

Competition 8: Evolution Puzzles

PART 1:

Gametes	A	B
A	AA	AB
B	AB	BB

Genotype:

25% AA, 50% AB and 25% BB

Phenotype:

25% chance of inheriting DISEASE X, 50% chance of being a carrier for DISEASE X and 25% chance of neither inheriting or being a carrier for DISEASE X

=25%

PART 2:

Probability of the father's genotype:

$$AB = 2p_A p_B = 2 \times 20\% \times 80\% = 32\%$$

$$AA = p_A^2 = 20\% \times 20\% = 4\%$$

$$BB = p_B^2 = 80\% \times 80\% = 64\%$$

Genotype of father is AB:

Gametes	A	B
A	AA	AB
B	AB	BB

Genotype of child:

25% AA, 50% AB and 25% BB

Phenotype of child:

25% chance of inheriting DISEASE X, 50% chance of being a carrier for DISEASE X and 25% chance of neither inheriting or being a carrier for DISEASE X

Probability of the father having genotype AB and the child developing the disease:

$$0.32 \times 0.25 = 0.08 = 8\%$$

Probability of child developing the disease:

= 8%

PART 3:

Probability of the mother's genotype:

$$AB = 2p_A p_B = 2 \times 20\% \times 80\% = 32\%$$

$$AA = p_A^2 = 20\% \times 20\% = 4\%$$

$$BB = p_B^2 = 80\% \times 80\% = 64\%$$

Probability of the father's genotype:

$$AB = 2p_A p_B = 2 \times 20\% \times 80\% = 32\%$$

$$AA = p_A^2 = 20\% \times 20\% = 4\%$$

$$BB = p_B^2 = 80\% \times 80\% = 64\%$$

Probability of the child developing the disease and the mother being a carrier:

As seen in part 2, there is an 8% chance of the child developing the disease if the mother is a carrier.

$$8\% \times 32\% = 2.56\%$$

Probability of child developing disease:

$$= 2.56\%$$

PART 4:

Probability of the father's genotype:

$$AB = 2p_A p_B = 2 \times 20\% \times 80\% = 32\%$$

$$AA = p_A^2 = 20\% \times 20\% = 4\%$$

$$BB = p_B^2 = 80\% \times 80\% = 64\%$$

Genotype of father is AB:

Gametes	A	B
A	AA	AB
B	AB	BB

Genotype of child:

25% AA, 50% AB and 25% BB

Phenotype of child:

25% chance of inheriting DISEASE X, 50% chance of being a carrier for DISEASE X and 25% chance of neither inheriting or being a carrier for DISEASE X

Probability of the father having genotype AB and the child being a carrier:

$$32\% \times 50\% = 16\%$$

Genotype of father is BB:

Gametes	A	B
B	AB	BB
B	AB	BB

Genotype:

50% BB and 50% AB

Phenotype:

50% chance of neither developing or carrying DISEASE X and 50% chance of being a carrier

Probability of the father having genotype BB and the child being a carrier:

$$64\% \times 50\% = 32\%$$

Probability of child being a carrier:

$$32\% + 16\%$$

$$= 48\%$$

PART 5:

Let child be female.

Probability of mother's genotype:

$$AB = 48\% \text{ (see part 4)}$$

$$AA = 8\% \text{ (see part 2)}$$

$$BB = 1 - (48\% + 8\%) = 44\%$$

Probability of the father's genotype:

$$AB = 2p_A p_B = 2 \times 20\% \times 80\% = 32\%$$

$$AA = p_A^2 = 20\% \times 20\% = 4\%$$

$$BB = p_B^2 = 80\% \times 80\% = 64\%$$

Probability of grandchild being a carrier when child is a carrier:

Genotype of father is AB:

Gametes	A	B
A	AA	AB
B	AB	BB

Genotype of grandchild:

25% AA, 50% AB and 25% BB

Phenotype of grandchild:

25% chance of inheriting DISEASE X, 50% chance of being a carrier for DISEASE X and 25% chance of neither inheriting or being a carrier for DISEASE X

Probability of the father having genotype AB and the grandchild being a carrier:

$$32\% \times 48\% \times 50\% = 7.68\%$$

Genotype of father is BB:

Gametes	A	B
B	AB	BB
B	AB	BB

Genotype:

50% BB and 50% AB

Phenotype:

50% chance of neither developing or carrying DISEASE X and 50% chance of being a carrier

Probability of the father having genotype BB and the grandchild being a carrier:

$$64\% \times 48\% \times 50\% = 15.36\%$$

Probability of grandchild being a carrier and child being a carrier:

$$7.68\% + 15.36\% = 23.04\%$$

Probability of grandchild being a carrier when child has genotype BB:

Genotype of father is AB:

Gametes	B	B
A	AB	AB
B	BB	BB

Genotype of grandchild:

50% BB and 50% AB

Phenotype of grandchild:

50% chance of neither developing or carrying DISEASE X and 50% chance of being a carrier for DISEASE X

Probability of the father having genotype AB and the grandchild being a carrier:

$$32\% \times 44\% \times 50\% = 7.04\%$$

Genotype of father is BB:

Gametes	B	B
B	BB	BB
B	BB	BB

Genotype:

100% BB and 0% AB

Phenotype:

100% chance of neither developing or carrying the disease

Probability of the father having genotype BB and the grandchild being a carrier:

0%

Probability of grandchild being a carrier and child having genotype BB:

7.04%

Probability of grandchild being a carrier:

$$23.04\% + 7.04\%$$

$$= 30.08\%$$