Genetics Concept Assessment
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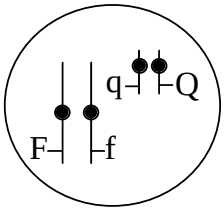
1. Which of the following human cells contains a gene that specifies eye color?
   a) Cells in the eye.
   b) Cells in the heart.
   c) Gametes (sperm and egg).
   d) Cells in the eye and gametes.
   e) All of the above.

2. In the germline cell below there are two pairs of chromosomes on which are shown the locations of two different genes. F and f represent two different alleles (versions or variants) of one gene, and Q and q represent two different alleles of another gene. If this cell divides normally to produce sperm, what are the possible sperm genotypes?



   a) F, f, Q, q
   b) Ff, Ff, Qq, Qq
   c) FQ, fq, Fq, fQ
   d) Ff, Qq, FQ, fq, Fq, fQ

3. An inherited disease that affects women and not men is likely to be caused by:
   a) a mutation in a gene on the X chromosome, which is a sex chromosome.
   b) a mutation in a gene on a non-sex chromosome (autosome).
   c) without additional information, either answer (a) or (b) is possible.

4. Suppose that a single DNA base change of an A to a T occurs and is copied during replication. Is this change necessarily a mutation?
   a) Yes, it is a change in the DNA sequence.
   b) Yes, if the base change occurs in a gamete (sperm or egg cell); otherwise no.
   c) Yes, if the base change occurs in the coding part of a gene; otherwise no.
   d) Yes, if the base change occurs in the coding part of a gene and alters the amino acid sequence of a protein; otherwise no.
   e) Yes, if the base change alters the appearance of the organism (phenotype); otherwise no.

5. An isolated population of prairie dogs has longer than average teeth. As a result they can eat more grass with less effort and are better able to survive. The mutation(s) that resulted in longer teeth:
   a) allowed the teeth to grow longer over several generations until they reached an optimal length for eating grass.
   b) arose in many members of the population at the same time.
   c) happened by chance.
   d) occurred because the prairie dogs needed to be more efficient at eating grass to survive and reproduce.
   e) would only occur in a prairie dog population that eats grass and would not occur in a population that lives on seeds.

6. Starting with a population of genetically identical mice, you discover two new independent mutant strains in which all of the animals have epileptic seizures. In both strains, you know that the epileptic seizures are due to a single DNA mutation. You cross a mutant mouse from one strain to a mutant mouse from the second strain and find that none of their many offspring undergo spontaneous seizures. From this experiment you would conclude that the two mutant strains of mice most likely have mutations in:

a) the same DNA base position within a particular gene.
b) the same gene, but not necessarily the same DNA base position.
c) two different genes.

7. A young man develops skin cancer that does not spread to any other tissues; the mutation responsible for the cancer arose in a single skin cell. If he and his wife (who does not have skin cancer) have children after the skin cancer diagnosis, which of the following statements is most likely to be true?

a) All the man's children will inherit the mutation.
b) All the man's children will inherit the mutation if the mutation is dominant.
c) Some of the man's children may inherit the mutation depending on which of his chromosomes they inherit.
d) None of the man's children will inherit the mutation.

8. The *MLH1* gene is located on chromosome 3 in humans and four different alleles have been identified. The maximum number of alleles a <u>single normal individual</u> can have is:

a) 1
b) 2
c) 3
d) 4

9. A population of buffalos is isolated such that no new buffalos can come into their territory. Which of the following is primarily responsible for the appearance of new alleles in this population?

a) Reassortment of chromosomes during the process of creating sperm or eggs.
b) Mutations in cells that will become sperm or eggs.
c) Changes in the environment that favor some buffalo traits over others.
d) Random mating between the buffalos in the population.

10. Cystic fibrosis in humans is caused by mutations in a single gene and is inherited as an autosomal (non-sex chromosome) recessive trait. A normal couple has two children. The first child has cystic fibrosis, and the second child is unaffected. What is the probability that the second child is a carrier (heterozygous) for the mutation that causes the disease?

a) 1/4
b) 1/2
c) 2/3
d) 3/4
e) 1

11. Use the following mRNA codon key as needed to answer the next two questions:

GCC Alanine
AAU Asparagine
CCU Proline
GGA Glycine
UGG Tryptophan
UGA "Stop" (no amino acid)
GAA Glutamic acid
GAG Glutamic acid
AGG Arginine
CCC Proline
CAU Histidine

The following DNA sequence (coding strand) occurs near the middle of the coding region of a gene.

