Respiration

Definition:

From thermodynamic standpoint, respiration can be defined as a process in which energy is liberated

From physio-chemical standpoint, it is the oxidation of organic compounds with molecular oxygen serving as an ultimate electron acceptor

Summary:

$C_6H_{12}O_6+6O_2 \rightarrow 6CO_2+6H_2O+686Kcals$

Types of respiration:

1. Aerobic respiration: in which complete oxidation of respiratory substrate takes place in presence of oxygen resulting in the end product of carbon dioxide and water

2. Anaerobic respiration: in which incomplete oxidation of respiratory substrate takes place in the absence of external oxygen resulting in ethyl alcohol and carbon dioxide as end products

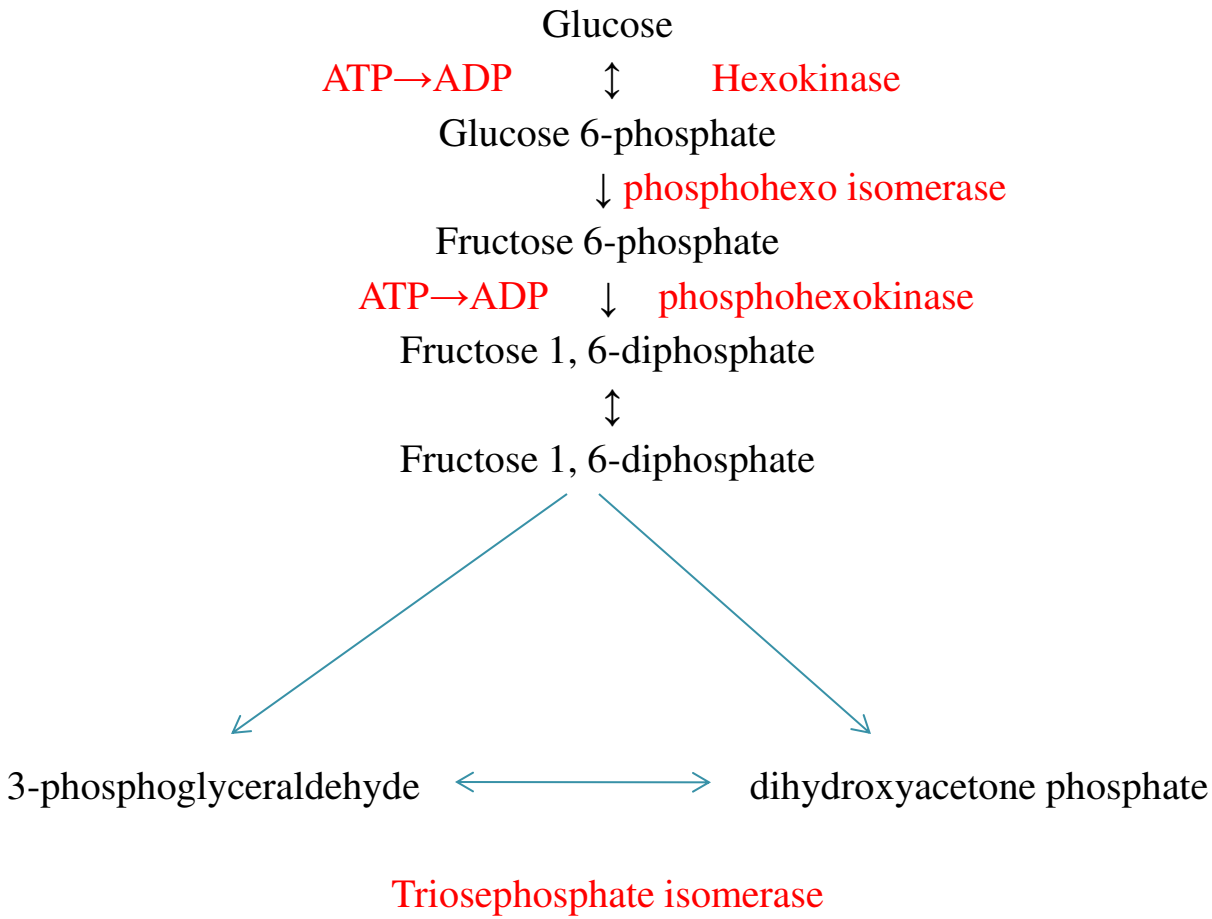
Significance:

