GHSGT Prep – Biology
Domain 1: Cells & Heredity

I. Structure of Cells

A. Cell membrane
1. composed of phospholipids with a polar head and 2 nonpolar tails
    a. polar heads orient close to water (hydrophilic – water-loving)
    b. nonpolar tails orient away from water (hydrophobic – water-fearing)
2. forms a lipid bilayer because cells are surrounded by water – heads away from middle of membrane; tails make up middle of membrane.
3. membrane proteins are dispersed throughout membrane
    a. peripheral proteins – on interior and exterior surfaces of membrane
    b. integral proteins – embedded into cell membrane
    c. proteins function in transporting substances through membrane; binds to substances to move from outside of cell to inside of cell
4. Fluid Mosaic model
    a. describes the cell membrane if lipids & proteins
5. Is semi-permeable: allows only certain substances to leave and enter the cell

B. Cell Organelles
1. Mitochondria
    a. transfers energy from organic compounds to ATP
    b. "powerhouse" of cell
    c. more numerous in cells that require high energy
    d. composed of outer & inner membranes with many folds (called cristae). Christae enlarge surface area to provide more space for chemical reactions to occur.
2. Ribosomes
    1. functions in protein synthesis
    2. not membrane bound
    3. free ribosomes that float freely in cytosol produce proteins for the cell's use
    4. ribosomes attached to endoplasmic reticulum produce proteins to be shipped out of cell or inserted into cell membrane
3. Endoplasmic reticulum (ER)
    1. primary function is to provide a pathway along which molecules can move from one part of another part of the cell
    2. amount of cell activity determines how many ER are in cell
    3. 2 types of ER
        1. rough ER
            a. has ribosomes attached to surface
            b. produces proteins to be exported from cell or inserted into cell membrane
        2. smooth ER
            a. no ribosomes on surface
            b. synthesis of steroids in gland cells and breaks down toxic substances by liver cells
4. Golgi Apparatus
    1. processes, packages and secretes substances produced by cell
    2. works in close association with ER to modify proteins exported by cell
5. Lysosomes
    1. contains hydrolytic enzymes that digests molecules, old organelles and foreign substances
    2. common in animal, fungal and protest cells, but rare in plants
    3. also aids in development of embryo

6. Microfilaments and microtubules
    a. Microfilaments
        1. made of actin that forms polymer chain
        2. aids in cell movement and in contraction of muscle cells
    b. Microtubules
        1. form spindle fibers during cell division
        2. also aids in providing support to cell
7. Cilia & Flagella
    a. Cilia
        1. small hairs that usually lines the surface of cells
        2. in unicellular organisms, they propel cell through water
        3. in multicellular organisms, they line the surface of cell to move substances across cell membrane
    b. Flagella
        1. usually long and very few in number
        2. aids in movement of cell
8. Nucleus
    a. control center of cell, stores hereditary information in DNA, synthesizes RNA and ribosomes
    b. surrounded by nuclear envelope (membrane)
    c. contains chromatin (becomes chromosomes during cell division) and nucleolus (where ribosomes are synthesized)
9. Cell Wall
    a. found in plants, fungi and some protests
    b. protects and supports the cell
    c. composed of cellulose (plants) or chitin (fungi)
10. Vacuoles
    a. only in plant cells
    b. stores enzymes and metabolic wastes
    c. can take up almost 90% of cell's volume
11. Plastids
    a. only in plant cells
    b. are double membrane (like mitochondria)
    c. stores starch or fats; contains light absorbing pigments (chlorophyll)
    e. chloroplast – most common plastid; contains chlorophyll that gives plants their green color

II. Prokaryote vs. Eukaryotic Cells

A. Prokaryotes
1. believed to be the first cells
2. Characteristics
    a. lack cell nucleus
    b. lacks membrane-bound organelles; does have ribosomes
    c. has circular DNA scattered in cytosol
    d. cell division by binary fission (asexual reproduction)
    e. all unicellular
3. Two kingdoms
    a. Archeabacteria
        1. thrive under extremely harsh environmental conditions
        2. chemosynthesis - uses chemicals to produce organic molecules

b. Eubacteria

1. all other bacteria – true bacteria
2. reproduce by binary fission
3. greatest number (along with archaebacteria) of living things on Earth

