

## 2008 CELL BIOLOGY – TRAINING HANDOUT

prepared by Karen L. Lancour

### *Introduction - Types of chemical reactions*

- **Endergonic:** require energy
- **Exergonic:** give off energy
- **Catabolism:** reactions breakdown large molecules and produce small molecules; Ex. Digestion of protein into amino acids
- **Anabolism:** reactions requiring energy to make large molecules from small molecules; Ex: the synthesis of a protein from amino acids

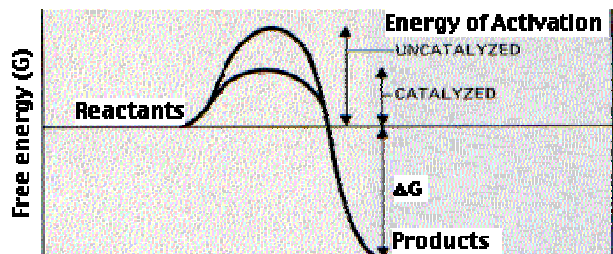
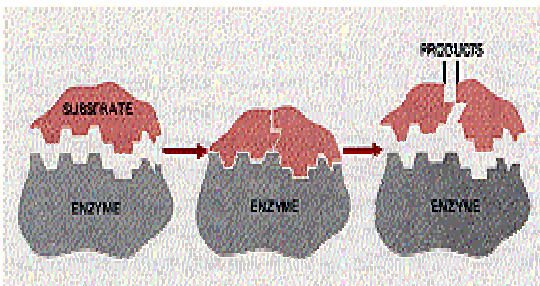
### *Types of Biological Molecules – Monomers and Polymers*

- Building blocks are monomers and macromolecules are polymers
- **Monomers** are simple sugars, amino acids, nucleotides, glycerol and fatty acids and they are the building blocks for the **Polymers** - polysaccharides, proteins, nucleic acid (DNA & RNA), and triglyceride or fats.
- Polymers are made by dehydration synthesis or the removal of the equivalent of water.
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monomer	polymer	example	Reagents
simple sugar (monosaccharide)	polysaccharide	starch, cellulose, glycogen (animal)	Benedicts-glucose Iodine-starch
amino acid	protein, polypeptide	hair, enzyme, hemoglobin, insulin	Ninhydrin, Biuret
nucleotide	nucleic acid	DNA, RNA	methyl green
fatty acid/glycerol	fat or tri - glyceride	cooking oil, butter	grease test with brown paper

**pH** – Hydrogen ion concentration - A liquid may be an acid, base, or neutral. The degree of acidity or basicity can be measured by using the pH scale. The scale is divided into three areas: Acid (readings below 7), neutral (reading of 7), and basic (readings above 7). Each division either increase or decreases the pH of a substance 10 times. The pH of 5 is ten times more acidic than a pH of 6. Water has a pH of 7 but when it mixes with air the suspended materials will either raise or lower its pH. Acid Rain is an example of this type of reaction.

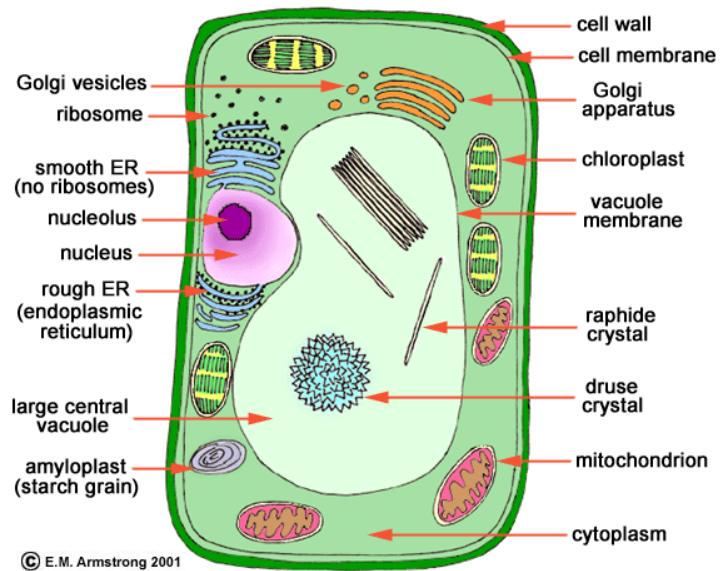
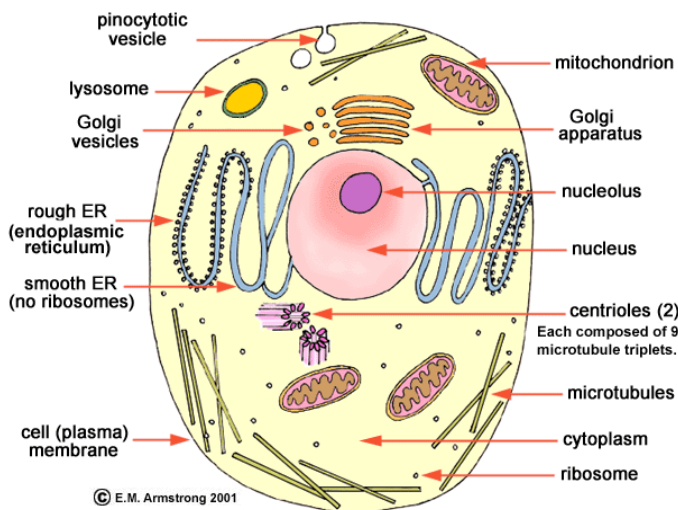
### *Enzymes*



