GENETICS & DNA STUDY GUIDE Key

1. Gregor Mendel is known as the "father of genetics."
   a. He performed his experiments on pea plants.
2. The factors that are passed on from parent to offspring are called genes. Different forms of genes are known as alleles.
   a. Organisms have 2 alleles for each gene.
   b. Offspring inherit 1 allele(s) from mom, and 1 allele(s) from dad.
3. The Principle of Dominance states that one allele may cover up another allele—some alleles are dominant and others are recessive.
   a. The allele doing the covering up is dominant; the allele getting covered up is recessive.
   b. Organisms that have TWO copies of the SAME allele for a gene (TT, tt) are homozygous for the trait.
   c. Organisms that have two DIFFERENT alleles for a gene (Tt) are heterozygous for the trait.
4. The genotype of an organism shows its GENETIC makeup (letters—Tt, tt, GG, etc).
5. The phenotype of an organism shows its PHYSICAL makeup (short, tall, green, etc).
6. A Punnett square uses mathematical probability to help predict the genotype and phenotype predictions in genetic crosses.
   a. Monohybrid Crosses look at the inheritance of 1 trait, whereas dihybrid crosses look at the inheritance of 2 traits.
7. Other than dominant and recessive alleles, there are other methods of inheritance:
   a. Incomplete Dominance occurs when one allele is not completely dominant over another—the heterozygous phenotype looks like a mix or blend of the two homozygous phenotypes.
   Example: (RR-Red, RW- Pink, WW- White)
   b. Codominance occurs when the phenotypes of both alleles are clearly expressed, causing a banding, spotting, or speckling pattern for the heterozygous phenotype.
   Example: (BB- Black, BW- Spotted Black and White, WW- White)
8. Many genes exist in more than two forms—a gene with more than two alleles is said to have multiple alleles
   Example: Rabbit coat color, human blood type
   a. The three alleles for human blood type are I^A, I^B, and i. (A, B, O > either order)

Blood Type	Genotype
b. A	c. $I^A I^A$ or $I^A i$
d. B	e. $I^B I^B$ or $I^B i$
f. AB	g. $I^A I^B$
h. O	i. ii

9. Many traits are produced by the interaction of several genes, like hair color, eye color, and skin color—traits controlled by two or more genes are called polygenic traits.
10. The environment also affects gene expression and influences genetically determined traits—hydrangea flowers change colors based on the soil's pH; Siamese cat fur is darker in areas of cooler temperature; alligator sex is determined by the incubation temperature of the eggs

11. In diploid (2N) cells, there are two sets of each chromosome—one from the female parent and one from the male parent.
    a. These pairs are known as homologous pairs.
    b. In human diploid cells there are 46 total chromosomes.
12. In a haploid (1N) cell, there is only ONE single set of chromosomes.
    a. In human haploid cells, there are *half* the number of chromosomes: 23 total chromosomes.
13. Meiosis is a process of reduction in which the chromosome number is cut in half through the separation of homologous chromosomes—meiosis produces [(haploid) diploid] gametes.
14. A tetrad consists of a homologous pair of chromosomes, each made of two chromatids (for a total of 4 chromatids—"tetra" means "4").
15. As homologous chromosomes pair up and form tetrads, they exchange portions of their chromatids in a process called Crossing over, which increases genetic variation.
16. In males, haploid gametes are called sperm.
17. In females, haploid gametes are called eggs.
18. Comparing mitosis and meiosis:

    Mitosis produces 2 (#) genetically identical cells, whereas meiosis produces 4 (#) genetically different cells. Mitosis produces diploid (2N) cells. Meiosis produces haploid (1N) cells. Mitosis allows an organism to grow and heal, whereas meiosis is used to produce sex cells/gametes
19. Linked genes are genes located on the same chromosome that will be inherited together. The farther apart the genes are located on a chromosome, the less likely they will be inherited together.

