

GENETICS MCAS

1. The following section focuses on nutrition information for dairy milk and soymilk. Read the information below and use it to answer the four multiple-choice questions and one open-response question that follow.

KEY

Milk is an important part of many people's diets. When the word *milk* is mentioned, most people think of dairy milk derived from cows. Many people, however, cannot drink dairy milk because of lactose intolerance. Individuals with this condition are unable to digest a component in the milk called lactose.

Lactose is the sugar in dairy milk. It is a disaccharide made from the sugars glucose and galactose. Lactose-intolerant individuals lack the enzyme lactase, which is needed for the digestion of lactose sugar.

Many lactose-intolerant individuals drink soymilk instead of dairy milk. Soymilk is produced from soybeans (the seeds of the soybean plant) and is a nutritious substitute for dairy milk. Soymilk contains protein, calcium, and other essential nutrients just as dairy milk does.

The table below compares some of the nutrition information for a serving of dairy milk and a serving of soymilk. Dairy Milk and Soymilk Nutrition Information

Serving size	Whole Dairy Milk		Unsweetened Soymilk	
	8 oz. (240 mL)		8 oz. (240 mL)	
	Amount per Serving	% Daily Value	Amount per Serving	% Daily Value
Calories	150		90	
Total fat	8 g	12%	4 g	6%
Saturated fat	5 g	25%	0.5 g	3%
Cholesterol	35 mg	11%	0 mg	0%
Sodium	125 mg	5%	85 mg	4%
Total carbohydrates	12 g	4%	4 g	1%
Sugars	12 g		1 g	
Protein	8 g	16%	7 g	14%
Vitamin A		6%		10%
Vitamin C		10%		0%
Vitamin D		25%		30%
Calcium		30%		30%
Iron		0%		6%

Individuals with one form of lactose intolerance do not produce the enzyme lactase because the gene coding for the production of lactase is shut off in their cells. This means that which of the following processes does not occur for the gene?

- A. hydrogenation
- B. mutation
- C. replication
- D. transcription

Lactase
Enzyme / protein

2. In a certain variety of chicken, some offspring have a feather pattern that is black-and-white checkered. Chickens with this checkered feather pattern result from the cross of a black chicken with a white chicken.

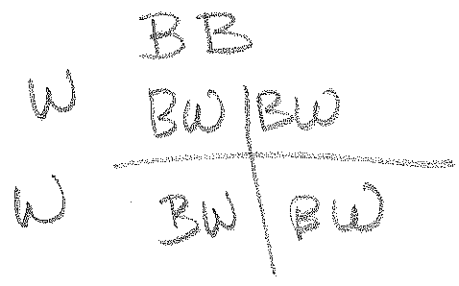
Which of the following types of inheritance is **most likely** responsible for

Black
B/w
white

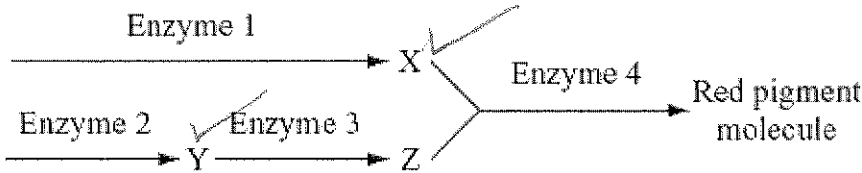
the checkered feather pattern?

[Hybrid yields both phenotypes]

- A. codominant
- B. dominant
- C. polygenic
- D. sex-linked



The diagram below shows the final steps of a biochemical pathway used by the bacterium *Serratia marcescens* to produce a red pigment molecule. Letters X, Y, and Z represent intermediate molecules produced in the pathway. Four enzymes are also involved in the pathway, as shown.



A mutant strain of *S. marcescens* produces molecules X and Y but does not produce the red pigment molecule or molecule Z.

3. Based on this result, it can be concluded that there must be a mutation in the gene coding for which enzyme?

- A. enzyme 1
- B. enzyme 2
- C. enzyme 3
- D. enzyme 4

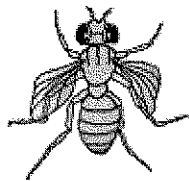
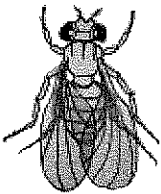
4. Which of the following statements best describes a DNA molecule?