Enzymes are catalysts. They lower activation energy and remain unchanged by the reaction because they do not take part in the reaction.

- Enzyme vs. other catalysts: enzymes are very specific and only work on one or a few molecules  
substrate: molecule(s) upon which enzyme works active site: part of enzyme that interacts with substrate
- Enzymes are proteins (usually, some RNA molecules can act as enzymes); proteins are sensitive to changes in temperature and pH. They will change shape and become inactive. some enzymes are larger inactive molecule; activation involves enzymatic removal of some amino acids
- Some enzymes require co-factors, usually metal or vitamin; others activated by addition/removal of phosphate
- **Competitive Inhibition** has the molecule binding at active site; it resembles the substrate and is overcome by increase in substrate concentration while **Non-competitive Inhibition** has binding at a site other than the active site; its molecule is different than the substrate and it is not reversed by increased substrate but it may be irreversible if it covalently alters the enzyme. It binds only to enzyme substrate complex

### Cell Organelles and their Function



### Surface of Cell:

- **Cell Wall** – commonly found in plants cells – protection & support
- **Plasma Membrane** – control of substances coming in and out
- **Cilia** - sweep materials across the cell surface
- **Flagellum** - enables a cell to propel and move in different directions

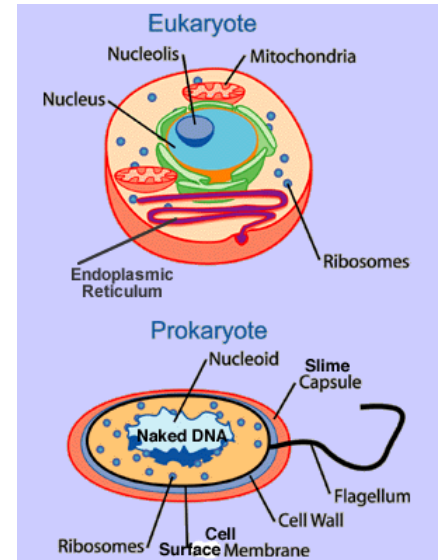
**Cytoplasm** – between plasma membrane and nucleus – many organelles

- **Endoplasmic reticulum (ER)** is the passageway for transport of materials within the cell
- Synthesis of lipids – modification of newly formed polypeptide chains
- **Ribosomes** are the site of protein synthesis
- **Golgi apparatus**- Final modification of proteins & lipids Packing of materials for secretion of the cell

- **Mitochondria** are the site of aerobic cell respiration-ATP production
- **Lysosomes** contain enzymes to digest ingested material or damaged tissue
- **Chloroplasts** – store chlorophyll – photosynthesis light reaction
- **Vacuoles** – storage – increase cell surface area
- **Centrioles** - organize the spindle fibers during cell division
- **Cytoskeleton** – cell shape, internal organization, cell movement & locomotion

