Cosmo School

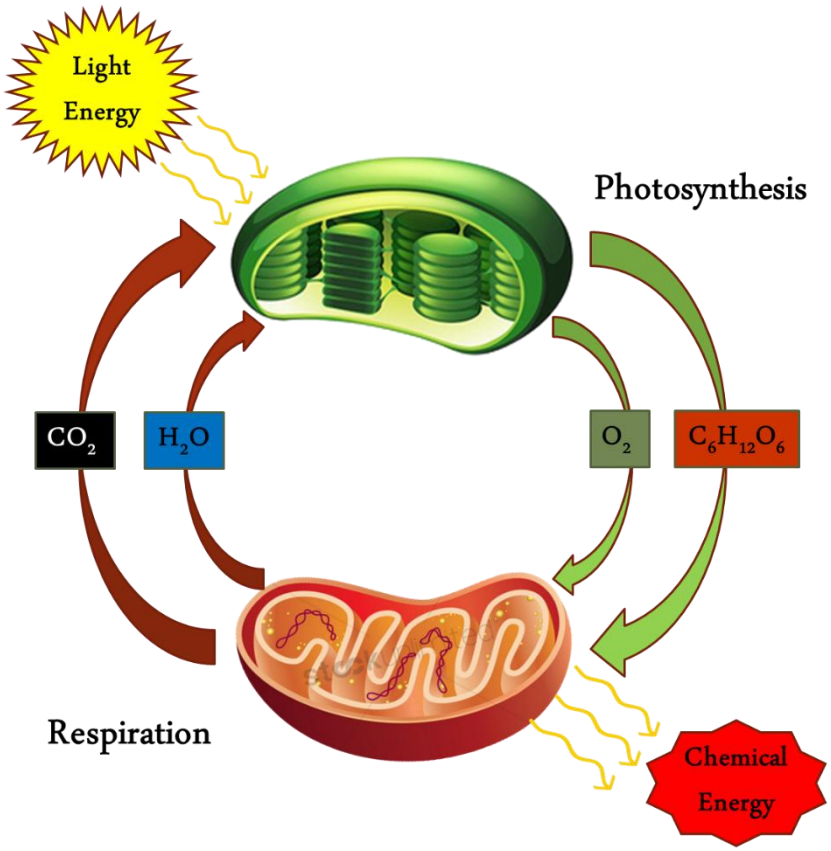
Work Sheet: 01

Biology (Chapter-4: Bioenergetics)

Class: IX

Name of the student: .....***Date:*** ...../...../.....

- **Bioenergetics** is the part of biochemistry concerned with the energy involved in making and breaking of chemical bonds in the molecules found in biological organisms.



- The energy that is involved in making and breaking of chemical bonds in the molecules found in biological organisms is called .....

- **Adenine** is a molecule made of carbon, nitrogen, and hydrogen atoms. Its chemical formula is $C_5H_5N_5$. It is found in **DNA** and **RNA.**

- Adenine ($C_5H_5N_5$) + Ribose sugar ($C_5H_{10}O_5$) ⟶ **Adenosine** ($C_{10}H_{13}N_5O_4$)

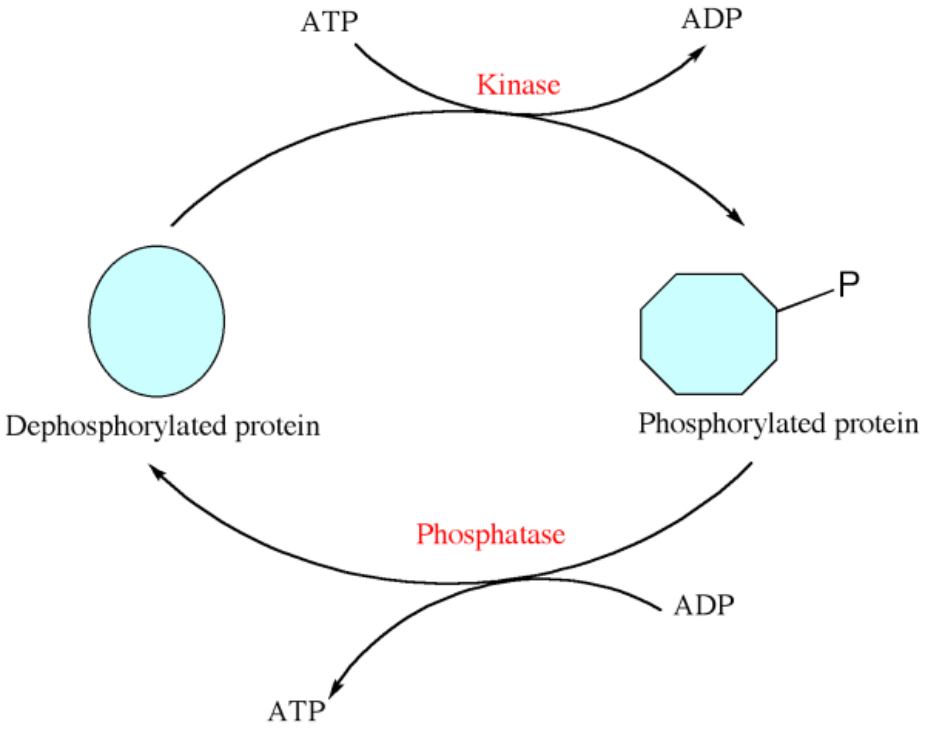
  - Adenosine ($C_{10}H_{13}N_5O_4$) + Monophosphate ⟶ Adenosine Monophosphate ($C_{10}H_{14}N_5O_7P$) or **AMP**