- A. It is a double helix.
- B. It contains the sugar ribose. *RNA*
- C. It is composed of amino acids. *Proteins*
- D. It contains the nitrogenous base uracil. *RNA*

In fruit flies, a single gene controls wing phenotype. The diagram below shows the phenotypes for long wings and vestigial wings in fruit flies.

Long wings

Vestigial wings



Two fruit flies that have long wings are crossed. Of the 95 offspring produced, 73 have long wings. The other 22 have vestigial wings.

5. Which of the following conclusions about the inheritance of long wings and vestigial wings is best supported by the results of this experiment?

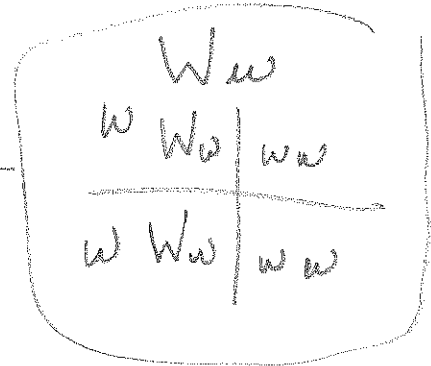
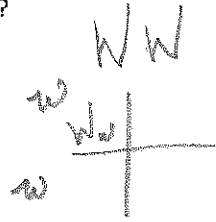
- A. The alleles for long wings and vestigial wings are sex-linked.
- B. The alleles for long wings and vestigial wings are codominant.
- C. The allele for long wings is dominant and the allele for vestigial wings is recessive.
- D. The allele for long wings is recessive and the allele for vestigial wings is dominant.

In sheep, the allele for white wool (**W**) is dominant, and the allele for black wool (**w**) is recessive. A farmer has mated two Suffolk sheep for a few years. These matings have resulted in six offspring, four with white wool and two with black wool. One parent has white wool and the other has black wool.

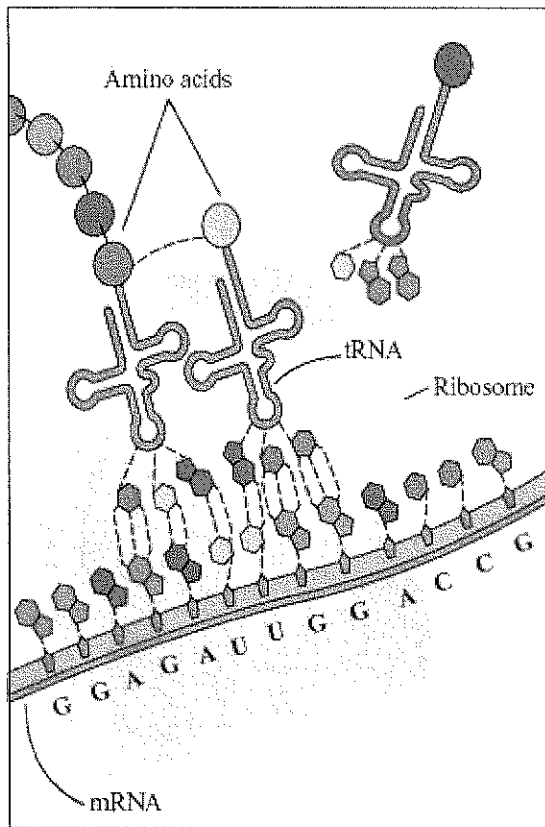
W = white
w = black

6. Which of the following could be the genotypes of the parent sheep?

- A. **WW** and **Ww**
- B. **WW** and **ww**
- C. **Ww** and **Ww**
- D. **Ww** and **ww**



The diagram below represents part of a process that occurs in cells.



