## PARTS INVOLVED:

- **Light-Dependent Reactions**:
  1. **Photosystems** - clusters of light-absorbing *chlorophyll* molecules found embedded in the thylakoid membrane inside the chloroplast; there are two kinds of photosystems: Photosystem II and Photosystem I; two photosystems are needed to absorb enough light energy to make the two products of the Light-Dependent Reactions.
  2. **Electron Transport Chain** – a series of protein molecules found embedded in the thylakoid membrane that receive *energized electrons* that shoot out of the photosystems and pass them along through the chain.
  3. **Protein Pumps** – the same proteins in the electron transport chain will use the energy of the moving electrons to pump \( H^+ \) ions from the stroma to the space inside of the thylakoids, creating a high concentration gradient there.
  4. **ATP Synthase** – an enzyme that uses the kinetic energy of moving \( H^+ \) ions (that return through a channel in the thylakoid membrane back to the stroma) to connect ADP with P to form the energy molecule: ATP for use in the Calvin Cycle.
  5. **NADP** – a shuttle molecule that collects \( H^+ \) ions and electrons from the transport chain (to become NADPH) and moves them into the *stroma* for use in the Calvin Cycle.

- **Light-Independent Reactions/ called Calvin Cycle**:
  1. Organic (carbon-based) molecules in the *stroma*, starting with RUBP.

## ENERGY SOURCE TO RUN THESE REACTIONS:

- **Light-Dependent Reactions**: Sunlight must be present to for these reactions to take place; this explains the name “Light-Dependent Reactions” and why they will only occur during the daytime.
- **Light-Independent Reactions**: ATP made during the Light-Dependent Reactions is the energy source that must be present for these reactions to take place; each time a phosphate group breaks off the ATP (turning it into ADP) a burst of energy is made available to power chemical changes in the Calvin Cycle.

## RAW MATERIALS NEEDED:

- **Light-Dependent Reactions**: Water molecules are split by solar energy into 3 things: a) a supply of replacement electrons for Photosystem II, b) \( H^+ \) ions to build up a high concentration, and c) Oxygen gas as a leftover; water is delivered to the leaf through the veins of the plant.
- **Light-Independent Reactions**: Carbon Dioxide gas – the required chemical for these reactions; it must be attached to 5-carbon RUBP to begin a process that will make glucose (a 6-carbon sugar); enters through a *stoma* (leaf opening).

## LOCATIONS FOR THESE REACTIONS:

- **Light-Dependent Reactions**: On the thylakoid membranes of every granum.
- **Light-Independent Reactions**: In the liquid *stroma* (surrounding the grana)

## PRODUCTS FORMED: (both to be used in the Light-Independent Reactions)

- **Light-Dependent Reactions**: ATP – formed with the help of the enzyme ATP Synthase
- **Light-Independent Reactions**: Glucose sugar, or other sugars, or plant starch (food molecules)
- **Light-Independent Reactions**: Cellulose (building material to create new cell walls)