

MCAS Review by Biology High School Standards

1. The Chemistry of Life

Broad Concept: Chemical elements form organic molecules that interact to perform the basic functions of life.

1.1 Recognize that biological organisms are composed primarily of very few elements. The six most common are C, H, N, O, P, S

- **Element**-a substance made of only one kind of atom. A **pure substance** that cannot be broken down by chemical means.
- **Carbon, Hydrogen, Nitrogen, Oxygen, Phosphorous, and Sulfur** are used to construct the 4 major organic compounds of life.
- **Compound**-a substance made of two or more elements chemically combined in definite proportions. 2 types:
- **Organic Compound**-compounds that contain carbon; associated with living organisms
- **Inorganic Compound**-compounds that do not contain carbon

1.2 Describe the basic molecular structures and primary functions of the four major categories of organic molecules

- **Carbohydrate**-an organic compound composed of carbon, hydrogen, and oxygen atoms; stores energy and provides shape or structure to organisms. Types include: **Monosaccharide** (glucose), **Disaccharide** (sucrose), & **Polysaccharide** (starch).
- **Lipid**- an organic compound such as fats, oils, waxes, phospholipids, steroids; lipids tend to be insoluble in water (**non-polar**); lipids such as fats and oils store energy very efficiently-more than twice the energy per gram as carbohydrates.
- **Protein**-a complex macromolecule composed of chains of amino acids
 - Amino Acid**-organic molecules that are the building blocks of proteins
 - Enzyme**-catalytic proteins that control chemical reactions in living organisms
- **Nucleic Acid**-a large complex organic molecule made of nucleotides (subunits of nucleic acids consisting of a nitrogen base, a 5-carbon sugar, and a phosphate group) molecule that carries hereditary or genetic information for cell function
 - DNA**-Deoxyribonucleic acid-a double-stranded helical shaped nucleic acid that stores hereditary information. Nucleotides: Nitrogen Base (**ATGC**), phosphate group, deoxyribose.
 - RNA**-Ribonucleic acid-a single-stranded nucleic acid involved in protein synthesis. **AUGC**, Ribose

1.3 Explain the role of enzymes as catalysts that lower the activation energy of biochemical reactions. Identify factors, such as pH and temperature, which have an effect on enzymes.

- **Enzymes**-catalytic proteins that speed up chemical reactions within living organisms. Enzymes provide activation energy in living organisms by increasing the speed of a chemical reaction.
- **Activation Energy**-the minimum amount of energy that is needed to start a chemical reaction. Chemical reactions are frequently catalyzed by enzymes
- **Chemical Reaction**-a process during which chemical bonds between atoms are broken and new ones are formed producing different substances.
 - Reactant**-the starting materials for chemical reactions.
 - Product**-newly formed substances.
- Enzymes function within a narrow range of environmental conditions, therefore changes in pH, temperature, salinity and other environmental conditions will effect the action of enzymes.
 - pH**-When an ionic compound is placed in water, forming a solution, the compound breaks apart and releases ions...
 - Acid**- a compound that forms hydrogen (H⁺) ions in water. 0-6.99999 on the pH scale.
 - Base**-a compound that produces hydroxide ions in water (OH⁻) 7.00001 on the pH scale
 - Neutral**-7 on the pH scale

2. Cell Biology

Broad Concept: Cells have specific structures and functions that make them distinctive. Processes in a cell can be classified broadly as growth, maintenance, and reproduction.

2.1 Relate cell parts/organelles (plasma membrane, nuclear envelope, nucleus, nucleolus, cytoplasm, mitochondrion, endoplasmic reticulum, Golgi apparatus, lysosome, ribosome, vacuole, cell wall, chloroplast, cytoskeleton, centriole, cilium, flagellum, pseudopod) to their functions. Explain the role of cell membranes as a highly selective barrier (diffusion, osmosis, facilitated diffusion, and active transport).

