

Revision Notes on Respiration in Plants

Significance of respiration:

Respiration plays a significant role in the life of plants. The important ones are given below:

- (i) It releases energy, which is consumed in various metabolic processes necessary for life of plant.
- (ii) Energy produced can be regulated according to requirement of all activities.
- (iii) It converts insoluble foods into soluble form.
- (iv) Intermediate products of cell respiration can be used in different metabolic pathways

Differences between Photosynthesis and Respiration

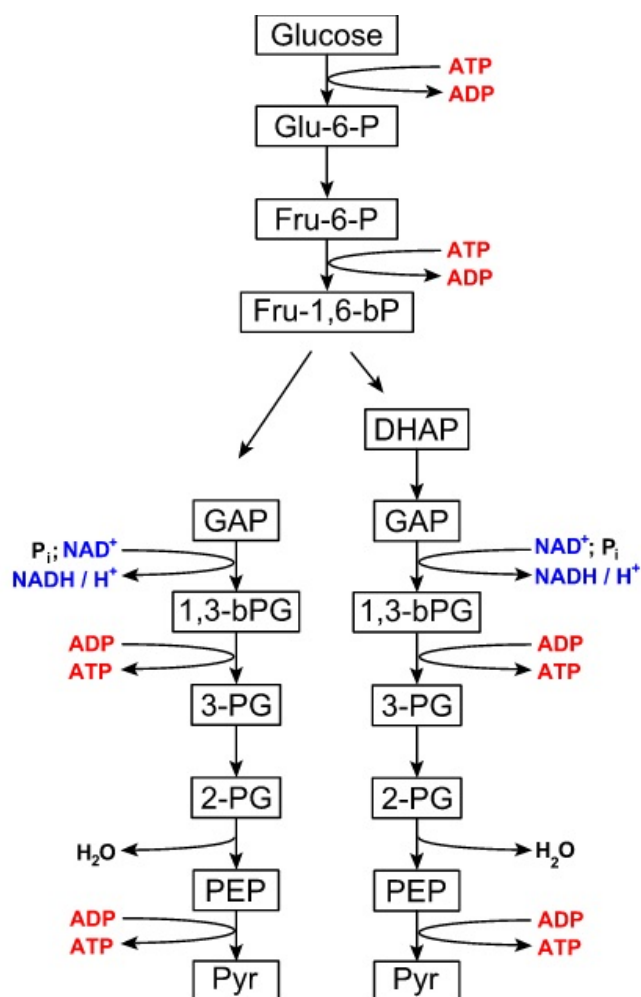
Photosynthesis	Respiration
Occurs only in chlorophyll containing cells of plants.	Occurs in all plant and animal cells.
Takes place only in the presence of light.	Takes place continually both in light and in the dark.
During photosynthesis, radiant energy is converted into potential energy.	During respiration, potential energy is converted into kinetic energy.
Sugars, water and oxygen are products.	CO_2 and H_2O are products.
Synthesizes foods.	Oxidizes foods.
CO_2 and H_2O are raw materials.	O_2 and food molecules are raw materials.
Photosynthesis is an endothermal process.	Respiration is an exothermal process.
Stores energy.	Releases energy.
It includes the process of hydrolysis, carboxylation etc.	It includes the process of the dehydrolysis, decarboxylation, etc.
Results in an increase in weight.	Results in a decrease in weight.
It is an anabolic process.	It is a catabolic process.
Require cytochrome.	Also require cytochrome.

Differences between cell respiration and combustion

S.No.	Characters	Cell respiration	Combustion
(i)	Nature of process	Biochemical and stepped process.	Physico-chemical and spontaneous process.
(ii)	Site of occurrence	Inside the cells.	Non-cellular.
(iii)	Control	Biological control.	Uncontrolled.
(iv)	Energy release	Energy released in steps.	Large amount of energy is released at a time.
(v)	Temperature	Remain within limits.	Rises very high.
(vi)	Light	No light is produced.	Light may be produced.
(vii)	Enzymes	Controlled by enzymes.	Not controlled by enzymes.
(viii)	Intermediates	A number of intermediates are	No intermediate is produced.

produced.

