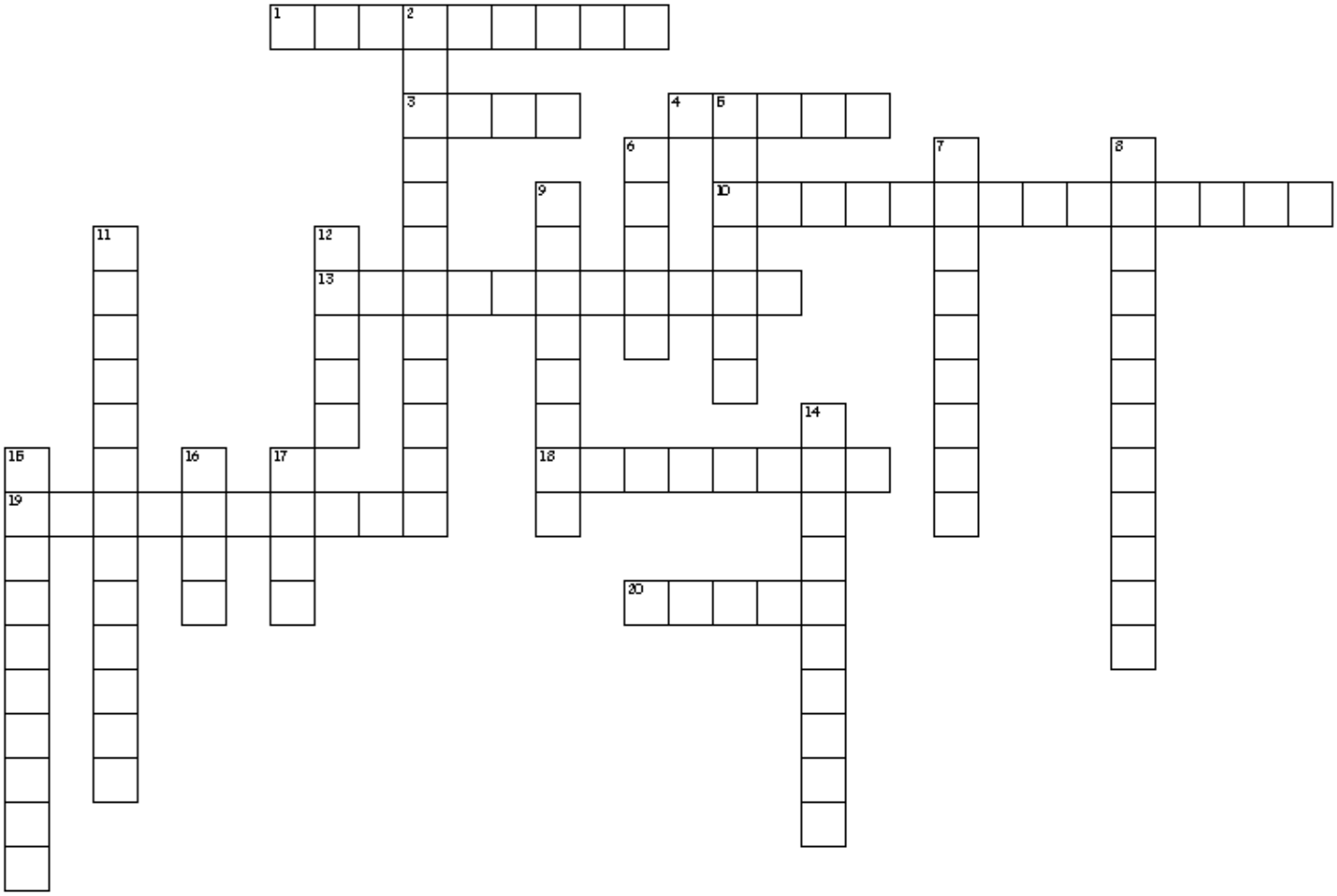
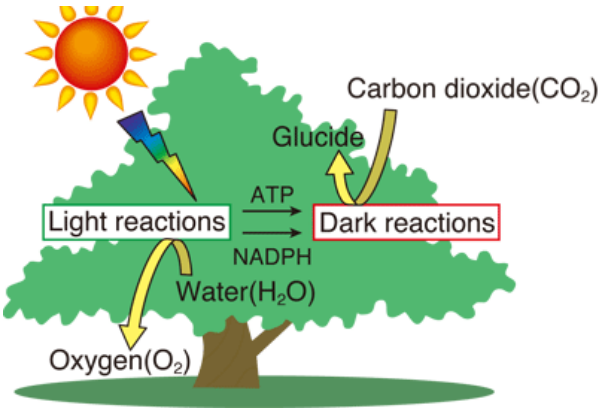
Name _____ Date _____

Read the article ***"Photosynthesis – The Light Reactions"*** – then use the clues to answer the puzzle.





Across

1. Given up by the photosystem II when it is activated by light
3. The sun's energy enters _____ cells where it is absorbed by chlorophyll
4. This is used in carbon fixation
10. This is the biochemical process by which plants make carbohydrates.
13. Carrier molecule for hydrogen ions as they move back into the stroma
18. These ions are pumped from the stroma into the interior of the thylakoids
19. Specialized membranes inside chloroplasts
20. An example of a photosynthetic plant.