20. A Karyotype is a map of homologous chromosomes arranged in order of decreasing size.
    a. Chromosome pair #23 are the chromosomes which determine an individual's sex.
        i. Female sex chromosomes are XX. Male sex chromosomes are XY.
        ii. A sex-linked gene is a gene located on a X or Y chromosome
    b. The remaining 44 chromosomes (pairs #1-22) are known as autosomes.
21. A pedigree is a diagram that follows the inheritance of a single gene through several generations of a family. Males are represented by squares. Females are represented by Circles.
22. An error in meiosis called nondisjunction occurs when homologous chromosomes fail to separate. This causes gametes to have an abnormal number of chromosomes. Ex: Down Syndrome

23. Trisomy, or 3 sets of chromosomes, at #21 causes Down syndrome.
24. Klinefelter's syndrome results from the inheritance of an extra X chromosome at pair #23. No babies have ever been born without an X chromosome, meaning it is vital for survival.

25. DNA is capable of storing, copying, and transmitting genetic information in a cell.
26. DNA is a macromolecule made up of individual monomers called nucleotides. Each nucleotide contains three parts: 1) deoxyribose sugar, 2) phosphate, and 3) nitrogenous base.
27. Name the 4 nitrogenous bases in DNA: adenine, thymine, guanine, cytosine
28. A pairs with T; C pairs with G
29. Watson & Crick developed the final model of DNA in the shape of a double helix (twisted ladder)
30. The sides of the "ladder" are made up of sugar + phosphate.
31. The bases are bonded to one another using hydrogen bonds.
32. Before a cells divides, it duplicates its DNA in a process called DNA Replication.
33. During replication, DNA "unzips" and each strand serves as a template for the new DNA strand being formed. This results in TWO DNA molecules, each with one old strand and one new strand.
34. If a DNA strand had the bases CTAGGT on its original strand, what bases would there be on the new strand? GATCCA
35. Genes are coded DNA instructions that control the production of proteins within a cell. However, DNA cannot leave the nucleus because it is too large to fit through the nuclear pores. Therefore, it uses mRNA to carry instructions out to the ribosomes in the cytoplasm for protein production.
    a. Both DNA and RNA are nucleic acids.

	DNA	RNA
# of strands	b. 2	c. 1
Sugar	d. deoxyribose	e. ribose
Bases Used	f. ATCG	g. AUCG → uracil

36. Proteins are made by joining amino acids into long chains called polypeptides.
37. The mRNA instructions from the nucleus are read 3 (#) letters at a time. Each three-letter "word" is known as a codon and codes for a specific amino acid. You can use a codon chart to determine the amino acid needed.
    a. If 3 nucleotide bases are needed to specify ONE amino acid, how many nucleotides would be needed to make a protein with THREE amino acids? 9 bases (123, 456, 789 → aa aa aa)
38. A mutation is a change in the genetic material. Point mutations only involve a few nucleotides. Frameshift mutations, like deletions or insertions, can change the entire reading sequence or frame of codons.

You should be able to...

- Set up and solve Simple, Codominance, and Incomplete Dominance Punnett squares,
- Determine the % of genotypes and phenotypes produced in a Punnett square cross
- Determine the blood type of offspring when given that of the parents
- Find the genotypes in a simple pedigree
- Interpret the genotype and phenotype from a completed Punnett square with more than one trait
- Put the stages of meiosis in order
- Describe the purpose of meiosis
- Read a karyotype to determine sex and whether or not a chromosomal disorder exists
- Determine whether a sequence of nucleotides comes from RNA or DNA (remember Uracil v. Thymine)
- Give the complementary strand of "New DNA" when given the "Old DNA" template
- Use a codon chart to determine the amino acids needed from an RNA strand

Practice Problems

- End of Chapter and End of Section Assessments for Ch 11, 12, 13, 14
- SOL Test Prep Questions for Ch 11, 12, 13, 14
- Old Homework Worksheets
- Practice Problems from Class Notes