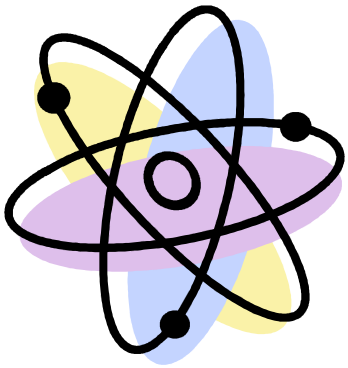
Bio& 242, Human A&P 2
Unit 1/Lecture 5



Overview of Energy and Metabolism

1. The food we eat (carbohydrates, lipids, proteins, and nucleic acids) are our only source of energy for doing the biological work of cells.
2. All molecules (nutrient molecules included) have stored (potential) energy in the bonds between their atoms.
3. The energy that runs most biological systems on earth comes from solar energy
4. Plants trap solar energy via the metabolic reactions of photosynthesis by producing these molecules

Overview of Energy and Metabolism

Terms

Calorie: basic unit of measurement of energy in biological system. Indicated by a "c"

In human metabolism, Calorie is really a kilocalorie or 1,000 calories. Indicated by a "C"

This calorie "C" is the amount of energy required to raise the temperature to 1 kg of water 1 degree C.

The caloric needs of most organisms is measured as Basal Metabolic Rate (BMR)

Overview of Energy and Metabolism

Terms

BMR is the minimum resting energy expenditures by an awake alert person

Average BMR: 70 C/hr or 1680 C/day

If we assume that average amounts of carbohydrates, lipids and proteins are being catabolized, we can calculate a ratio of 4.825 "C" per liter of O2 consumed.

BMR is influenced by age, gender, physical condition, body weight and genes.

Three Basic Uses of Nutrients Absorbed by the Digestive System

1. Energy for immediate use by cells to conduct their normal metabolic processes (muscle contraction, secretions, active transport)

2. Synthesize structural or functional molecules to repair and replace cells.
(Mitosis and Cytokinesis)

3. Storage as glycogen or fat for later use as energy (nutrient reserves)

ALL Living Things from Bacteria to Humans Conduct METABOLISM

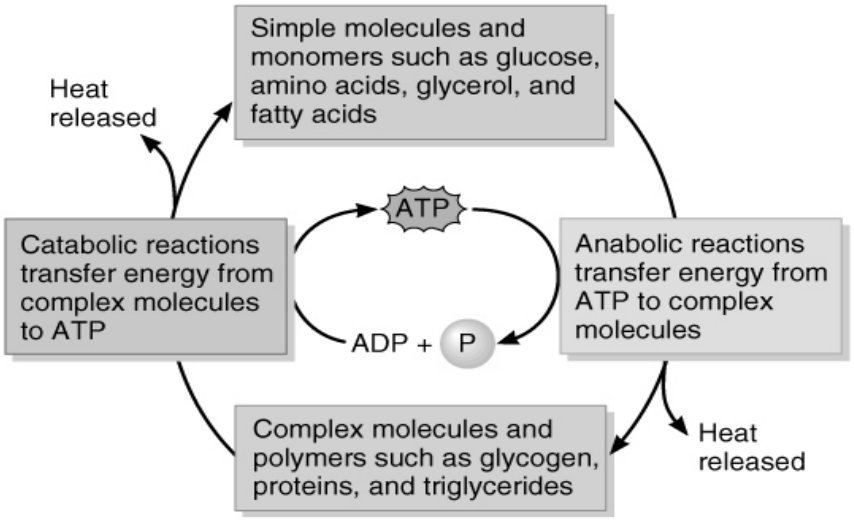
Metabolism is the ability to acquire and use energy from the environment.

Metabolic processes are all the chemical reactions that occur in cells, tissues, organs, and organ systems.