Glycolysis Cycle



Enzymes of glycolysis and their co-factors

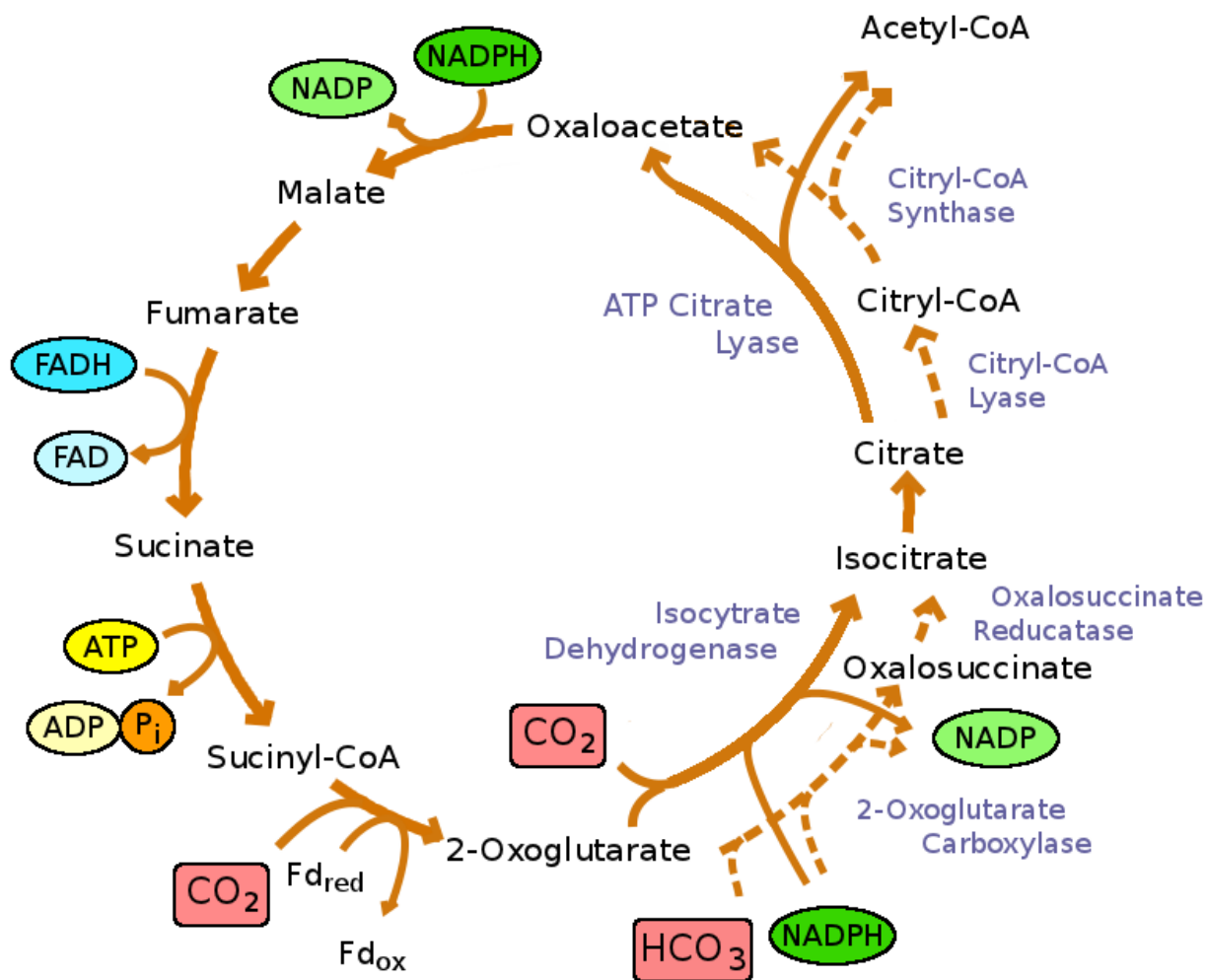
S. No.	Enzyme	Coenzyme (s) and cofactor	Activator (s)	Inhibitor (s)	Kind of reaction catalyzed
(i)	Hexokinase	Mg^{2+}	ATP^{4-} , P_i	Glucose 6-phosphate	Phosphoryl transfer
(ii)	Phosphogluco-isomerase	Mg^{2+}	-	2-dioxyglucose 6-phosphate	Isomerization
(iii)	Phosphofructo-kinase	Mg^{2+}	Fructose 2, 6-diphosphate, AMP, ADP, cAMP, K^+	ATP^{4-} , citrate	Phosphoryl transfer
(iv)	Aldolase	Zn^{2+} (in microbes)	-	Chelating agents	Aldol cleavage
(v)	Phosphotriose isomerase	Mg^{2+}	-	-	Isomerization
(vi)	Glyceraldehyde	NAD	-	Iodoacetate	Phosphorylation

	3-phosphate dehydrogenase				coupled to oxidation
(vii)	Phosphoglycerate kinase	Mg ²⁺	-	-	Phosphoryl transfer
(viii)	Phosphoglycerate mutase	Mg ²⁺ , 2,3-diphosphoglycerate	-	-	Phosphoryl shift
(ix)	Enolase	Mg ²⁺ , Mn ²⁺ , Zn ²⁺ , Cd ²⁺	-	Fluoride+phosphate	Dehydration
(x)	Pyruvate kinase	Mg ²⁺ , K ⁺	-	Acetyl CoA, analine, Ca ²⁺	Phosphoryl transfer

Total input and output materials in glycolysis

Total Inputs	Total Outputs
1 molecule of glucose (6 C)	2 molecules of pyruvate (2×3 C)
2 ATP	4 ATP
4 ADP	2 ADP
2 × NAD ⁺	2× NADH + 2H ⁺
2 Pi	2×H ₂ O