DNA

```
                50          55          60          65
5'—A A T G A A T G G G A G C C T G A A G G A G  –-3'
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The corresponding mRNA sequence is shown below. Note that the coding strand of DNA has the same sequence as the mRNA, except that there are U's in the mRNA where there are T's in the DNA. The first triplet of nucleotides AAU (underlined) is in frame for coding, and encodes Asparagine as the codon table above indicates.

mRNA

```
                50          55          60          65
5'—A A U G A A U G G G A G C C U G A A G G A G  –-3'
```

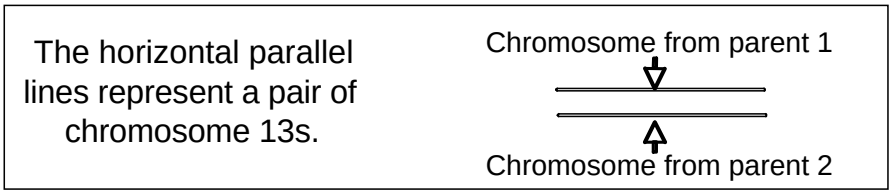
Which of the following DNA mutations is almost certain to result in a shorter than normal mRNA?

a) A→G at position 50
b) G→A at position 53
c) C→A at position 58
d) None of the above

12. For the same DNA sequence, which of the following DNA mutations is almost certain to result in a shorter than normal protein?

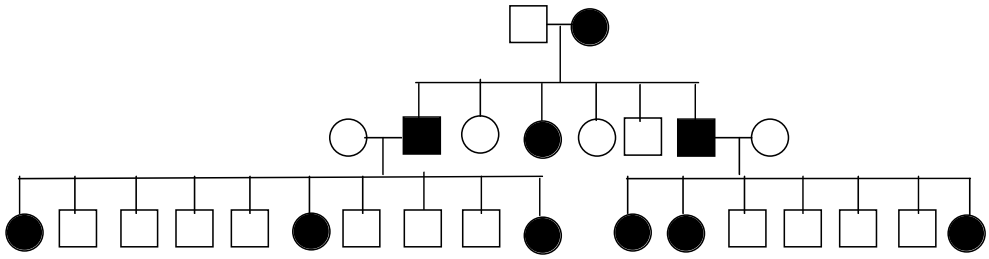
a) T→C at position 59
b) A→G at position 61
c) Insertion of a G after the G at position 54
d) None of the above

13. A man is a carrier for Wilson's disease (Aa) and Rotor syndrome (Rr). Assume the genes involved in these two disorders are both on chromosome 13 (a non-sex chromosome). Below are possible representations of his genotype (labeled #1, #2, and #3). Which of them could be correct?



a) #1 only
b) #2 only
c) #3 only
d) #2 and #3 only
e) #1, #2 and #3

14. This pedigree shows a family afflicted with a rare genetic disease (circles represent females, squares represent males, and individuals with filled symbols have the disease; assume that any people who marry into the family are not carriers for the disease). The genetic mode of inheritance that is <u>most consistent</u> with this pedigree is:

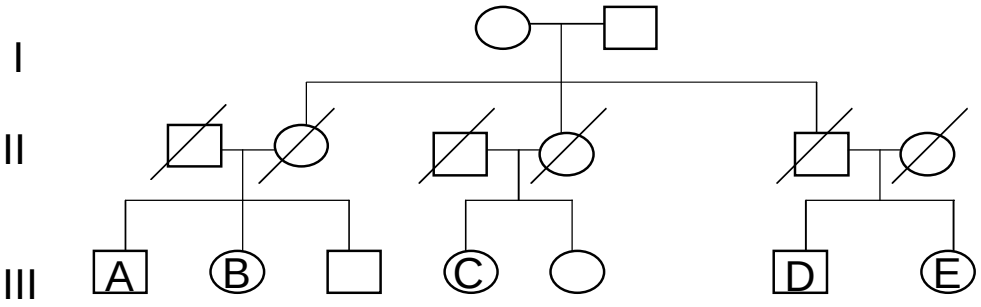


a) autosomal dominant
b) autosomal recessive
c) X-linked dominant
d) X-linked recessive

15. You have identified a previously unknown human gene that appears to have a role in autism. It is similar enough in DNA sequence to a known mouse gene that you believe the two genes may be evolutionarily related. You determine and compare the DNA sequences, the predicted mRNA sequences, and the predicted amino acid sequences corresponding to the two genes. You would expect to find the *greatest* sequence similarity from comparisons of the two:

a) DNA sequences.
b) mRNA sequences.
c) amino acid sequences.
d) All three comparisons are likely to show the same degree of sequence similarity.

16. Below is a pedigree of a family in which all the people in generation II are dead (indicated with a slash) because of political unrest in their country. Circles represent females, squares represent males.



Which children in generation III could be traced to the grandmother in this pedigree by using only mitochondrial DNA sequences:

a) A and D
b) A, B, and C
c) B, C, and E
d) A, B, C, D, and E