- Respiration converts the stored potential energy into utilizable kinetic energy
- the carbon dioxide released in respiration maintain the balance of carbon cycle in nature

Respiratory Quotient (RQ)

It is the ratio of the volume of CO_2 evolved to the volume of O_2 taken simultaneously in the process

Glycolysis


Glucose
ATP→ADP
Hexokinase
Glucose 6-phosphate
phosphohexo isomerase
Fructose 6-phosphate
ATP→ADP
phosphohexokinase
Fructose 1, 6-diphosphate
Fructose 1, 6-diphosphate
3-phosphoglyceraldehyde
dihydroxyacetone phosphate
Triosephosphate isomerase

Glycolysis

Dihydroxyacetone phosphate

↕ triose phosphate isomerase

3-phosphoglyceraldehyde

NAD+--NADH+H ↓ triose phosphate dehydrogenase

1,3-diphosphoglyceric acid

ADP→ATP ↓ phosphoglycero kinase

3-phosphoglyceric acid

↕ phosphoglycero mutase

2-phosphoglyceric acid

Water ↓ Enolase

2-phosphoenol pyruvic acid

ADP→ATP ↓ phosphopyruvate kinase

Enolpyruvic acid

↕

Pyruvic acid

Glycolysis

Pyruvic Acid

↓ pyruvate decarboxylase

Thiamine pyrophosphate (TPP)

