Non-Mendelian Genetics

Activity

Part I: Introduction

You may have noticed that some traits do not strictly follow Mendel's laws of inheritance. For example, skin color varies widely among humans and even within the same family. This is because this trait is influenced by multiple genes located on different chromosomes instead of just one gene, as Mendel first thought.

Instructions

You and a partner will distinguish between traits that follow Mendel's laws of heredity and those that do not. Sort the trait scenario cards that your teacher gives you into two piles. When you are finished, have your teacher check you work and record the traits in the T-chart below.

Mendelian Inheritance	Non-Mendelian Inheritance

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Part II: Incomplete Dominance

All offspring pink

	R	R
R’	RR’	RR’
R’	RR’	RR’

Mendel’s law of dominance states that the recessive allele will always be masked by dominant alleles. However, in nature, incomplete dominance can be seen in several instances when neither allele is considered dominant. With Mendel’s experiments, the offspring would always looks like one of the two parents. However, in incomplete dominance, because neither allele is considered dominant, the phenotypic trait will actually be a blend of the two parents. An example of this can be seen with the cross-pollination of a red snapdragon flower (RR) and a white snapdragon flower (R’R’). Since neither flower color is considered dominant, a blend of the two phenotypes takes place to produce a new pink flower phenotype (RR’).

1.Using this information, cross a pink flower and a red flower.

Genotype = ☐ X ☐

☐	☐
☐	1	2
☐	3	4

2.Use the information from the Punnett square to fill in the chart below.

Offspring Box Number	Genotype	Phenotype	Homozygous or Heterozygous?
1			
2			
3			
4			

F1 Genotypic Ratio: _____ RR : _____ R’R’ : _____ RR’

F1 Phenotypic Ratio: _____ Red : _____ White : ____ Pink

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Part III: Codominance

In certain species of plants and animals, two homozygous dominant parents will cross to produce an F1 generation that fully expresses both parental phenotypes. This can be seen in a certain variety of chickens. The alleles for both black feathers (BB) and white feathers (WW) are dominant. If a heterozygous offspring is produced (BW), the chicken would be black and white speckled, not gray.

	B	B
W	BW	BW
W	BW	BW

1.Using this information, cross two black and white speckled chickens.

Genotype = ☐ X ☐

☐ ☐

☐ 1 2

☐ 3 4

2.Use the information from the Punnett square to fill in the chart below.

Offspring Box Number	Genotype	Phenotype	Homozygous or Heterozygous?
1			
2			
3			
4			

F1 Genotypic Ratio: _____ BB : _____ WW : _____ BW

F1 Phenotypic Ratio: _____ Black : _____ White : ____ Black/White Speckled

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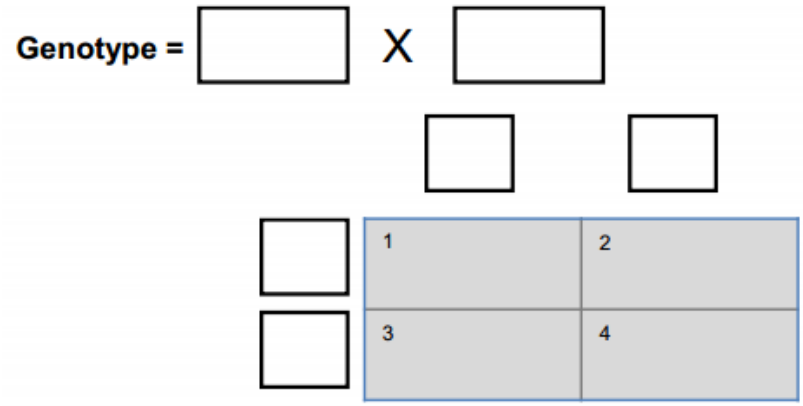
Part IV: Multiple Alleles

In Mendelian genetics, genes can only have two alleles, dominant and recessive. However, nature has shown that genes can have more than two alleles. Blood types are an example of a gene having more than two alleles. There is a dominant allele for A blood type (I^A), a dominant allele for B blood type (I^B), and a recessive allele for O blood type (i). The three different alleles give four different possible phenotypic blood types: A, B, AB, or O.

