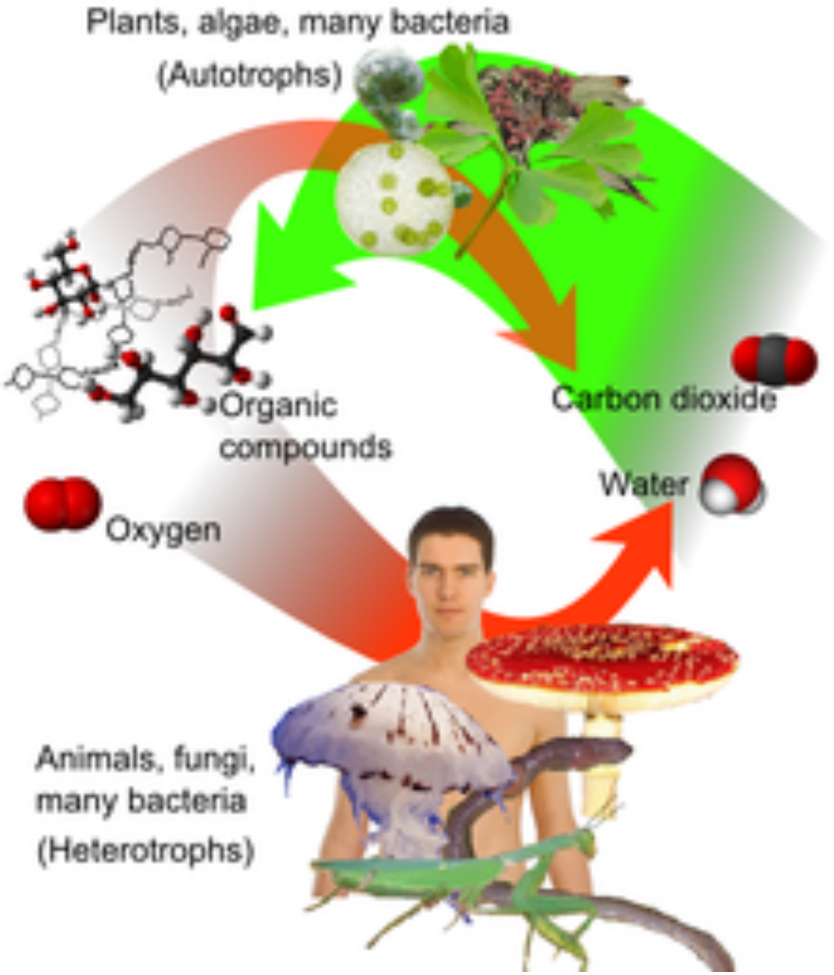
First: Calvin Cycle on Ted- Ed

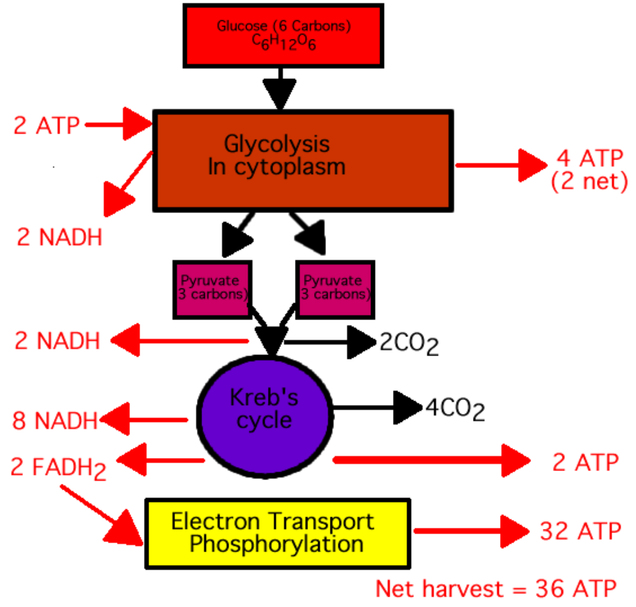
Cellular Respiration

- both plants and animals respire
- cells obtain their energy from the breakdown of carbohydrates, proteins and lipids
- these molecules are converted to glucose which is then broken down into CO_2 and H_2O
- $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$



- **process of respiration is not as simple as indicated by the above reaction**
  Amoeba Sisters Respiration