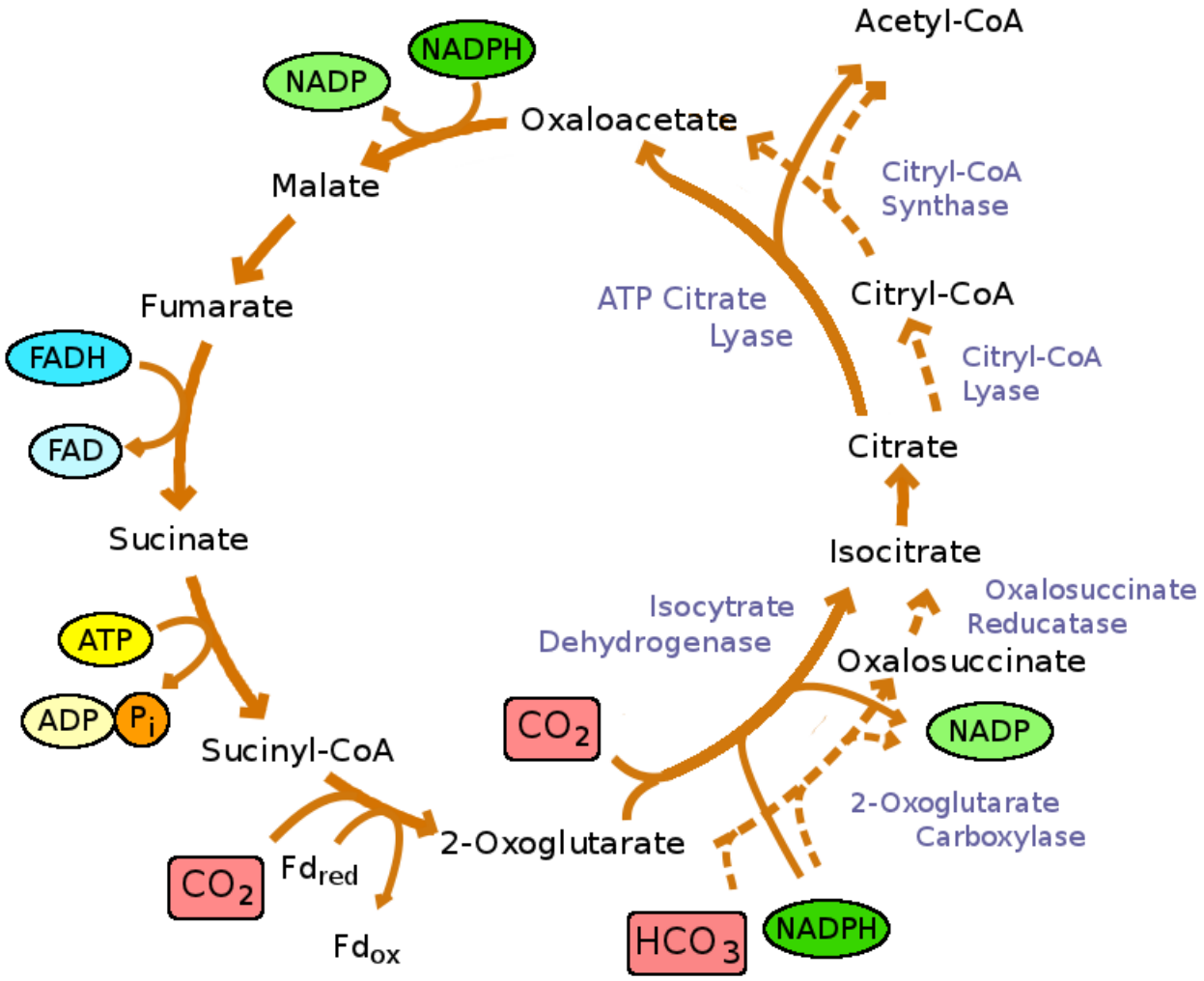
↓ lipoate acetyl transferase

Acetly hydrolipoate

↓ lipoate dehydrogenase

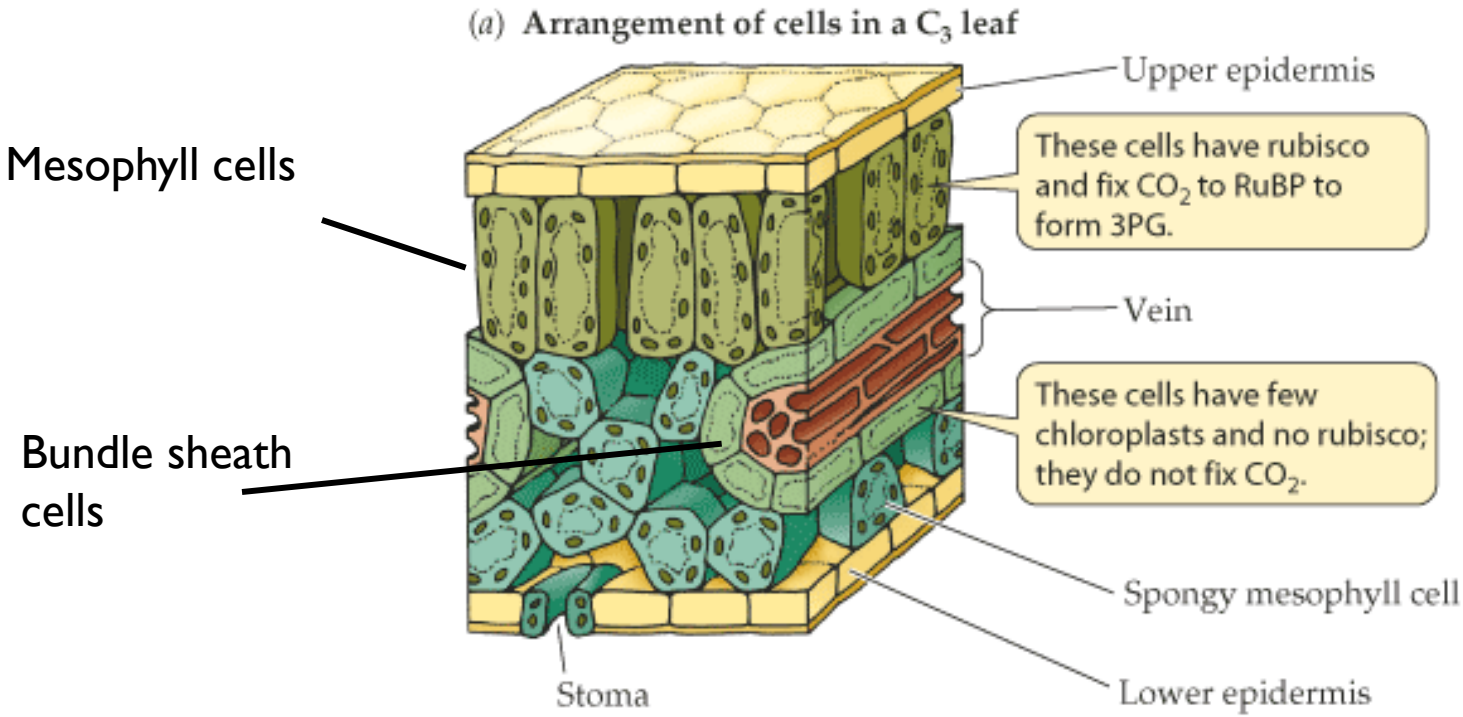
Acetyl Co-A

Krebs Cycle


Acetyl-CoA
NADPH
NADP
Oxaloacetate
Malate
Citryl-CoA Synthase
ATP Citrate Lyase
Citryl-CoA
Citryl-CoA Lyase
Fumarate
FADH
FAD
Citrate
Sucinate
