2022 MCAS Sample Student Work and Scoring Guide

High School Biology
Question 21: 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: Identify possible parental genotypes for a dominant-recessive genetic condition and a x-linked genetic condition and complete Punnett squares to determine the expected percentages of offspring that will inherit the conditions.

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Scoring Guide

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

Score*	Description
4A	The response demonstrates a thorough understanding of genotype and phenotype combinations in offspring caused by different types of inheritance patterns. The response correctly identifies all possible genotypes for the man and woman with a normal phenotype, correctly completes a Punnett square to show how the man and woman can have a biological child with the genetic condition, and correctly identifies the percentage of offspring that are expected to have the genetic condition. The response also correctly identifies all possible genotypes of the man and woman with normal phenotypes for the X-linked genetic condition, correctly completes a Punnett square with the parental genotypes that could produce a child with the condition, and correctly identifies the percentage of males that are expected to have the condition.
4B	
3	The response demonstrates a general understanding of genotype and phenotype combinations in offspring caused by different types of inheritance patterns.
2	The response demonstrates a limited understanding of genotype and phenotype combinations in offspring caused by different types of inheritance patterns.
1	The response demonstrates a minimal understanding of genotype and phenotype combinations in offspring caused by different types of 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., 4A and 4B).

Score Point 4A

This question has four parts.
A man and a woman plan to have a biological child. They want to determine the likelihood that their child will inherit a genetic condition that runs in both of their families. One gene with two alleles is responsible for the condition. The dominant allele (**A**) produces the normal phenotype, and the recessive allele (**a**) produces the genetic condition. Both the man and the woman have the normal phenotype.

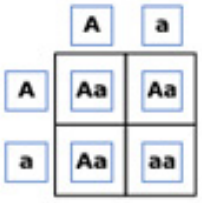
Part A
Using the allele symbols **A** and **a**, identify **all** possible genotypes of the man and **all** possible genotypes of the woman for this genetic condition.

The possible genotypes of the man for this genetic are Aa and AA since he has the normal phenotype. The possible genotype of the woman for this genetic condition are Aa and AA because she has the normal phenotype.

Part B
Complete the Punnett square to show how the man and the woman can have a biological child with this genetic condition.

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.

A a AA Aa aa



Identify the percentage of offspring that are expected to have the genetic condition based on this Punnett square.

25% for the offspring to have genetic conditions

Part C

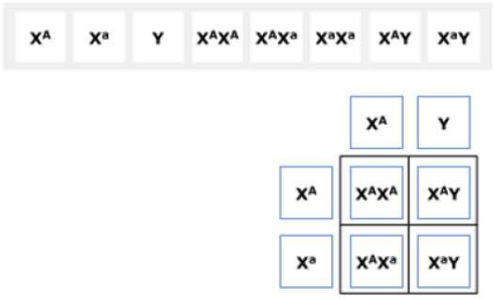
After doing some research, they determine the genetic condition is X-linked.

Drag and drop allele pairs into the boxes to identify **all** possible genotypes of the man and **all** possible genotypes of the woman. Each allele pair may be used once, more than once, or not at all.

Part D

Complete the Punnett square with the parental genotypes identified in Part C that could produce a child with this X-linked genetic condition.

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.



Identify the percentage of males that are expected to have the genetic condition based on this Punnett square.

The percentage of males that are expected to have the condition is 50%

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Score Point 4B

This question has four parts.
A man and a woman plan to have a biological child. They want to determine the likelihood that their child will inherit a genetic condition that runs in both of their families. One gene with two alleles is responsible for the condition. The dominant allele (**A**) produces the normal phenotype, and the recessive allele (**a**) produces the genetic condition. Both the man and the woman have the normal phenotype.

Part A
Using the allele symbols **A** and **a**, identify **all** possible genotypes of the man and **all** possible genotypes of the woman for this genetic condition.

male genotypes: AA, Aa
female genotypes: AA, Aa

Part B
Complete the Punnett square to show how the man and the woman can have a biological child with this genetic condition.

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.

A **a** **AA** **Aa** **aa**

	A	a
A	Aa	Aa
a	Aa	aa

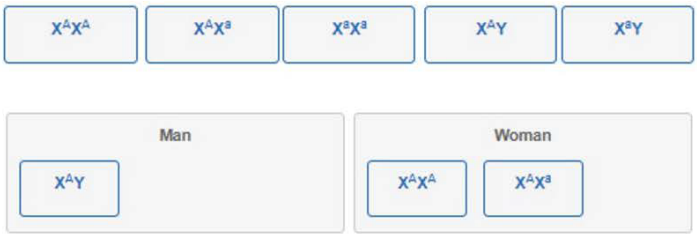
Identify the percentage of offspring that are expected to have the genetic condition based on this Punnett square.