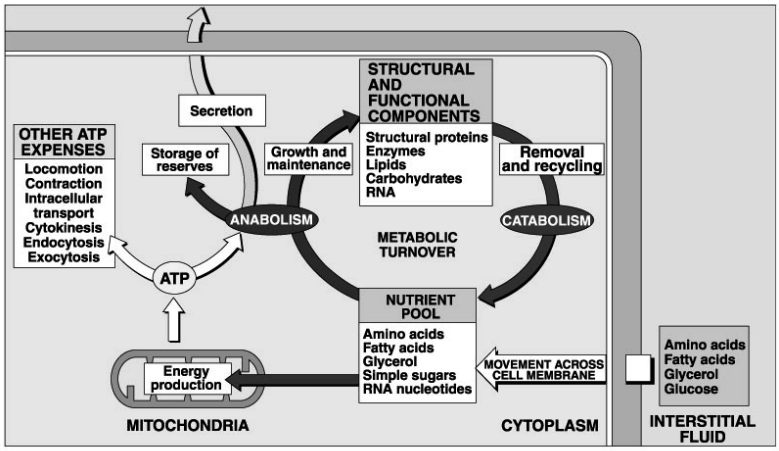
Two Kinds of Metabolic Reactions:

1. **Catabolism = breakdown of large molecules into simple ones to produce energy. (release energy)**
2. **Anabolism = build large molecules from simple molecules. (requires energy input)**

Two Basic Kinds of Chemical Reactions found in Biological System



Metabolic Turnover and Cellular ATP Production



Carbohydrate Metabolism

Amino acid synthesis: Convert pyruvic acid into an Amino Acid requires a transamination

