Dihybrid Cross vs Dihybrid Test Cross

The names of the type of mating pattern are very important to understand and memorize for genetics. Many students either begin confused or forget about the difference between a dihybrid cross and dihybrid test cross. To understand the difference, this document will break down the words, explain their meaning, and detail the ratios for both mating situations.

The word dihybrid explains the genotype of an individual. The prefix “di” means two. The “hybrid” portion of the word means mixed. A dihybrid is an individual who is heterozygous for two genes. These individuals have a dominant and a recessive allele for each of the genes. Because dominant alleles are always expressed in mendelian genetics, a dihybrid individual will have the dominant phenotype for both characteristics the genes code for.

A test cross is a mating situation where one parent is a true breeder who is homozygous recessive. They will be homozygous recessive for every gene of interest. Because they do not have any dominant alleles, they have a recessive phenotype. A test cross can be used to determine the genotype of another individual by looking at offspring phenotypic ratios. A test cross is completed always with a homozygous recessive individual because it makes it easy to understand where all the alleles in the offspring came from. A homozygous recessive individual is used instead of a homozygous dominant individual because a recessive allele cannot mask any other alleles from being expressed and the phenotype of the offspring will explain the genotype. A homozygous (true breeder) individual is used instead of any other type of individual to be able to easily track which alleles came from which parent. A true breeder only has one possible gamete genotype.

A dihybrid cross is a mating situation where two dihybrid individuals are mated together. This results in a 9:3:3:1 offspring phenotypic ratio. 9/16 individuals have the dominant phenotype for both characteristics, 3/16 individuals will have the dominant phenotype for the first characteristic and the recessive phenotype for the second characteristic, 3/16 individuals will have the recessive phenotype for the first characteristic and the dominant phenotype for the second characteristic, and 1/16 individuals will have the recessive phenotype for both characteristics. The Punnett square below shows where these ratios come from.

	AB	Ab	aB	ab
AB	AABB	AABb	AaBB	AaBb
Ab	AABb	AAbb	AaBb	Aabb
aB	AaBB	AaBb	aaBB	aaBb
ab	AaBb	Aabb	aaBb	aabb

Decipher:

Dominant for gene A Dominant for gene B	Dominant for gene A Recessive for gene B	Recessive for gene A Dominant for gene B	Recessive for gene A Recessive for gene B

A dihybrid test cross is a mating situation where a dihybrid is mated as part of a test cross. This means a dihybrid mates with a homozygous recessive individual. This results in a 1:1:1:1 ratio because only the dihybrid's gamete can differ. The true breeder only has one option for the genotype of gamete they can donate. The Punnett square below shows where these ratios come from.

A 4x4 Punnett square can be done for this mating situation, but because the true breeder can only produce one option for sperm, every column would contain the same information:

	ab	ab	ab	ab
AB	AaBb	AaBb	AaBb	AaBb
Ab	Aabb	Aabb	Aabb	Aabb
aB	AaBb	AaBb	AaBb	AaBb
ab	aabb	aabb	aabb	aabb

Instead of making such a large Punnett square, a much smaller Punnett square like the one below can be used:

	ab
AB	AaBb
Ab	Aabb
aB	AaBb
ab	aabb

Decipher:

Dominant for gene A Dominant for gene B	Dominant for gene A Recessive for gene B	Recessive for gene A Dominant for gene B	Recessive for gene A Recessive for gene B

Learning Objectives:

- Understand the difference between dihybrid crosses and dihybrid crosses.
- Be able to identify if a problem is an example of a dihybrid cross or dihybrid test cross.
- Memorize and be able to apply ratios for dihybrid crosses and dihybrid test crosses. Be able to explain why their ratios are different.
- Master the ability to use expected ratios and data to explain the mating situation and identify which alleles are dominant.
- Be able to use expected ratios to predict how number of offspring in phenotypic classes.
- Understand how to and be able to list possible genotypes of individuals given their phenotype when given parental phenotype, offspring phenotype and number of offspring, and when asked about standard expected ratios.

Order of Activities:

1. Watch this video that explains dihybrid crosses: https://youtu.be/3Sd87aIMr3k
2. Read this article explaining how Mendel learned about the dihybrid cross ratio. Notice the explanation of a dihybrid individual. https://www.nature.com/scitable/definition/dihybrid-cross-dihybrid-303/
3. Watch this video to understand the reasoning behind all test crosses: https://youtu.be/0Qsp5bo3tCo
4. Test yourself by completing the corresponding worksheet for this material. Attempt to first complete this on your own, then pair up with a partner or group to discuss when possible. There is an answer key provided so you can check your work and read through all explanations for the questions. Any questions you get wrong or confused about you should attempt to explain why the answer is correct and then complete again after you finish the activities in this guide.
5. After reviewing any topic, it is a good idea to have a metacognition check. Ask yourself the following questions:

    - What are my emotional responses to learning this material? Which material am I frustrated with and need aid in understanding?
    - What difficulties have I had with the learning tasks? What specific tasks will I do to master this content?
    - Do I understand all of the learning goals? Can I explain each of them out loud to someone clearly and concisely?
    - How is what I learned related to other things I have learned in this class? How is it related to other classes, my career, and my life?

6. If you would like to have more aid in learning this material, please reach out. There are numerous individuals who want to help you feel confident in your understanding. If your course has learning assistants or teaching assistant(s), you should reach out to them to review concepts you want to learn more about. Your professor is also a great resource to go to when you do not understand a topic. You can study with your peers or receive academic support through the LRC as well. If you would like help identifying how to receive the support you need, do not hesitate to contact the CU Denver Learning Resources Center at LRC@ucdenver.edu or stop by our front desk in the learning commons building.
7. Attempt the following problem set for all topics you have covered so far in your course. This problem set contains additional topics that are explored throughout the semester. https://www.k-state.edu/parasitology/biology198/answers2.html
8. Challenge: Think about how dihybrid crosses and dihybrid test crosses compare to other ratios you have learned about. Complete the chart found here to organize your notes and have a deeper understanding of how the ratios compare to each other. Make a table comparing the ratios and an explanation of what they mean, the number of genes, the number of phenotypic classes, and the parents' genotypes and phenotypes. Reminder, you may see problems where the type of mating situation is not explicitly stated. For such problems, you will have to determine the mating situation to fully and correctly answer the question.