3) Regeneration of RuBP →

a) 2 molecules of fructose - 6 - phosphate and 2 molecules of 3-PGAL reacts in the presence of enzyme transketolase to form 2 molecules of erythose - 4 phosphate and 2 molecules of Xylulose - 5 - phosphate.

2 molecules of fructose - 6 - phosphate + 2 molecules of 3-PGAL —transketolase→ 2 molecules of erythose - 4 - phosphate + 2 molecules of Xylulose - 5 - phosphate

b) 2 molecules of erythose - 4 - phosphate combines with 2 molecules of 3 - PGAL in the presence of enzyme Aldolase to form 2 mol sedoheptalose - 1, 7 - diphosphate.

2 molecules of erythose - 4 - phosphate + 2 molecules of 3 - PGAL —Aldolase→ sedoheptulase - 1, 7 - disphosphate (2 mol).

c) 2 molecules of sedoheptulose - 7 - phosphate ~~in the~~ + converts into 2 molecules of sedoheptulose are - 7 - phosphate in the presence of enzyme of phosphatase.

2 molecules of sedoheptulose - 1 - 7 - diphosphate —phosphatase→ 2 molecules of sedoheptulase - 7 - phosphate.

d) 2 molecules of sedoheptulose-7-phosphate reacts with 2 molecules of DiHAP in the presence of enzyme transketolase to form 2 molecules of xylulose-5-phosphate and 2 molecules of Ribose-5-phosphate.

2 molecules of sedoheptulose-7-phosphate + 2 molecules of DiHAP $\xrightarrow{\text{transketolase}}$ 2 molecules of xylulose-5-phosphate + 2 molecules of Ribose-5 phosphate.

e) 3 molecules of fructose-1,6-diphosphate converts into 3 molecules of fructose-6-phosphate in the presence of enzyme phosphatase

3 molecules of fructose-1,6-diphosphate $\xrightarrow{\text{Phosphatase}}$ 3 molecules of fructose-6-phosphate.

f) 1 molecule of fructose-6-phosphate is isomerized into Glucose-6 phosphate in the ~~presence~~ presence of enzyme Isomerase.

Fructose-6-phosphate $\xrightarrow{\text{Isomerase}}$ Glucose-6-phosphate.

g) 1 molecule of Glucose-6-phosphate converts into Glucose in the presence of enzyme phosphatase.

Glucose-6-phosphate $\xrightarrow{\text{Phosphatase}}$ Glucose.

C_3 plants:-

C_3 plants are defined as the plants that exhibit the C_3 pathway. These plants use Calvin cycle in dark reaction of photosynthesis. The leaves of C_3 plants do not show Kranz anatomy. In these plants, the process takes place only when the stomata are open. C_3 plants examples are:- cereals, barley, oats, rice and wheat sunflower, etc.

C_4 plants:-

C_4 Plants are defined as the plants that use the C_4 pathway or Hatch-slack pathway during dark reaction of photosynthesis. The leaves posses Kranz anatomy. About 5% of plants on earth are C_4 plants. Examples of C_4 plants include sugarcane, sorghum, amaranth, pineapple, corn, etc.

Photorespiration

Photorespiration is defined as a process of taking oxygen in the presence of light and releasing CO_2. This process occurs in C_3 plants only. The cell organelles involved in the photorespiration are chloroplast, peroxisomes and mitochondria. Photorespiration occurs usually when there is a high concentration of oxygen, a high temperature, and a low CO_2 concentration. Due to this metabolic pathway, glycolate is synthesized in chloroplasts.

Importance

1) Photorespiration does not produce energy. Rather it consumes energy.
2) It ~~undergoes~~ undoes the work of photosynthesis. It may reduce photosynthesis up to 5%
3) It is a highly wasteful process.
4) It protects the plants from photo-oxidative damage by dissipating excess of excitation energy.

Factors affecting photosynthesis

External factors.