Transamination: Pyruvic Acid + NH3 ⟹ Amino Acid

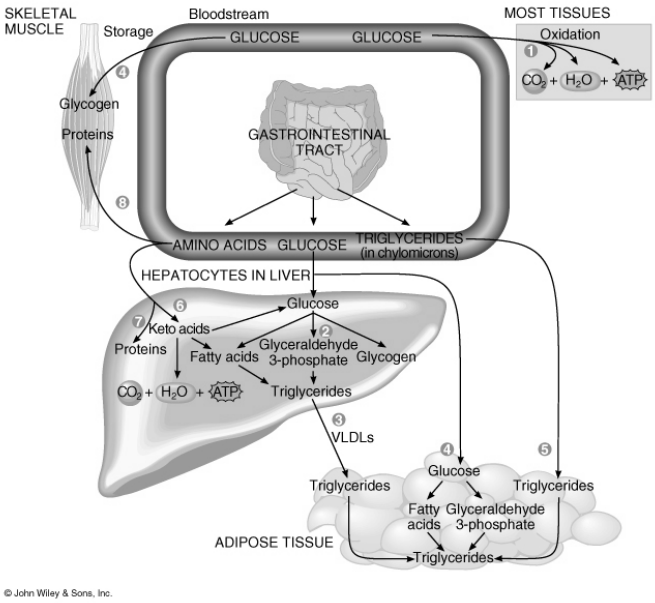
Glycogenesis: glucose ⟹ glycogen

Lipogenesis: glucose ⟹ triglyceride

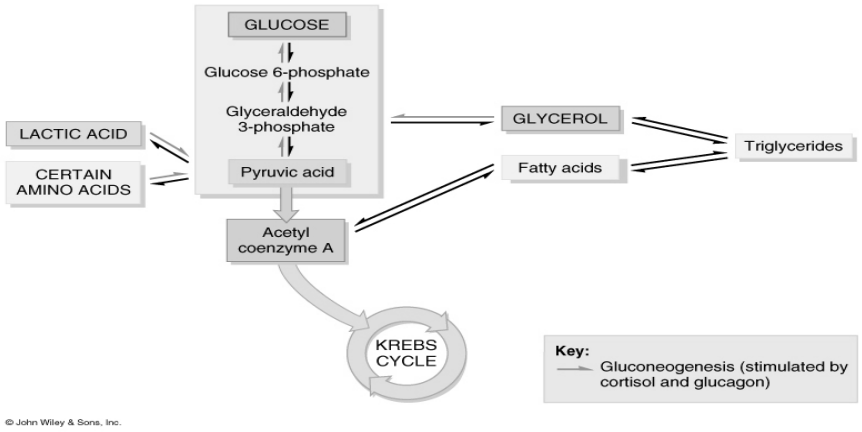
Glycogenolysis: glycogen ⟹ glucose

Gluconeogenesis: lactic acid, amino acids, or triglycerides ⟹ glucose

Summary of Glucose Metabolism



Summary of Gluconeogenesis



ATP production from Carbohydrates

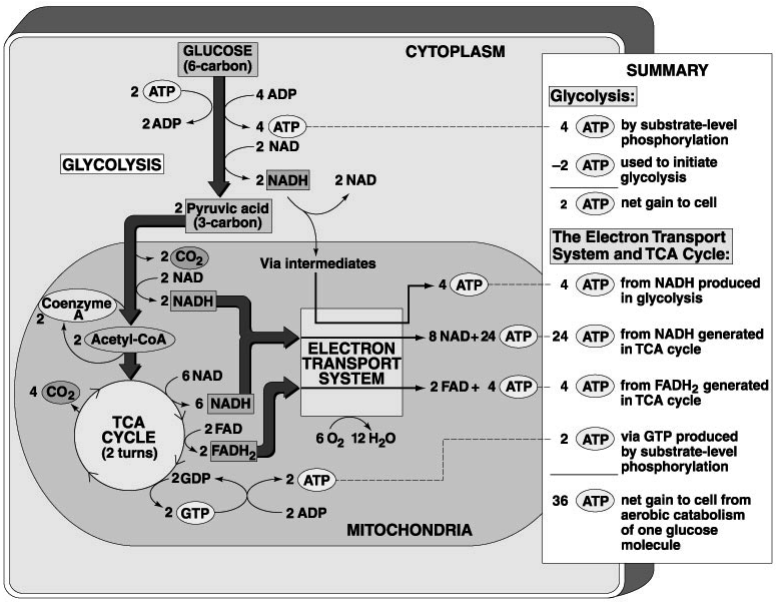
Glycolysis

Substrates required: Glucose, 2 ATP, 4 ADP, and 2 NAD+

Intermediate Reactants: Glucose-6-phosphate, Fructose-1,6 bisphosphate

Products: 2 molecules of Pyruvic Acid
2 ATP
2 NADH

Overview of Cellular Respiration



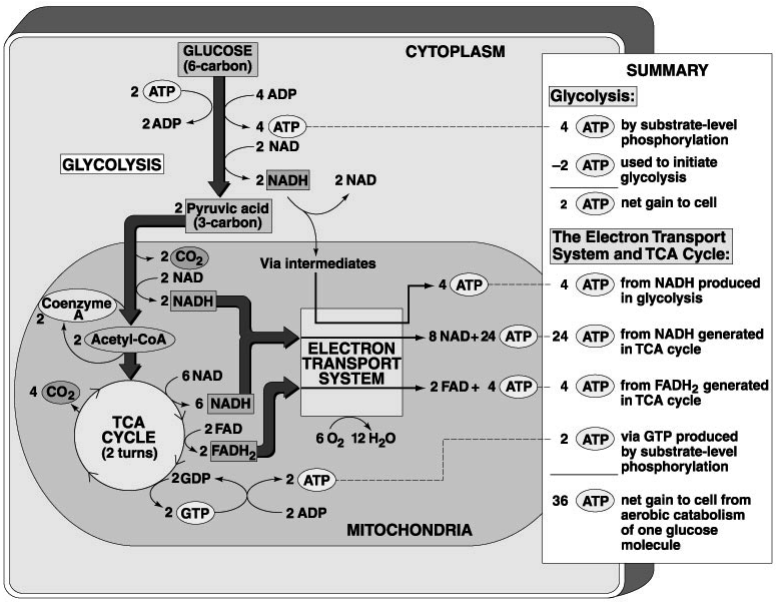
ATP production from Carbohydrates

Formation of Acetyl-CoA

Substrates required: **2 Pyruvic Acid**
2 NAD+
