



Introduction to Cell Respiration

- * Catabolic Pathways
- * $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O + \text{energy (ATP) and heat}$
- * Efficiency
 - Cell @ 40%
 - Car @ 20%
- * Average energy use per day per adult human 2200 kcal



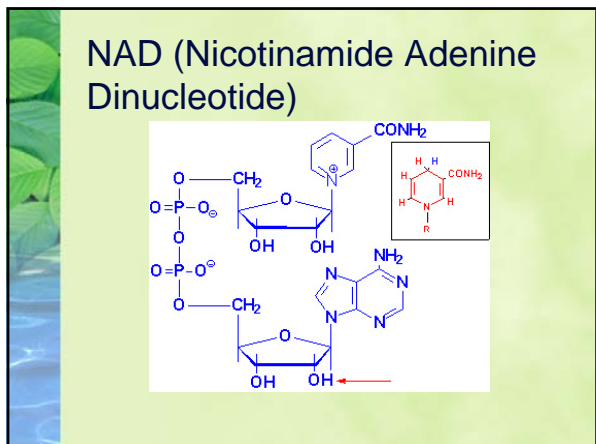
How Energy is Released and Stored

- * Transfer of Electrons
- * When electrons are transferred so are hydrogens (The mechanism for electron transfer)
- * Broken down into steps
- * Some energy is stored as Phosphate bonds in ATP



How Energy is Released and Stored

- * Hydrogen carriers (NAD+) shuttle electrons in oxidation reduction reactions.
- * LEO-GER
 - Loss of Electrons = Oxidation
 - Gain Electrons = Reduction

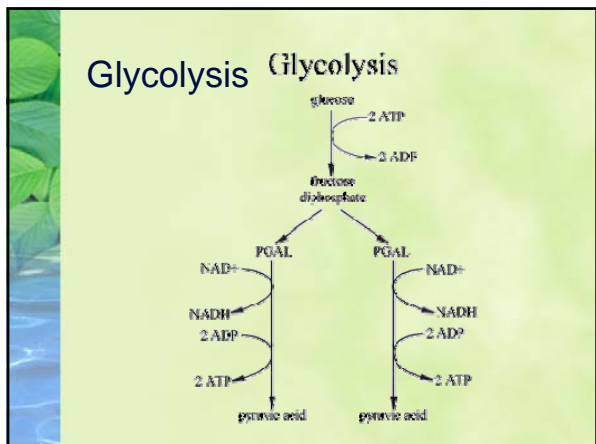


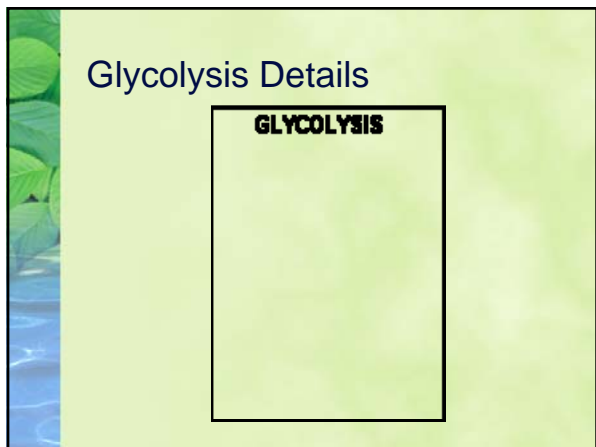
Mechanisms to Generate ATP

- * Chemiosmosis
- * Substrate Level Phosphorylation

Stages of Cell Respiration

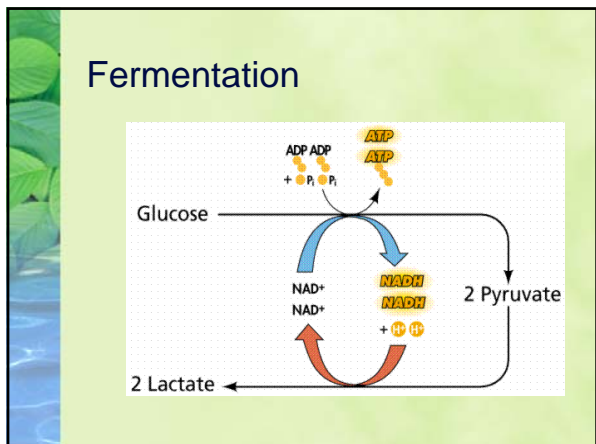
- * Three main stages
 - * Glycolysis
 - * Krebs Cycle (Citric Acid Cycle)
 - * Electron Transport (Chemiosmosis)

