2023 MCAS Sample Student Work and Scoring Guide

High School Biology
Question 16: Constructed-Response

Reporting Category: Heredity
Practice Category: Evidence, Reasoning, and Modeling
Standard: HS.LS.3.3 - Apply concepts of probability to represent possible genotype and phenotype combinations in offspring caused by different types of Mendelian inheritance patterns.
Item Description: Analyze a pedigree to determine the inheritance pattern for a condition, complete a Punnett square for a given cross, determine the probability of inheriting the condition, and explain how the probability was determined.

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Scoring Guide

Select a score point in the table below to view the sample student response.

Score*	Description
3A	The response demonstrates a thorough understanding of genotype and phenotype combinations in offspring caused by inheritance patterns. The response correctly identifies the most likely inheritance pattern for the condition. The response also correctly completes the Punnett square, determines the probability that the child from this cross will inherit the condition, and clearly explains the reasoning.
3B	
2	The response demonstrates a partial understanding of genotype and phenotype combinations in offspring caused by inheritance patterns.
1	The response demonstrates a minimal understanding of genotype and phenotype combinations in offspring caused by inheritance patterns.
0	The response is incorrect or contains some correct work that is irrelevant to the skill or concept being measured.

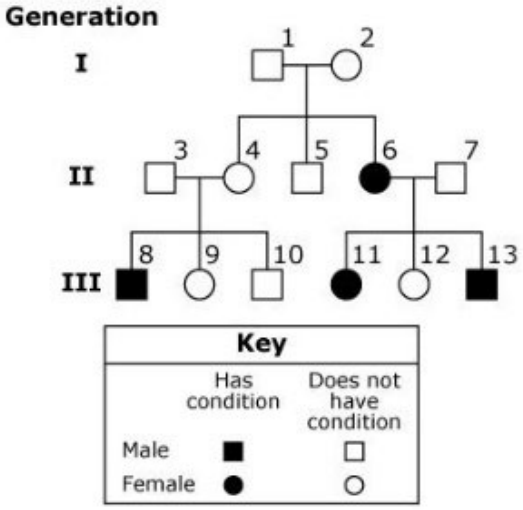
*Letters are used to distinguish between sample student responses that earned the same score (e.g., 3A and 3B).

Score Point 3A

The *CFTR* gene is responsible for regulating the flow of water across cell membranes that produce mucus, sweat, saliva, and tears. Mucus is the substance that moistens and protects the lining of airways in the lungs, the digestive system, and other tissues in the body.

An inherited condition is caused by a mutation in the *CFTR* gene. For people with this CFTR mutation, the cells that make mucus produce a very thick mucus, which builds up. The buildup of thick mucus in the lungs can lead to severe breathing problems, such as frequent coughing and respiratory infections. A buildup of thick mucus in the pancreas can also disrupt digestion.

The diagram shows a pedigree for a family that is affected by this inherited condition.



This question has three parts.

The condition caused by the CFTR mutation is controlled by a single gene with two alleles, **D** and **d**.

Part A

Based on the pedigree, identify the most likely inheritance pattern (codominant, dominant, recessive, or sex-linked) for the condition.

The most likely inheritance pattern is recessive for the condition. We can determine this because looking at generation I, in the pedigree we can see that neither the male or the female has the condition. However, with the three offspring they have, one of them does have the condition. That would only be possible if both parents had a recessive allele along with their domainant allele that allowed for them to not actually have this condition. Therefore, the most likely inheritance pattern for this condition is recessive.

Part B

The person labeled 12 in the pedigree has a biological child with a person who is heterozygous for the condition.

Complete the Punnett square for this cross. Drag and drop an allele or allele pair into each box. Each allele or allele pair may be used once, more than once, or not at all.

D | d | DD | Dd | dd

	D	d
D	DD	Dd
d	Dd	dd

Part C

Based on your Punnett square in Part B, determine the probability that the child from this cross will inherit the condition. Explain your reasoning.