2 Coenzyme A

Products: **2 Acetyl-CoA**
2 NADH
2 CO2

Overview of Cellular Respiration



ATP production from Carbohydrates

Kreb's cycle

Substrates required: **2 Oxaloacetic Acid**
2 Acetyl-CoA
6 NAD+
2 FAD
2 GDP

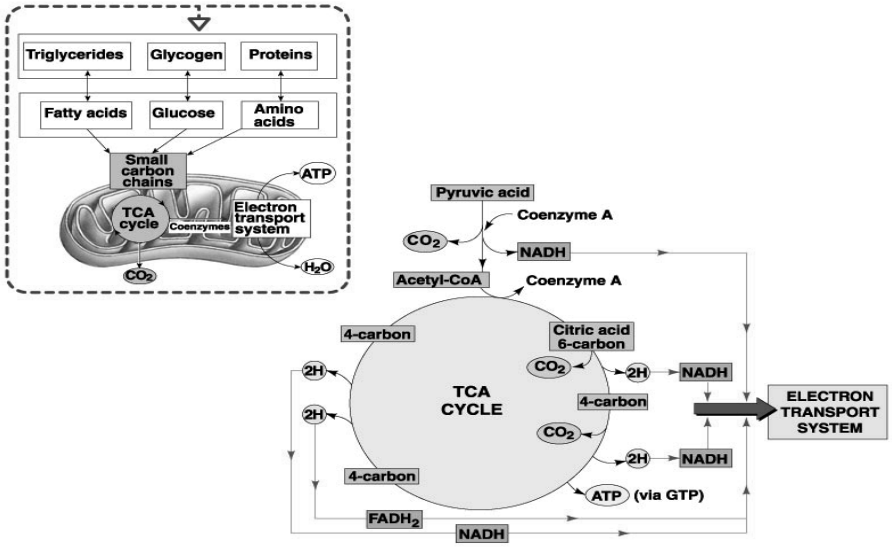
Intermediate Reactants: **Citric Acid**

ATP production from Carbohydrates

Kreb's cycle

Products: **2 Oxaloacetic Acid**
6 NADH
2 FADH2
2 GTP
4 CO2

Overview of the Kreb's Cycle



ATP production from Carbohydrates

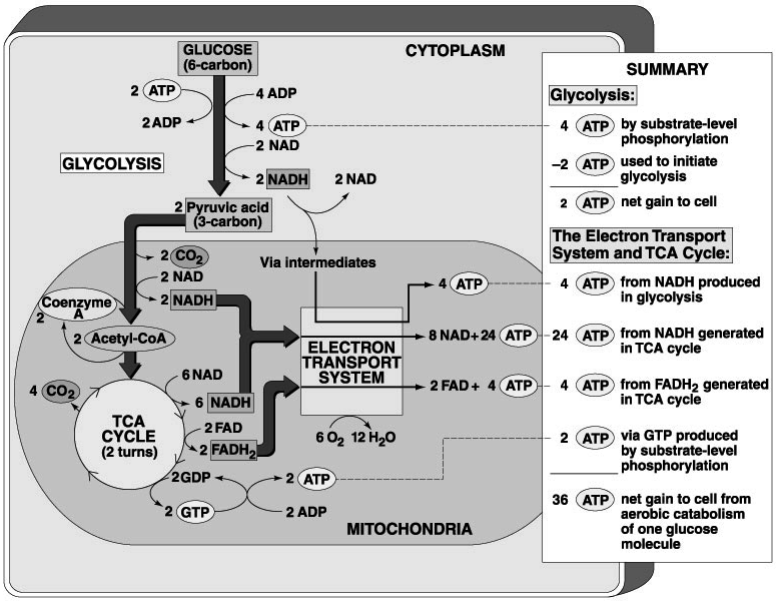
Electron Transport Chain

A series of Oxidative Phosphorylation reactions

Oxidation = the removal of electrons from a molecule and results in a decrease in the energy content of the molecule. Because most biological reactions involve the loss of hydrogen atoms, they are called dehydrogenation reactions.

