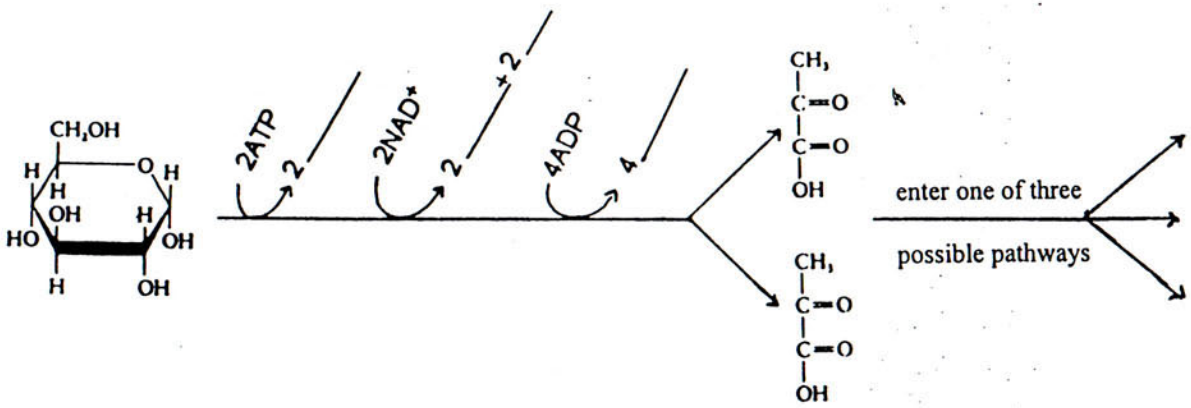
# Cellular Respiration

(production of ATP by the oxidation of food molecules)

<u>Glycolysis</u> (1st step of all respiratory pathways)

occurs in the _____ of the cell; has _____ steps catalyzed by _____ enzymes




_____

2_____

(each with much potential energy available in its bonds)

_____

(produces a lot of ATP in the absence of oxygen; similar to aerobic respiration but uses an inorganic molecule other than oxygen as a final electron acceptor; found in a few bacteria)

_____

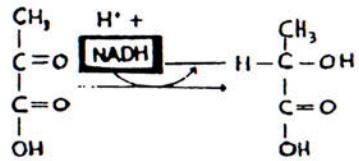
(produces a lot of ATP using oxygen as the final electron acceptor; main form of respiration in most organisms)

_____

(produces a very small amount of ATP in the absence of oxygen; uses an organic molecule as a final electron acceptor)

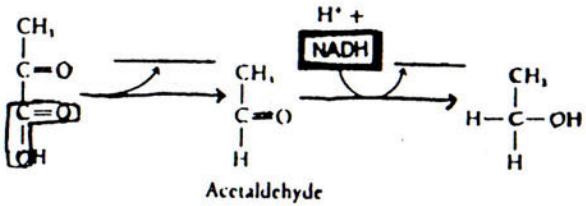
## Fermentation

**Lactic Acid Fermentation**
(skeletal muscle fibers, some bacteria)




_____ _____

**Alcohol Fermentation**
(yeast)




_____ _____

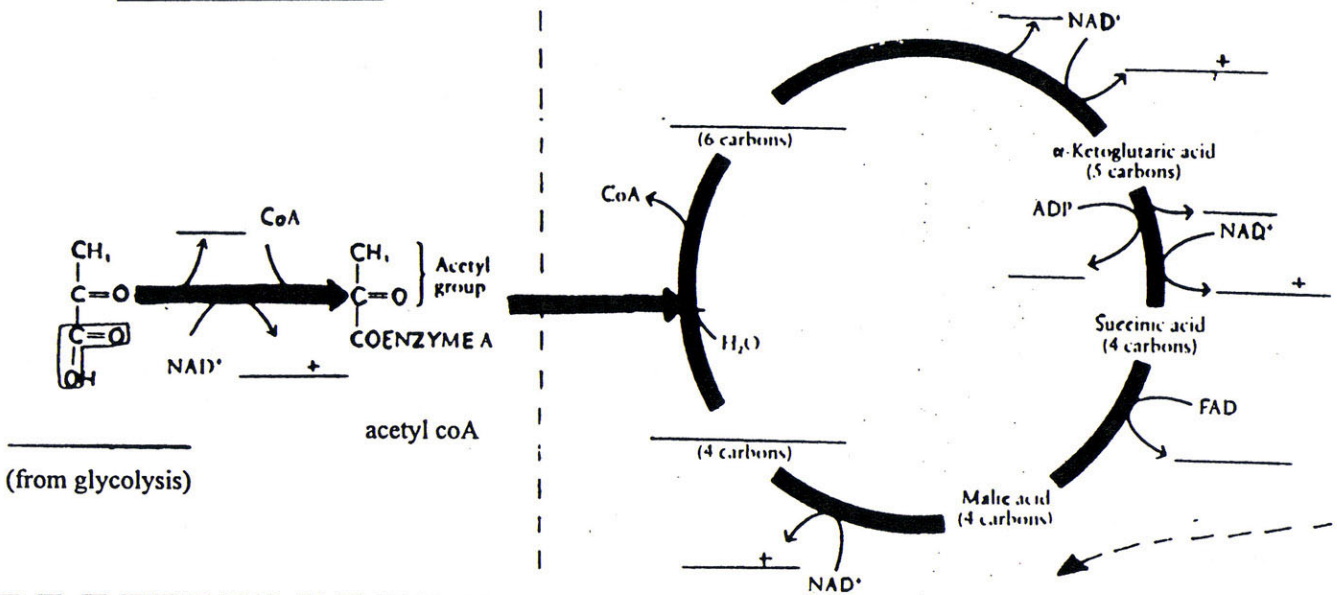
Fermentation occurs in normally aerobic organisms in the absence of _____. Without oxygen, the prep steps, citric acid cycle and electron transport chain cannot proceed. The purpose of fermentation is to regenerate the coenzyme _____ for use in glycolysis. (There is only a limited number of $NAD^+$ molecules that must be continually recycled in order for the oxidation of glucose to continue. Since fermentation pathways involve only glycolysis, they generate only _____ net ATP's per molecule of glucose.