7. Which process is represented?

- A. meiosis
- B. osmosis
- C. replication
- D. translation

F1
4:2 ratio
2:1

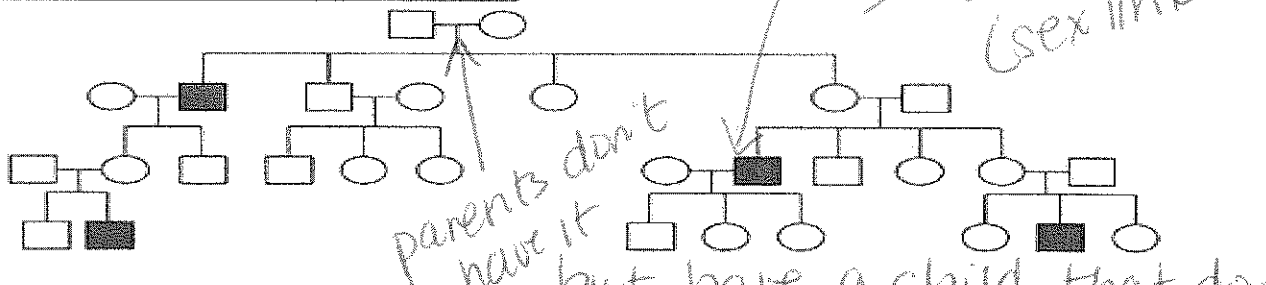
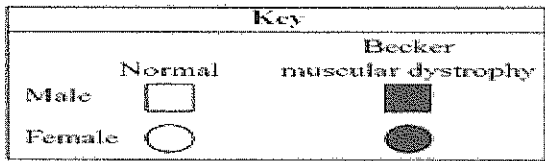
8. In pea plants, the genes for seed color and seed shape are on different chromosomes. Which of the following explains why the genes for these traits are not inherited together?

- ~~A. natural selection~~
- B. artificial selection
- C. the law of segregation
- D. the law of independent assortment**

9. Which of the following **best** describes the result of a mutation in an organism's DNA?

- ~~A. The mutation may produce a zygote.~~
- B. The mutation may cause phenotypic change.**
- C. The mutation causes damage when it occurs.
- D. The mutation creates entirely new organisms.

10. The pedigree below shows the occurrence of Becker muscular dystrophy in a family. Becker muscular dystrophy causes muscle weakness.



11. Based on this pedigree, it is **most** reasonable to conclude that Becker muscular dystrophy is which of the following?

- A. a polygenic trait
- B. a codominant trait
- C. a sex-linked recessive trait**
- D. an autosomal dominant trait

12. The mold *Aspergillus flavus* grows on grain. *A. flavus* produces a toxin that binds to DNA in the bodies of animals that eat the grain.

The binding of the toxin to DNA blocks transcription, so it **directly** interferes with the ability of an animal cell to do which of the following?

- ~~A. transport glucose across the cell membrane into the cytoplasm~~
- B. produce ATP using energy released from glucose and other nutrients
- C. transfer proteins from the endoplasmic reticulum to Golgi complexes
- D. send protein-building instructions from the nucleus to the cytoplasm and ribosomes**

13. Human blood types are genetically determined. The table below shows the symbols used to represent two of the alleles for blood types and gives a description of each allele.

Two Alleles Controlling Human Blood Type

Symbol	Allele Description
I^A	produces antigen A on red blood cells
I^B	produces antigen B on red blood cells

In homozygous individuals, two I^A alleles result in blood type A and two I^B alleles result in blood type B. The I^A and I^B alleles are codominant, resulting in blood type AB in individuals heterozygous for the two alleles.

14. A male and a female both have blood type AB. If they have a child, what is the probability that the child will also have blood type AB?

A. $\frac{1}{4}$

B. $\frac{1}{2}$

C. $\frac{3}{4}$

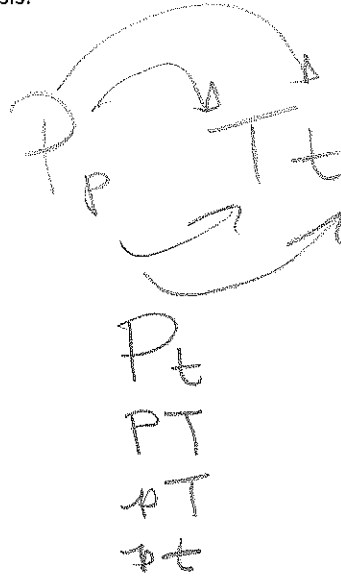
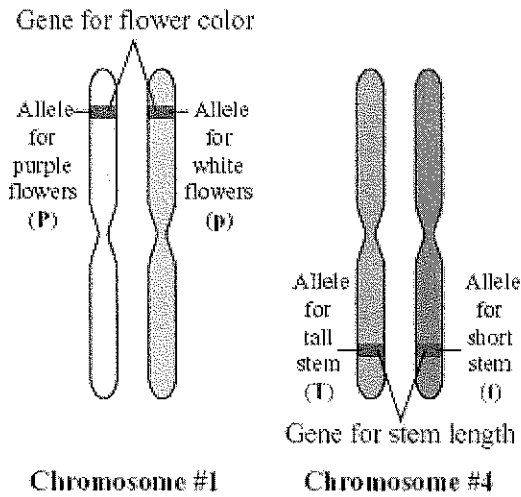
D. $\frac{1}{1}$

	A	B
A	AA	AB
B	AB	BB

15. In phenylketonuria (PKU), an enzyme that converts one amino acid into another does not work properly. Which of the following is the **most likely** cause of this genetic condition?