Reduction = the opposite of oxidation; the addition of electrons to a molecule, and results in an increase in the energy content of the molecule.

Overview of Cellular Respiration



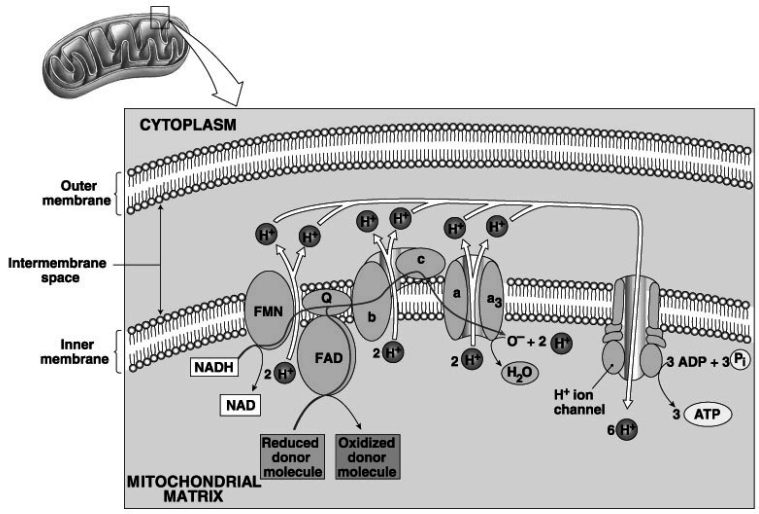
ATP production from Carbohydrates

Electron Transport Chain

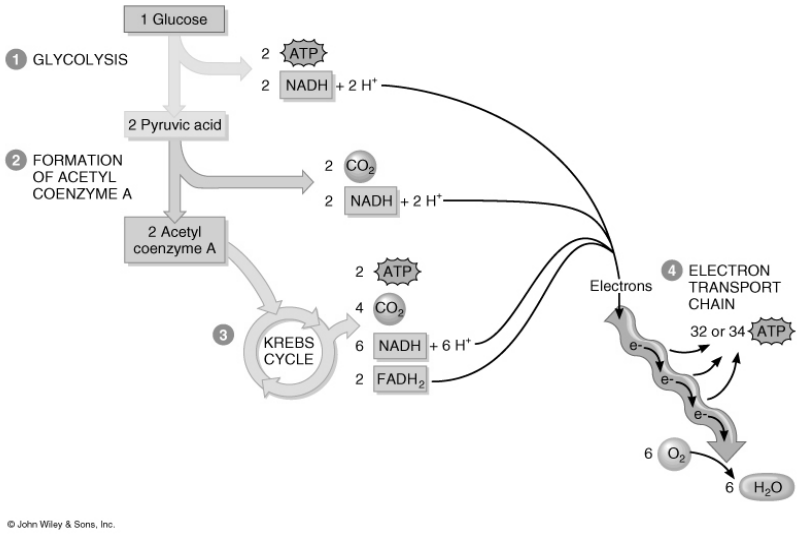
Substrates required: 10 NADH
2 FADH
6 O2

Products: 32 ATP
6 H20

Overview of Electron Transport System



Summary of ATP Production



Protein Metabolism

Deamination: removal of the amino group (NH2) leaving an acetyl molecule

Transamination: Adding an amino group to pyruvic acid to produce any of the nonessential amino acids

Protein Synthesis: Production of protein molecule using an RNA model.

Protein catabolism: breaking down a protein into individual amino acids.