Kreb's Cycle



Enzymes of Kreb's cycle

Step	Enzyme	(Location in mitochondria)	Coenzyme(s) and cofactor (s)	Inhibitor(s)	Type of reaction catalyzed
(a)	Citrate synthetase	Matrix space	CoA	Monofluoro-acetyl-CoA	Condensation
(b)	Aconitase	Inner membrane	Fe^{2+}	Fluoroacetate	Isomerization
(c)	Isocitrate dehydrogenase	Matrix space	NAD^+ , NADP^+ , Mg^{2+} , Mn^{2+}	ATP	Oxidative decarboxylation
(d)	alpha-ketoglutarate dehydrogenase complex	Matrix space	TPP, LA, FAD, CoA, NAD^+	Arsenite, Succinyl-CoA, NADH	Oxidative decarboxylation
(e)	Succinyl-CoA synthetase	Matrix space	CoA	-	Substrate level phosphorylation
(f)	Succinate dehydrogenase	Inner membrane	FAD	Melonate, Oxaloacetate	Oxidation
(g)	Fumarase	Matrix space	None	-	Hydration
(h)	Malate dehydrogenase	Matrix space	NAD^+	NADH	Oxidation

Products formed during aerobic respiration by Glycolysis and Krebs's cycle

Total formation of ATP

ATP formation in Glycolysis				
	Steps	Product of reactions		In terms of ATP
ATP formation by substrate phosphorylation	1, 3-diphosphoglyceric acid (2 moles) ®			
	3 phosphoglyceric acid (2 moles)	2 ATP		2 ATP
	Phosphoenolpyruvic acid (2 moles) ®	2 ATP		2 ATP
	Pyruvic acid (2 moles)			
		Total		4 ATP
ATP formation by oxidative phosphorylation or ETC	1, 3 - disphosphoglyceraldehyde (2 moles)	2 NADH ₂		6 ATP
	1, 3 – diphosphoglyceric acid (2 moles)			
	Total ATP formed	4 + 6 ATP =		10 ATP
ATP consumed in Glycolysis	Glucose (1 mole) ® Glucose 6 phosphate (1 mole)	– 1 ATP		– 1 ATP
	Fructose 6 phosphate (1 mole) ®	– 1 ATP		– 1 ATP
	Fructose 1, 6- diphosphate (1 mole)			
		Total		2 ATP
	Net gain of ATP = total ATP formed – Total ATP consumed	10 ATP – 2ATP		8 ATP
ATP formation in Kreb’s cycle				
ATP formation by substrate phosphorylation	Succinyl CoA (2 mols) ®	2 GTP	2 ATP	
	Succinic acid (2 mols)			
		Total	2 ATP	
ATP formation by oxidative phosphorylation or ETC	Pyruvic acid (2 mols) ®			
	Acetyl CoA (2 mols)	2 NADH ₂	6 ATP	
	Isocitric acid (2 mols) ®			
	Oxalosuccinic acid (2 mols)	2 NADH ₂	6 ATP	
	a-Ketoglutaric acid (2 mols) ®	2 NADH ₂	6 ATP	
	Succinyl CoA (2 mols)			
	Succinic acid (2 mols) ®	2 FADH ₂	4 ATP	
	Fumaric acid (2 mols)			

	Malic acid (2 mols) ® Oxaloacetic acid (2 mols)	2 NADH ₂	6 ATP
		Total	28 ATP
	Net gain in Kreb's cycle (substrate phosphorylation + oxidative phosphorylation)	2ATP + 28 ATP	30 ATP
Net gain of ATP in glycolysis and Kreb's cycle	Net gain of ATP in glycolysis + Net gain of ATP in Kreb's cycle	8 ATP + 30 ATP	38 ATP
Over all ATP production by oxidative phosphorylation or ETC	ATP formed by oxidative phosphorylation in glycolysis + ATP formed by oxidative phosphorylation or ETC.	6 ATP + 28 ATP	34 ATP

Difference between Aerobic, Anaerobic Respiration and Fermentation

Aerobic Respiration	Anaerobic Respiration	Fermentation
<p>Molecular oxygen is the ultimate electron acceptor for biological oxidation. The ETS serves to transfer electrons from oxidisable donor to molecular oxygen. The early enzymatic steps involve dehydrogenation whereas the final steps are mediated by a group of enzyme called cytochromes. Ultimately the electrons are transferred to oxygen which is reduced to water. During aerobic respiration ATP is generated by coupled reaction</p>	<p>The ultimate electron acceptor is an inorganic compound other than oxygen. The compounds accepting the hydrogen (electrons) are nitrates, sulphates, carbonates or CO₂. Anaerobic respiration produces ATP through phosphorylation reaction involving electron transfer systems. (mechanism not known)</p>	<p>The final electron acceptors are organic compounds. Both electron donors (oxidizable substrate) and electron acceptors (oxidizing agent) are organic compounds and usually both substrates arise from same organic molecules during metabolism. Thus part of the nutrient molecule is oxidised and part reduced and the metabolism results in intramolecular electron rearrangement. ATP is generated by substrate level phosphorylation. This reaction differs from oxidative phosphorylation because oxygen itself is not required for ATP generation.</p>