- A. an error in the transcription of the gene for the enzyme
- B. a mutation in the DNA sequence that codes for the enzyme
- C. an excess of the amino acids necessary to produce the enzyme
- D. a structural variation in the amino acid modified by the enzyme

The diagram below shows the positions of the genes for flower color and stem length in a pea plant. The chromosomes represented below will replicate before meiosis.



16. For these two genes, what is the maximum number of different allele combinations that can be formed normally in gametes produced from this cell?

- A. 2
- B. 4
- C. 6
- D. 8

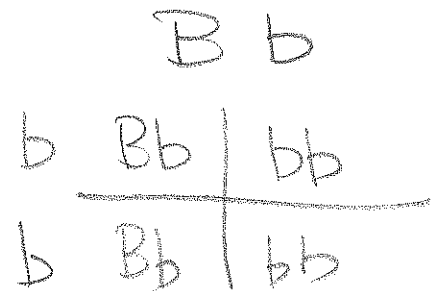
17. Which of the following terms applies to traits, such as human eye color, that are controlled by more than one gene?

- A. codominant
- B. polygenic
- C. recessive
- D. sex-linked

In pigeons, the allele **B** produces ash-red feathers. The allele **b** produces blue feathers. The **B** allele is dominant to the **b** allele.

18. A pigeon with genotype **Bb** is crossed with a pigeon with genotype **bb**. What percent of the offspring are expected to have ash-red feathers?

- A. 0%
- B. 25%
- C. 50%
- D. 100%



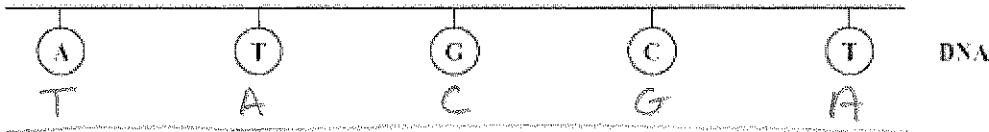
19. In 1950, Erwin Chargaff and colleagues examined the chemical composition of DNA and demonstrated that the amount of adenine always equals that of thymine, and the amount of guanine always equals that of cytosine. This observation became known as Chargaff's rule.

a. Based on current knowledge of the structure of DNA, explain the basis of Chargaff's rule.

Adenine always equals Thymine; Guanine = Cytosine

Supports the
Complimentary
Base pairing
Rules

b. The diagram below represents a single-stranded segment of DNA. In your Student Answer Booklet, write the complementary DNA strand that would form from this strand during replication. Use the letters A, C, G, and T to designate the bases: A = adenine; C = cytosine; G = guanine; T = thymine.



c. Why is Chargaff's rule so important to DNA's ability to replicate itself accurately?

it permits two exact copies to be made (as long as there are no mutations)

20. Corn snakes show variety in their skin color pattern. While the complete genetics of corn snake color are complex, the most common colors on normal corn snakes—red and black—are each coded by one gene.

For the red gene, the allele for the presence of red pigment (**R**) is dominant and the allele for the absence of red pigment (**r**) is recessive. Likewise, for the black gene, the allele for the presence of black pigment (**B**) is dominant and the allele for the absence of black pigment (**b**) is recessive.

a. Draw the Punnett square for the cross of a snake that is homozygous dominant for the red color with a snake that is heterozygous for the red color. What percentage of the offspring is expected to have red pigment in their skin?

RR = red
Rr = red

	R	R
R	RR	RR
r	Rr	Rr

OFFSPRING ARE
100% red

b. Draw the Punnett square for the cross of two snakes that are heterozygous for the black color. What percentage of the offspring are expected to have black pigment in their skin?

	B	b
B	BB	Bb
b	Bb	bb

75% Black pigment

c. The parent snakes in part (b) that are heterozygous for black color are both homozygous recessive for the red gene. Each parent has genotype rr for the red gene. Based on this information, what percentage of their offspring are expected to lack both the red and black pigments in their skin? Explain your reasoning.