1) **Light:-**

It is an essential factor for the photosynthesis. Leaves absorb approximately 80% of total radiations falling on them. A very small fraction (0.5 to 3.5%) of light is utilized in the process of photosynthesis. The quality of light, intensity of light and the duration of light significantly affects the rate of photosynthesis.

i) **Quality of light:-**

Photosynthesis takes place only in the wavelength of visible spectrum (390-760 nm). The maximum absorption occurs in the blue and red regions of the spectrum.

ii) Intensity of light:-

Generally, the ~~light~~ rate of photosynthesis is greater in the intense light than in the diffused light. However the effect of light depends upon the photophilous or sciophilus nature of plants.

iii) Duration of light.

Even a brief flash of light is ~~occur~~ enough for the photosynthesis to occur, However, the rate of photosynthesis is greater in intermittent light than in the continuous light.

2) Carbon dioxide:

CO_2 concentration has a very marked influence on the rate of photosynthesis. In the nature, CO_2 constitutes about 0.03 %. (300 ppm). This level of CO_2 is far below the requirement for optimum photosynthesis. Thus, the rate of photosynthesis could be increased several times by increasing the CO_2 concentration.

3) Temperature:

In general, temperature in the range of 10-35°c is optimum for the photosynthesis. A/c to Vant Hoff's laws, the rate ~~of~~ increases with the increase in tempr within this range. High temperatures normally affects the activity of enzymes

4) Water:-

It is essential factor and a raw material for photosynthesis. The photosynthetic process utilizes less than 1% of the water absorbed by a plant; hence it rarely acts as a limiting factor for photosynthesis.

5) Oxygen:-

An increase in the oxygen concentration at many plants (C_3 plants) results in a decrease in the rate of photosynthesis. The phenomenon of the inhibition of photosynthesis by oxygen is called warburg's effect (after the name of German biochemist warburg). This effect is not shown by plants like maize, sugarcane, sorghum, etc which are known as C_4 plants.

2) External factors:-

i) Chlorophyll content:

chlorophyll is the most essential for photosynthesis because it traps the light energy only by it. A small quantity of chlorophyll content is quite enough to maintain the large bulk of the reaching substances.

ii) Protoplasmic factors:-

Proper hydration of the protoplasm is essential for the photosynthesis. However isolated chloroplasts are also capable of carrying on photosynthesis under the suitable conditions.

Respiration in plants:

All the living organisms require a constant supply of energy to sustain their life. They obtain energy through the chemical reactions that release the internal potential energy stored in the chemical bonds of molecules through respiration. Therefore, respiration is defined as "the process of ~~oxyg~~ oxidation of organic substances in the living cells resulting in the formation of energy."

$$C_6H_{12}O_6 + 6O_2 \longrightarrow 6CO_2 + 6H_2O + 686K \text{ cal energy.}$$

In respiration, potential energy stored in the organic compounds such as carbohydrates, proteins fats, etc, in the living cells is liberated in the form of kinetic energy (ATP).

ATP - power supply of the cells.

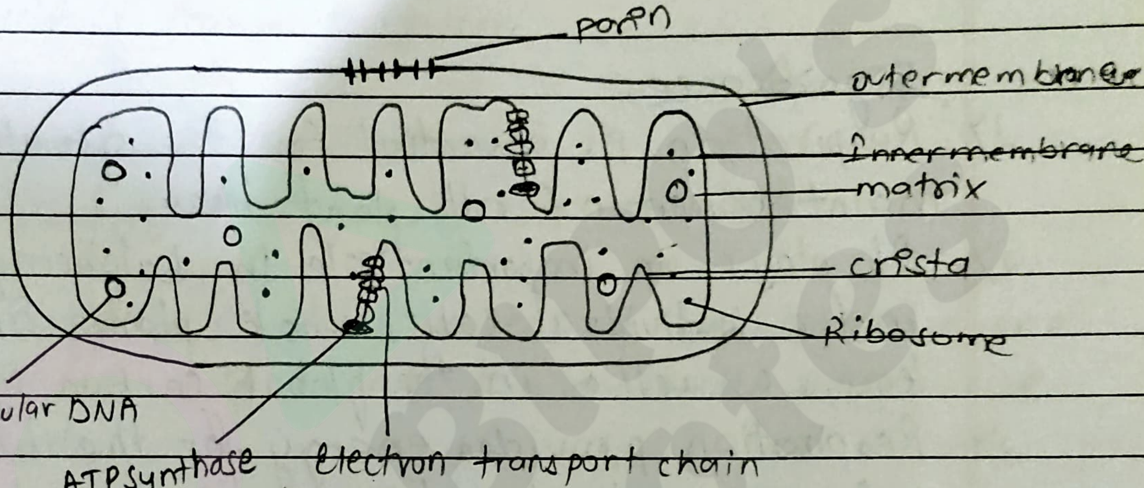
ATP stands for adenine triphosphate. ATP is a high-energy molecule or it contains a high energy phosphate bond. It is also called "Energy currency" in the organism. It consists of adenine (a nitrogenous base) with tree inorganic Phosphate (Pi) molecules.