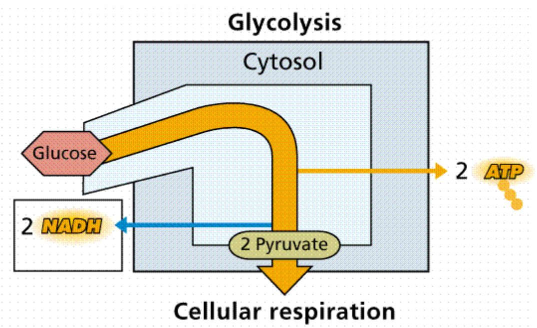
- **it requires 4 subpathways before CO_2 and H_2O are given off**



These subpathways are:

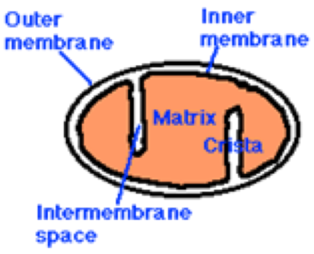
1. Glycolysis :the breakdown of glucose (6C) into 2 pyruvic acid molecules (2 - 3C) occurs in the cytoplasm end of the glycolysis process yields:

   1. 2 pyruvic acid (3C) molecules
   2. 4 ATP (a net of 2 ATP because 2 ATP was used to start the reaction)
   3. 2 NADH per glucose



2. Transition reaction

- pyruvic acid (3C) is changed to active acetate (2C) (same as acetyl CoA)
- loss of 1C per molecule of pyruvic acid

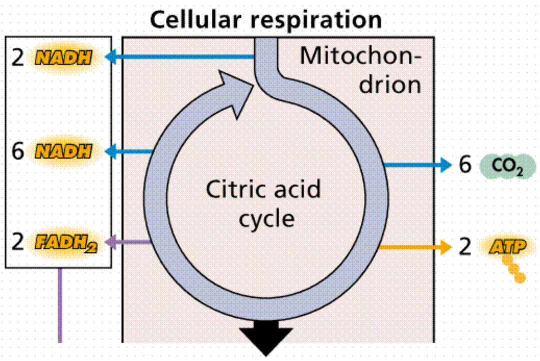


- occurs in mitochondrion
- end of the transition reaction yields:

1. 2C segment being passed to the Krebs
2. 1 NADH molecule per pyruvic acid
3. 1 CO_2

3. Krebs cycle

- oxidative decarboxylation takes place (H's and C's removed)
- cyclic; occurs over and over
- The end of Kreb Cycle yields:

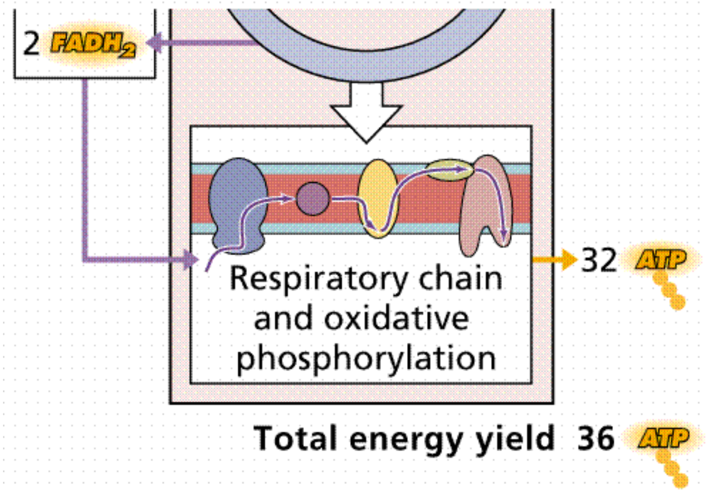


1. 1 Oxaloacetic Acid molecule (4C)
2. 1 ATP
3. 3 NADH
4. 1 $FADH_2$
5. 2 CO_2

4. Respiratory chain

H's (attached to NAD and FAD) are attached to O's to form H_2O

- **end of Electron Transport**
- **Phosphorylation yields:**
  1. **3 ATP per NADH**
  2. **2 ATP per $FADH_2$**
  3. **2 water molecules per NADH or $FADH_2$**



Summary

•energy produced from ONE glucose molecule

1. NADH

Subpathway	Per molecule	Total
Glycolysis	1 NADH/ Glyceraldehyde 3-Phosphate	**2** NADH
Transition Reaction	1 NADH/ pyruvic acid	**2** NADH
Kreb Cycle	3 NADH/ pyruvic acid	**6** NADH
Total		**10** NADH

