STUDY GUIDE - *Ch. 14.2 – Probability Laws Govern Mendelian Inheritance* **NAME:** _____

- **PHYSICALLY PRINT OUT this PDF and HANDWRITE (with a black or blue pen) your answers directly on this PDF.** *Typed or digitally-written work is **not** accepted. Do **not** answer questions on separate paper.*
- **Importantly, study guides are NOT GROUP PROJECTS!!!** *You, and you alone, are to answer the questions as you **read** your assigned textbook. You are **not** to share answers with other students. You are **not** to copy any answers from any other source, including the internet.*
- **Get in the habit of writing LEGIBLY, neatly, and in a medium-sized font.** *AP essay readers and I will skip grading anything that cannot be easily read so start perfecting your handwriting, and don't write so large you can't add all the relevant details and key elaborations in the space provided.*
- **SCAN physical documents in color and with good resolution. Then, upload your final work as PDFs to Archie.** *Avoid uploading dark, shaded, washed-out, sideways, or upside-down scans of homework. Keep completed physical study guides organized in your biology binder to use as future study and review tools.*
- **READ FOR UNDERSTANDING and not merely to complete an assignment.** ***First**, read a section quickly to get an overview of the topic covered. Then, read it a **second** time slowly, paraphrasing each paragraph **out loud** and analyzing every figure. Finally, read it a **third** time as you answer the study guide questions if assigned and start building your memory. Try to write answers out in your own words, when possible, and try to purposefully and accurately use all new terminology introduced.*

1. **An event that is certain to occur has a probability of _____, while an event that is certain not to occur has a probability of _____.**

2. a. First, define when you use the **Multiplication Rule**.

   b. Next, define when you use the **Addition Rule**.

3 a. When you toss a die, there are 6 possible outcomes. What is the probability that you toss a die and it landing with 3 pips showing?

   b. What is the probability of getting 3 pips on one toss AND 5 pips on another toss? *Always show your work.*

   c. What is the probability of getting 3 pips OR 5 pips on a toss? *Always show your work.*

   d. What is the probability of getting a number of pips other than 3 on a die toss? ***Explain in words & show your work.***

Remember, to follow these steps when making a Punnett Square:

1. First, figure out the **genotypes of the two parents** that are being crossed (mated)**!!!**
2. Then, determine the **genotypes of the possible gametes** (reproductive cells: sperm & eggs) the parents can make.
3. Then, place the gametes along the top and side of the Punnett Square.
4. Within the boxes of the Punnett Square combine the gametes to show the **possible fertilization events** that could occur between the different gametes that your parents can produce.

➡ **The Punnett Square, thus, shows you the types of offspring (genotypes & their corresponding phenotypes) that two parents could make.**

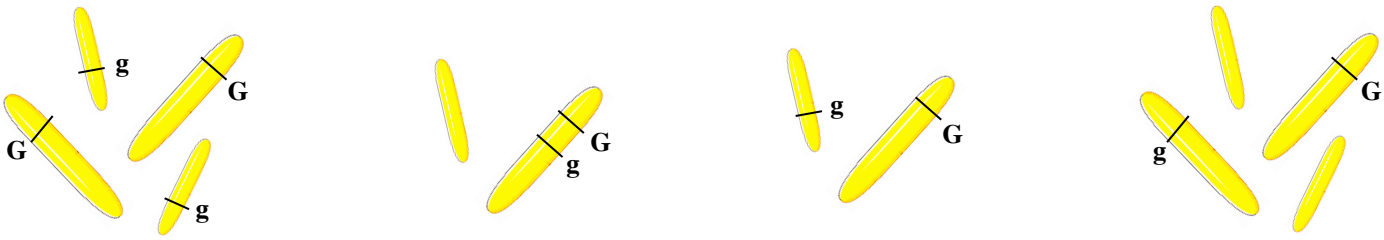
➡ **It also tells you the likelihood (probability/frequency) of get getting the different types of offspring.**

- The Punnett Square does **NOT** tell you which of the possible offspring **WILL** be produced.
- The Punnett Square does **NOT** tell you **HOW MANY OF WHICH** type of possible offspring will be produced.
- Just because an offspring with a certain genotype can be produced, that does **NOT** mean that that **WILL** be one of the offspring produced.

FYI - The math behind your answers to question #3 is a. 1/6, b. 1/6 **x** 1/6 = 1/36, c. 1/6 **+** 1/6 = 2/6 or 1/3, d. Probability of getting 1 pip or 2 pips or 3 pips or 4 pips or 5 pips or 6 pips is 1/6 **+** 1/6 **+** 1/6 **+** 1/6 **+** 1/6 **+** 1/6 = **1**. The probability of getting 3 pips is 1/6. The probability of getting all pip numbers except 3 is 1 **-** 1/6 = 5/6

4. a. *Think:* An organism has genotype Gg and phenotype green pod color. Is this organism haploid or diploid? **Why?**

b. *Think:* Below are the contents of four hypothetical nuclei. Circle the one containing the correctly drawn and labeled chromosomes, carrying the pod color alleles that corresponds to the Gg genotype notation. *Let's assume this organism's haploid number is n=2.*