Isocitrate
Isocytrate Dehydrogenase
Oxalosuccinate Reducatase
ATP
ADP
Pi
Oxalosuccinate
CO2
NADP
Sucinyl-CoA
2-Oxoglutarate Carboxylase
2-Oxoglutarate
CO2
Fdred
Fdox
HCO3
NADPH

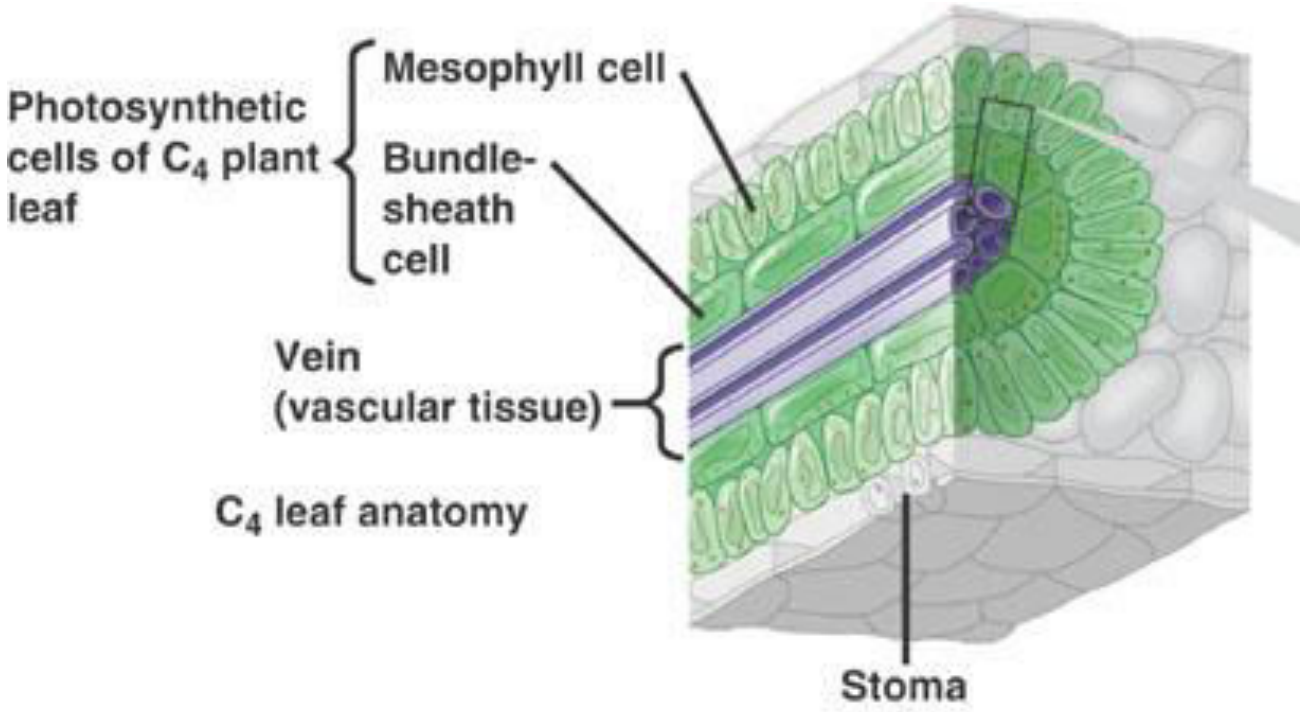
Leaf Anatomy

- In C3 plants (those that do C3 photosynthesis), all processes occur in the mesophyll cells.