Phenotype	A	B	AB	O
Genotypes	I^AI^A I^Ai	I^BI^B I^Bi	I^AI^B	ii

	I^A	i
I^B	I^AI^B	I^Bi
i	I^Ai	ii

1.Using this information, cross a heterozygous B blood type male with a heterozygous A blood type female.



2.Use the information from the Punnett square to fill in the chart below.

Offspring Box Number	Genotype	Phenotype	Homozygous or Heterozygous?
1			
2			
3			
4			

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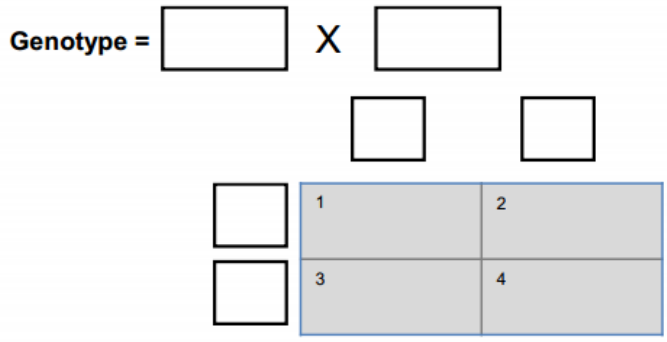
Part V: Sex-Linked Traits

The X and Y chromosomes are designated human sex chromosomes. Females have two X chromosomes (XX) while males have an X and Y chromosome (XY). Some traits and diseases are carried on these sex chromosomes, especially the X chromosome. Because males only have one X chromosome, they are more likely to express a sex-linked trait since they cannot be heterozygous. Hemophilia and color blindness are two examples of sex-linked traits primarily seen in males. For a female to inherit these diseases, she must receive a recessive X chromosome from each parent. Below is an example of a sex-linked Punnett square showing the inheritance of color blindness which is a recessive trait. The mother is normal but heterozygous (X^CX^c), and the father is normal (X^CY)

	X^C	Y
X^C	X^CX^C	X^CY
X^c	X^CX^c	X^cY

The two will have a 25% chance of having a child who is color blind. Notice that it only occurs in the male; the female that receives the recessive allele is masked by the dominant normal allele. She would be considered a carrier and could pass this trait off to her offspring.

1.Hemophilia is a recessive sex linked trait that causes individuals to have problems with their blood clotting. A female who is a carrier for hemophilia marries a man who has hemophilia. Determine the potential of their offspring inheriting the hemophilia trait.



2.Use the information from the Punnett square to fill in the chart below.

