Georgia Performance Standards Framework for Biology 9-12

Unit: Growth and Heredity
Differentiated Task

Genetic Variability and the Dihybrid Cross

Overview: The purpose of this task is to demonstrate the role of meiosis in reproductive variability using Mendel's Laws and a dihybrid cross simulation. As a result of this activity students will be able to describe the role and mechanisms of DNA in genetic inheritance and to explain the function of meiosis as a mechanism of reproductive variability.

Standards (Content and Characteristics):

SB2. Students will analyze how biological traits are passed on to successive generations.
- b. Explain the role of DNA in storing and transmitting cellular information.
- c. Using Mendel's laws, explain the role of meiosis in reproductive variability.

SCSh1. Students will evaluate the importance of curiosity, honesty, openness, and skepticism in science.
- a. Exhibit the above traits in their own scientific activities.
- b. Recognize that different explanations often can be given for the same evidence.
- c. Explain that further understanding of scientific problems relies on the design and execution of new experiments, which may reinforce or weaken opposing explanations.

SCSh6. Students will communicate scientific investigations and information clearly.
- b. Write clear, coherent accounts of current scientific issues, including possible alternative interpretations of the data.
- c. Use data as evidence to support scientific arguments and claims in written or oral presentations.
- d. Participate in group discussions of scientific investigation and current scientific issues.

Enduring Understandings:

- Cells in sexually reproducing organisms contain two copies of each chromosome; therefore, two copies of each gene explain many features of heredity such as how variations that are hidden in one generation can be expressed in the next.
- Hereditary information, coded by DNA, is passed down from generation to generation in a predictable way.

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Essential Questions:

- What are the effects of meiosis on genetic variability?
- How is the basis of the principle of segregation a mechanism of genetic variability?
- How does independent assortment correlate with reproductive variability?

Pre-Assessment:
Have students answer the following questions on an index card.
1. What are some causes of genetic variation?
2. How does the Law of Segregation support genetic variation?
3. How is it possible for a child to have new combinations of genes that are absent in both parents?
4. How does meiosis promote variations in the genetic code of an organisms' offspring?

	BASIC	INTERMEDIATE	ADVANCED
Outcome/ Performance Expectation	1. Describe the role and mechanisms of DNA in genetic inheritance. 2. Explain the function of meiosis as a mechanism of reproductive variability.		
Performance Task: (Detailed Description) **Teacher Preparation Notes:** *Use plastic Easter eggs to represent the gametes. Add a piece of yarn to four gametes to represent sperm. Using a poster make an enlarged 4 x4 Punnett square and laminate. Erasable whiteboard markers can also be used on this as needed for instruction and clarification.*	Guide students to complete the Meiosis Allele Combinations worksheet to determine the combinations of alleles that would be inherited by the gametes of two parents that are both heterozygous for two different traits. ***Teacher Note*:** For the basic group students, discuss Mendel's Laws of Segregation and Independent Assortment as well as demonstrate a	Ask students to determine the combinations of alleles that would be inherited by the gametes of two parents that are both heterozygous for two different traits. ***Teacher Note:*** For the intermediate group, students discuss Mendel's Laws of Segregation and Independent Assortment as well as demonstrate a dihybrid cross. On the Dyhibrid	Determine the combinations of alleles that would be inherited by the gametes of two parents that are both heterozygous for two different traits. ***Teacher Note:*** For the advanced group, students discuss Mendel's Laws of Segregation and Independent Assortment as well as demonstrate that they can create a dihybrid cross. Ask the students to explain how the dihybrid

	dihybrid cross and show students how it models Mendel's Laws and genetic variability. Next, put the letters inside eggs and sperm as you wrote on your Dyhibrid Cross Worksheet. Place the sperm along the top of the large Punnett Square and the eggs along the left side of the large Punnett Square On the Dyhibrid Cross Worksheet, write the letters that are inside the egg and sperm. Perform the dihybrid cross by opening each egg and sperm that would combine to create a possible offspring. The gametes combine as shown in the Punnett Square template above. ***Teacher Note:*** It will be helpful to provide a key chart to clarify the crossing method On the Dyhibrid Cross Worksheet, write the letters that are combined during reproduction for each box on your Punnett	Cross Worksheet, write the letters that are inside the egg and sperm. Perform the dihybrid cross by opening each egg and sperm that would combine to create a possible offspring. The gametes combine as shown in the Punnett Square template. On the Dyhibrid Cross Worksheet, write the letters that are combined during reproduction for each box on your Punnett Square. Put the letters back inside the gametes and repeat until all boxes on the Dyhibrid Cross Worksheet are completed. Select two of the possible off spring and perform a second dihybrid cross. ***Teacher Note:*** Ask the students to describe the role and mechanisms of DNA in genetic inheritance AND to explain how the dihybrid cross models Mendel's Laws and genetic variability. Use guided questioning as needed. This may be	cross models Mendel's Laws and genetic variability. Perform the dihybrid cross simulation using four dice covered with paper to represent the alleles. On the Simulation of Random Outcomes of 100 Crosses, record the outcomes of 100 simulated crosses. Graph the results of both activities and discuss the differences between the two simulation types. ***Teacher Note:*** Ask students to describe the role and mechanisms of DNA in genetic inheritance AND have students explain and justify reproductive variations using Mendel's Laws of Segregation and Independent Assortment. This may be done as a ticket out the door or oral assessment.