Site of respiration.

Respiration process occurs inside the cells, hence called cellular respiration. Glycolysis is carried out in the cytoplasm of the cells whereas Kreb's cycle ~~or~~ in matrix of mitochondria.

Roles of mitochondria.

Mitochondria are present in all eukaryotic (plants, animals, fungi and protists). Internally, a mitochondrion has many projections called cristae which project into the fluid-filled matrix. The inner membrane of cristae contain numerous minute stalked structures called elementary particles which are meant for the production of energy rich ATP compounds.



Types of Respiration:-

There are 2 types of respiration. They are:-

1) **Aerobic Respiration:-**

It is the type of respiration in which the organic food in completely oxidized to form CO_2, H_2O and energy. It occurs in presence of O_2. Complete oxidation of one ~~molecule~~ glucose molecule can be represented by the following eqns:-

$$C_6H_{12}O_6 + 6O_2 \longrightarrow 6CO_2 + 6H_2O + 686 \text{ K cal energy}$$

2) Anaerobic respiration:-

It is the type of respiration without presence of oxygen. It involves incomplete oxidation of food which forms CO_2 and ethyl alcohol (C_2H_5OH) or lactic acid ($CH_3CHOH.COOH$). Due to incomplete oxidation of glucose molecule, it release much less energy in the anerobic respiration.

$$C_6H_{12}O_6 \longrightarrow 2C_2H_5OH + 2CO_2 + 50k\ cal\ energy$$

Significance.

1) Respiration is essential for the growth and maintenance of all plant tissues.
2) It plays an important role in balancing carbon in the individual cells, whole plants and ecosystems, as well as in the global carbon cycle.
3) Respiration provides energy for the biosynthesis of macromolecules like carbohydrates, lipids, proteins, etc that are required by the cells.
4) Respiration is important for the growth of plants.

Mechanism of Respiration.

The chemical events that take place durin respiration and liberation of energy are collectively described as the metabolic pathway or respiratory cycle. The process of aerobic respiration involve four steps:-

A) Glycolysis
B) Oxidative decarboxylation of pyruvic acid
C) Kreb's cycle.
D) Electron's transport system

A) Glycolysis (EMP-Pathway).

(glycol = sugar; lysis = to split).

Glycolysis is the process of breaking down one glucose molecule into two molecules of pyruvic acids.

Steps of glycolysis.

a) Energy spending phase.

Step 1 (First phosphorylation):-

In this step a phosphate group is added to glucose molecule in the cell cytoplasm by the action of enzyme hexokinase. In this a phosphate group is transferred from ATP to glucose forming glucose 6-phosphate.

$$\text{Glucose} + \text{ATP} \xrightarrow{\text{hexokinase}} \text{Glucose 6-phosphate} + \text{ADP}$$

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Step 2 (Isomerization):

Glucose 6-phosphate is isomerized into fructose 6-phosphate by the enzyme phosphohexo isomerase.

Glucose 6-phosphate $\xrightarrow{\text{Phosphohexo isomerase.}}$ fructose 6-phosphate

Step 3:- Second phosphorylation.

The other ATP molecule tranfer a phosphate group to fructose 6-phosphate and converts it into fructose 1,6-bisphosphate by the action of enzyme. Phosphofructokinase.