  - Adenosine ($C_{10}H_{13}N_5O_4$) + Diphosphate ⟶ Adenosine Diphosphate ($C_{10}H_{15}N_5O_{10}P_2$) or **ADP**

- Adenosine ($C_{10}H_{13}N_5O_4$) + Triphosphate ⟶ Adenosine Triphosphate ($C_{10}H_{16}N_5O_{13}P_3$) or **ATP**

➢ **Phosphorylation** is the addition of a phosphate (PO_4^{3-}) group to an organic compound in the presence of **Phosphatase** enzyme

➢ **Dephosphorylation** is the removal of a phosphate (PO_4^{3-}) group from an organic compound by hydrolysis in the presence of **Kinase** enzyme.



Q. Write three differences between **Phosphorylation** and **Dephosphorylation**.

Phosphorylation	Dephosphorylation

➢ **Oxidative phosphorylation** is the metabolic pathway in which cells use enzymes to oxidize nutrients, thereby releasing the chemical energy of molecular oxygen, which is used to produce adenosine triphosphate. In most eukaryotes, this takes place inside **mitochondria**.

Energy-rich Compounds:

✓ ATP=Adenosine triphosphate (ATP stores energy & supplies energy)

✓ NAD=Nicotinamide adenine

✓ $NADP^+$=Nicotinamide adenine dinucleotide phosphate

✓ NADPH=The reduced form of $NADP^+$

✓ GTP=Guanosine triphosphate

✓ GDP=Guanosine diphosphate

✓ FAD=Flavin adenine dinucleotide

✓ CoA=Co enzyme A

Q. Why is ATP called energy coin or biological coin?

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➢ $6CO_2 + 6H_2O \xrightarrow[\text{Chlorophyll}]{\text{Light}} C_6H_{12}O_6 + 6O_2$

Q. What is **Photosynthesis**?

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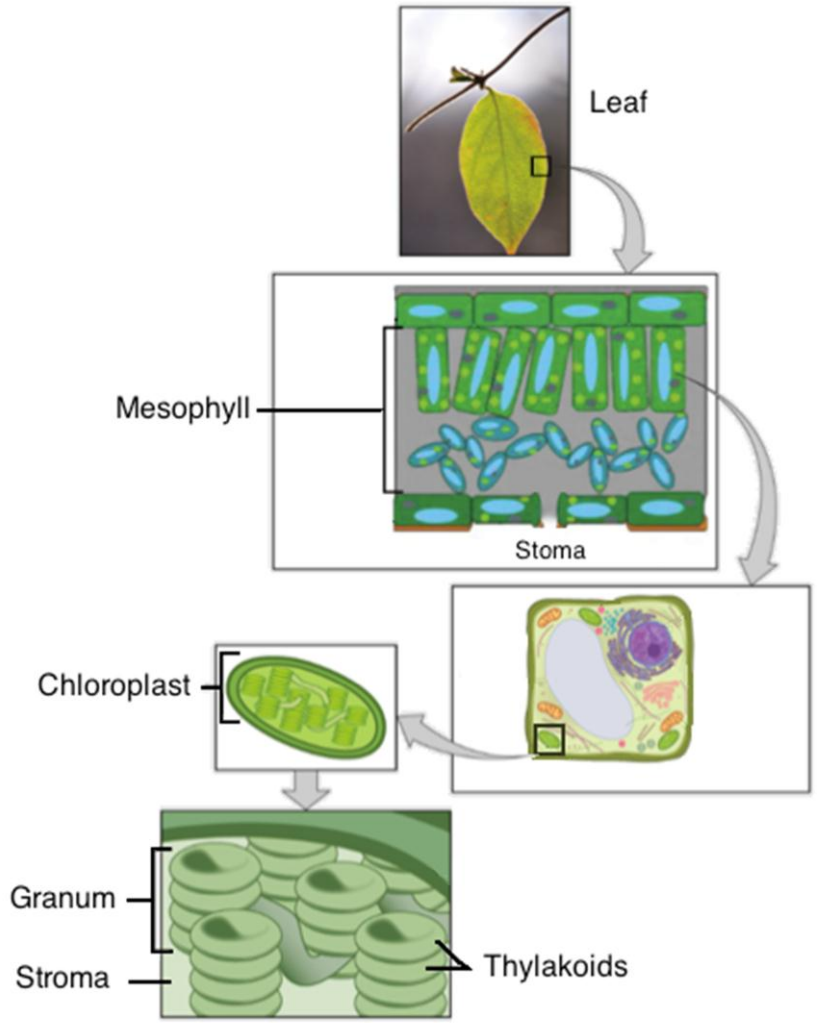
➢ **Photosynthesis** is a **redox** process where **oxidation** and **reduction** both occur. During **photosynthesis**, water is **oxidized** to **oxygen** which means it loses electrons, and carbon dioxide is **reduced** to **glucose**, meaning it gains electrons.