25% are expected to have the genetic condition

Part C

After doing some research, they determine the genetic condition is X-linked.

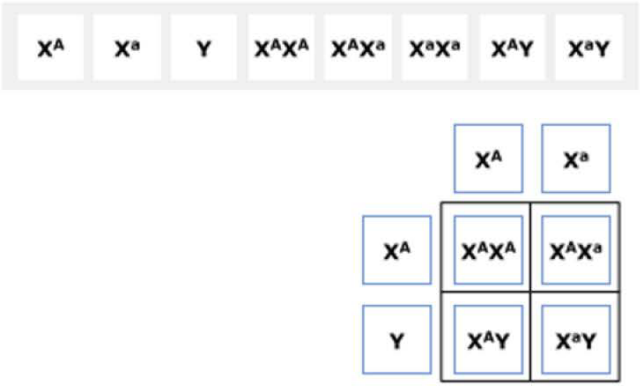
Drag and drop allele pairs into the boxes to identify **all** possible genotypes of the man and **all** possible genotypes of the woman. Each allele pair may be used once, more than once, or not at all.



Part D

Complete the Punnett square with the parental genotypes identified in Part C that could produce a child with this X-linked genetic condition.

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.



Identify the percentage of males that are expected to have the genetic condition based on this Punnett square.

50% of males are expected to have the genetic condition

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Score Point 3

This question has four parts.
A man and a woman plan to have a biological child. They want to determine the likelihood that their child will inherit a genetic condition that runs in both of their families. One gene with two alleles is responsible for the condition. The dominant allele (**A**) produces the normal phenotype, and the recessive allele (**a**) produces the genetic condition. Both the man and the woman have the normal phenotype.

Part A
Using the allele symbols **A** and **a**, identify **all** possible genotypes of the man and **all** possible genotypes of the woman for this genetic condition.

man- Aa or AA
woman - Aa or AA

Part B
Complete the Punnett square to show how the man and the woman can have a biological child with this genetic condition.

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.

A a AA Aa aa

	A	a
A	AA	Aa
a	Aa	aa

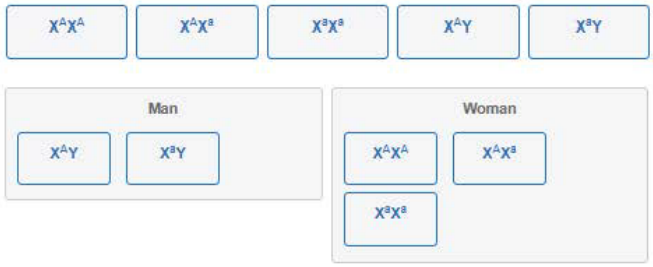
Identify the percentage of offspring that are expected to have the genetic condition based on this Punnett square.

25% chance of the genetic condition

Part C

After doing some research, they determine the genetic condition is X-linked.

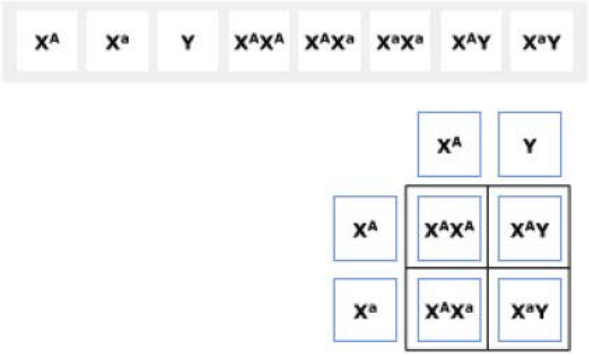
Drag and drop allele pairs into the boxes to identify **all** possible genotypes of the man and **all** possible genotypes of the woman. Each allele pair may be used once, more than once, or not at all.



Part D

Complete the Punnett square with the parental genotypes identified in Part C that could produce a child with this X-linked genetic condition.

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.



Identify the percentage of males that are expected to have the genetic condition based on this Punnett square.

50% of males are expected to have the condition

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Score Point 2

This question has four parts.

A man and a woman plan to have a biological child. They want to determine the likelihood that their child will inherit a genetic condition that runs in both of their families. One gene with two alleles is responsible for the condition. The dominant allele (**A**) produces the normal phenotype, and the recessive allele (**a**) produces the genetic condition. Both the man and the woman have the normal phenotype.

Part A

Using the allele symbols **A** and **a**, identify **all** possible genotypes of the man and **all** possible genotypes of the woman for this genetic condition.

Both the man and woman could have the potential genotypes of AA or Aa.

Part B

Complete the Punnett square to show how the man and the woman can have a biological child with this genetic condition.