Fructose 6-phosphate + ATP $\xrightarrow{\text{phosphofructokinase}}$ fructose 1,6, bisphosphate + ADP.

Step 4:- Splitting:

The enzyme aldolase convertes fructose 1,6-biphosphate into 3-phosphoglyceraldehyde and dihydroxyacetone phosphate, which are the isomers of each other.

Fructose 1,6,-biphosphate $\xrightarrow{\text{aldolase}}$ 3-phosphoglyceraldehye + Dihydroxyacetone phosphate.

Step 5:- (Isomerization)

Triose-phosphate isomerase enzyme converts dihydroxyacetone phosphate into 3-phosphoglyceraldehyde which is the substrate in the succesive steps of glycolysis.

Dihydroxyacetone phosphate $\xrightarrow{\text{Triose-phosphate isomerase}}$ 3phosphoglyceraldehyde.

b) ~~Energy yielding phase~~:-

Step 6 (phosphorylation and dehydrogenation):-

This step undergoes two Rxn:-

-> The enzyme glyceraldehyde phosphate ~~dyo~~ dehydrogenase transfers one hydrogen molecule from glyceraldehyde phosphate to NAD to form $NADH + H^+$.

-> ~~P~~ Glyceraldehyde phosphate dehydrogenase adds a phosphate to the oxidized glyceraldehyde phosphate to form 1, 3- diphosphoglyceral acid.

Glyceraldehyde + NAD $\xrightarrow{\text{glyceraldehyde Phosphate dehydrogenase}}$ 1,3-diphosphoglyceric acid, $2NADH + 2H^+$.

Step 7:- (Formation of ATP):-

A phosphate is transferred from 1,3 diphosphoglyceric acid to ADP to form ATP with the help of phosphoglyceric kinase. Thus two molecules of 3-phosphoglyceric acid and ATP are formed.

1,3-diphosphoglyceric acid + ADP $\xrightarrow{\text{phosphoglyceric kinase}}$ 3-phosphoglyceric acid.

Step 8: Isomerization:-

3- phosphoglyceric acid is isomerized in the presence of enzyme phosphoglyceromutase, to give 2-phosphoglyceric acid.

3- phosphoglyceric acid $\xrightarrow{\text{Phosphoglycero mutase}}$ 2-phosphoglyceric acid

Step 9 :(Dehydration):

The enzyme enolase removes a water molecule from 2-phosphoglyceric acid to form 2-phosphophenol pyruvic acid.

2-phosphoglyceric acid $\xrightarrow{\text{enolase}}$ 2-phosphoenol pyruvic acid + H_2O.

Step 10: (Formation of ATP):

2 phosphoenol pyruvic acid is converted into 2-pyruvic acid + ATP in the presence of enzyme pyruvate kinase.

2-phosphoenol pyruvic acid + ADP $\xrightarrow{\text{pyruvate kinase}}$ 2-pyruvic acid + ATP

The whole event of glycolysis is summarised as follows:-

Glucose + 2ATP + 2NAD$^+$ + 2H_3PO_4 $\longrightarrow$ 2ATP + 2 NADH + 2H$^+$ + 2 pyruvic acid.

Kreb's cycle or citric acid cycle

The pyruvic acid, in the presence of molecular oxygen, is oxidized to acetyl-CoA, which then undergoes a series of changes reffered as kreb's cycle.

It involves the following steps:-

1) **Condensation:-**

Acetyl-CoA combines with oxaloacetic acid to form citric acid. It is the first stable product of Kreb cycle.

Acetyl-CoA + oxaloacetic acid + H_2O $\xrightarrow{\text{citrate synthetase}}$ citric acid + CoA

2) **Dehydration:-**

Citric acid losses one molecule of H_2O to change into cis-aconitic acid in presence of an aconitase enzyme.

citric acid $\xrightarrow{\text{aconitase}}$ cis-aconitic acid + H_2O

3) **Hydration:-**

cis-aconitic acid reacts with one molecule of water to form iso-citric acid in presence of acotinase enzyme.