Offspring Box Number	Genotype	Male or Female?	Expresses Trait?
1			
2			
3			
4			

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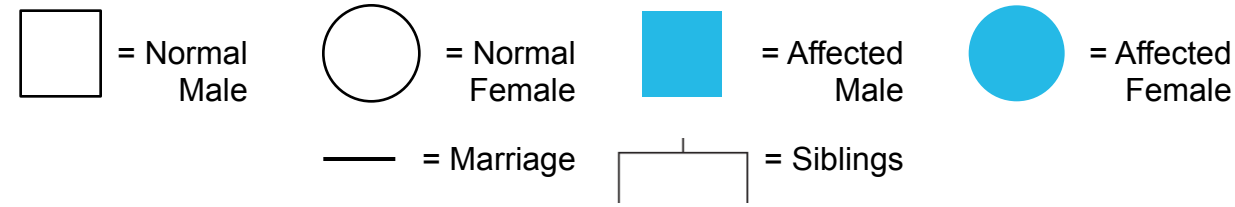
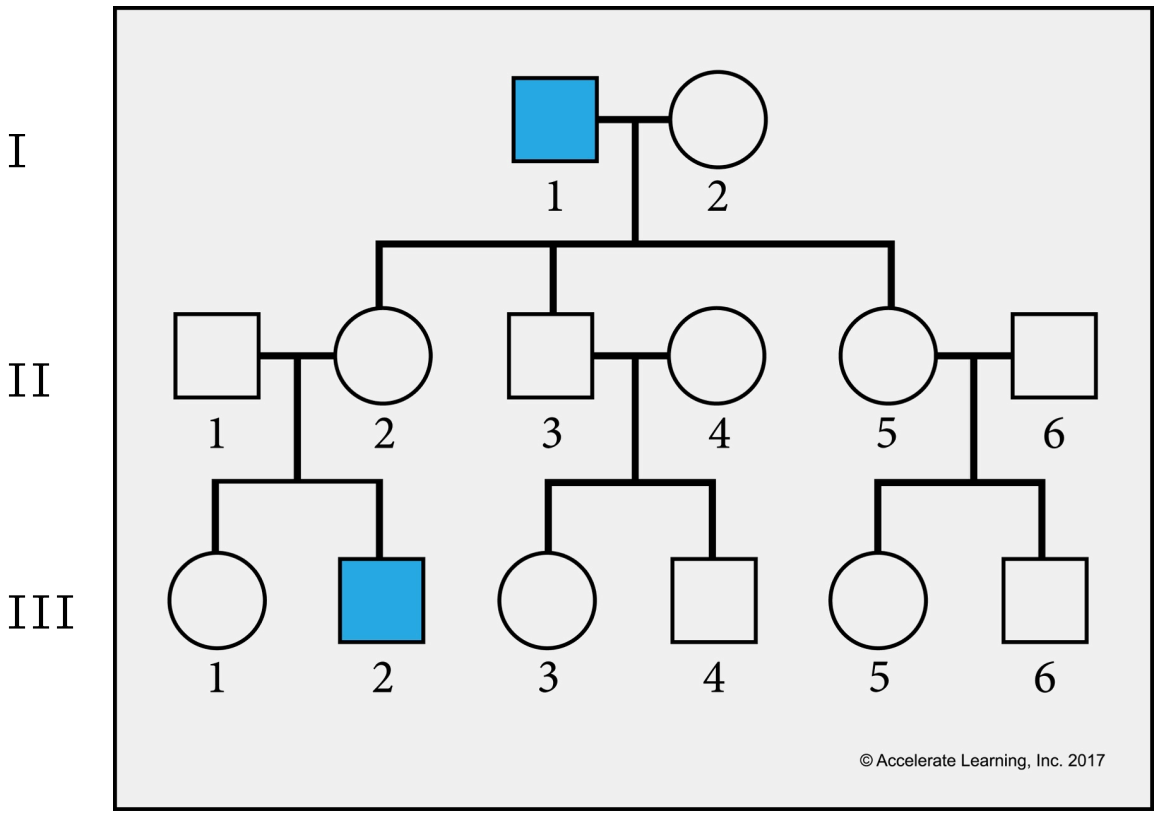
Part VI: Pedigrees

Pedigrees are useful because they provide a graphic representation of the traits inherited within a family. The graphics show which phenotypes each offspring inherited. Scientists can use pedigrees to understand where certain traits were inherited and can even help determine the genotypes of parents.

The table below shows a key to the accompanying pedigree. Review the pedigree and then answer the questions on the next page.





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Activity, continued

Part VI: Pedigrees, continued

1. Are the phenotypes of the affected individuals caused by a dominant or recessive allele?

   _____
   _____
   _____

2. If this pedigree represents the inheritance of a widow's peak hairline (dominant) or straight hairline (recessive), what phenotype and genotype would individual 1 in row one have?

   _____
   _____

3. What would the genotype of individual 2 in the second row have to be? How did you determine this?

   _____
   _____
   _____

4. Create a pedigree in the space below using the following criteria:
   a. A woman who has hemophilia (X^hX^h) marries a man who does not have hemophilia (X^HY).
   b. They have two sons.
   c. Both sons marry a female who does not have hemophilia.
   d. Son Number One has a daughter who is normal and a son who has hemophilia.
   e. Son Number Two has two sons and two daughters who are normal.

5. What genotype does the woman who married Son 1 have? How did you determine this?

6. Explain why males are more likely to express a sex-linked trait.

   _____
   _____