Explain why you selected the illustration you did. *Refer back to Ch.12 and 13 if you are unsure to review the basics about* ***chromosome structure, homologous chromosomes****, and* ***cell ploidy.***

c. *Practice:* What is the probability that a heterozygote for green pod color (Gg) produces **gametes** *(**not** offspring)* with allele G? *Report your answer as a fraction and **explain** why you concluded what you did.*

d. *Practice:* What is the probability that a heterozygote for green pod color (Gg) produces **gametes** *(**not** offspring)* with allele g? *Report your answer as a fraction and **explain** why you concluded what you did.*

e. *Practice:* What is the probability that an **offspring** (a **zygote**) will be produced with two G alleles (GG) from a cross between two heterozygotes (Gg). Show your mathematical calculation as you **use the Law of Multiplication** to derive your answer. ***Do NOT draw a Punnet Square this time to answer this question!!***

5. a. What proportion of offspring form a **DD x Dd** cross are expected to be homozygous dominant? Produce your answer by **building a Punnett Square** and **visually** determining your chance of making a homozygous dominant offspring. *Report your final answer as a fraction.*

b. Now, produce the answer you did above by **using the laws of probability instead of your Punnett Square**. (So, **FIRST** figure out the probability (a fraction) of each parent making the gamete that will allow you to produce a homozygous dominant offspring. **THEN** calculate the probability that both these gametes will join together to produce the homozygous dominant zygote/offspring). ***Explain each step and show all your work.*** *Report your final answer as a fraction.*

c. Using the laws of probability again, what is the chance of getting an offspring that is homozygous recessive? ***Explain each step,*** *show your calculations, and report your final answer as a fraction.*

d. Using the laws of probability again, what is the chance of getting an offspring that is heterozygous? ***Explain each step,*** *show your calculations, and report your final answer as a fraction*

FYI - The partial answers to 4.a-e are a. diploid, b. nucleus #4, c. 1/2, d. 1/2, e. 1/2 x 1/2 = 1/4.
The math behind the answers to 5.a-d are a. 1/2 based on the fact that 2 out of the 4 boxes show DD offspring, b. 1 x 1/2 = 1/2, c. 0 x 1/2 = 0, d. 1 x 1/2 = 1/2.

Read carefully the remainder of Ch.14 Section 2 in your textbook, making sure you understand the examples in the rest of the section before proceeding to the practice problems below.

6. a. An organism with the genotype **BbDD** is mated to one with the genotype **BBDd**. Assuming independent assortment of these two genes *(that these two genes are located on **DIFFERENT** types of chromosomes in the set of chromosomes that defines the species)*, write the genotypes of all possible offspring from this cross. Construct ***ONE*** *Punnett Squares to answer. (Again, each gamete a parent makes must contain one copy of **both** genes because each parent contributes one set of chromosomes to their offspring)*

b. Now, **use the rules of probability** *(instead of your Punnett Square)* to mathematically calculate the chance that each genotype you mentioned above occurring. *For **each** genotype probability calculation, **show and explain your work**.*

For example, one offspring genotype you should have listed in part 1 is **BBDD.** So, what steps should you take to calculate the chance that these parents make an offspring with genotype BBDD using the rules of probability?

1. We will assume for now that the B and D genes sort independently. So since the allele for the B genes is located on a different type of chromosome from the allele for the D genes, let's treat each gene separately.

2. The probability that parent #1 (Bb) makes the B gamete is 1/2.
3. The probability that Parent #2 (BB) makes the B gamete is 1.
4. Thus, the probability that the B gamete from parent #1 **AND** the B gamete from parent #2 combine in a zygote (BB) is 1/2 x 1 = **1/2.**
5. The probability that parent #1 (DD) makes the D gamete is 1.
6. The probability that parent #2 (Dd) makes the D gamete is 1/2.
7. Thus, the probability that the D gamete from parent #1 **AND** the D gamete from parent #2 combine in a zygote (DD) is 1 x 1/2 = **1/2.**
8. Finally, the probability that the zygote inherits **BOTH** the BB genotype **AND** the DD genotype is **1/2** x **1/2** = **1/4**

Now, you should list and show the same 8 steps for EACH of the other **(3)** possible offspring this cross can produce.

Offspring possibility #2

Offspring possibility #3

Offspring possibility #4

*(Check your answers to question #6 above by going to the **Ch.14.2 Concept Check Question #2** answer in Appendix A)*

7. *Practice:* A dihybrid cross is conducted between two heterozygotes for green pod color and round seed shape (**GgRr**). What **percentage** of offspring would be predicted to exhibit the recessive phenotype for at least 1 character? *(Explain how you will derive your answer, following your explanation with the step-by-step calculations made)*

   Hint - Since these genes sort independently, **now make two monohybrid crosses**, one for one gene and one for the other. Then, use your rules of probability to combine the genotypes of offspring to produce the phenotype you are looking for to finish your calculations with.

8. *Practice:* Three characters (flower color, seed color, and pod shape) are considered in a cross between two pea plants **PpYyIi x ppYyIi.** Using the rules of probability, what fraction of offspring would be predicted to showcase the recessive phenotype for at least two of the three characters? ***Explain*** *how you will derive your answer, following your explanation with the step-by-step calculations made.*

*(Check your answers to questions #8 above by going to the **Ch.14.2 Concept Check Question #3** answer in Appendix A)*

FYI - Did you get 43.75% for question #7 above???