B. Eukaryotes

1. Characteristics
   a. DNA in nucleus of cell
   b. membrane-bound organelles
   c. reproduction asexual and/or sexual
   d. larger in size that prokaryotes
2. Four kingdoms
   a. Fungi
   b. Protists
   c. Plantae
   d. Animalia

III. Genetics

A. Mendel's Laws of Genetics

1. Law of Dominance
   a. states that in a given allele pair, of the dominant allele is present that is the trait that will show in the organism
2. Law of Segregation
   a. states that a pair of factors (genes) is segregated, or separated, during formation of gametes
3. Law of Independent Assortment
   a. states that factors (genes) for different characteristics are distributed to gametes independently (randomly)

B. DNA & RNA

1. DNA (deoxyribonucleic acid)
   a. composed of a nitrogenous base, a sugar (deoxyribose) and a phosphate
   b. 4 different nitrogenous bases
      1. adenine
      2. guanine
      3. cytosine
      4. thymine
   c. bases are always paired:
      1. adenine to thymine
      2. guanine to cytosine
   d. structure is a double helix (twisted ladder)
   e. function – stores and transmits the genetic information that tells cells which proteins to make and when to make them
   f. DNA replication
      1. occurs just prior to cell division (mitosis or meiosis)
      2. process of copying DNA
2. RNA (ribonucleic acid)
   a. composed of a nitrogenous base, a sugar (ribose) and a phosphate
   b. 4 different nitrogenous bases
      1. adenine
      2. guanine
      3. cytosine
      4. uracil
   c. bases always paired:
      1. adenine – uracil (or thymine if attached to DNA)
      2. guanine – cytosine
   d. single-stranded, not double
   e. functions – movement of genetic information from the DNA in nucleus to site of protein synthesis (in ribosomes) in cytosol

f. types of RNA
1. messenger RNA (mRNA) – carries genetic information from DNA in nucleus to cytosol of eukaryotic cell
2. transfer RNA (tRNA) – binds to specific amino acids
3. ribosomal RNA (rRNA) – makes up ribosomes where proteins are made

4. Differences between DNA and RNA
a. DNA ia double-stranded; RNA is single-stranded
b. DNA has thymine; RNA has uracil
c. DNA has deoxyribose; RNA has ribose

C. Transmission of Genetic Information
1. Transcription
a. process by which genetic information is copied
b. Steps
1. DNA unzips
2. RNA polymerase separates DNA at appropriate place
3. complimentary RNA bases attaché to DNA bases (A-T, U-A, C-G)
4. stops at termination signal. RNA polymerase releases DNA which then rezips and rewinds
5. mRNA has formed and moves out of nucleus

2. Translation
a. process of assembling polypeptides
b. Steps
1. mRNA (with codon) migrates to ribosome. Codon is a sequence of 3 nucleotides that codes for a specific amino acid.
2. free floating amino acids (in cytosol) are transported to ribosome by tRNA (with anticodon)
3. amino acids continue to be added until stop codon is reached
4. protein is finished

D. Genotypes & Phenotypes
1. Genotypes
a. the genetic makeup of organisms
b. denoted by letter; capital letter for dominant gene, and lower case letter for recessive gene

c. variations in genotype occurs 3 ways
1. mutations
2. recombination
3. random fusion of gametes

2. Phenotypes
a. trait that shows in organism
3. Punnett Square
a. table that shows the probability of a trait in offspring
b. shows both genotype and phenotype

