Introduction to Metabolism

Metabolism Depends on the Organism

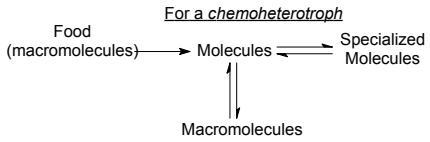
Metabolism- "the sum total of anabolism and catabolism"

Anabolism- "building up"

Catabolism- "breaking down"

Metabolism of a plant has some similarities and some differences to animals. (Most animals eat plants, but very few plants eat animals.)

Mammalian Metabolism



1. Catabolism of nutrient molecules to building block molecules
2. Nutrient molecules → simpler molecules + energy
3. Building blocks ⇔ our own molecules
4. Anabolism and catabolism of specialized molecules

Bioenergetics

$\Delta G = \Delta H - T \Delta S$

Free Energy- that type of energy that can do work at constant temperature and pressure

ΔH - enthalpy

First Law of Thermodynamics- energy is neither created nor destroyed, but can change forms.

ΔS - entropy

Second Law of Thermodynamics- the entropy of the universe is constantly increasing.

$\Delta G = \Delta H - T \Delta S$

- <0- spontaneous
- 0- at equilibrium
- >0- nonspontaneous

Standard Free Energy Change and the Modified Standard State

ΔG^o- standard free energy change under standard conditions (298 K, 1 M product(s) and reactant(s), 1 atm)

$\Delta G'^o$- pH 7

ΔG'° Values are Additive

Coupled Enzyme reaction- two reactions, one non-spontaneous and one spontaneous, are linked together by an enzyme, allowing the overall reaction to be spontaneous.

Glc + Pi	→ Glc-6-P	ΔG°'=+13.8 kJ/mol
ATP	→ Pi + ADP	ΔG°'= -30.5 kJ/mol
Glc + ATP	→ Glc-6-P + ADP	ΔG°'= -16.7 kJ/mol

ΔG Depends on Actual Concentrations

ΔG= ΔG'° + RT ln [products]/[reactants]

This can and does change the likelihood of a reaction occurring

$$\Delta G = \Delta G^{\circ\prime} + RT \ln \frac{[\text{products}]}{[\text{reactants}]}$$

$$= -13.8\text{kJ/mol} + (8.31 \tfrac{\text{J}}{\text{mol K}})(310\text{ K}) \ln \frac{[\text{Glc}][\text{Pi}]}{[\text{G6P}]}$$

$$= -13.8\text{kJ/mol} + (8.31 \tfrac{\text{J}}{\text{mol K}})(310\text{ K}) \ln \frac{[5.0][1.0]}{[1.5]}$$

$$= -13.8\text{kJ/mol} + (8.31 \tfrac{\text{J}}{\text{mol K}})(310\text{ K})\,(1.2)$$

$$\Delta G = -10.8\text{kJ/mol}$$

Also influenced by enzyme coupling

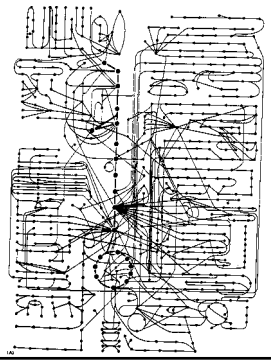
Srere's ARB Figure

Metabolite-

Enzyme-

Pathway-

- linear
- circular
- "spiral"
- convergent
- divergent



Pathways and Enzymes of Pathways Have a Specific Location

Marker enzyme-

Ways of Studying Pathways

Inborn errors of metabolism

Radioactive Tracers

Genetically manipulated organisms

Glycolysis

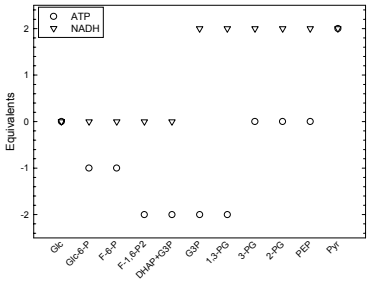
Importance- only source of energy for some tissues (RBC's, CNS)

Location- cytoplasm of all tissues/organisms

Reactions of Glycolysis

Know the name and structure of all molecules involved
Know all required coenzymes and cofactors
Know a reasonable name of all enzymes
Know which enzymes are regulated and by what substances

Energetics of Glycolysis



Regulation of Glycolysis

- Regulated steps tend to be at beginning of pathway
- Regulated steps tend to be irreversible
- 3 regulated steps and their activators/inhibitors
  - Hexokinase (inh by G6P) or Glucokinase (stim by insulin)
  - Phosphofructokinase RDS
    - Inh by Fru-2,6-P_2
  - Pyruvate kinase

What Happens to Pyruvate Depends on the Organism, the Tissue, and the Metabolic State

ethanol- microorganisms (fermentation)
lactate- mammals, etc. (fermentation)
    anaerobic glycolysis in muscle
    Cori cycle
acetyl CoA - mammals, etc.
    aerobic glycolysis in heart

Why Lactate?

Must have NAD^+ for glycolysis to continue
Some energy is better than none