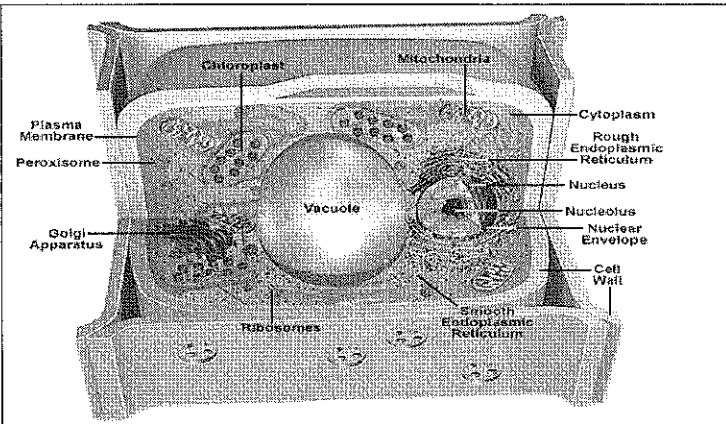
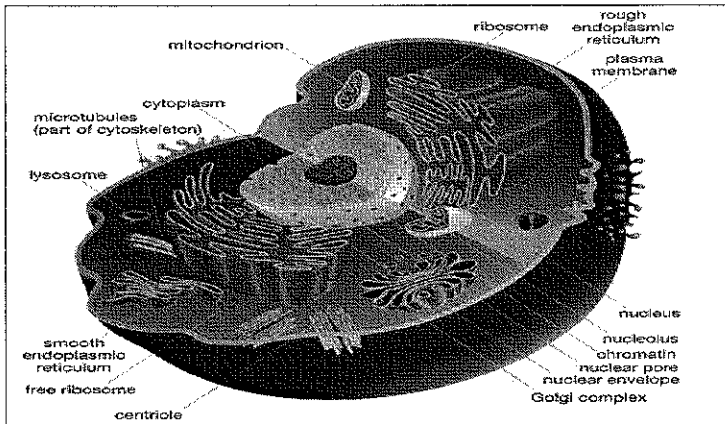
- **Organelle**- "little organs" structures in eukaryotic cells that have a specialized function.

- **Nucleus**-the organelle that houses DNA (genetic information) in eukaryotic cells.
 - Chromosome** “colored body”-a structure made of DNA and associated proteins where genes are located
 - Nucleolus**-a specialized organelle in the nucleus which produces ribosomes
 - Nuclear Envelope/Membrane**-a phospholipid bilayer which separates the nucleus from the cytoplasm
 - Nuclear Pores**-channels in the nuclear envelope which pass substances made in the nucleus (proteins and RNA)
- **Cytoplasm**-a jelly-like material consisting primarily of water and organic compounds occupying the space between the cell membrane and the nucleus. Various organelles are suspended in the cytoplasm.
- **Cytoskeleton**-a network of protein filaments (fibers and tubes) extending throughout the cytoplasm. The cytoskeleton plays a role in cell movement, shape, division, and intracellular transport. The cell membrane and some organelles are anchored to the cytoskeleton
- **Flagella/Cilia**-long thread-like/short hair-like structures that protrude from the cells surface and enable movement
- **Centriole**-microtubules that assist in the division of chromosomes during cellular reproduction.
- **Ribosome**-cell organelles that produce proteins during a process called **protein synthesis**.
- **Endoplasmic Reticulum (ER)**-an extensive system of internal membranes that move proteins and other substances throughout the cell. The ER is often considered an extension of the outer Nuclear Membrane and therefore also consists of a lipid bilayer with embedded proteins.
 - Smooth ER**- produces lipids and membrane proteins and helps to break down toxic substances like alcohol and drugs
 - Rough ER**-helps to transport proteins manufactured in the ribosomes, which dot its surface. Proteins made in the ribosomes dotting the surface of Rough ER pass into the ER through the ER membrane. Then the ER membrane that contains this completed protein pinches off and forms a small membrane bound sac, known as a **vesicle**.
- **Golgi Apparatus**-a set of flattened membrane-bound sacs that serves as the packaging and distribution center of the cell. Some vesicles produced by Golgi Apparatus release their proteins from the cell, while other newly budded vesicles containing **lysosomes** act as the cells digestive enzymes. Enzymes inside the Golgi Apparatus modify proteins received in vesicles from the ER. The modified proteins are then repacked in new vesicles that bud from the surface of the Golgi Apparatus.
- **Lysosomes**-small spherical organelles that contain digestive enzymes, which help to break down large molecules of carbohydrates, proteins, and lipids for use by the cell. Lysosomes also digest old organelles and act as a cell’s recycling center.
- **Mitochondria**-organelles that harvest energy from organic compounds to make **ATP**, the main energy currency of cells they are the power centers of the cell. Mitochondria are membrane-bound organelles with two membranes: a smooth outer membrane and greatly folded inner membranes called **cristae**, which form the compartments where ATP-producing chemical reactions combine sugar and oxygen to make ATP.