E. Mutations
1. any change in DNA code
2. Types of mutations
a. germ-cell
1. occurs in gametes
2. doesn't affect organism itself, but can be passed on to offspring if affected gamete is fertilized

b. somatic mutation
    1. affects body cells
    2. not passed on to offspring, but does affect organism
c. chromosome mutations
    1. changes in the structure of chromosomes or loss of entire chromosome
    2. types
        a. deletion – loss of a piece of chromosome due to breakage. Causes loss of information
        b. inversion – chromosome segment breaks off and reattaches in reverse orientation on same chromosome
        c. translocation - chromosome piece breaks off and reattaches to a nonhomologous chromosome
        d. nondisjunction - failure of chromosome to separate from its homologue during meiosis
d. gene mutations
    1. can involve large segments of DNA or a single nucleotide
    2. point mutations
        a. substitutions - addition or removal of single nucleotide Ex. sickle cell anemia
        b. frame shift mutation – occurs when a number of nucleotides inserted or deleted is not in multiples of 3

3. Environmental causes of mutations
    a. extreme temperatures
    b. radiation or chemotherapy
    c. chemicals
    d. X-rays
    e. extreme pH

IV. Organic Macromolecules

A. Four main types
    1. Carbohydrates
        a. organic compounds composed of carbon, hydrogen and oxygen; always in a 1:2:1 ratio
        b. functions – major energy source for organisms
        c. 3 categories
            1. monosaccharides
                a. simple sugars – glucose, fructose and galactose
                b. general formula - $(CH_2O)_n$
                c. most common – glucose ($C_6H_{12}O_6$) ; galactose and fructose have some formula, but different shapes
            2. disaccharides
                a. double sugar – sucrose
            3. polysaccharides
                a. composed of 3 or more monosaccharides
                b. stored in animal cells as glycogen
                c. stored in plants as cellulose
    2. Proteins
        a. organic compounds composed of carbon, hydrogen, oxygen and nitrogen
        b. building blocks of proteins called amino acids
        c. 3 parts of an amino acid
            1. carboxyl group (-COOH)
            2. amino group ($-NH_2$)
            3. R group – functional group that determines differences in amino acids

d. peptide bond – joins amino acids together
e. many amino acids bonded together – polypeptide

2. Lipids
    a. large, nonpolar organic molecules that does not dissolve in water
    b. has higher ratio of carbon and hydrogen to oxygen than carbohydrates
    c. function- energy storage and makes up cell membrane
    d. fatty acids
        1. unbranched carbon chains that make up most of lipid with carboxyl group at one end
        2. 2 ends of chain
            a. hydrophilic (water-loving) lines outer and inner boundary of cell membrane
            b. hydrophobic (water-fearing) makes up inside of cell membrane
    e. 3 classes of lipids
        1. triglycerides
            a. 3 fatty acids and 1 glycerol
            b. 2 main types
                1. saturated – animal fats
                2. unsaturated – plant seeds and fruit
        2. phospholipids
            a. 2 fatty acids and 1 glycerol
            b. makes up cell membrane
        3. waxes
            a. 1 fatty acid and 1 alcohol chain
            b. waterproof; protects cells
    f. steroids
        1. composed of 4 fused carbon rings with various functional groups
        2. cholesterol – needed for cells to function

V. Classification

A. Organized according to:
    1. morphology
    2. physical characteristics
    3. evolutionary history
    4. fossil record
    5. chromosomes and macromolecules
    6. embryological development

B. Six Kingdoms
    1. Archaebacteria
        a. unicellular, prokaryotic
        b. some produce food by chemosynthesis
        c. some autotrophs
        d. most live in extremely harsh environments
        e. reproduce by binary fission
    2. Eubacteria
        a. unicellular, prokaryotic
        b. most use oxygen; few anaerobic
        c. reproduce by binary fission
    3. Protista
        a. eukaryotic
        b. unicellular and multicellular
        c. lack specialized tissues
        d. most reproduce by asexual reproduction
        e. can be heterotroph or autotroph

4. Fungi
    a. eukaryotic
    b. most multicellular; few unicellular (yeasts)
    c. obtains energy from absorbing nutrients
    d. sexual and asexual reproduction
5. Plantae
    a. eukaryotic, multicellular
    b. autotrophic; few parasitic
    c. mosy land-dwelling
6. Animalia
    a. eukaryotic, multicellular
    b. heterotrophs
    c. most symmetrical body organization
    d. reproduce sexually