Cis-aconitic acid + H_2O $\xrightarrow{\text{acotinase}}$ Iso-citric acid

4) **Dehydrogenation:-**

In this rxn, Hydrogen is released, Hydrogen is accepted by NAD to form $NADH_2$.

Iso-citric acid + NAD^+ $\xrightarrow{\text{Isocitrate dehydrogenase}}$ Oxalosuccinic acid + NADH + H

5) **Decarboxylation:-**

Oxalosuccinic acid losses one molecule of CO_2 to form α-ketoglutaric acid in the presence of decarboxylase enzyme.

Oxalosuccinic acid $\xrightarrow{\text{decarboxylase}}$ α-ketoglutaric + CO_2

6) **Dehydrogentation and decarboxylation:-**

In this step, one molecule of NAD^+ is reduced to $NADH_2$.

α-ketoglutaric acid + CoA + NAD^+ $\xrightarrow[\text{dehydrogenase}]{\text{α-ketoglutaric acid}}$ Succinyl CoA + NADH + CO_2 + H^+

7) **Formation of ATP/GTP:-**

In this step, succinyl CoA reacts with water molecule to form succinic acid; CoA become free and one molecule of GDP (Guanosine diphosphate) is phosphorylated in presence of inorganic phosphate to form one molecule of GTP.

Succinyl CoA + H_2O + GDP + Ip $\xrightarrow{\text{Succinyl thiokinase}}$ Succinic acid + CoA + GTP.

8) Dehydrogenation:-

Succinic acid is oxidized to form fumaric acid in presence of succinic dehydrogenase. The Coenzyme FAD (Plavin Adenin Dinucleotide) is reduced to $FADH_2$.

Succinic acid + FAD $\xrightarrow{\text{succinic dehydrogenase}}$ Fumaric acid + $FADH_2$

9) Hydration:-

One molecule of water is added to fumaric acid in the presence of fumarase enzyme to form malic acid.

Fumaric acid + H_2O $\xrightarrow{\text{fumarase}}$ Maltic acid

10) Dehydrogenation:-

In the last step:-

Oxaloacetic acid is regenerated by oxidation of malic acid in the presence of malic dehydrogenase.

Malic acid + NAD + malic dehydrogenase, oxaloacetic acid + NADH + H^+

The whole event of Kreb's cycle is summarized as follows:-

Acetyl CoA + $8H_2O$ + 2FAD + 6NAD + 2 ADP/GDP + $2H_3PO_4$

$\longrightarrow$ $4CO_2$ + 2ATP + $2H_2O$ + $6NADH_2$ + $2FADH_2$ + $6H^+$

Amount of ATP yield during aerobic respiration.

steps	Production of ATP(A)	No. of reduced co-enzymes produced (B)	Yield of ATP from terminal oxidation of reduced co-enzyme (C)	Total (A+C)
Glycolysis	(4-2)=2	$2NADH_2$	2×3=6	2+6=8
oxidative de-carboxylation of pyruvic acid.	-	$2NADH_2$	2×3=6	6
Kreb'cycle	2	$6NADH_2$ $2FADH_2$	6×3=18 2×2=4	2+18+4 =24
Total	4	$10NADH_2$+ $2FADH_2$	(10*3)+(2*2) =34	38 ATP

Factors affecting respiration,

The rate of respiration is affected by the external and internal factors:

a) External factors.

1) Temperature:

It is an important facto. With a temp^n range of 10-30°C, the rate of respiration gets doubled for every 10°C rise. The optimum temperature for respiration is 30°C. Below 0°C, the rate of respiration is highly reduced, through though in few plants, respiration takes place even at -30°C.

2) Oxygen:-

In aerobic respiratio, oxygen is highly essential. With the increase of oxygen concentration, the rate of respiration increases, If the concentration of O_2 goes below 5% the process ~~fa~~ rapidly falls off

3) Light:-

The effect of light is only indirect; in bright sunlight, the respiratory activity is greater than in the subdued light.

4) Supply of water:-

The protoplasm saturated with water respires more vigorously than that in a desiccated condition, as in dry seeds. Thus, with the supply of water, the rate of respiration increases.