➢ $6CO_2 + 6H_2O \xrightarrow[\text{Chlorophyll}]{\text{Light}} C_6H_{12}O_6 + 6O_2$

a) Write Oxidation reaction: .....

b) Write Reduction reaction: .....

Leaves are sites of photosynthesis



The figure at the left—

Magnification 1:

The entire leaf that contains small pores named stomata that let CO_2 diffuse into and O_2 diffuse out

Magnification 2:

Mesophyll tissue within the leaf (Middle layer of a leaf)

Magnification 3:

A single mesophyll cell

Magnification 4:

A chloroplast within the mesophyll cell that absorbs light

Magnification 5:

Stacks of thylakoids—grana—and the stroma within a chloroplast

Q. Why do leaves act as the sites for photosynthesis?

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❖ Photosynthesis:

Photosynthesis in the leaves of plants involves many steps, but it can be divided into **two phases**: the **light-dependent phase** and **light-independent phase**.

1) Light dependent phase:

The **light-dependent reactions** take place in the thylakoid membrane and require a continuous supply of light energy. In light dependent phase—

- ✓ Chlorophylls absorb this light energy, which is converted into chemical energy through the formation of two compounds—
    1. ATP—an energy storage molecule and
    2. NADPH—a reduced (electron-bearing) electron carrier.
- ✓ In this process, water molecules are also converted to oxygen gas that we breathe.

Additional Information:

- ADP + Pi (Inorganic phosphate) $\xrightarrow[\text{Chlorophyll}]{\text{Light}}$ ATP
- $H_2O \xrightarrow{\text{Light}} 2H^+ + 2e^- + \frac{1}{2} O_2$
- $NADP^+ + e^- + H^+ \longrightarrow NADPH$

Q. What is photophosphorylation?

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2) Light independent phase:

The **light-independent reactions** also called **Calvin cycle** takes place in the stroma and does not directly require light. Instead, the Calvin cycle uses ATP and NADPH from the light-dependent reactions to fix carbon dioxide and produce three-carbon sugars—glyceraldehyde-3-phosphate, or G3P, molecules—which join up to form glucose.