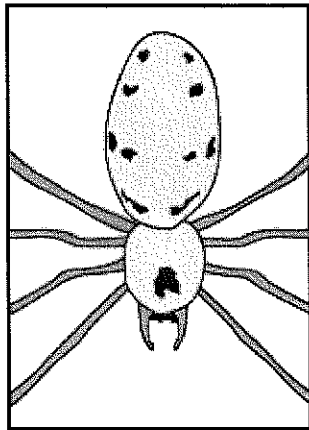
Bb rr x Bb rr
(Br) & (br) ← gametes

	Br	br
Br	BBrr	Bbrr
br	Bbrr	bbrr

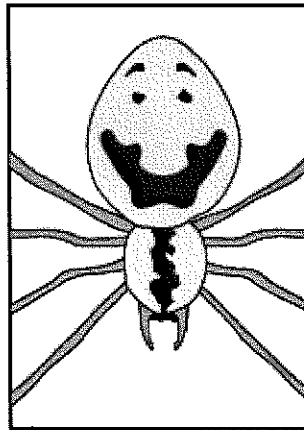
1/4

21. Hawaiian happy face spiders from the island of Maui can have different markings, as shown below. A single gene determines the markings on the spiders.

Plain Spider



Patterned Spider



P = pattern

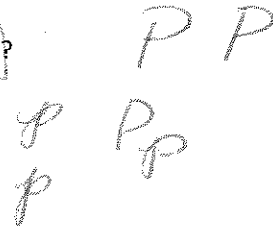
p = plain



A plain spider is crossed with a patterned spider. The patterned spider is homozygous. The pattern allele is dominant to the plain allele.

What percentage of the offspring from this cross are expected to be patterned instead of plain?

- A. 0%
- B. 25%
- C. 50%
- D. 100%



22. During DNA replication, the wrong nucleotide was inserted in the DNA sequence. Which of the following terms describes this situation?

- A. mutation
- B. regeneration
- C. transcription
- D. translation

23. A partial Punnett square is shown below.

AA	AA
Aa	Aa

Handwritten Punnett square for a cross between a heterozygous (Aa) and a homozygous dominant (AA) parent:

	A	A
A	AA	AA
a	Aa	Aa

Which of the following statements describes the parental genotypes that would result in this Punnett square?

- A. Both parents are heterozygous.
- B. Both parents are homozygous dominant.
- C. One parent is homozygous recessive and the other parent is heterozygous.
- D. One parent is homozygous dominant and the other parent is heterozygous.

24. According to Mendel's law of segregation, which of the following statements describes what happens to the alleles of a gene pair?

- A. The alleles are moved to different chromosomes.
- B. The alleles are mutated in the process of mitosis.
- C. The alleles are separated during fertilization.
- D. The alleles are separated during gamete formation.

Learn the Definition!

25. Which of the following features of DNA is **most important** in determining the phenotype of an organism?

- A. the direction of the helical twist
- B. the number of deoxyribose sugars
- C. the sequence of nitrogenous bases
- D. the strength of the hydrogen bonds

→ proteins → phenotype!

26. A portion of one strand of a DNA molecule has the sequence shown below.

ACCTGAAGG

Assuming there are no mutations in this portion of the DNA, what is the corresponding sequence on the complementary DNA strand?

- A. ACCTGAAGG
- B. ~~GTCAGGAA~~
- C. TGGACTTCC
- D. UGGACUUC

TGG

← RNA

27. Fireflies produce light inside their bodies. The enzyme luciferase is involved in the reaction that produces the light. Scientists have isolated the luciferase gene.

A scientist inserts the luciferase gene into the DNA of cells from another organism. If these cells produce light, the scientist knows that which of the following occurred?

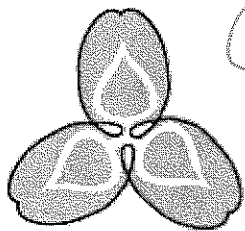
- A. The luciferase gene mutated inside the cells.
- B. The luciferase gene was transcribed and translated.
- C. The luciferase gene destroyed the original genes of the cells.
- D. The luciferase gene moved from the nucleus to the endoplasmic reticulum.

Protein Synthesis → Genetic expression

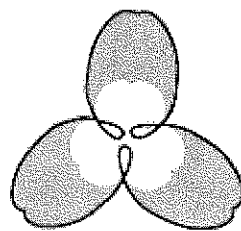
Leaves from two white clover plants, each with a different pattern, are shown below.

