1. Cell cycle

a. Reason for division- as cells increase in volume, the surface area decreases and demand for material resources increases which limits cell size

b. Smaller cells have a more favorable surface area-to-volume ratio for exchange of materials with the environment (diffusion, etc.). High SA:V ratio is favorable. Ex. 6:1 is better than 6:5

c. Cell cycle switches between interphase and cell division.

d. Interphase has three phases: growth (G1), synthesis of DNA (S) and preparation for mitosis (G2).

e. During mitosis duplicated chromosomes line up in center with spindle fibers attached to help pull them apart. Duplicated chromosomes are pulled apart by spindle fibers.

f. Cytokinesis-division of cytoplasm and reformation of cell membrane. Animal cell- pinches in (cleavage) using microfilaments; plant cell- form cell plate reforms cell wall.

g. The cell cycle is directed by internal controls or checkpoints. Internal (enzymes and promoting factors) and external signals (growth factors) provide stop and- go signs at the checkpoints. Ex. Mitosis-promoting factor (MPF)

h. Cancer results from disruptions in cell cycle control (too much division, defective tumor suppressor genes, overactive genes) which are a result of DNA damage to proto-oncogenes (regulatory genes) which make products like cyclins and cyclin-dependent kinases.

i. Cells spend different amounts of time in interphase or division. Nondividing cells may exit the cell cycle; or hold at a particular stage in the cell cycle.

j. Mitosis is used for growth and repair in animals; plants use mitosis to make gametes and for growth or repair.

k. Mitosis usually begins with 1 cell, makes 2 identical cells or clones; maintains chromosome number; 1n🡪1n or 2n🡪2n.

l. Meiosis (occurs after interphase) takes diploid cells and reduces the chromosome number to haploid. 2n🡪1n.

m. During meiosis, homologous chromosomes are paired (one from mom and one from dad) and line up in the center of the cell randomly. The homologues are pulled apart and separated in meiosis I. A second division occurs in which the duplicated chromosomes are pulled apart.

n. Variation occurs in gametes during “crossing over,” and fertilization because of all possible combinations of homologous chromosomes aligning during metaphase I.

2. Mendel’s Laws (remember he laid groundwork for genetics, but these rules can all be broken looking at chromosome theory and molecular genetics)

a. Law of Dominance- one allele will be expressed over another (ex. Aa – if big A is purple it will be seen over little a which is white)

b. Law of Segregation- alleles pairs separate from each other during meiosis

c. Law of Independent Assortment- alleles assort independently during meiosis IF they are on separate chromosomes (i.e. AaBb can make gametes AB, Ab, aB or ab)

3. Probability, Patterns and Exceptions to Mendel’s Rules

a. product rule- multiply chance of one event happening by the chance of another event happening to get the chance of both events occurring together

b. autosomal vs. sex-linked (on the X or Y chromosome)

c. monohybrid cross; one trait; 3:1 (Aa x Aa); 1:1 (Aa x aa) or 4:1 (AA x\_), (aa x aa)

d. dihybrid cross; 9:3:3:1 genotype (AaBb x AaBb) or test cross 1:1:1:1(AaBb x aabb)

e. Thomas Hunt Morgan- fruit flies, X- linked traits

(1) male- heterozygous XY; Y chromosome is very small in mammals and fruit flies with few genes

(2) female- homozygous XX

(3) single gene mutations on X chromosome cause disease such as hemophilia or colorblindness

(4) sex limited traits are dependent on sex of individual like milk production or male patterned baldness

f. incomplete dominance- red X white 🡪 pink; both protein product are expressed and blended

g. codominance- red x white 🡪 red and white; both protein products are equally expressed ex. AB blood types

h. epistasis- one gene affects expression of another

i. linked genes- genes on same chromosome that are inherited together (can be unlinked by crossing over); recombination frequency calculated by recombinants/total; used for chromosome mapping; genes further apart cross over more often

j. gene/environment- phenotypes affect by environment, Siamese cat, flower color with soil pH, seasonal color in arctic animals, human height and weight

k. polygenic- continuous variation, many genes affect one trait- height, color

4. Human Genetics

a. karyotype- 22 pair autosomes & 1 pair sex chromosomes + 46 total chromosomes

b. Chromosomal Mutations (occur during gamete formation)

(1) deletion, inversion, addition of genes as a result of crossing over mistakes

(2) chromosomal number abnormalities 🡪 nondisjunction is failure of chromosomes to separate at anaphase of meiosis