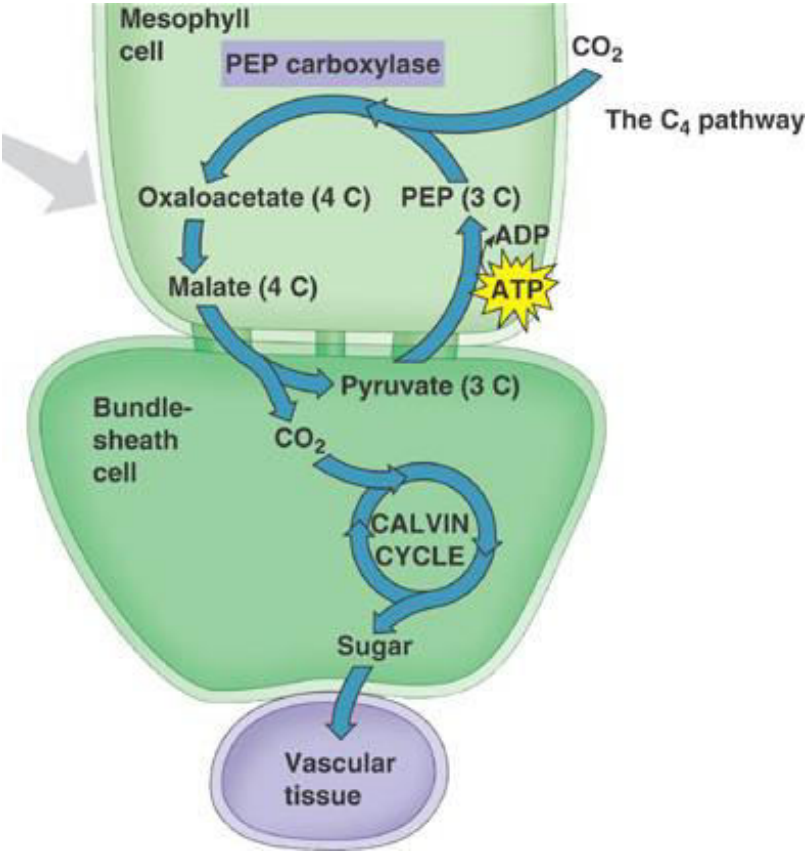
C4 Pathway

- In C4 plants photosynthesis occurs in both the mesophyll and the bundle sheath cells.



