Cell Physiology *(Photosynthesis and Respiration)*

Frameworksheet

Standards: 1f, 1g, 9a

1. f. *Students know* usable energy is captured from sunlight by chloroplasts and is stored through the synthesis of sugar from carbon dioxide.

Photosynthesis is a complex process in which visible sunlight is converted into chemical energy in carbohydrate molecules. This process occurs within chloroplasts and specifically within the thylakoid membrane (light-dependent reaction) and the stroma (light-independent reaction). During the light-dependent reaction, water is oxidized and light energy is converted into chemical bond energy generating ATP, NADPH + H^+, and oxygen gas.† During the light-independent reaction (Calvin cycle), carbon dioxide, ATP, and NADPH + H^+ react, forming phosphoglyceraldehyde, which is then converted into sugars. By using a microscope with appropriate magnification, students can see the chloroplasts in plant cells (e.g., lettuce, onion) and photosynthetic protists (e.g., euglena).

Students can prepare slides of these cells themselves, an activity that provides a good opportunity to see the necessity for well-made thin sections of specimens and for correct staining procedures. Commercially prepared slides are also available. By observing prepared cross sections of a leaf under a microscope, students can see how a leaf is organized structurally and think about the access of cells to light and carbon dioxide during photosynthesis. The production of oxygen from photosynthesis can be demonstrated and measured quantitatively with a volumeter, which can collect oxygen gas from the illuminated leaves of an aquatic plant, such as elodea. By varying the distance between the light source and the plant, teachers can demonstrate intensities of the effects of various illumination. To eliminate heat as a factor, the teacher can place a heat sink, such as a flat-sided bottle of water, between the plant and light source to absorb or dissipate unwanted heat.

Questions for Standard 1.f.

1. **According to standard 1.f, which organelles capture energy from sunlight?**
2. **Describe the process of photosynthesis.**
3. **Where do the light –dependent reactions of photosynthesis occur? Where do light-independent reactions occur?**
4. **Describe what happens during the light-dependent reaction of photosynthesis.**
5. **Describe what happens during the light-independent reaction, or Calvin Cycle, of photosynthesis.**
6. **How could a microscope be used to investigate photosynthesis?**
7. **Explain how the production of oxygen gas could be measured investigated in a lab.**

1. g. *Students know* the role of the mitochondria in making stored chemical-bond energy available to cells by completing the breakdown of glucose to carbon dioxide.

Mitochondria consist of a matrix where three-carbon fragments originating from carbohydrates are broken down (to CO_2 and water) and of the cristae where ATP is produced. Cell respiration occurs in a series of reactions in which fats, proteins, and carbohydrates, mostly glucose, are broken down to produce carbon dioxide, water, and energy. Most of the energy from cell respiration is converted into ATP, a substance that powers most cell activities.

Questions for Standard 1.g.

8. **What is the role of mitochondria?**

9. **Describe the process that occurs to produce ATP in mitochondria.**
10. **What is cell respiration?**
11. **Which types of macromolecules can be broken down in cell respiration?**
12. **Write a word equation that describes the reaction of cell respiration.**
13. **Why is ATP important to cells?**

9. a. *Students know* how the complementary activity of major body systems provides cells with oxygen and nutrients and removes toxic waste products such as carbon dioxide.

The digestive system delivers nutrients (e.g., glucose) to the circulatory system. Oxygen molecules move from the air to the alveoli of the lungs and then to the circulatory system. From the circulatory system glucose and oxygen molecules move from the capillaries into the cells of the body where cellular respiration occurs. During cellular respiration these molecules are oxidized into carbon dioxide and water, and energy is trapped in the form of ATP. The gas exchange process is reversed for the removal of carbon dioxide from its higher concentration in the cells to the circulatory system and, finally, to its elimination by exhalation from the lungs.

The concentration of sugar in the blood is monitored, and students should know that sugar can be stored or pulled from reserves (glycogen) in the liver and muscles to maintain a constant blood sugar level. Amino acids contained in proteins can also serve as an energy source, but first the amino acids must be deaminated, or chemically converted, in the liver, producing ammonia (a toxic product), which is converted to water-soluble urea and excreted by the kidneys. Teachers should emphasize that all these chemicals are transported by the circulatory system and the cells. Organs at the final destination direct these chemicals to their exit from the circulatory system.

Questions for Standard 9.a.

14. **How is the digestive system involved in cellular respiration?**
15. **How is the circulatory system involved in cellular respiration?**
16. **Describe the gas exchange that occurs in cellular respiration.**
17. **How does the body obtain more glucose, if it is needed for cell respiration?**
18. **How can amino acids (through the process of cell respiration) be used as an energy source?**