## Aerobic respiration
(follows glycolysis in most cells)

NOTE: The prep steps and citric acid cycle occur twice for each original glucose because glucose produces two _____ molecules which are fed into the prep steps.

**"prep steps"**
(occur in the _____
of the _____)

**citric acid cycle (Krebs cycle)**
(occurs in the _____
of the _____)

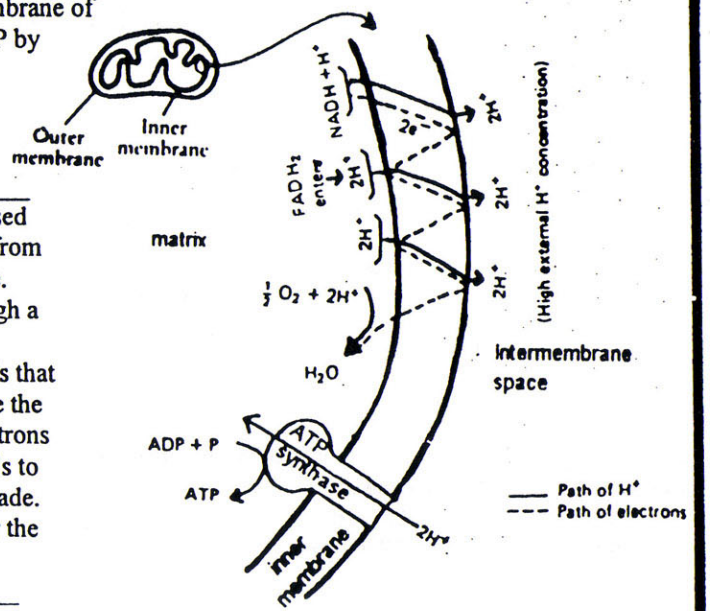



Record what is yielded by the prep steps and citric acid cycle. The left column shows the products for one pyruvic acid. Double these numbers to fill in the second column – the yield for a molecule of glucose.

| | |
|---|---|
| _____ATP (x2) = | _____ATP |
| _____NADH + $H^+$ (x2) = | _____NADH + $H^+$ |
| _____$FADH_2$ (x2) = | _____$FADH_2$ |

(NADH and $FADH_2$ carry high energy electrons along with $H^+$'s to the electron transport chain.)

## Electron transport chain
(occurs across the _____ membrane of a _____; produces ATP by chemiosmosis)




Energy from the flow of _____ down the electron transport chain is used to actively transport pairs of _____'s from the matrix to the intermembrane space. These flow back into the matrix through a channel associated with the enzyme _____. For each pair of $H^+$'s that flow through, the enzyme can catalyze the formation of one ATP. Since the electrons carried by NADH allow 3 pairs of $H^+$'s to be pumped, _____ ATP's can be made. The electrons carried by $FADH_2$ enter the chain later so only 2 pairs of $H^+$'s are pumped. These electrons allow _____ ATP's to be made.

**Summary of Maximum Energy Yield from the Oxidation of One Molecule of Glucose**

| | | | | | |
|---|---|---|---|---|---|
| **In the Cytoplasm** | | | | | |
| Glycolysis: | | __ATP | → | | __ATP |
| **In the Mitochondria** | | | | | |
| From glycolysis: | __NADH | → __ATP | → | | __ATP* |
| From respiration: | | | | | |
| Pyruvic acid → Acetyl CoA: | __NADH | → __ATP | (× 2) | → | __ATP |
| Krebs cycle: | | __ATP | | | |
| | __NADH | → __ATP | (× 2) | → | __ATP |
| | __$FADH_2$ | → __ATP | | | |
| **Total:** | | | | | __ATP |

* In some cells, the energy cost of transporting the electrons from the NADH molecules formed in glycolysis across the inner mitochondrial membrane lowers the net yield from these 2 NADH to 4 ATP; thus the total maximum yield in these cells is 36 ATP.