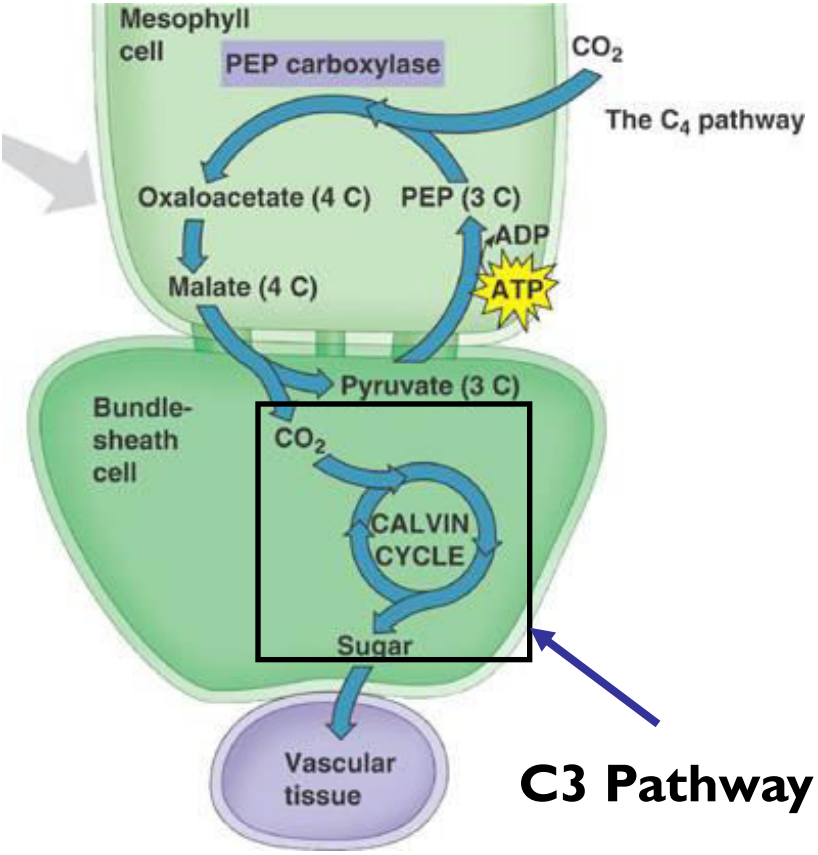
C4 Pathway

- CO_2 is fixed into a 4-carbon intermediate
- Has an extra enzyme– **PEP Carboxylase** that initially traps CO_2 instead of Rubisco– makes a 4 carbon intermediate



C4 Pathway

- The 4 carbon intermediate is "smuggled" into the bundle sheath cell
- The bundle sheath cell is not very permeable to CO_2
- CO_2 is released from the 4C malate → goes through the Calvin Cycle

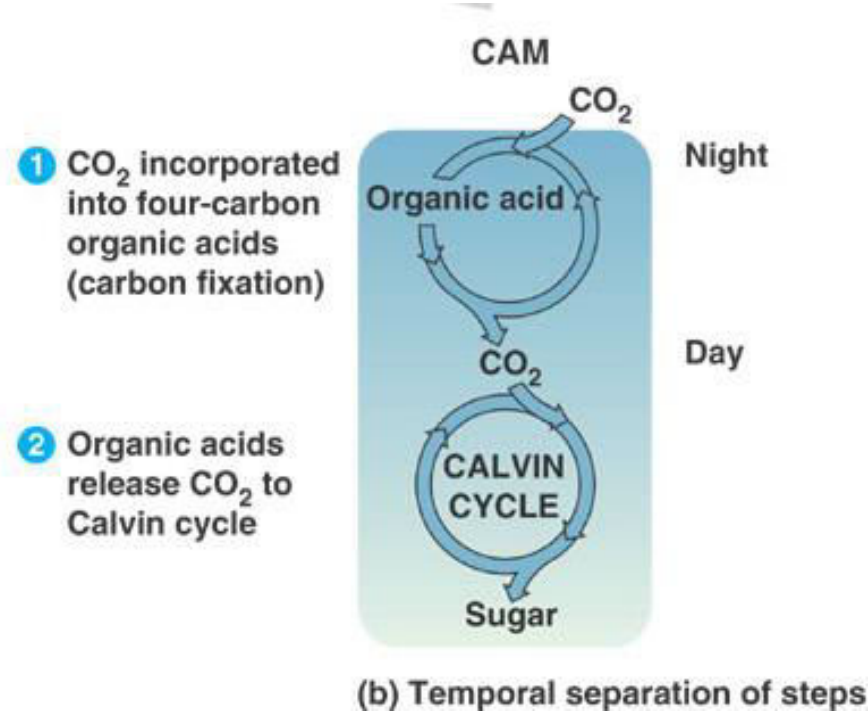


How does the C4 Pathway limit photorespiration?

- Bundle sheath cells are far from the surface– less O_2 access
- PEP Carboxylase doesn't have an affinity for O_2 → allows plant to collect a lot of CO_2 and concentrate it in the bundle sheath cells (where Rubisco is)

CAM Pathway

- Fix CO_2 at night and store as a 4 carbon molecule
- Keep stomates closed during day to prevent water loss
- Same general process as C4 Pathway



How does the CAM Pathway limit photorespiration?

- Collects CO_2 at night so that it can be more concentrated during the day
- Plant can still do the calvin cycle during the day without losing water

Summary of C4 Photosynthesis

- C4 Pathway
  - Separates by space (different locations)
- CAM Pathway
  - Separates reactions by time (night versus day)