2. FADH

Subpathway	Per molecule	Total
Kreb Cycle	1 $FADH_2$/ pyruvic acid	2 $FADH_2$
Total		2 $FADH_2$

3. ATP

Subpathway	Per molecule	Total
Glycolysis	2 ATP/ Glyceraldehyde 3-Phosphate	net of 2 ATP *used 2 ATP to start the reaction
Kreb Cycle	1 ATP/cycle	2 ATP
Electron Transport	3 ATP/NADH	30 ATP
Electron Transport	2 ATP/FADH	4 ATP
Total		38 ATP

Other Types of Metabolism

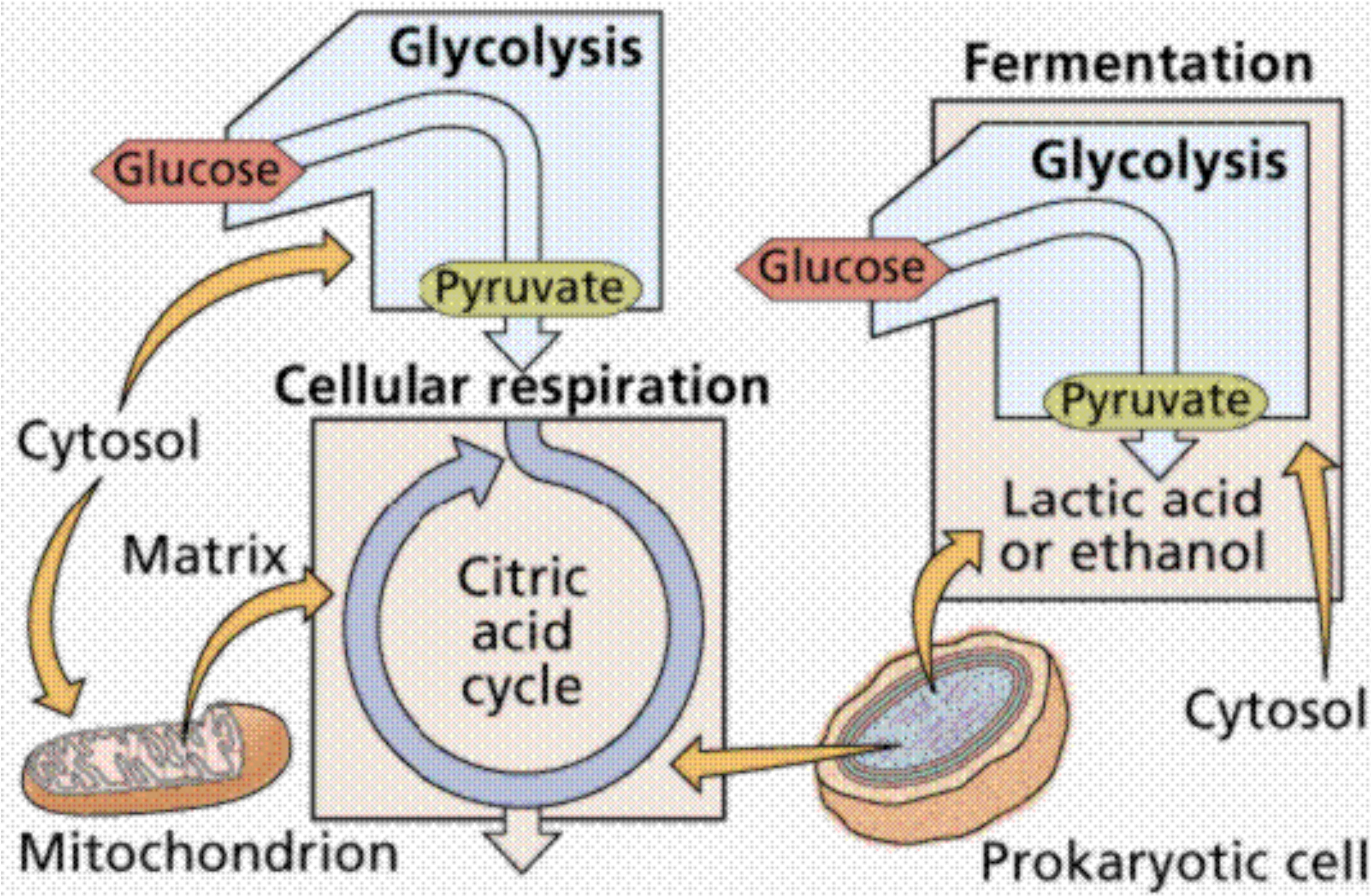
- carbohydrates (ie. glucose) are not the only products that can supply energy to the cell for storage as ATP