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.

A **a** **AA** **Aa** **aa**

	A	a
A	AA	Aa
a	Aa	aa

Identify the percentage of offspring that are expected to have the genetic condition based on this Punnett square.

25% of the offspring are expected to have the genetic condition.

Part C

After doing some research, they determine the genetic condition is X-linked.

Drag and drop allele pairs into the boxes to identify **all** possible genotypes of the man and **all** possible genotypes of the woman. Each allele pair may be used once, more than once, or not at all.

X^AX^A X^AX^a X^aX^a X^AY X^aY

Man

X^aY X^AY

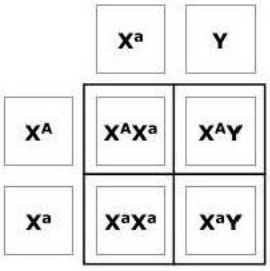
Woman

X^AX^a X^AX^A X^AX^a

Part D

Complete the Punnett square with the parental genotypes identified in Part C that could produce a child with this X-linked genetic condition.

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.



Identify the percentage of males that are expected to have the genetic condition based on this Punnett square.

25% of male offspring are expected to have the genetic condition.

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Score Point 1

This question has four parts.

A man and a woman plan to have a biological child. They want to determine the likelihood that their child will inherit a genetic condition that runs in both of their families. One gene with two alleles is responsible for the condition. The dominant allele (**A**) produces the normal phenotype, and the recessive allele (**a**) produces the genetic condition. Both the man and the woman have the normal phenotype.

Part A

Using the allele symbols **A** and **a**, identify **all** possible genotypes of the man and **all** possible genotypes of the woman for this genetic condition.

For the possible genotypes of the man are AA, Aa, aa. For the womans possible genotypes they are AA, Aa, aa.

Part B

Complete the Punnett square to show how the man and the woman can have a biological child with this genetic condition.

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.

A **a** **AA** **Aa** **aa**

	A	**a**
A	**AA**	**Aa**
a	**Aa**	**aa**

Identify the percentage of offspring that are expected to have the genetic condition based on this Punnett square.

It could be 75% or 25%

Part C

After doing some research, they determine the genetic condition is X-linked.

Drag and drop allele pairs into the boxes to identify **all** possible genotypes of the man and **all** possible genotypes of the woman. Each allele pair may be used once, more than once, or not at all.

X^AX^A X^AX^a X^aX^a X^AY X^aY

Man

X^AY X^aY

Woman

X^aX^a X^AX^a X^AX^A

Part D

Complete the Punnett square with the parental genotypes identified in Part C that could produce a child with this X-linked genetic condition.

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.

X^A	X^a	Y	X^AX^A	X^AX^a	X^aX^a	X^AY	X^aY

	X^A	Y
X^A	X^A	X^AY
X^a	X^AX^a	X^aY

Identify the percentage of males that are expected to have the genetic condition based on this Punnett square.

25%

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Score Point 0

This question has four parts.

A man and a woman plan to have a biological child. They want to determine the likelihood that their child will inherit a genetic condition that runs in both of their families. One gene with two alleles is responsible for the condition. The dominant allele (**A**) produces the normal phenotype, and the recessive allele (**a**) produces the genetic condition. Both the man and the woman have the normal phenotype.

Part A

Using the allele symbols **A** and **a**, identify **all** possible genotypes of the man and **all** possible genotypes of the woman for this genetic condition.

Aa

Part B

Complete the Punnett square to show how the man and the woman can have a biological child with this genetic condition.

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.

A **a** **AA** **Aa** **aa**

	Aa	**Aa**
Aa	**Aa**	**Aa**
Aa	**Aa**	**Aa**

Identify the percentage of offspring that are expected to have the genetic condition based on this Punnett square.

100%

Part C

After doing some research, they determine the genetic condition is X-linked.

Drag and drop allele pairs into the boxes to identify **all** possible genotypes of the man and **all** possible genotypes of the woman. Each allele pair may be used once, more than once, or not at all.

X^AX^A X^AX^a X^aX^a X^AY X^aY

Man

X^AX^a

Woman

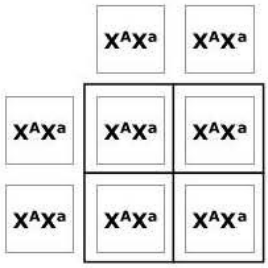
X^AX^a

Part D

Complete the Punnett square with the parental genotypes identified in Part C that could produce a child with this X-linked genetic condition.

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.

X^A	X^a	Y	X^AX^A	X^AX^a	X^aX^a	X^AY	X^aY



Identify the percentage of males that are expected to have the genetic condition based on this Punnett square.

100%

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