Plant Cells contain three additional structures that are not found in animal cells.

- **Chloroplasts** are organelles that contain chlorophyll and use light energy to make carbohydrates from carbon dioxide and water using a process called **photosynthesis**.
- **Cell Wall**-provides shape, protection and interconnectivity to the cell. The cell wall consists of a mixture of proteins and carbohydrates, including cellulose.
- **Central Vacuole**- a large organelle that stores water and may contain a variety of substances including ions, nutrients, and wastes.

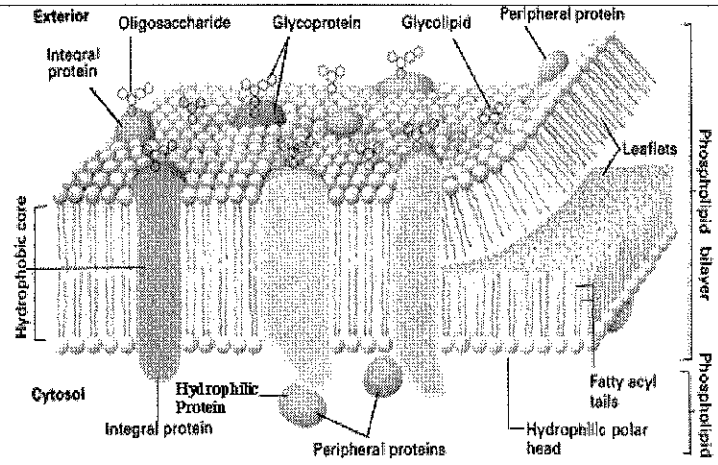
Plant vs. Animal



Cell/Plasma Membrane-a thin layer of lipids and proteins that separates the cell's contents from its surrounding environment. The cell membrane consists of a **phospholipid bilayer** with embedded proteins that encloses the cytoplasm of a cell. The selective permeability of the cell membrane is caused by the interaction of phospholipids with water.

1. A hydrophilic "water-loving" phosphate-based polar head-easily dissolves in water.
2. A hydrophobic "water-fearing" non-polar lipid tail which does not dissolve in water.

The cell membrane is fluid with the consistency of vegetable oil. Proteins found within and on the membrane form patterns/mosaics and move like slow-moving ships at sea resulting in its description in the **Fluid Mosaic Model**



Passive Transport- the movement of substances across a cell membrane without the input of the cell's energy

- **Diffusion**- the movement of a substance from an area of high concentration to an area of low concentration, known as movement down a concentration gradient. Diffusion is caused by the random motion of particles. If diffusion is allowed to continue **equilibrium** results.
- **Osmosis**-the diffusion of water across a selectively permeable membrane cell

Hypotonic Solution-having the lower osmotic pressure of two solutions. If a cell were placed in a hypotonic solution the concentration of solutes would be lower outside of the cell than inside the cytoplasm of the cell.

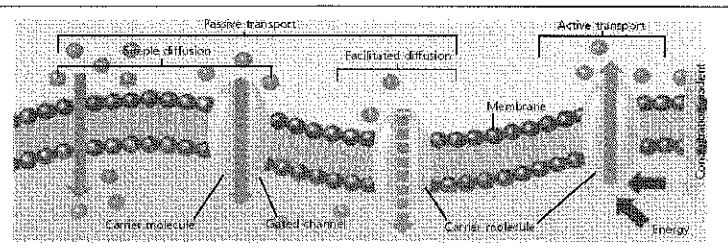
Isotonic Solution-a solution of equal osmotic pressure. In an isotonic solution concentration of solutes outside the cell is equal to that inside the cell.