17. Cells in the king crab have 104 pairs of chromosomes. You have discovered another similar looking species of crab that you call the prince crab, which has only 100 pairs of chromosomes in its cells. From this finding, you can conclude that:

a) the king crab has a larger genome than the prince crab.
b) the king crab has more genes than the prince crab.
c) the king crab evolved from the prince crab.
d) all of the above.
e) there is not enough information to make any of the above conclusions.

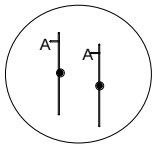
18. A woman who is a carrier for X-linked hemophilia (she does not have the disease) marries a man who does not have hemophilia. They have a daughter, named Angela, who does not have the disease. Angela marries George, who also does not have hemophilia. Angela and George have a son named Robbie. What is the chance that Robbie will have hemophilia?

a) 0
b) 1/8
c) 1/4
d) 1/3
e) 1/2

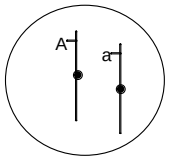
19. Polydactyly is an inherited trait that results in extra fingers or toes. In the United States 0.1% of the population exhibits polydactyly. People with polydactyly have the genotype Pp, where P represents the allele that causes polydactyly and p represents the normal allele of this gene. Which of the following is true?

a) The P allele is more frequent in the US than the p allele.
b) The P allele is less frequent in the US than the p allele.
c) The two alleles, P and p are at approximately equal frequencies in the US population.
d) There is not enough information to answer this question.

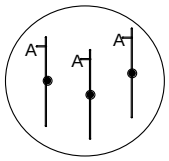
20. Sue's chromosome #18 pair looks like this:



Bob's chromosome #18 pair looks like this:



Bob and Sue have a stillborn son with three copies of chromosome #18 that look like this:



In which parent did the chromosome separation problem occur?

a) Sue
b) Bob
c) You need additional information to determine which parent.

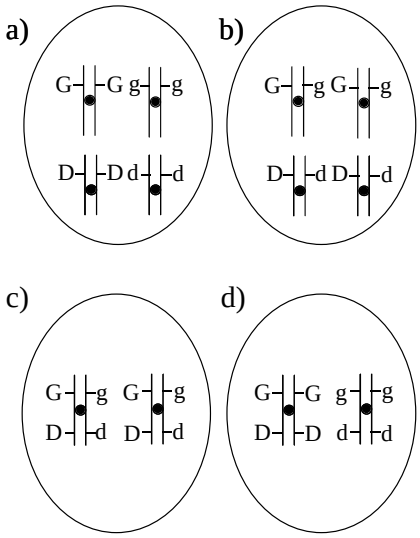
21. You are interested in studying a gene called CFTR because mutations in this gene in humans cause cystic fibrosis. You have made a line of mice that lack the mouse CFTR gene. These mice are unable to clear bacteria from their lungs, so they get lung disease. You put a normal human CFTR gene into some of these mice and discover that the mice with the human gene are able to clear bacteria from their lungs and no longer get lung disease. From this experiment, you can conclude that:

a) The DNA sequences of the mouse CFTR gene and human CFTR gene are identical.
b) The amino acid sequences of the mouse CFTR protein and the human CFTR protein are identical.
c) The mouse CFTR gene and human CFTR gene encode proteins that can serve a similar function.
d) Both answers b) and c) are true.
e) All of the above are true.

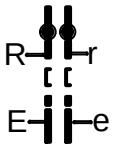
