

Introduction to Metabolism

General

- nutrients absorbed from digestion (animals); starches (4 kcal/g) fats (9 kcal/g) protein (4 kcal/g) vitamins and minerals
- catabolism supplies energy to the organism,; nutrients converted to intermediates (convergence); oxidation of metabolites
- anabolism uses energy from organism's supply; intermediates converted to building blocks(divergence); building blocks converted to biopolymers; reduction of metabolites

Regulation

- metabolism is integrated; small number of intermediates connect many biomolecule pathways
- metabolism is coordinated; allosteric control and covalent control of important enzymes
- anabolic and catabolic reactions between the same metabolites are reciprocally regulated, i.e. inhibitor of anabolic enzyme is also activator of catabolic enzyme
- hydrophilic hormones control enzyme activity in cells that have receptors for those hormones in their plasma membrane; second messengers (allosteric modulators) generated inside of the cell as a result

Energy

- continuous supply of energy needed for cell maintenance, growth and reproduction
- exergonic reactions drive endergonic reactions; most often ATP stores and delivers; energy from catabolic processes used to produce ATP; ATP then used to supply energy to anabolic processes
- ATP energy storage and supply via chemical coupling or chemiosmotic coupling

Oxidation-Reduction

- oxidation of metabolites in catabolic pathways produce NADH/H⁺, FADH₂ and NADPH/H⁺
- NADH/H⁺ and FADH₂ react with O₂ to produce H₂O by the electron transport system in mitochondria; example of chemiosmotic coupling, with 1 NADH/H⁺ producing 2.5 ATP and 1 FADH₂ producing 1.5 ATP
- NADPH/H⁺ is used for reduction reactions of metabolites

Intermediates

- organic phosphates important in carbohydrate metabolism; connect to nucleotide metabolism
- α -ketoacids and α -amino acids important in connecting carbohydrate and protein metabolism, they also act as nitrogen storage and supply molecules
- acetylCoA (thioesters) important in fatty acid metabolism; carbohydrate, fat and amino acid catabolism converge at acetylCoA

Catabolic	Anabolic
<p>Glycolysis•aerobically, glucose to pyruvate to acetylCoA•anaerobically, glucose to lactate</p> <p>α-oxidation•fatty acids to acetylCoA; makes NADH/H⁺ and FADH₂ for chemiosmotic production of ATP</p> <p>Citric Acid Cycle•oxidation of acetylCoA producing NADH/H⁺ and FADH₂ for chemiosmotic production of ATP; all three food groups converge here</p> <p>Electron Transport System•electrons passed down to oxygen; proton gradient across mitochondrial inner membrane•proton gradient tapped to make ATP from ADP and P_i (chemiosmotic coupling)</p> <p>Amino Acid Catabolism•redistribution of reduced nitrogen; elimination of excess by urea cycle</p>	<p>Glycogenesis•synthesis of glycogen from glucose</p> <p>Gluconeogenesis•synthesis of glucose from pyruvate</p> <p>Palmitate biosynthesis•synthesis of fatty acid from acetylCoA</p> <p>Nonessential amino acid biosynthesis•aminotransferase reactions from α-ketoacids</p> <p>Purine and pyrimidine nucleotide biosynthesis•ring structures from nitrogen donors</p> <p>Protein Biosynthesis•translation</p> <p>Nucleic Acid Biosynthesis•replication, transcription</p>