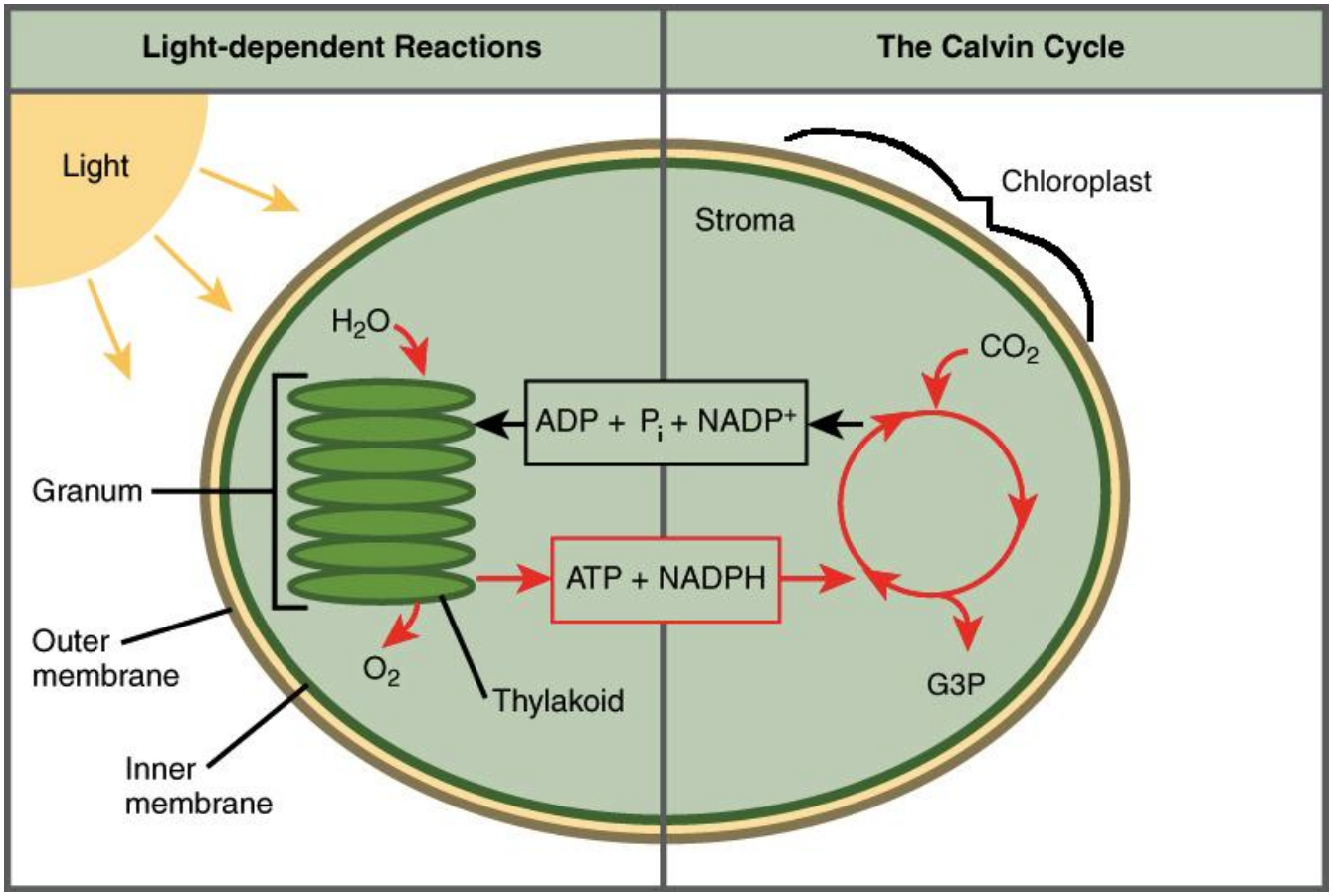
Additional Information:

Light-independent reactions or Calvin cycle reactions can be divided into three main stages:

1. **Carbon fixation.** A CO_2 molecule combines with a five-carbon acceptor molecule, ribulose-1, 5-bisphosphate (**RuBP**). This step makes a six-carbon compound that splits into two molecules of a three-carbon compound, 3-phosphoglyceric acid (3-PGA). This reaction is catalyzed by the enzyme RuBP carboxylase/oxygenase, or **rubisco**.

2. **Reduction.** In the second stage, ATP and NADPH are used to convert the 3-PGA molecules into molecules of a three-carbon sugar, glyceraldehyde-3-phosphate (**G3P**). This stage gets its name because NADPH donates electrons to, or **reduces**, a three-carbon intermediate to make G3P.

3. **Regeneration.** Some G3P molecules go to make glucose, while others must be recycled to regenerate the RuBP acceptor. Regeneration requires ATP and involves a complex network of reactions.



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Q. Write three differences between light-dependent phase and light-independent phase of photosynthesis.

Light-dependent phase	Light-independent phase

Carbon fixation:

Carbon fixation or **Carbon assimilation** is the conversion process of inorganic carbon (carbon dioxide) to organic compounds by living organisms. In photosynthesis, energy from sunlight drives the carbon fixation pathway.

C_3, **C_4** and **CAM** are the three different processes that plants use to fix carbon during the process of photosynthesis. Fixing carbon is the way, plants remove the carbon from atmospheric carbon dioxide and turn it into organic molecules like carbohydrates.

1. During the CO_2 fixation, when the photosynthetic plants produce 3-phosphoglyceric acid (PGA) or 3-carbon acid as the first product is called **C_3 pathway**.

2. When the photosynthetic plant, prior going to the C_3 pathway, produces oxaloacetic acid (OAA) or 4-carbon compound as their first stable product is called as **C_4** or **Hatch** and **Slack pathway**.

3. When the plants absorb the energy of the sunlight at the day time and use this energy for the assimilation or fixing the carbon dioxide at night time is called as **crassulacean acid metabolism** or **CAM**.