I. Characteristics of Living Things

A. Living things are made up of cells
   1. Cell = a collection of living matter enclosed by a barrier that separates the cell from its surroundings
   2. Cells are the smallest units of an organism that can be considered living
   3. Cells grow, respond to their environment, and reproduce
   4. Unicellular = one cell; Multicellular = many cells

B. Living things reproduce
   1. Sexual reproduction = two cells from different parents unite to produce the first cell of the new organism.
   2. Asexual reproduction = the new organism has a single parent

C. Living things are based on a genetic code
   1. DNA (deoxyribonucleic acid) carries the directions for inheritance.

D. Living things grow and develop
   1. Growth can be an increase in size or it can be through development.
   2. Development = when a single fertilized egg divides again and again to form a mature organism
   3. Differentiation = when cell divide they change shape and function to form cells like liver cells, brain cells, skin cells

E. Living things need materials and energy
   1. Metabolism = chemical reactions that allow an organism to build up or breakdown materials for its life processes.
   2. Plants get their energy from the sun and undergo photosynthesis to convert light energy into usable energy for cells
   3. Animals use the energy plants store from photosynthesis to get energy.

F. Living things respond to their environment
   1. Organisms detect and respond to stimuli
   2. Stimulus = a signal an organism responds to

G. Living things maintain an internal balance
   1. Homeostasis = involves internal feedback (like a thermostat) to maintain constant conditions inside the body; like temperature and water content.

H. Living things evolve
   1. Species change over time

II. Biology and Levels of Organization

A. Biology = the study of life
   a. Zoologist = study animals
   b. Botanist = study plants
   c. Entomologist = study insects
   d. Paleontologist = study ancient life

B. Levels of Organization (largest to smallest)
   1. Biosphere = the part of the Earth that contains life, includes: water, land, and air
   2. Ecosystem = a collection of animals that live in a particular place together with their nonliving environment.
   3. Community = different populations that live together in a define area
4. Population - group of individuals of the same species living together
5. Organism - individual living thing
6. Groups of Cells - tissues, organs, and organisms
7. Cells - smallest functional unit of life
8. Molecules - groups of atoms

III. Microscopes
A. Compound Light Microscopes
   1. Microscope contributors
      a. Zaecharia Janseen - around 1595 he put two lenses together and discovered that these lenses could magnify objects
      b. Robert Hooke - in 1665 he wrote about observing little boxes being present in living things when observed through a microscope. He named these little boxes ‘cells.’
      c. Anton van Leeuwenhoek - built over 200 microscopes by mounting lenses on metal frames. He could magnify objects up to 300X. He composed books with sketches and descriptions of his observations. He introduced the world to microbes.

B. Parts of the light microscope and their uses
   - Condenser - The light rays are concentrated on the object to be observed by the condenser
   - Ocular - 10X
   - Objective - 4X scanning
     - 10X low power
     - 40X high dry power
     - 100X oil immersion
   - Light switch
   - Stage - holds the specimen
   - Iris diaphragm - controls the amount of light reaching the object through the condenser
   - Coarse adjustment
   - Fine adjustment
   - Arm and Base - how you carry the microscope

C. Light Microscope
   1. Lower the stage, make sure the microscope is on the lowest magnification.
   2. Place the slide on the stage. The clips do not go over the slide, they are used to hold it in place.
   3. Raise the stage with the coarse adjustment knob, the microscope should be on the lowest magnification.
   4. Use the fine adjustment knob next to focus on the object.
   5. Move to a higher objective if needed.
   6. Fine focus again.

D. Dissecting Microscope
   1. Used to view objects too large or thick for the compound light microscope.
   2. Used to view things in 3-D.
3. Lower range of magnification, 4-40X.
4. Has zoom magnification and there are no separate objective lenses.

E. Microslide viewer
   1. Only used with special slides made for the viewer.
   2. There is no light source or objective lenses.
   3. Only need to focus

F. Electron Microscopes use beams of electrons instead of light to produce images
   1. TEMs (transmission electron microscopes) - shine electrons through a specimen
   2. SEMs (scanning electron microscopes) - scan a narrow beam of electrons back and forth across the surface of a specimen

IV. Cell structure
   A. Introduction: What is a cell?
      a. It is the smallest structural and functional unit of life. There are some organisms made up of a single cell (amoeba), while others are composed of groups of cells that work together to perform a particular function

B. Cell Theory
   1. The cell is the basic unit of life.
   2. Cells come from other living cells.
   3. All living things are composed of cells.

C. Features shared by all cells:
   b. Plasma Membrane – provides the boundary between the internal environment of a cell and the external environment.
   c. Cytoplasm - what the interior of the cell is composed of.
      Eukaryotes - everything enclosed within the plasma membrane (cytosol, cytoskeleton elements, and the organelles, except the nucleus)
      Prokaryotes - all elements including the nucleoid region where genetic material is concentrated.

D. Prokaryotes:
   Lack a true nucleus, lack membrane bound organelles, smaller than eukaryotes. Their genetic material is found in a nucleoid region. They have ribosomes, a cell wall, and a capsule. Representative organisms: Bacteria, Cyanobacteria, and Archaeabacteria.

E. Eukaryotes:
   Posses a true nucleus, have membrane bound organelles. Larger than prokaryotes. Representatives are: Protists, Fungi, Plants, and Animals.

F. Organelles:
   a. Cell membrane - flexible, also called the plasma membrane. Found at the boundary of every cell. Acts as a selective barrier by allowing certain molecules in and out of the cell.
   b. Cytoplasm - every thing in a cell except the nucleus.
   c. Cytosol - semi-fluid part of the cytoplasm.
   d. Cytoskeleton - protein fibers that provide the framework for many cellular activities
e. **Ribosomes** - ‘workbenches’ of the cell, site of protein assembly. Is either free or bound to the ER. Free ribosomes produce proteins for use within the cell. Bound ribosomes produce proteins that leave the cell.

f. **Endoplasmic reticulum** - where membrane components and lipids are synthesized. (with ribosomes rough ER vs. no ribosomes smooth ER) Rough ER synthesizes proteins and the smooth ER synthesizes lipids, detoxifies drugs and poisons that get into your body.

g. **Mitochondria** - ‘power plant’ site of ATP production. ATP is the form of energy the cell uses.

h. **Plasmid** - stores nutrients and pigments

i. **Vacuole** - Membrane bound sac that stores water, sugar and salts. Applies pressure to the cell membrane, causing it to expand and stick close to the cell wall

j. **Lysosome** - Membrane enclosed sacs that contain digestive enzymes that digest macromolecules, such as bacteria.

k. **Golgi body** - Processes, packages, and distributes products made in the ER.

l. **Nucleus** - Contains the genetic information in the cell. Tells each cell what its function is.

m. **Nucleolus** - Site of ribosomal RNA production. It is the location of ribosome assembly.

n. **Nuclear envelope** - surrounds the nucleus separating it from the cytoplasm. It has nuclear pores through which RNA passes through on its way to the ribosomes for translation

G. Compare and Contract Animal and Plant Cells

a. **Plant Cells**:

1. **Cell wall** - Acts as a protective coat, helps to maintain the cell shape, and prevents the cell from bursting in a hypotonic environment.

2. **Chloroplasts** - Only found in green plants and algae. Contains chlorophyll, enzymes, and other molecules that function in photosynthesis. Photosynthesis converts the suns energy to chemical energy (carbohydrates).

b. **Animal Cell**:

3. **Cell Membrane** - composed of phospholipids and proteins.

4. **Centrioles** - Play a part in cellular division.