**Nucleus:** - control center of the cell

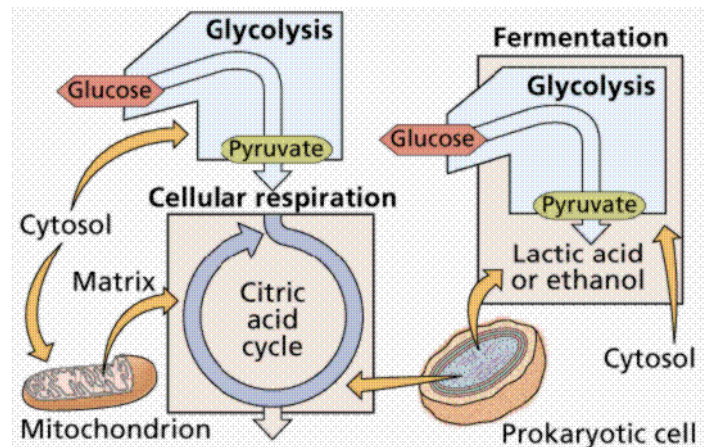
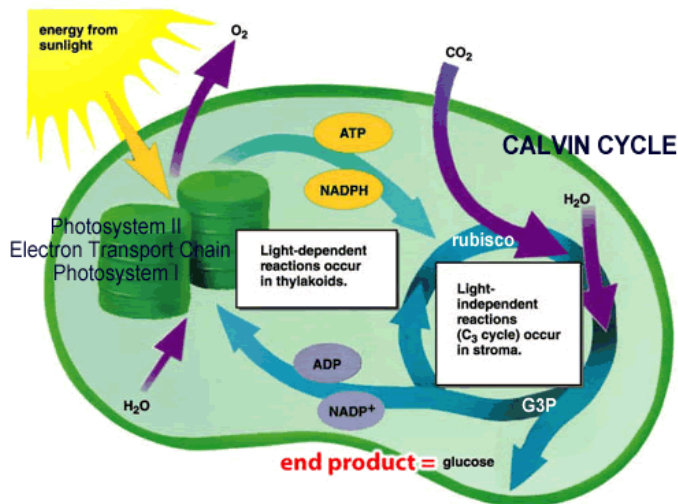
- **Nuclear membrane** – membrane around nucleus – controls movement in and out
- **Nucleolus** – assembly of subunits of ribosomes.
- **DNA** - encoding of heredity information
- **RNA** – transcription and translation of DNA coding into proteins



### Differences between Prokaryotic vs Eukaryotic Cells

- **Prokaryotic cell** – single celled microorganism (Archaeobacterium or Eubacterium), most often with a cell wall but lacks membrane bound organelles observed in Eukaryotic Cells.
- **Eukaryotic cell** – cell has nucleus with a membrane around the genetic material and other membrane organelles.

### Qualitative Aspects of Photosynthesis and Respiration

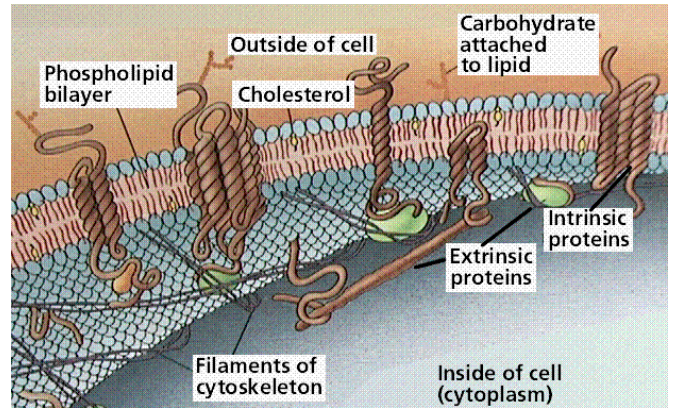


**Photosynthesis** – Trapping of sunlight energy followed by its conversion to chemical energy (ATP, NADPH, or both) and then synthesis into sugar phosphates which convert into sucrose, cellulose, starch, and other end products. It is the main pathway by which energy and carbon enter the food webs.

**Cellular Respiration** - Organic substances are broken down to simpler products with the release of energy which is incorporated into special energy-carrying molecules (ATP) and is eventually used for metabolic processes. All cells carry on some form of cellular respiration. Most plants and animals require oxygen. **NOTE: The amount of NET ATP production varies from cell to cell.**

## Membrane Structure and Function

- **Composition:** mainly protein and phospholipid; some proteins extend thru membrane
- **Protein function:** receptors, transport in and out of cells, structure
- **Lipids** in membrane can move laterally at about 2 $\mu$ m/sec
- **Saturated fatty acids** in P-lipids make membrane more rigid; unsaturated fatty acids will increase the fluidity of membrane.
- **Note:** As temp drops, organisms put more unsaturated fatty acids in membrane



## Movement across Membranes

- **Diffusion:** molecules moving from high to low concentration; concentration = #molecules/volume
- **Osmosis:** diffusion of water across a selective membrane; amount of water is opposite of number molecules-if water is high, solute (molecules) is low.
- **Facilitative diffusion:** just like diffusion (high to low) but a protein carrier is involved
- **Active transport:** movement from low to high; requires protein carrier; requires ATP
- **Note:** diffusion will continue but rate of transport with carrier will level off because carrier becomes saturated
- **hypotonic, hypertonic, and isotonic solutions**

