**Tutorial Teacher Notes: Photosynthesis**

**Slide 1: Two-part process**

* The leaf of a cell has layers of cells, the layer called the mesophyll is where photosynthesis occurs in eukaryotes.
  + The palisade mesophyll contains the most chloroplast and is the major region of photosynthesis within a plant.
* Tiny pores in the leaf called stomata are where the exchange of CO2 and O2 occur.
* Photosynthesis is broken down into two separate parts.

1. Light-Dependent reactions that occur in the thylakoids
2. Light Independent reactions (Calvin Cycle) that occur in the stroma

**Slide 2: Big Picture of Photosynthesis**

* The cells of the mesophyll contain chloroplast where stacks of thylakoids containing a pigment called chlorophyll is used to capture the sun’s energy in the form of photons.
* The energy from the sun’s light excites electrons found within the chlorophyll and sends them along the ETC disrupting the concentration gradient of H+ ions across the thylakoid membrane.
* Water is also brought up through the roots of the plant and is split using enzymes creating O2 which is released through the stomata and further H+ ions that contribute to the imbalanced concentration gradient.
* Once the electrons are at the end of the ETC, they require a carrier for their energy so NADP+ picks up the electrons as well as a H+ ion creating NADPH.
* The imbalance of H+ ions along the membrane cause H+ ions to be pumped through a protein channel making energy that is used to make ATP from ADP.
* All of the captured energy (NADPH and ATP) is taken to the Calvin cycle where it as well as CO2 entering from the stroma is combined with carbon molecules. The energy from NADPH and ATP are used to combine carbon molecules to create glucose.
* Once the energy is used ADP and NADP+ are produced and sent back to the LDR.

**Slide 3: Light-dependent Reaction**

* The purpose of light-dependent reactions is to trap energy to be passed onto the Calvin cycle.
* The steps to LDR are:
  1. Inside the thylakoid membrane, sunlight is absorbed by chlorophyll found within proteins called photosystems which causes electrons found in chlorophyll to become excited.
  2. The excited electrons move along the electron transport chain causing further H+ ions to be pumped across the thylakoid membrane from the stroma contributing to an imbalance in the H+ ion concentrations on either side of the membrane.
  3. Once the electrons reach photosystem I they are re-excited and energized by the sun and require electron carriers (think hot coals requiring a carrier) to pass the energy on to be used later.
     + One such carrier is NADP+ which accepts an excited electron and a hydrogen ion from the stroma to make NADPH.
  4. Water that enters through the roots from the soil is split in the thylakoid membrane by enzymes found there.
     + The hydrogen is released into the thylakoid space further contributing to the H+ ion concentration gradient imbalance.
     + The oxygen is released through the stoma of the leaf into the atmosphere.
  5. Hydrogen ions in the in the thylakoid space moved across the membrane through a protein channel called ATP synthase in an effort to reduce the charge inside caused by the change in H+ gradient.
     + The flow of hydrogen ions to a lower concentration of ions provides energy to produce ATP by binding a phosphoryl group to ADP.

**Slide 4: Calvin Cycle**

* + The purpose of the Calvin cycle is to use the energy from the light-dependent reactions as well as CO2 from the atmosphere to create glucose.
    - This process does not require light.
  + The steps to the Calvin cycle are:

1. Six CO2 molecules enters the stroma through an open stoma and attach using an enzyme called RuBisCo to an already existing 6-carbon molecule forming twelve 3-carbon molecules.
2. The twelve 3-carbon molecules are converted to higher forms using the energy from ATP and NADPH formed during the LDR’s.

* Two 3-carbon molecules are removed to create glucose (energy).

1. The remaining carbon molecules are converted to six 5-carbon molecules with the use of ATP and are used to start the cycle again.

**Photosynthesis Review**

* The cells of the mesophyll contain chloroplast where stacks of thylakoids containing a pigment called chlorophyll which captures the sun’s energy in the form of photons.
* The energy from the sun’s light excites electrons found within the chlorophyll. The excited electrons move along the electron transport chain causing H+ ions to cross the thylakoid membrane causing a greater concentration of them within the thylakoid rather than outside it in the stroma.
* Once at the end of the ETC the electrons are re-excited and this energy is carried by carrier molecules such as NADP+ forming NADPH.
* The creation of a H+ concentration gradient causes H+ ions to move through ATP synthase providing energy to attach a phosphate to ADP making ATP.
* The ATP and NADPH move through the stroma to the Calvin cycle where they are used to convert carbon molecules to higher forms of energy. The starting molecule of carbon is attached to 6 CO2 molecules.
* The new carbon molecules have 6 carbons removed using energy found in ATP and NADPH forming glucose. The left-over molecules of ADP and NADP+ are recycled and restored of their energy by entering the LDR again.