	Square. Put the letters back inside the gametes and repeat until all boxes on the Dyhibrid Cross Worksheet are completed. ***Teacher Note:*** Ask the students to describe the role and mechanisms of DNA in genetic inheritance AND to explain how the dihybrid cross models Mendel's Laws and genetic variability. Use guided questioning as needed. This may be done as a ticket out the door or oral assessment.	done as a ticket out the door or oral assessment.	
Resources	*Video Segments* The Dihybrid Cross http://www.mansfieldct.org/schools/MMS/staff/hand/gendihybrid.htm Increasing the Genetic Variability in Species: Crossing Over in Meiosis (02:19) Sexual Reproduction: Producing Variations in the Genetic Material Within a Population (02:01) Biologix: Meiosis and Gamete Formation. United Learning (1997). Retrieved June 14, 2007, from unitedstreaming: http://www.unitedstreaming.com/		

Homework/Extension	Create a table of the genotypic and phenotypic results for the dihybrid cross. Answer the question: How is it possible for a child to have new combinations of genes present when they are absent in the parents?	Create a pedigree for the generations in the two dihybrid crosses. Answer the questions: How is it possible for a child to have new combinations of genes present when they are absent in the parents? What effect will it have on a phenotypic ratio, if in a dihybrid, one set of alleles are codominant?	Create a pedigree for the F1 and F2 generations of the dihybrid cross. Have students set up a trihybrid (polyhybrid) cross from parents that are also heterozygotes. See if they can predict the pattern of the phenotype using rules of probability based on what they have observed in both the monohybrid and dihybrid crosses of heterozygotes.
Instructional Tasks Accommodations for ELL Students	• Modify language requirements for written assessments • Pair with more advanced native language speaking partner (allow for translation in native language for comprehension) as needed. • Provide graphic organizer (fill in the blank format) for the table homework assignment • Provide bilingual support using word to word translation such as dictionaries, and glossaries • Provide native language text books and support material whenever possible • Post all new vocabulary on a word wall; allow student to interact with the word wall using yarn to make connections between vocabulary words • Check for comprehension of expectations, instructions, and relevant vocabulary before students begin a task; repeat or reinforce as needed		
Instructional Tasks Accommodations for Students with Specific Disabilities	• **Review and Implement IEP accommodations for specific student needs** Other accommodations may include: • Post all new vocabulary on a word wall; allow student to interact with the word wall using yarn to make connections between vocabulary words		

	• Check for comprehension of expectations, instructions, and relevant vocabulary before students begin a task; repeat or reinforce as needed • This activity can be modified to represent a monohybrid cross to enhance understanding of Mendelian patterns of inheritance.
Instructional Tasks Accommodations for Gifted Students	Using multimedia, students create a visual such as a poster to illustrate the role of meiosis in reproductive variability