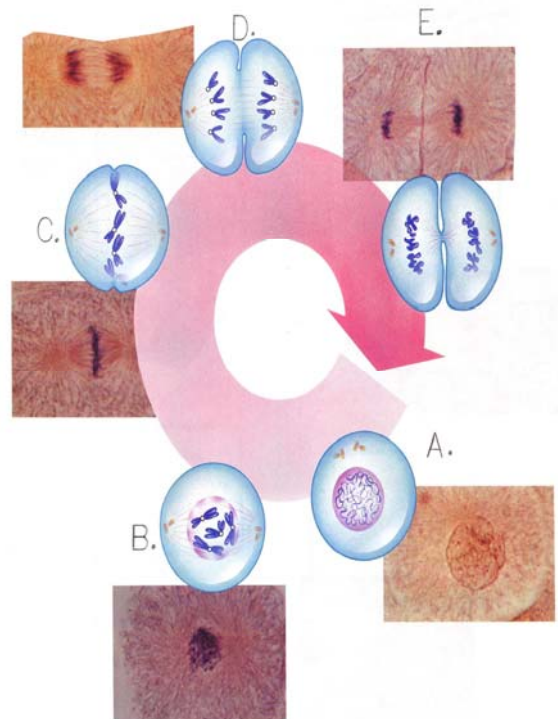
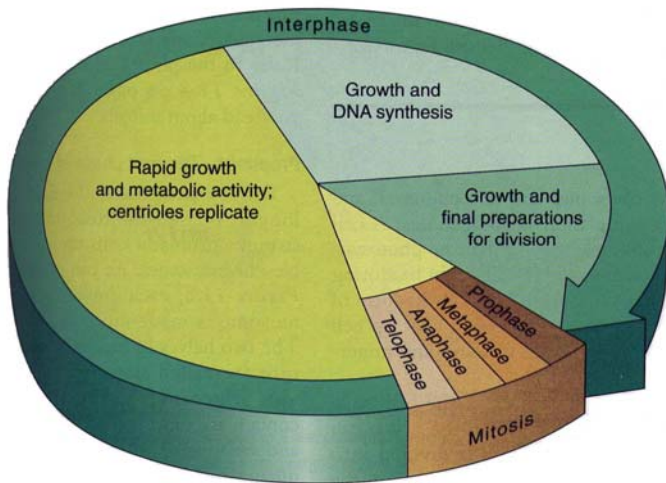
## Importance of ATP

- Production of much ATP requires membranes to generate current to make ATP
- Note: plants carry out both photosynthesis and cellular respiration; almost all of ATP produced in photosynthesis is used in photosynthesis to make glucose
- Amount of ATP produced in cellular respiration is not important; emphasize quantitative aspects; most of ATP is produced via electron transport chain.
- Main reason that cells need oxygen: to allow them to make lots of ATP - NOT to keep them alive Oxygen can not be stored, so it must be constantly supplied and is very reactive and dangerous to cells

## Structure of Viruses

- Non-cellular infectious agent
- Composed of DNA or RNA and a protein coat
- Replicates only after its genetic material enters a host cell
- Subverts the host's metabolic machinery

## Cell Cycle



**G<sub>1</sub> Phase** – high rate of biosynthesis and growth

**S Phase** – DNA content doubles and chromosomes replicate

**G<sub>2</sub> Phase** - final preparations for Mitosis

**M Phase** – Mitosis and Cytokinesis

- **Prophase** – chromatid pairs coil up, spindle forms, nuclear membrane dissolves, chromatid pairs attach to spindle fibers (microtubules),
- **Metaphase** – chromatid pairs move to the equator, chromatid pairs align at the equator,
- **Anaphase** – chromatids separate into individual chromosomes, chromosomes are pulled apart toward the equator by the spindle fibers (microtubules)
- **Telophase** - chromosomes uncoil, spindle dissolves, nuclear membrane reforms
- **Cytokinesis** – division of the cytoplasm to make two new cells

### Sample Stations, Methods and Process Skills

The **Event Supervisor Guide** for Sample Stations for each topic, methods and process skills.

The **Internet Resources** for links to Cell Biology sites and an on-line textbook and lab manual

plus excellent study notes.

The **Sample Tournament** has sample stations and an answer key.

### Bacteriophage Structure

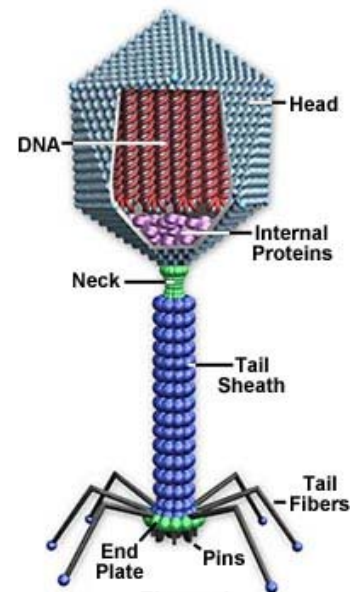


Figure 1