5) CO_2 Concentration:-

As a result of respiration, CO_2 is allowed to accumulate around the plant, which ~~sho~~ slows down respiration. If CO_2 is removed, respiration again goes on normal.

6) Chemical Inhibitors:-

Chemicals like cyanides, azides, carbon monoxide, iodoacetate, chloroform, ether, acetone, alkaloids, etc. even in a very small quantity increases the rate of respiration initially, If the concentration is increased, there is a fall in the rate of respiration.

Internal factors:-

1) **Concentration of respiratory substrate:-**

The rate of respiration depends on the presence of respiratory substrate. The rate of respiration increases with the increase in respiratory substrate if others factors are not limiting.

2) **Protoplasmic factors:-**

The rate of respiration depends on the quantity and quality of protoplasm of the cell. The younger cells which have more active protoplasm respire more rapidly than other cells. The rate of respiration is also affected by the qualities of the respiratory ~~system~~ enzymes present in the protoplasm.

3) **Age of plant:-**

The rate of respiration decreases with the age of the plant.

Differences betn photosynthesis and Respiration.

	Photosynthesis	Respiration.
1	It is a constructive (anabolic) process.	It is a destructive (catabolic) process.
2	In this process, CO_2 and H_2O are utilized to build up sugar with the storage of energy.	In this process, sugar is broken down into CO_2 and H_2O with the liberation of energy.
3	In photosynthesis, plant utilize CO_2 and give out O_2.	In respiration, plants utilize O_2 and give out CO_2
4	Photosynthesis is performed only by green plants (green cells).	Respiration is performed by all the living cells of a plant.
5	It takes place in the presence of sunlight.	It takes place all the time i.e, it is independent of light.
6	The sites of photosynthesis are chloroplasts.	The sites of respiration are cytoplasm and mitochondria.
7	ATP is generated as a result of photophosphorylation.	ATP is generated as a result of oxidative phosphorylation.
8	Light energy is converted into chemical energy and stored in the form of glucose.	Chemical energy is converted into heat and partly into useful energy for various activities.

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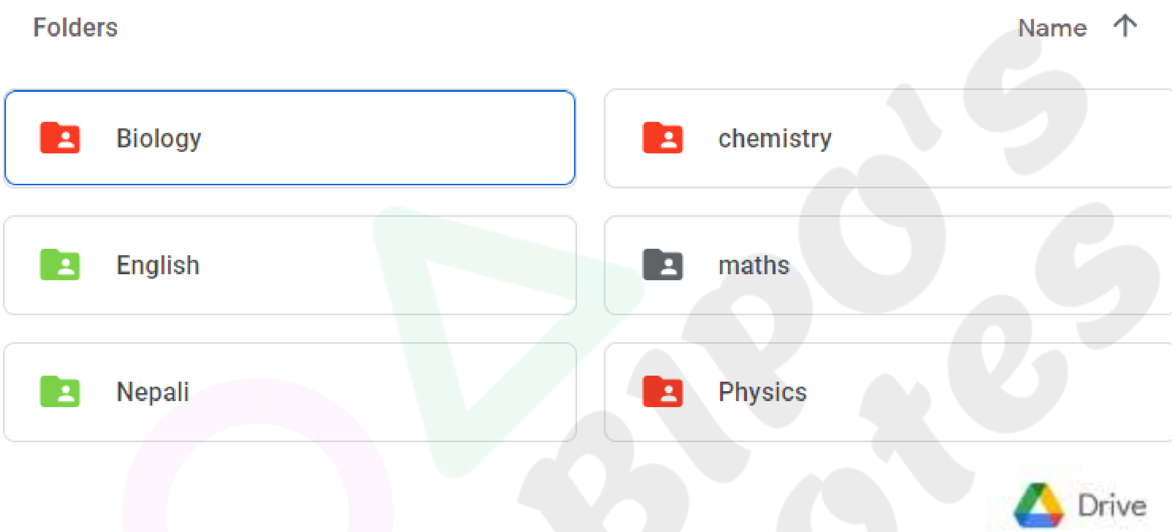
Class 12 complete notes and paper collection.



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