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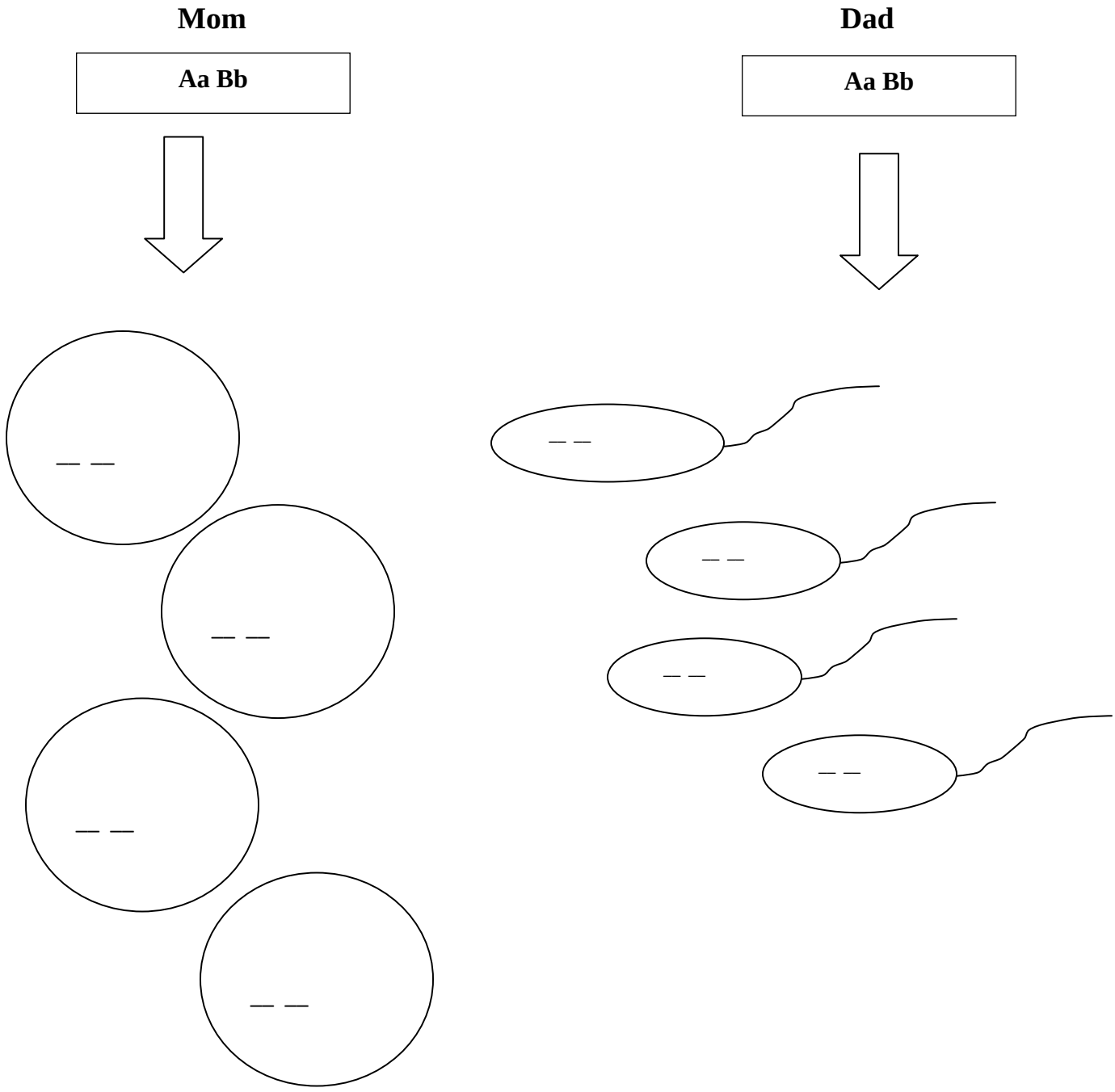
Gamete Allele Combinations



Return to Task

Key Chart

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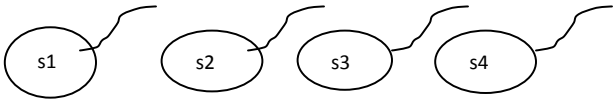

E1	E1 + s1	E1 + s2	E1 + s3	E1 + s4
E2	E2 + s1	E2 + s2	E2 + s3	E2 + s4
E3	E3 + s1	E3 + s2	E3 + s3	E3 + s4
E4	E4 + s1	E4 + s2	E4 + s3	E4 + s4

