**CONCEPT:** PROPERTIES OF THE CELL

1. Cells **Evolve,** or adapt to their circumstances over time

□ Complex organic molecules originally came from spontaneous formation in an ancient organic soup

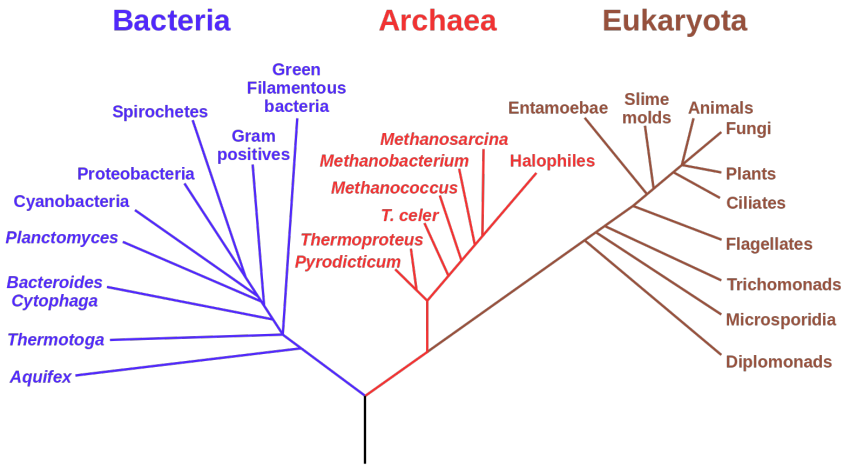
□ Single ancestral cell formed around _____ billion years ago

□ Three domains of living cells have evolved: **Archaea, Bacteria** (**Prokaryotes**) and **Eukarya (Eukaryotes)**

- DNA/RNA sequencing can identify differences and similarities between the domains

- **Mutations**, or changes in the DNA sequence, drive evolution

**EXAMPLE:** Three domains of living organisms




2. Cells are organized, complex, and varied in their size and appearance

□ All cells have a **plasma membrane** that acts to provide shape and support to the cell

- Membranes are made up of **hydrophilic** and **hydrophobic** components that assemble into a **bilayer**

□ Differences in the internal _____ of cells exist between prokaryotes and eukaryotes

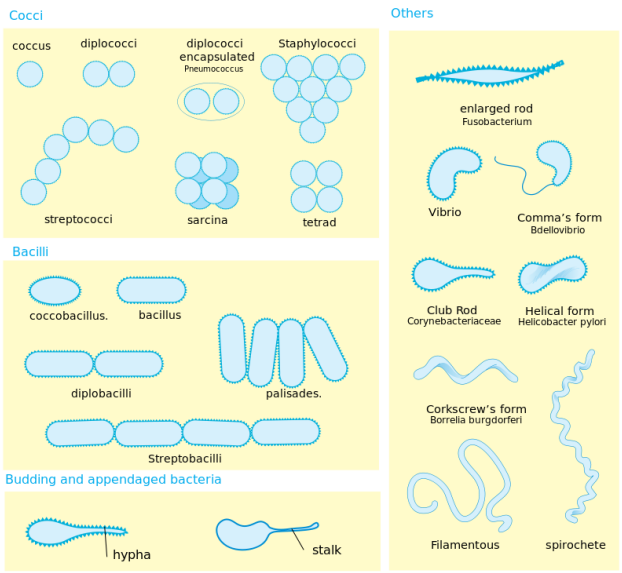
- Eukaryotes have **organelles** and a nuclear envelope to divide DNA from other cellular components

□ There is great diversity in the size and appearance of cells

- Cells size can range from a *Lactobacillus* bacteria (25μm) to a frog egg (1mm)

- Cell shape can extend like a nerve cell or can have projections like an amoeba

**EXAMPLE:** Prokaryotic cell shapes




3. Cells contain a genetic program and mechanisms to control **gene expression**

□ Each cell has a collection of **genes** that are encoded by _____

- **Nucleotides** made with **deoxyribose** sugar, phosphate group, and base (A,T,C,G) = building blocks
- Size of **genome** can vary greatly (smallest = 500 genes; 60 genes are shared by all organisms)