Plant 1
Chevron pattern

Plant 2
Oval pattern



CC

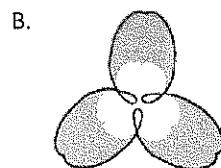
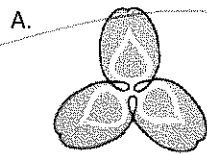
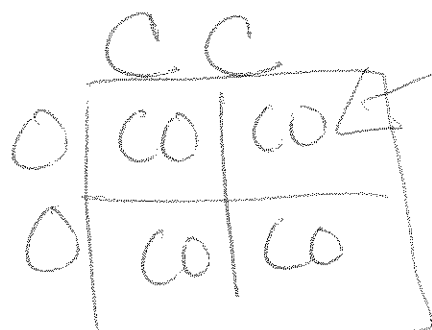


OO

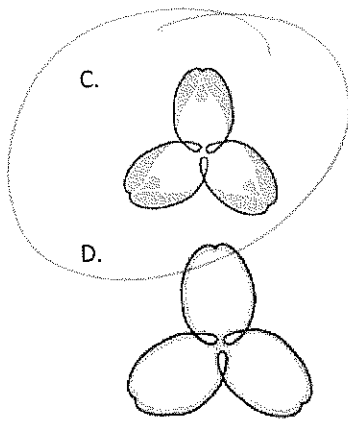
C = chevron
O = oval

The leaf patterns are genetically determined by alleles of a single gene. Plant 1 is homozygous for the chevron allele. Plant 2 is homozygous for the oval allele. The chevron and oval alleles are codominant.

28. If plant 1 and plant 2 are crossed, the codominance of the alleles will **most likely** result in which of the following leaf patterns on the offspring plants?

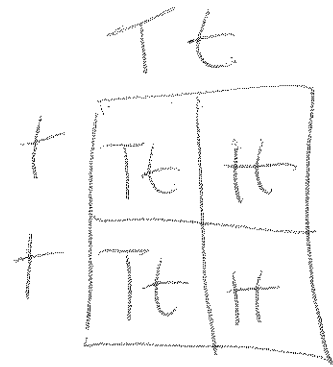
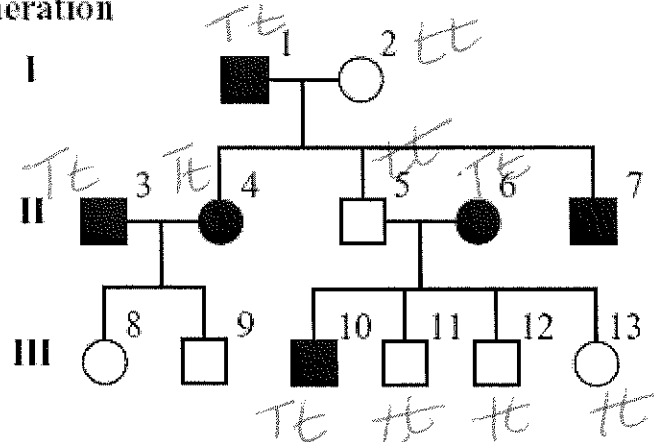


Both Expressed



29. People who are tone deaf are unable to follow a rhythm. Scientists have evidence that tone deafness can be genetic. The pedigree below traces the inheritance of tone deafness in a family. Individuals in the pedigree are numbered.

Generation



Key		
	Tone deaf	Normal tone perception
Male	■	□
Female	●	○

50% Tt
50% tt

Not exact in percentages!

Scientists have analyzed the inheritance patterns for tone deafness and have concluded that tone deafness is caused by an autosomal dominant allele, T.

- Provide evidence from the pedigree that conclusively shows that the tone deafness allele is autosomal dominant, not autosomal recessive. Explain your reasoning.
- Identify the genotypes of individuals 5 and 6, and then draw the Punnett square for the cross of these two individuals.
- Compare the expected percentage of each phenotype of the offspring from the cross in part (b) with the actual percentage of each phenotype observed in the children of individuals 5 and 6.

a. If the disorder was autosomal recessive (tt) two parents that have the disease would have a 100% chance of having a child with the disorder. This goes against what is in the pedigree (Parents 3 + 4 have the disorder but children 8 + 9 do not).