4/4/16 Metabolism

The sum of all chemical reactions in a living cell.

Catabolism - breaking down - reactions that release energy.
- generally hydrolytic (decomposition) + exergonic

Catabolism of:

① Carbohydrates → polysaccharides → di/monosaccharides
* mainly glucose through cellular respiration and/or fermentation

② Lipids → fatty acids → smaller hydrocarbons

③ Proteins → amino acids → organic acids

Anabolism: Reactions that require or consume energy
- generally involve synthesis and endergonic

Anabolism of:

① Carbohydrates starts w/ mono/disaccharides → polysaccharides → complex carbs and peptidoglycan

② Lipids: Acetyl CoA → fatty acids + glycerol → lipids → Complex lipids

③ Proteins: amino acids → proteins → complex proteins
↳ purines + pyrimidines → nucleic acids ⇒ DNA / RNA
ATP/GTP energy

Basic ATP Cycle:

1. Catabolic rxn release energy held in bonds, ATP is produced (heat is a by-product)
2. Complex molecules are now simple building blocks.
3. Anabolic rxn use the ATP to form bonds reconstructing complex molecules
4. Simple building blocks are polymerized into larger complex compounds storing energy in the bonds.

Aerobic respiration → produces heat + ATP
Eukaryotic : 36 ATP
Prokaryotic : 38 ATP (from the full oxidation of glucose)

Chemical Rxns

Activation Energy: minimum energy required for a chemical reaction to occur.

Catalysts: a substance that increases the rate of reaction, generally by lowering the activation energy. * The catalyst is not changed or consumed by the reaction.
** in a chemical reaction the catalyst is written over the arrow.

Enzyme: a biological catalyst, usually proteins (globular 3-D) generally end with -ase.

Substrate: any compound on which an enzyme reacts.

When the enzyme bonds to the reactant, the enzyme-substrate complex is formed. This complex increases the chances of collisions thus reducing the required activation energy.

Categories of enzymes:

1. Hydrolases: add water
2. Hydrases: remove water
3. Oxidases and dehydrogenases: promote oxidation-reduction reactions (transfer e^-)
4. Transferases: aide in the transfer of a radical
5. Desmolases: splitting or formation of carbon to carbon bonds
6. Isomerases: change the geometry of a structure
7. Ligases: join two molecules through the hydrolysis of the phosphate bond in ATP or GTP.

Factors that affect the efficiency of enzymes:

1. Temperature – generally when the temperature increases the rate of the reaction increases, however, there is a max temp that after which the proteins will be denatured.
2. pH – the most favorable pH is considered to be the pH at which the enzyme is most active (optimum pH) However, if the pH is too low or too high the activity of the enzyme can be lost.
3. Strength of Concentrations = Ionic strength, substrate conc. & Co-factor conc.
4. Inhibitors:
   a. Competitive inhibition – "lock + key"
   b. non-competitive – allosteric inhibition
   c. Substrate inhibition – excessive amts of substrate present.

Trophic Types:

- Photoautotrophs: photophosphorylation & carbon fixation
- Phototrophs: a) cyanobacteria – oxygenic phototrophs
  b) green/purple bacteria – anoxygenic phototrophs
- Photoheterotrophs: light for energy, organic compounds for carbon and e^- donor
- Chemoautrophs: use inorganic compounds as their energy source and CO_2 as their carbon source.
- Chemoheterotrophs: use complex organic molecules as their carbon and energy sources.

Identifying Bacteria

Differential Tests:

I. Stains: primarily gram stain

- gram+ / gram- } cell wall
- Shape (morphology)

II. Identify the air requirements:

A. Ambient Air – nothing special – aerobic

B. Anaerobic – low to no oxygen needed

1. aerotolerant – they don't require oxygen but can survive in the presence of oxygen
2. obligate anaerobe – can not survive in the presence of O_2.