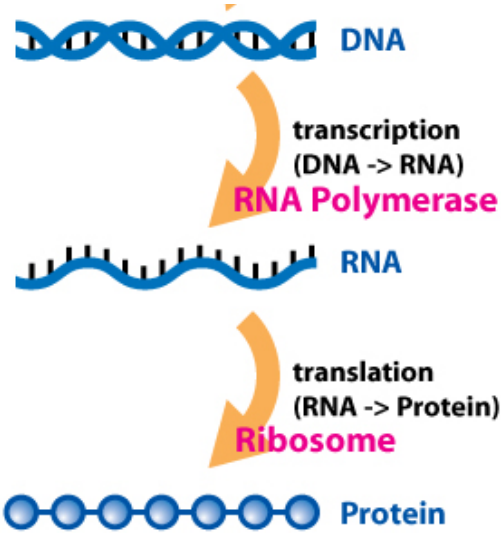
□ **Heredity** is a mechanism of passing genes to offspring

□ To express genes the DNA is **transcribed** to RNA and then **translated** to protein (**Central Dogma)**

- **Messenger RNA** (mRNA) contains Uracil instead of Thymine
- **Transfer RNA** (tRNA) read mRNAs to string together the appropriate amino acid code
  - Occurs in the ribosome – which is made up of **ribosomal RNA (rRNA)**
- Proteins are composed of **amino acids** arranged in a **polypeptide** chain; they can act as **enzymes**
- All cells in a multicellular organism have same genome**;** differences stem from gene expression control

□ Gene expression can also occur through _____ molecules with activities like those of proteins

**EXAMPLE:** Central Dogma of Biology




4. Cells replicate in order to produce more of themselves

□ **DNA replication** is the basis of all cell division

- Each strand of the helix is pulled apart and serves as a **template** during replication

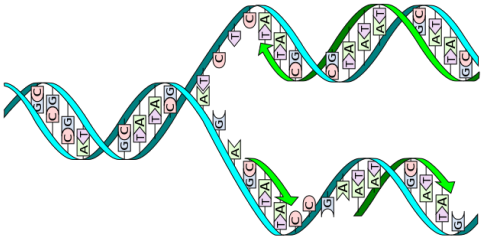
□ Cell **division** results in the production of two separate genetically identical or similar cells

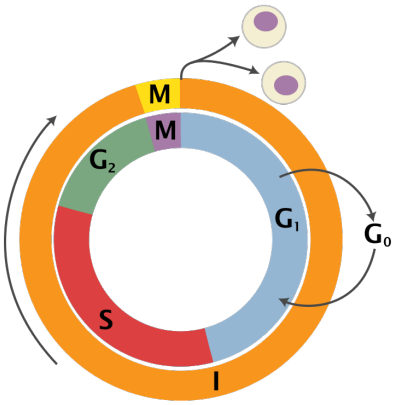
- **Mitosis** creates two genetically _____ cells and consists of three phases: **G, S** and **M**

- **Daughter cells** are produced by asymmetric cell division. These are two genetically different cells.

□ Cells are considered the basic unit of living matter

**EXAMPLE:** During the S phase of Mitosis DNA replication occurs by splitting the two DNA strands





5. Cells require and use energy

□ Source of energy varies greatly

- **Organotrophic:** organisms that harvest energy from other living things

- **Phototrophic:** organisms that harvest the energy of sunlight

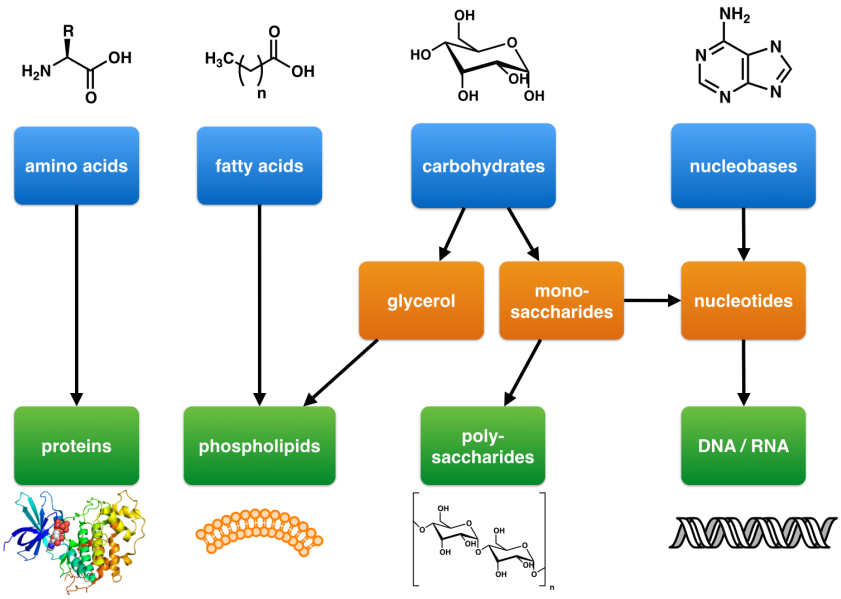
- **Lithotrophic:** organisms that harvest the energy of inorganic chemicals