22. In the cells of all human females, one X chromosome is inactivated. The *opsin1* gene is on the X chromosome and is expressed in the retinal cells of the eye. Mutations in this gene cause the recessive trait of colorblindness. Most women who have one mutant allele of the *opsin1* gene and one normal allele of the *opsin1* gene (they are heterozygous) can still see color. What is the most likely explanation for this finding?

a) The X with the mutant allele of the *opsin1* gene is more likely to be inactivated because of the *opsin1* mutation.
b) Any mutations in the *opsin1* gene on the active X can be corrected through genetic exchange (recombination) with the inactive X.
c) If the active X has the mutant allele of *opsin1* gene, the inactive X with the normal allele will be reactivated.
d) Some retinal cells will have an active X with the mutant allele of the *opsin1* gene, and some will have an active X with the normal allele of the *opsin1* gene.

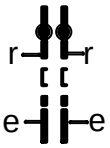
23. Suppose there are two genes on two different chromosomes, one gene called G and the other called D. An individual has the genotype GgDd. Which of the following drawings correctly shows cells in this individual after DNA replication but before cell division of the first meiosis? Assume no recombination/crossing-over occurs between the chromosomes.



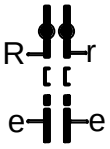
24. Two different genes are located on the same chromosomal pair in rabbits. A particular female rabbit is heterozygous for alleles of both these genes, with the alleles arranged as shown in the diagram to the right. Scientists know that the two genes are on the same chromosome, but do not know their exact position, as indicated by the dashed line.



Suppose this female mates with a male rabbit in which the same chromosome pair looks like this:



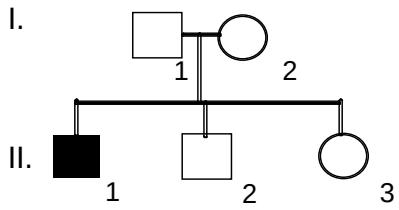
How likely is it that this pair of rabbits would have offspring with a chromosome pair that looks like this:



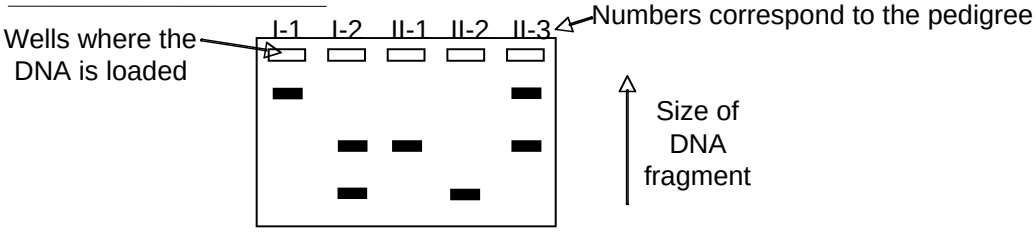
a) Not likely, because the R and e alleles are not on the same chromosome in either parent.
b) Very likely, because the random assortment of chromosomes during cell division to make sperm or eggs allows for the mixing of all alleles.
c) More likely if the two genes are very close together on the chromosome.
d) More likely if the two genes are not very close together on the chromosome.

25. Mutations in the *shin* gene result in a bone disease called Shingularia. The *shin* gene is located next to a DNA marker called S50, which exists in three variants of different sizes in humans. Below is a pedigree of a family with Shingularia and a gel showing the Marker S50 size for each person. All bands on the gel are equally intense.

Pedigree:



Marker S50 Information:



Which mode of inheritance for the disease Shingularia is most consistent with the pedigree and the information on Marker S50?

a) X-linked dominant.
b) X-linked recessive.
c) Autosomal dominant.
d) Autosomal recessive.
e) More than one mode of inheritance is possible.