Lipid Metabolism

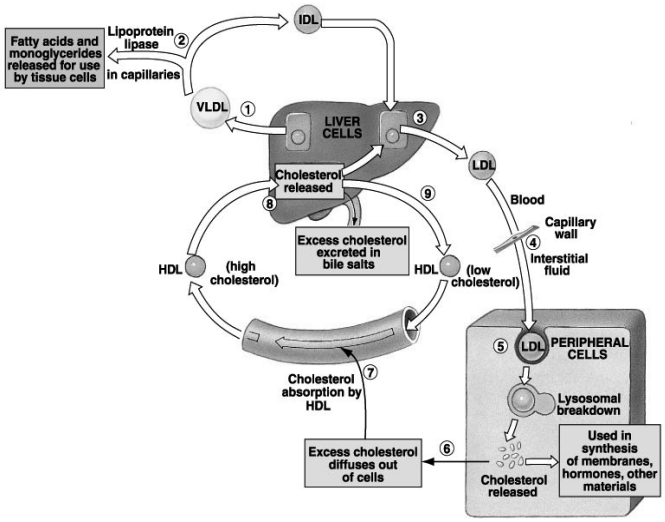
- **Lipoproteins: surrounding triglycerides with apoproteins to make them more transportable in water**
  - **Very low-density lipoproteins (VLDL's)**
  - **Low-density lipoproteins (LDL's)**
  - **High-density lipoproteins (HDL's)**

Lipolysis: break down lipids

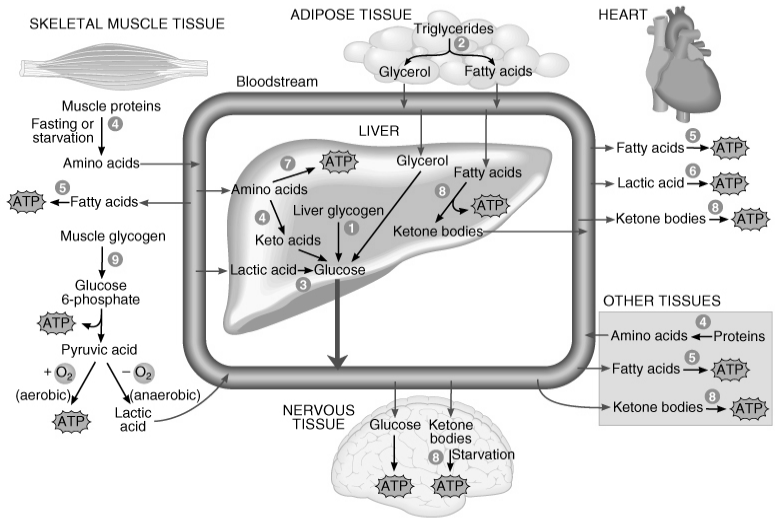
Beta Oxidation: breaking a fatty acid into 2-carbon compounds

Lipogenesis: formation of lipids from non-lipids

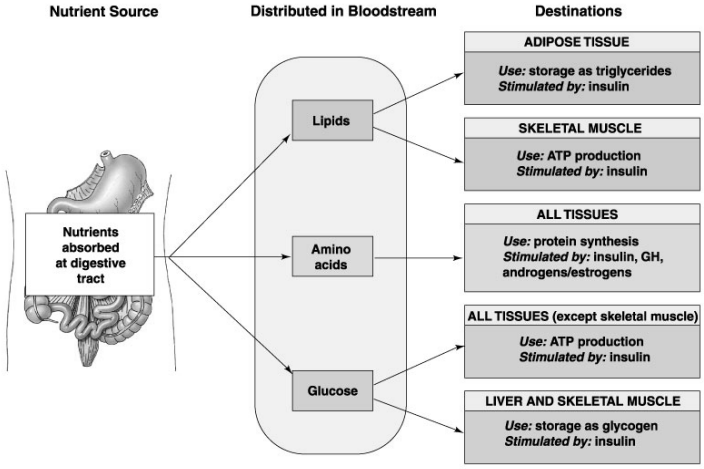
Overview of the Role of the Liver in Lipid Metabolism



Summary of the Interconnection Between Tissues and Metabolic Reactions



Metabolic Overview: The Absorptive State



Metabolic overview: The Post-Absorptive State