- **Anerobic** doesn't require oxygen; **aerobic** requires oxygen

□ Cells use _____ to form important **macromolecules** used in a variety of cell functions

□ The principles of **free energy** explain the mechanisms of cell energy acquisition and usage

**EXAMPLE:** The four classes of macromolecules




6. **Metabolism**, or a sum of all chemical reactions in a cell, is a necessary component of cell biology

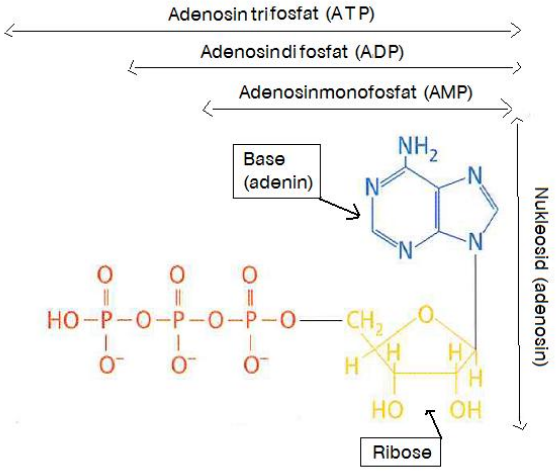
□ Adenosine tri-phosphate (**ATP**) is the main energy _____ molecule that is crucial for cellular activities

□ **Metabolic pathways** are crucial network of chemical reactions responsible for energy transfer.

- Examples include: *Photosynthesis*, *Oxidative Respiration*, and *Glycolysis*

□ Proteins can act as chemical reaction **catalysts**; these proteins are called **enzymes**

**EXAMPLE:** Structure of ATP




7. All cells engage in mechanical activities that help regulate diverse cellular functions

□ _____ of materials in and out of the cell is crucial to keep the cell "running"

- **Diffusion,** or movement of a substance between areas of differing concentration is affected by size

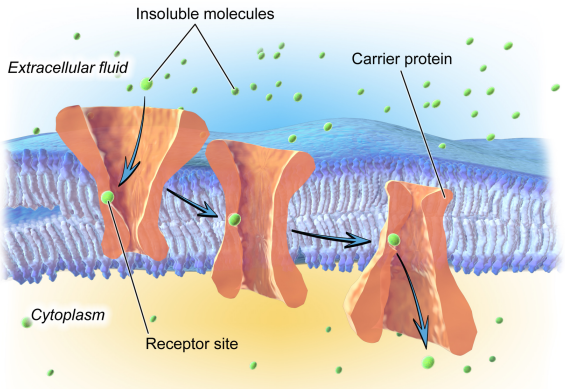
- Material movement is controlled through proteins found in the plasma membrane

- A balanced *surface area to volume ratio* is necessary for cellular uptake/expulsion

□ Assembly and Disassembly of structural components helps provide mechanical support for the cell

- Cell movement occurs through mechanical support and assembly of structural components

**EXAMPLE:** Proteins embedded in a membrane facilitate interaction with extracellular environment



8. Cells respond to external stimuli

□ **Receptors** on the plasma membrane can bind to and respond to _____ signals

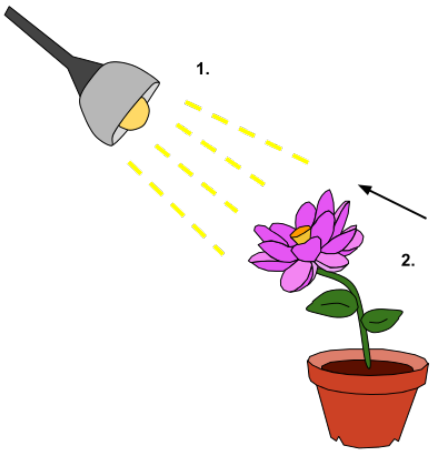
□ Internal cellular responses depend on having proper concentrations of reactants and catalysts

9. Cells self-regulate

□ Plasma membrane helps to regulate the cell's chemistry

□ **Feedback circuitry** are mechanisms that respond to levels of signaling molecules within a cell

**EXAMPLE:** Plant responds to external environment




**PRACTICE:**

1. Which of the following is not a property of all cells?
   a. Evolution
   b. Use of energy
   c. Genetic program to control gene expression
   d. Mobility

2. Which of the following terms describes an organism who obtains energy from sunlight?
    a. Organotrophic
    b. Lithotrophic
    c. Phototrophic
    d. Aerobic

3. True or False: To be considered a cell, it must evolve, have metabolism, replicate its DNA, and never interact with the external environment?
    a. True
    b. False