Hypertonic Solution-having the higher osmotic pressure of two solutions. In a hypertonic solution the concentration of solutes is higher outside the cell than in the cytoplasm of the cell.

Conditions	Environment Outside the Cell	Cell Inside	Water Will Move	
Hypotonic solution 	Solute concentration in the environment is lower than in the cell.	Hypotonic	Hypertonic	Into the cell, and cell will burst
Isotonic solution 	Solute concentration in the environment is equal to that in the cell.	Isotonic	Isotonic	Equal amounts will move into and out of the cell, and cell volume is maintained
Hypertonic solution 	Solute concentration in the environment is higher than that in the cell.	Hypertonic	Hypotonic	Out of the cell, and cell will shrivel

Facilitated Transport- a type of passive transport in which specific substances (such as amino acids and sugars) are transported through proteins down their concentration gradient.

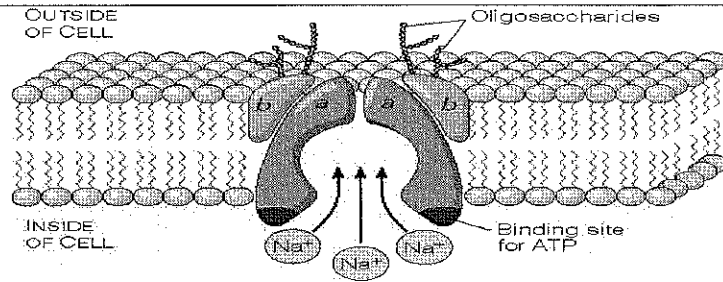
Active Transport-is the movement of a substance across a cell membrane against its concentration gradient. Active Transport requires the expenditure of



energy, which is often supplied either directly or indirectly by ATP.

Sodium-Potassium Pump-a carrier protein that transports sodium ions out of a cell and potassium ions into the cell. This pump actively transports both sodium and potassium against their concentration gradients. The S-P Pump:

1. prevents the toxic build-up of sodium ions that have diffused into the cell through ion channels
2. helps maintain the concentration gradients of sodium and potassium ions across the cell membrane, which facilitates the transport of other substances.



Copyright © 2005 Pearson Education, Inc. publishing as Benjamin Cummings

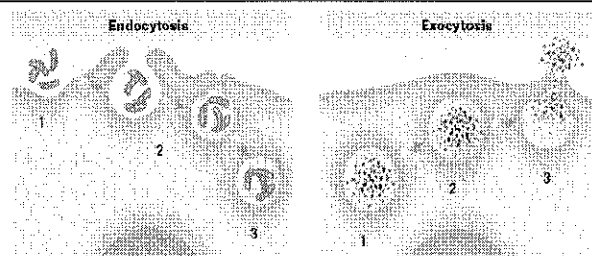
Vesicles-Substances that are too large to be transported by Carrier Proteins, such as proteins and polysaccharides, are moved across the cell membrane by vesicles.

1. Endocytosis-the movement of a substance into a cell by a vesicle

a. Phagocytosis-"cell eating" is the ingestion of solid particles by endocytosis. The cytoplasmic membrane invaginates and pinches off placing the particle in a phagocytic vacuole. The phagocytic vacuole then fuses with lysosomes and the material is degraded.

b. Pinocytosis-"cell drinking" is when a cell takes in liquids.

2. Exocytosis-the movement of a substance out of a cell by a vesicle



2.2 Compare and contrast, at the cellular level, prokaryotes and eukaryotes (general structures and degrees of complexity).

Prokaryote (before nucleus)-a single-celled organism that lacks a nucleus and other internal compartments (membrane-bound organelles). The Kingdoms Eubacteria and Archaeobacteria (the Monerans) are examples of prokaryotes.

vs.

Eukaryote (true nucleus)-an organism whose cells have a membrane-bound nucleus and membrane-bound organelles. Members of the Kingdoms Protista, Fungi, Plantae, and Animalia are eukaryotes. They evolved about 1.5 bya