III. Identify Media (nutrient) Requirements

4/4/16 Metabolism (2A)

The sum of all chemical rxn in the living cell.

Catabolism - Releases energy - generally hydrolytic (decomposition) exergonic

Catabolism of:

Carbohydrates → polysaccharides → mono/di saccharides
main saccharide is glucose (cellular respiration / fermentation)

Lipids → fatty acids → smaller hydrocarbons

Proteins → amino acids → organic acids

Anabolism - Requires energy - generally involves synthesis & endergonic

Anabolism of:

- carbohydrates
  mono/di saccharides → polysaccharides → complex carbs + peptidoglycan
- Lipids
  acetyl CoA → fatty Acids (+glycerol) → lipids + complex lipids
- Proteins
  amino acids → proteins → complex proteins
  ↳ purines + pyrimidines → nucleic acids → RNA/DNA
  → ATP/GTP

Basic ATP Cycle:

1. Catabolic Rxns - break bonds releasing energy (ATP produced) by product = heat
2. Complex molecules have now been reduced to simple building blocks.
3. Anabolic Rxns - use ATP to reform bonds when creating complex polymers.
4. Simple compounds are polymerized into larger compounds storing energy in the new bonds.

Chemical Reactions

Activation energy: energy required for a chemical reaction to occur

Catalyst: any substance that reduces the required activation energy & increases the rate of reaction).
* the catalyst remain unchanged, record over the yield sign.

Enzyme: a biological catalyst, protein (3-D, globular) generally end w/ -ase

Substrate: any compound on which an enzyme acts.

When the enzyme bonds to a reactant an enzyme-substrate complex is formed. This complex increases the chances for collision and reduces the required activation energy.

Categories of enzymes:

1. Hydrolases - adding water
2. Hydrases - removal of water
3. Oxidase & dehydrogenase - promote oxidation-reduction reactions (transfer of e^-)
4. Transferases - aide in the transfer of radicals)
5. Desmolases - splitting or formation of carbon-carbon bonds.
6. Isomerases - change the geometry of a structure
7. Ligases - joining two molecules through hydrolysis of the phosphate bond in ATP or GTP.

Factors that influence the activity of enzymes

1. Temperature – generally increasing the temperature increases the rate of the enzyme activity, however, if the temp is increased too much it will begin to denature the proteins (enzymes) rendering them inactive.
2. pH – optimal pH – the pH at which the enzyme is most active. However, pH that is too high or too low can result in complete loss of activity for the enzyme.
3. Concentration: ionic strength, co-factors, substrate
4. Inhibitors:
   a. Competitive inhibitors: "lock + key"
   b. non-competitive: allosteric inhibition
   C. Substrate inhibition: excessive amounts of substrate are present.

Aerobic respiration: produces heat + ATP
Eukaryotic: 36 ATP
prokaryotic: 38 ATP (from full oxidation of glucose) } NET

Trophic Types:

Photoautotrophs: photophosphorylation and carbon fixation

phototrophs: a) cyanobacteria – oxygenic phototroph
b) green/purple bacteria – anoxygenic phototrophs

photoheterotrophs: light for energy, use organic compounds for carbon and e^- donor

Chemoautotrophs: use inorganic compounds as energy sources and CO_2 as the carbon source

Chemoheterotrophs: use complex organic molecules as both energy + carbon sources.

Identifying Bacteria:

Differential Tests: Creating separation of information, characteristics, behaviors or requirements

I. Stains: focusing on Gram Stain

- Cell wall composition
  - gram ⊕
  - gram ⊖
- cell morphology (shape)
  - cocci, bacillus, spiral
  - (chains + clusters)

II. Identify Air Requirements

A. Aerobic (regular air containing O_2)

B. Anaerobic - requires low to no O_2.

1. Aerotolerant - can survive in a low O_2 environment but does not require O_2
2. Obligate anaerobe - cannot survive in oxygen

C. Capnophile - likes (requires) a CO_2 rich environment