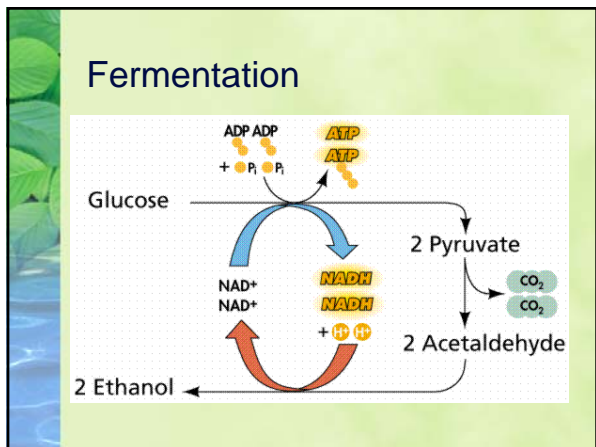




Fermentation

- * If Oxygen isn't present then Krebs and ET can't happen
- * Two types of fermentation happen to enable Glycolysis to continue (Regenerate NAD)
 - Alcoholic Fermentation
 - Lactic Acid Fermentation





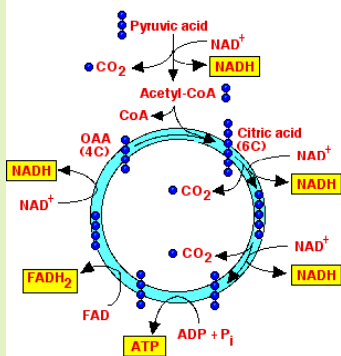
Fuel for Respiration

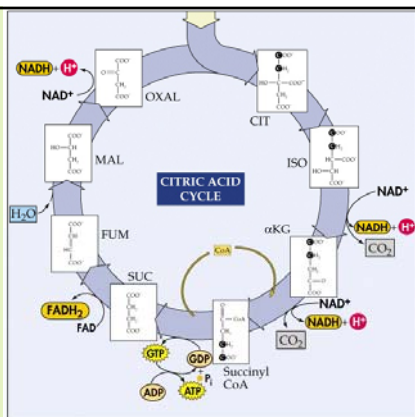
- * Food is the source of energy (digestion)
- * Ultimately the source of energy for cell respiration comes from photosynthesis.

How Other Molecules Can be Used for Energy

- * Glucose is the best fuel
- * Polysaccharides are broken to release Glucose
- * Proteins can be broken down to be Amino acids and then converted to intermediate products that are broken down in Krebs.
- * Lipids are broken down to glycerol (to Glycolysis) and fatty acids (to krebs)

Krebs Cycle (Citric Acid Cycle)





Electron Transport and Chemiosmosis

- ✦ Electron Transport occurs in the inner membrane of the mitochondria
- ✦ Transport is carried out by proteins in the membrane
- ✦ Some carry just electrons, while others take protons with electrons (H^+ and e^-)
- ✦ Transfer from matrix to intermembrane space.

Electron Transport

Inner Membrane Intermembrane Compartment Outer membrane

Complex I Complex II Ubiquinone Complex III Cytochrome c Complex IV

$NADH$ Succinate (from citric acid cycle) Fumarate H^+ H^+ H^+ O_2

Shuttle Molecules

Complex I = NADH-ubiquinone oxidoreductase
 Complex II = succinate-ubiquinone oxidoreductase
 Complex III = ubiquinol-cytochrome c oxidoreductase
 Complex IV = cytochrome c- O_2 oxidoreductase

Chemiosmosis or Chemiosmotic coupling

pyruvate from cytoplasm (inner membrane)

acetyl CoA $NADH$ $FADH_2$ electron transport system

Krebs cycle $NADH$ H^+ $2e^-$ H_2O O_2

many ATP ATP synthase

Inner Compartment Outer Compartment

