Medical Biology and General Genetics

Situational problems

1. In the snail Cepaea nemoralis, an autosomal allele causing a banded shell (b) is recessive to the allele for unbanded shell (B). Genes at a different locus determine the background color of the shell; here, yellow (d) is recessive to brown (D). A banded, yellow snail is crossed with a homozygous brown, unbanded snail. The F1 are then crossed with banded, yellow snails (a testcross). What will be the results of the testcross if the loci that control banding and color are linked with no crossing over?

2. In the snail Cepaea nemoralis, an autosomal allele causing a banded shell (b) is recessive to the allele for unbanded shell (B). Genes at a different locus determine the background color of the shell; here, yellow (d) is recessive to brown (D). A banded, yellow snail is crossed with a homozygous brown, unbanded snail. The F1 are then crossed with banded, yellow snails (a testcross). What will be the results of the testcross if the loci are linked and 20 map units apart?

3. Female with brachydactyly has two older brothers who are identical twins; they both have short fingers. Also she has two younger sisters with normal fingers. Female's mother has normal fingers, and her father has short fingers. Female's paternal grandmother has short fingers; her paternal grandfather, who is now deceased, had normal fingers. Both of female's maternal grandparents have normal fingers. Female marries male, who has normal fingers. They produce two children: an older daughter with short fingers and a younger son with normal fingers. Using correct symbols and labels, draw a pedigree illustrating the inheritance of short fingers in the family. What is the most likely mode of inheritance for short fingers in this family?

4. Proband is color-blind. His mother and father both have normal vision, but his mother's father is color-blind. All proband's other grandparents have normal color vision. He has three sisters - all with normal color vision. One of the sisters is married to a man with normal color vision; they have two children, a 9-year old color-blind boy and a 4-year-old girl with normal color vision. Using correct symbols and labels, draw a pedigree of proband's family. What is the most likely mode of inheritance for color blindness in proband's family?

5. Phenylketonuria (PKU) is a disease that results from a recessive gene. Two normal parents produce a child with PKU. What is the probability that their next child will have PKU? What is the probability that their next child will be heterozygous for the PKU gene?

6. Color blindness in humans is most commonly due to an X-linked recessive allele. Woman has normal vision, but her mother is color blind. Man is color blind. If the woman and the man marry and have a child together, what is the probability that the child will be color blind?

7. Red–green color blindness is an X-linked recessive trait in humans. Polydactyly (extra fingers and toes) is an autosomal dominant trait. Woman has normal fingers and toes and normal color vision. Her mother is normal in all respects, but her father is color blind and polydactylous. Man is color blind and polydactylous. His mother has normal color vision and normal fingers and toes. If the man and the woman marry, what types and proportions of children can they produce?

8. Red–green color blindness and hemeralopia are X-linked recessive traits in humans. Loci located in the chromosome at distance 30 map units apart. What is probability of childbirth with both anomalies if parents have normal sight. In family from mother side, mother of woman suffer hemeralopia, father is color blind.

9. Ptosis (droopy eyelid) may be inherited as a dominant human trait. Give probability of childbirth with droopy eyelid in family where father is heterozygote in this gene and mother is healthy.

10. Arachnodactily is a dominant autosomal trait that inherited with 30% penetrance. Left-handedness is a recessive autosomal trait with full penetrance. What is the probability of childbirth with both traits if parents in the family are heterozygous at both genes?

11. In silkmoths (Bombyx mori) red eyes (re) and white-banded wing (wb) are encoded by two mutant alleles that are recessive to those that produce wild-type traits (RE and WB); these two genes are on the same chromosome. A moth homozygous for red eyes and white-banded wings is crossed with a moth homozygous for the wild-type traits. The F1 have normal eyes and normal wings. The F1 are crossed

with moths that have red eyes and white-banded wings in a testcross. The progeny of this testcross are:

wild-type eyes, wild-type wings - 418
red eyes, wild-type wings - 19
wild-type eyes, white-banded wings - 16
red eyes, white-banded wings - 426

What phenotypic proportions would be expected if the genes for red eyes and white-banded wings were located on different chromosomes? What is the genetic distance between the genes for red eyes and white-banded wings?

12. The color and the shape of corn seeds controlled by two genes localized in same chromosome with distance 3.6 map units apart. Smooth and coloured seeds are dominant attributes; wrinkled and colorless seeds are recessive attributes.

Plant with genotype $\frac{AB}{ab}$

was crossed with homozygote plant with wrinkled colorless seeds. What is phenotypic proportion of progeny with smooth and coloured seeds?

13. Red–green color blindness and hemeralopia are X-linked recessive traits in humans. Loci located in the chromosome at distance 30 map units apart. What is probability of childbirth with both anomalies if woman is heterozygote for both traits and inherited traits from father, man have both anomalies.

14. Albinism is an autosomal recessive trait in humans. Hemophilia is a recessive X-linked trait. Couple that is normal for both traits has son with both diseases. Give probability of healthy childbirth in the family.

15. Phenylketonuria and agammaglobulinemia are diseases that result from autosomal recessive genes. What is the probability of healthy childbirth if parents in the family are heterozygous at both genes?

16. Hemophilia and daltonism are recessive X-linked traits. Genes of both traits are linked with 9.8 map units apart. Healthy female marries male, who has both diseases. Female's mother has daltonism, and her father has hemophilia. What is the probability of childbirth with both diseases in the family.

17. Alkaptonuria is inherited as autosomal recessive attribute. Female has normal metabolism, but her brother has alkaptonuria. Female's father has alkaptonuria, and her mother has normal metabolism. Give the genotypes of female, her mother, her father, and her brother. If female's parents have another child, what is the probability that this child will have alkaptonuria?

18. Hypertrychosis is a Y-linked trait in humans, polydactily is a dominant autosomal trait. Man with hypertrychosis and woman with polydactily produce normal daughter. What is the probability of childbirth with both anomalies in the family.

19. Give the expected genotypic and phenotypic ratios for the following crosses for AB0 and Rh blood types.

(a) $I^AI^0\ Rh^+Rh^-$ x $I^BI^0\ Rh^+Rh^-$

(b) $I^AI^B\ Rh^-Rh^-$ x $I^AI^0\ Rh^-Rh^-$

(c) $I^AI^B\ Rh^+Rh^-$ x $I^AI^B\ Rh^+Rh^-$

20. Give the expected genotypic and phenotypic ratios for the following crosses for AB0 and Rh blood types.

(a) $I^AI^B\ Rh^+Rh^-$ x $I^AI^B\ Rh^+Rh^-$

(b) I^0I^0 Rh^-Rh^- x I^AI^0 Rh^+Rh^-
(c) I^AI^B Rh^-Rh^- x I^0I^0 Rh^+Rh^-

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