Honors Biology Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
NDHS Per: \_\_\_\_\_\_\_\_\_ Date: \_\_\_\_\_\_\_\_\_\_\_\_\_

**Photosynthesis**

Meaning:
 Synth = **to put together**
 Photo = **light**

 **To put together using light**

Importance:

 **Producers** (organisms that make their own food) **fix (trap) light energy** into **biological molecules** for themselves and **consumers** (organisms that eat other things).

 **Basis of all energy for all organisms**

**Equation**:

**6 H2O + 6 CO2 🡪 6 O2 + C6H12O6**

Location: in the cells of producers
 Ex: **Plants, Algae, Cyanobacteria (blue green algae)**

In plants and algae photosynthesis occurs in the **chloroplast**.

**Chloroplast Structure:**



**Process of Photosynthesis**

Two Main Steps:

1. **Light Dependent Reaction (Light Reaction)**: Light is used to **break water into hydrogen, oxygen, and energized electrons. Energized electrons are used to make ATP and NADPH.**

Occurs in the **Thylakoid**

1. **Light Independent Reaction (Dark Reaction)**: Energy in ATP and NADPH are used to **FIX carbon into glucose** Occurs in the **Stroma**

**Light Dependent Reaction:**

Occurs in the Thylakoid of the Chloroplast

Structure of the Thylakoid:

Thylakoid Membrane and Thylakoid space

Thylakoid Membrane Contents:

1. **Pigments** for **absorbing** light energy

Primary Pigment: **Chlorophyll**

* Two forms: Chlorophyll a and Chlorophyll b – slight different in molecular structure – allows them to absorb **different colors** of light
- Chlorophyll absorbs **red and blue light the best**

Secondary Pigments: in a lesser abundance in the thylakoid so not as apparent
- **help absorb different colors of light**
- **Caratenoids and Xanthophylls** – yellow and orange pigments

All the pigments make up an **antenna complex** called a **PHOTOSYSTEM** that **gathers light and focuses** it into one area.

1. **Electron Transport Chain**
- series of **proteins** that **move electrons from the photosystem through transmembranal proteins to NADP+**
2. **Transmembranal Proteins**: use the energy from electrons to **actively transport hydrogen ions** from the **stroma into the thylakoid**
3. **NADP+ Reductase**: an enzyme that puts electrons, hydrogen ions, and NADP+ together to **make NADPH**.
4. **ATP Synthase**: An enzyme that makes **ATP**

**NADP+/NADPH:**

Nicotinamide Adenine Dinucleotide Phosphate – is a **Hydrogen Acceptor**

This is a **temporary energy storage molecule** that **carries energized electrons and Hydrogens to other reactions**



**ATP is Adenosine Triphosphate**



ATP **stores energy for cellular work** in the Phosphate bonds when a phosphate is bound to ADP (adenosine diphosphate)



**Steps of the Light Dependent Reaction**1) In the thylakoid space, **water is split into hydrogen ions, electrons, and oxygen**.
 Oxygen diffuses out of the chloroplast and out of the leaf through the **stomata**

2) The **photosystem gathers light energy and it energizes the electron**

3) The electron passes through the **electron transport chain** and gives energy for the transmembranal proteins to **pump hydrogen ions** from the **stroma into the thylakoid space**

4) The electrons are **reenergized** at a **second** photosystem and then pass to **NADP+ reductase** where they join a hydrogen ion and NADP+ to make **NADPH**

5) The hydrogen ions that have been pumped into the thylakoid space have bu**ilt a chemical gradient that pass through ATP Synthase (facilitated diffusion) to make ATP.**

The ATP and NADPH are then used in the Light Independent Reaction



**Light Independent Reaction**

Occurs in the **stroma** of the chloroplast

Called the “**Dark**” reaction because it **does not need light**, but can occur in the light.

Also known as the **Calvin Cycle**

**Requires:
Carbon Dioxide
Energy from ATP
Hydrogens and Electrons from NADPH
Rubisco: Carbon fixing enzyme**

**Process of Light Independent Reaction**

**Rubisco binds three carbon dioxide molecules together using the energy of ATP** **and adds hydrogens and electrons from NADPH.**

This occurs **twice** forming **two molecules** with three carbons each. These are then joined to make **glucose.**



**Summary**:

6 H2O + 6 CO2 🡪 6 O2 + C6H12O6

Dark Reaction

Stroma

Dark Reaction

Stroma

Light Reaction

Thylakoid

Light Reaction

Thylakoid