Down

2. Where photosynthesis take place
5. Special carrier proteins
6. Another term of energy-fixing reactions
7. The ATP formed from chemiosmosis is a(n) _____ factor in carbon-fixing reactions of photosynthesis.
8. The mechanism through which ATP is produced in chloroplast of plant cells
9. Source of energy in light reactions
11. ATP is used to form this molecule
12. This molecules is the source of free hydrogen ions and diatomic oxygen
14. The electron acceptor after chlorophyll absorbs light energy at 700 nm
15. Where oxygen is released
16. Another term for carbon-fixing reactions
17. Large quantity of _____comes from photosynthesis.

Chapter 2-10: Photosynthesis—The Light Reactions

Photosynthesis is the biochemical process by which sunlight, oxygen, and water are converted into energy contained in the chemical bonds of carbohydrates. Photosynthetic organisms include green plants, algae, and certain species of bacteria. These organisms are key elements in the cycles of life on Earth, since all atmospheric oxygen and a large quantity of food come from photosynthesis.

The two main processes of photosynthesis involve a series of energy-fixing (light) reactions and a series of carbon-fixing (dark) reactions. In the light reactions, energy from sunlight is trapped in the chemical bonds of ATP, while in the second process, this ATP is used to form carbohydrate molecules. The dark reactions are the subject of the next plate.

This plate contains three diagrams that depict the energy-fixing reactions of photosynthesis. The biochemistry of these reactions can be difficult to comprehend, so go through the reading slowly.

Photosynthesis takes place inside chloroplasts in specialized membranes called thylakoids (which were mentioned in the last plate). In the main diagram of this plate, we show a large leaf. If you want to color it, use a very pale color.

The process of photosynthesis begins with the sun's **light energy (A)**. This energy enters leaf cells and is absorbed and transferred to a series of chlorophyll molecules within a complex cluster called a photosystem. The first photosystem involved in this transfer is **photosystem II (B)**, and this photosystem contains chlorophyll molecules that absorb light that has a wavelength of 680 nanometers (nm).

When the complex in photosystem II is activated by light energy, it gives up **electrons (C)**, which are then absorbed by an **electron acceptor (D)**. This electron acceptor is part of what is called an energy transfer system, through which the electrons move until they reach **photosystem I (F)**. During these transfers, hydrogen ions are pumped from the stroma into the interior of the thylakoid. As hydrogen ions leak back across the membrane through special carrier proteins called ATPases, **ADP (E_1)** is phosphorylated, forming **ATP (E)**.

Now photosynthesis continues. Light energy (A) is absorbed by photosystem I (F), whose chlorophyll pigments absorb light energy that measures 700 nm. Once again, energy is transmitted by the chlorophyll in the complex, and an electron is given off to an electron acceptor, ferredoxin.

The electron acceptor then transfers the electron to a molecule of nicotinamide adenine dinucleotide phosphate, or **NADP (G_1)**, which takes on a **hydrogen ion (H)** to become **NADPH (G)**. NADPH is used in carbon fixation in the next plate.

We complete the process of photosynthesis by referring back to the original P680 molecule, which has lost an electron that must be replaced. A **water molecule (I)** breaks down, forming free hydrogen ions and **diatomic oxygen (J)**, and contributing an electron to the P680 complex. The oxygen is released to the atmosphere.

We have completed the discussion of the energy-fixing reactions of photosynthesis, and will now spend a moment on an alternative one called the cyclic reaction.

An alternative process of photosynthesis occurs in certain types of bacteria and is used to produce ATP, but does not produce NADPH, nor does it involve water or oxygen. In this cyclic reaction, light energy stimulates photosystem I (F) to emit an electron (C). An electron acceptor picks up the electron and passes it on through a series of molecules until it eventually returns to the photosystem. During this process, ADP (E_1) combines with a phosphate molecule to produce ATP (E). This reaction is cyclic because the electron moves out of the photosystem and then back into it.

We conclude by looking at the key elements of the light stages of photosynthesis, in which ATP is produced. This reaction is entitled Chemiosmosis. Read about the process as you focus on the final diagram of the plate.

Chemiosmosis is the mechanism through which ATP is produced in the chloroplast of the plant cell. Light energy (A) enters a specific **chlorophyll molecule (B_1)** of photosystem II, and then we see **energy flow (L)** as this energy moves into photosystem I (F). All of this takes place within the **thylakoid membrane (K)**. During this transferal of energy, there is **hydrogen ion flow (M)** across the membrane, from the **stroma (P)** into the **thylakoid space (O)**.

As hydrogen ions move back into the stroma, they travel through an enzyme complex called **ATP synthetase (N)**. The hydrogen ion flow coincides with the formation of molecules of ATP (E) from ADP. The ATP formed in chemiosmosis is an essential factor in the carbon-fixing reactions of photosynthesis, which are discussed in the next plate.