The probability that the child from this cross will inherit the condition is 25%. This is because in order to have the condition, the offsprings genotype would have to be dd. Based on the pedigree, we know that person #12 is heterozygous for the condition as well because both her parents have at least one recessive gener for the condition. Knowing this, when crossing a heterozygous with a heterozygous, only one of the four boxes had the genotype dd which stands for homozygous recessive which means they have the condition. That is why there is a 25% chance that the child from this cross will inherit the condition.

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Score Point 3B

This question is part of a module with an introduction. The introduction can be seen in score point 3A.

This question has three parts.

The condition caused by the CFTR mutation is controlled by a single gene with two alleles, **D** and **d**.

Part A

Based on the pedigree, identify the most likely inheritance pattern (codominant, dominant, recessive, or sex-linked) for the condition.

The conidition is most likely recessive.

Part B

The person labeled 12 in the pedigree has a biological child with a person who is heterozygous for the condition.

Complete the Punnett square for this cross. Drag and drop an allele or allele pair into each box. Each allele or allele pair may be used once, more than once, or not at all.

D d DD Dd dd

	D	d
D	DD	Dd
d	Dd	dd

Part C

Based on your Punnett square in Part B, determine the probability that the child from this cross will inherit the condition. Explain your reasoning.

The child from the cross has a 25% chance of inheriting the condition. We can see, through the Punnet square, that only one of the four allele pairs is homozygous recessive, which results in the condition.

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Score Point 2

This question is part of a module with an introduction. The introduction can be seen in score point 3A.

This question has three parts.

The condition caused by the CFTR mutation is controlled by a single gene with two alleles, **D** and **d**.

Part A

Based on the pedigree, identify the most likely inheritance pattern (codominant, dominant, recessive, or sex-linked) for the condition.

recessive

Part B

The person labeled 12 in the pedigree has a biological child with a person who is heterozygous for the condition.

Complete the Punnett square for this cross. Drag and drop an allele or allele pair into each box. Each allele or allele pair may be used once, more than once, or not at all.

D d DD Dd dd

	D	d
D	DD	Dd
d	Dd	dd

Part C

Based on your Punnett square in Part B, determine the probability that the child from this cross will inherit the condition. Explain your reasoning.

the probability is 75% likely to inherit it.

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Score Point 1

This question is part of a module with an introduction. The introduction can be seen in score point 3A.

This question has three parts.

The condition caused by the CFTR mutation is controlled by a single gene with two alleles, **D** and **d**.

Part A

Based on the pedigree, identify the most likely inheritance pattern (codominant, dominant, recessive, or sex-linked) for the condition.

Codominant because theirs no dominant allele's in this sequence.

Part B

The person labeled 12 in the pedigree has a biological child with a person who is heterozygous for the condition.

Complete the Punnett square for this cross. Drag and drop an allele or allele pair into each box. Each allele or allele pair may be used once, more than once, or not at all.

D d DD Dd dd

	D	d
D	DD	Dd
d	Dd	dd

Part C

Based on your Punnett square in Part B, determine the probability that the child from this cross will inherit the condition. Explain your reasoning.

their is a 50% chance that child in the cross will inherit the condition

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Score Point 0

This question is part of a module with an introduction. The introduction can be seen in score point 3A.

This question has three parts.

The condition caused by the CFTR mutation is controlled by a single gene with two alleles, **D** and **d**.

Part A

Based on the pedigree, identify the most likely inheritance pattern (codominant, dominant, recessive, or sex-linked) for the condition.

dominant

Part B

The person labeled 12 in the pedigree has a biological child with a person who is heterozygous for the condition.

Complete the Punnett square for this cross. Drag and drop an allele or allele pair into each box. Each allele or allele pair may be used once, more than once, or not at all.

D d DD Dd dd

	D	d
d	D	d
D	D	D

Part C

Based on your Punnett square in Part B, determine the probability that the child from this cross will inherit the condition. Explain your reasoning.

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