Return to Task

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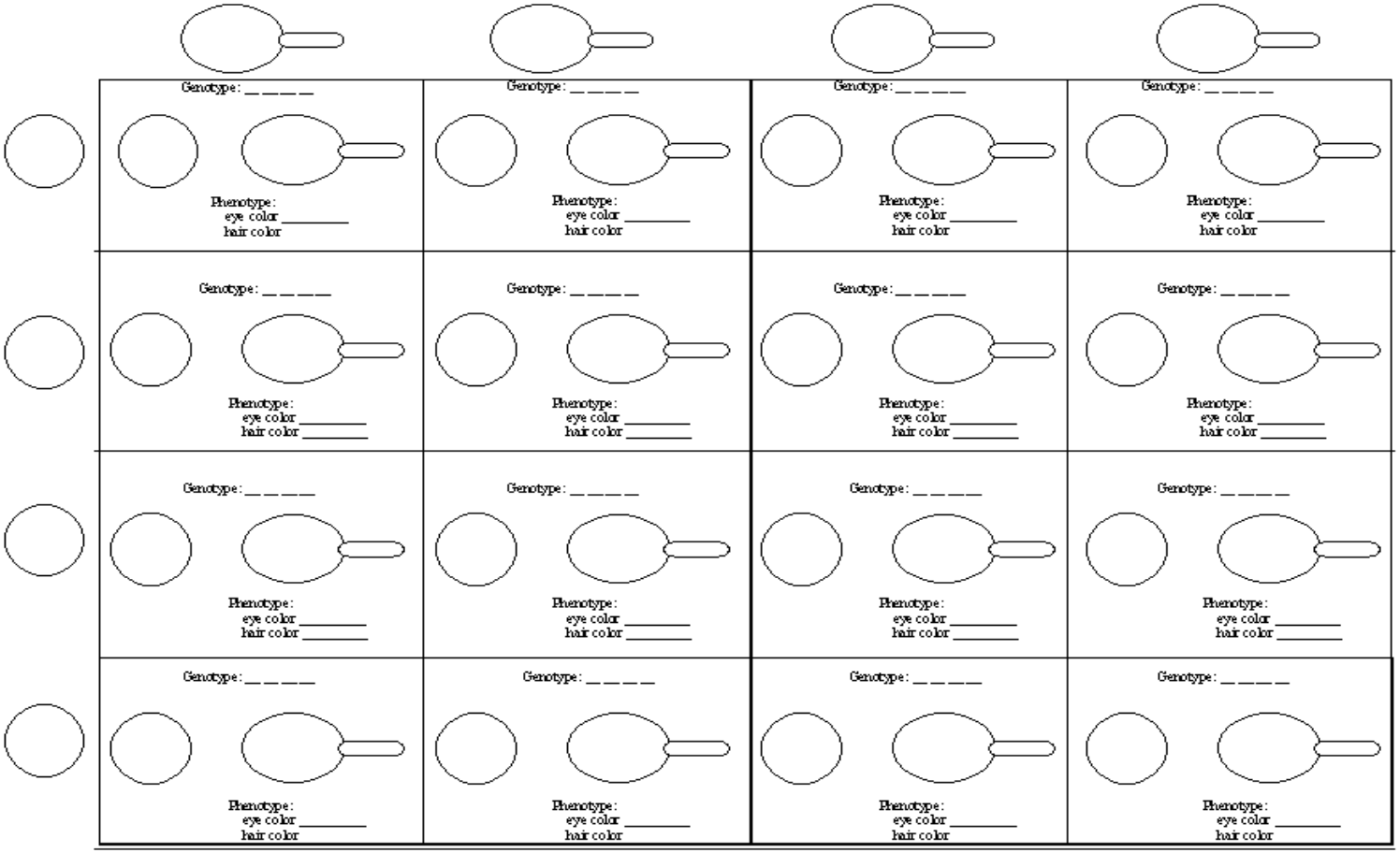
Dyhibrid Cross Worksheet



Simulation of Random Outcomes of 100 Crosses

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Directions:

1. Obtain 4 dice from your teacher. Cover two sets of dice with blue paper and the other two sets of dice with pink paper. Write "A" on three sides of one pink die and "a" on the other three sides. Write a "B" on three sides of the other pink die and "b" on the other three sides. Repeat with sequence with the blue dice.
Roll all four dice at once and record the results of the roll by making a hash mark in the correct box in the table below to describe the outcome. Repeat until you have recorded 100 trials. Graph your results. (Teacher note: The dice roll procedure may also be performed using a probability simulation program on a graphing calculator or computer program.)
2. Pass the dice to someone else in your group who will repeat the procedure record their own outcomes on 100 trials. Add data from each of the sets of 100 trials and record in the pooled data chart below.
3. Graph percentage frequencies of each outcome for individual results, grouped results with the results of the dihybrid cross Punnett square activity by hand or using a spreadsheet program. Explain variations in each.

Results of 100 Random Crosses of two Parents Heterozygous for Two Non-linked traits.

F1 Genotype	AABB	AaBB	aaBB	AaBb	Aabb	aaBb	aabb	AABb	AAbb
Frequency N=100									

Results of Pooled Random Crosses of two Parents Heterozygous for Two Non-linked traits.

F1 Genotype	AABB	AaBB	aaBB	AaBb	Aabb	aaBb	aabb	AABb	AAbb
Total number									