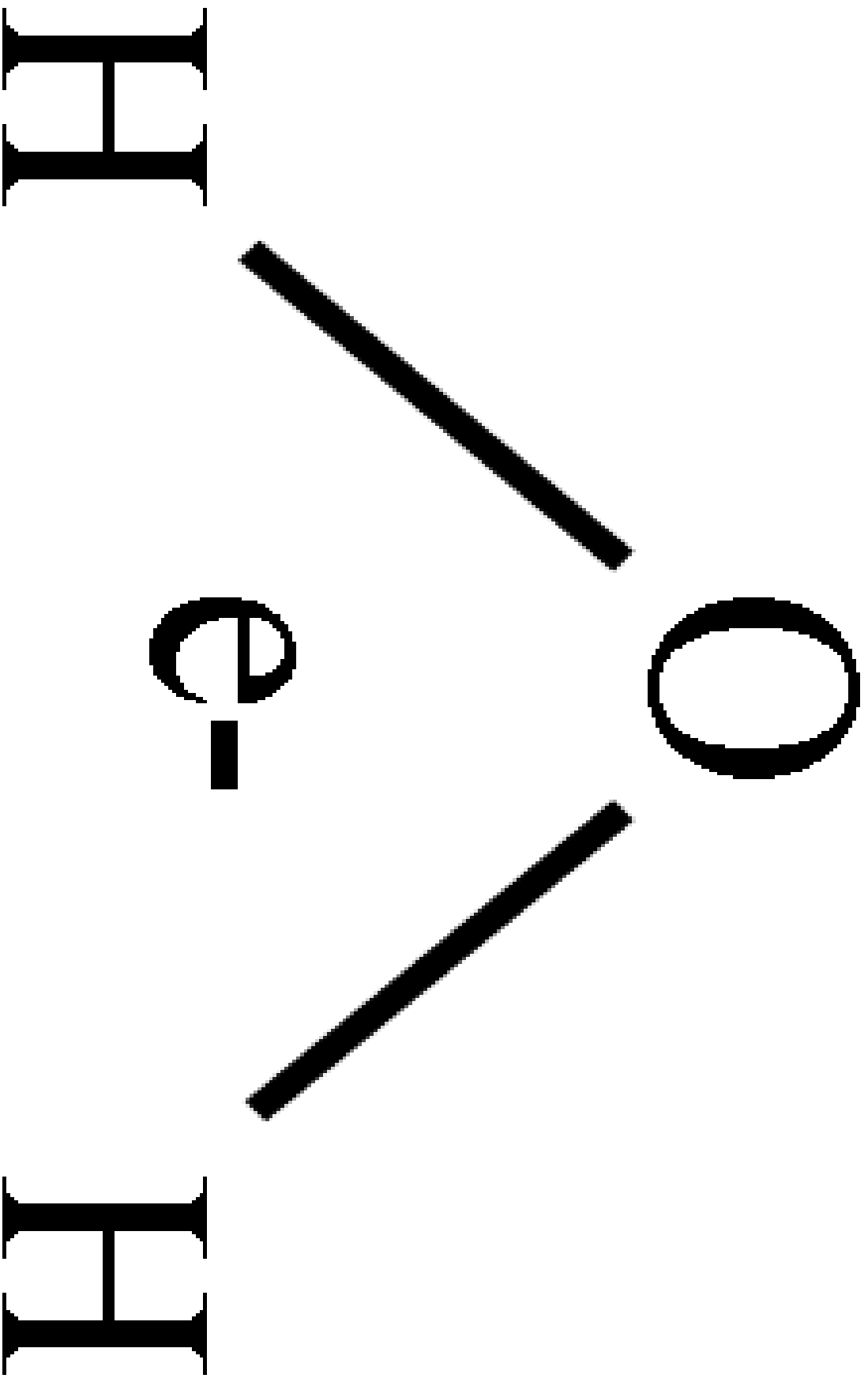


1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____

Light Dependent Reactions



Chlorophyll



I am chlorophyll and the light I absorb splits water to form oxygen gas, electrons and hydrogen ions.