- proteins and lipids can also be broken down and supply energy to the cell

- fats are a much better supplier of energy than is glucose but glucose is the preferred energy source

Aerobic vs. Anerobic Respiration

- when oxygen is present (aerobic conditions), most organisms will undergo the Kreb's Cycle and Electron Transport Phosphorylation to produce ATP
- in eukaryotes, these processes occur in the mitochondria, while in prokaryotes they occur in the cytoplasm


Glycolysis
Glucose
Pyruvate
Cellular respiration
Cytosol
Matrix
Citric acid cycle
Mitochondrion
Fermentation
Glycolysis
Glucose
Pyruvate
Lactic acid or ethanol
Cytosol
Prokaryotic cell

- **under anaerobic conditions, the absence of oxygen, pyruvic acid can be routed by the organism into one of three pathways [Amoeba Sisters Fermentation]**

  1. **lactic acid fermentation**

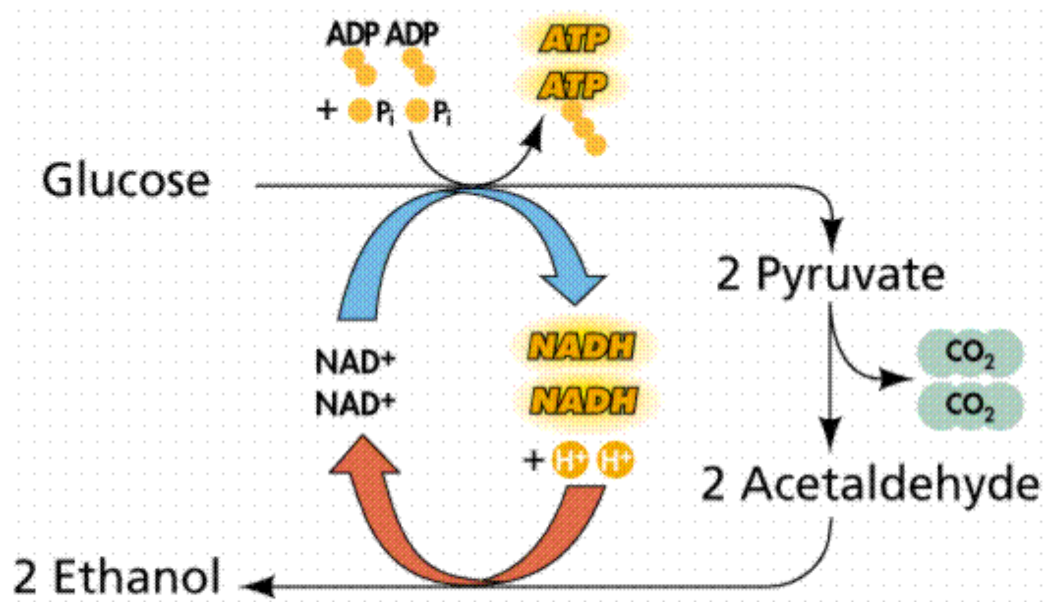
  2. **alcohol fermentation**

  3. **cellular (anaerobic) respiration**

- Humans cannot ferment alcohol in their own bodies, we lack the genetic information to do so.

- However, this is possible in something like yeast or anaerobic bacteria:

- these biochemical pathways, with their myriad reactions catalyzed by reaction-specific enzymes all under genetic control, are extremely complex.



- **alcohol fermentation is the formation of alcohol from sugar**
- **many organisms will also ferment pyruvic acid into other chemicals, such as lactic acid**
- **ex. Humans ferment lactic acid in muscles where oxygen becomes depleted, resulting in localized anaerobic conditions**
- **this lactic acid causes the muscle stiffness couch-potatoes feel after beginning exercise programs**

• the stiffness goes away after a few days since the cessation of strenuous activity allows aerobic conditions to return to the muscle, and the lactic acid can be converted into ATP via the normal aerobic respiration pathways