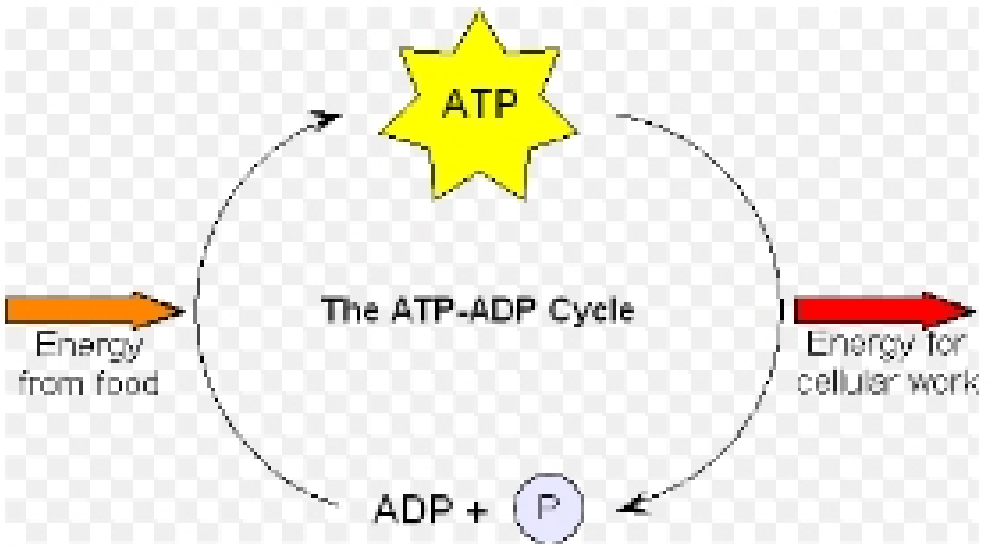
Notes
2/27/2014

Mitochondria:
-ATP producing powerhouse of cell
-Double-membrane system
-Carry out the most efficient energy-releasing reactions
-Reactions require oxygen, which is reduced to water
-Have own DNA-mutation (mt) diseases
-Have their own DNA, which is a circular molecule
-All mitochondrial DNA is inherited from the mother, and none is inherited from the dad
-Mitochondrial transplant to egg cell-three parent babies

Mitochondrial Structure:
-Outer membrane faces cytoplasm
-Inner membrane folds back on itself
-Membranes form two distinct compartments
-Most ATP-making machinery is embedded in the inner mitochondrial membrane
-Circular DNA- Some people may have a mixture of mutant and wilt-type (normal) mt DNA

ATP- Universal Energy Currency
-ATP is a nucleotide
-ATP is formed in reactions that yield energy, and spent in reaction that require it.
-To release energy, ATP is broken down (hydrolyzed) to ADP and phosphate



Cellular Respiration & NAD
-**Aerobic Respiration** requires oxygen, and **anaerobic** respiration does not require oxygen.
-In anaerobic respiration (fermentation):
-Glucose gets converted to **pyruvate,** which has three carbons. Called glycolysis, and produces a net of 2 ATPs.
-Pyruvate (3carbons) converted to lactic acid in muscles – is called **lactic acid fermentation** LA has 3 carbons
-In yeast, pyruvate converted to ethanol and carbon dioxide by yeast. Called **alcohol fermentation**. Alcohol has two carbons, and carbon dioxide has one carbon.
-Fermentation keeps glycolysis going in absence of oxygen.
-Fermentation is a metabolic dead end – it produces more NAD+ from NADH for respiration. **NAD+ is a coenzyme that is needed to keep glycolysis going in the cell.**

Overview of Aerobic Respiration

Glucose + Oxygen → Carbon Dioxide + Water + Energy

$$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O + \text{Energy}$$

Glycolysis
-Occurs in cytoplasm
-Reactions are catalyzed by ten enzymes

1 Glucose→ 2 Pyruvates
(6 carbons)→ (3 carbons)

Net Energy Yield- Glycolysis
Energy-requiring steps:
2 ATP invested
Energy-releasing steps:
2 NADH formed – used in stage 3 of respiration
4 ATP formed per glucose

Second Stage- Krebs Cycle
-Preparatory Stage
-**Pyruvate** is oxidized into two-carbon acetyl units and carbon dioxide
-NAD+ is reduced to NADH (used in stage three)
Krebs Cycle- 8 different enzymes
-Occurs in mitochondrial matrix.
-The acetyl units are oxidized to carbon dioxide.
-NAD+ and FAD are reduced-these are coenzymes
Aerobic Respiration
Glycolysis: Glucose produces two ATP molecules, and occurs in cytoplasm. Makes pyruvate , which has 3 carbons
Krebs Cycle: Produce 2 ATP molecules, and occurs in mitochondrial matrix, the liquid part of mitochondria
Electron Transport: occurs in the inner mitochondrial membrane, produces 32 ATP molecules Oxygen converted to water.
-One glucose is broken down to carbon dioxide and water, and a net total of 36 ATP molecules are produced.

Third State: Electron Transport:
-Occurs in inner membrane of mitochondria
-Coenzymes such as NADH (act like hot potatoes) give up high powered electrons to electron transport chain.
-Electrons are transported through the IM (inner membrane) system

-The final electron acceptor is **oxygen→ water**
-H+ (protons) are moved from inner to outer compartment of mitochondria during ET in mitochondria
-H+ flow back across membrane drives ATP synthesis

Formation of a Chemiosmotic Gradient:
-During ET, protons flow to pink area. When ATP is made, protons flow into light pink area. **AREA BECOMES ACIDIC- pH of 5**

Mitochondrial Reactions
-Mitochondrial membranes form two distinct compartments
-Most of ATP making machinery is embedded in the outer mitochondrial membrane (IMM)

Stage 3: Electron Transport Chain:
-Occurs in IMM
-Most (but not all) of ATP is produced in stage 3- 32 ATPs total in stage 3
-Occurs via electron flow to oxygen, which is reduced to water at the last step.
-Produces a pH (proton) gradient
-pH gradient goes through membrane and turns a protein turbine making ATP

ATP Production During ET:
-Electron transport **produces the most** ATP during aerobic respiration (32 out of 36 ATPs, or 88%)
-When electrons are transported in IMM, protons are released to area between outer and inner membrane
-Protons **back** flow into the matrix through a lollipop type structure, and cause the lollipop to rotate.
-ATP is made from ADP and phosphate by this lollipop enzyme that sits in the IMM

Importance of Oxygen:
-Operation of mitochondrial ET requires oxygen.
-Oxygen withdraws spent electrons from the electron transport systems, then combines with H+ to form a water molecule
-The conversion of oxygen to water is the final step of electron transport, and thus the final step of aerobic respiration

Summary of Energy Harvest:
Glycolysis: 2 ATP formed by substrate-level (enzymatic) phosphorylation (net of 2 ATPs)
Krebs Cycle: and preparatory reactions
-2 ATP formed by enzymatic phosphorylation
Electron Transport phosphorylation of ADP to ATP in the inner mitochondrial membrane by a **proton** gradient 32 ATP formed
NET OF 36 ATPS FORMED FROM AEROBIC REPIRATION
New Topic: Metabolic Pathways