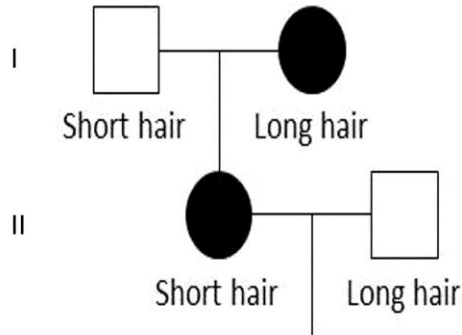


In cavies (guinea pigs) solid-colored coats (W) are dominant to white-spotted coats (w) and short hair (L) is dominant to long hair (l). Imagine genes W and L are 18 map units apart on chromosome 5. Examine the pedigree below. Note that solid-colored cavies are indicated by solid symbols and white-spotted cavies are indicated by open symbols. The next two questions refer to this information.



1. What proportion of the gametes produced by II-1 will be $\underline{L}w$ gametes?
 - a) 18%
 - b) 82%
 - c) 9%
 - d) 41%**
 - e) none of the above

2. The first offspring of II-1 and II-2 has a white-spotted coat. What is the probability this offspring will also have long hair?
 - a) 82%
 - b) 41%
 - c) 18%**
 - d) 9%
 - e) none of the above

3. If genes A and B are tightly linked on chromosome 12, a dihybrid, $Ab//aB$, will produce the following gametes:
 - a) AB , aB , Ab and ab in a 1:1:1:1 ratio
 - b) ab and AB in a 1:1 ratio
 - c) $AaBb$, $aaBb$, $Aabb$ and $aabb$ in equal frequencies
 - d) $Ab//ab$ and $aB//ab$ in a 1:1 ratio
 - e) Ab and aB in a 1:1 ratio**

A breeder of morning glory plants has plants which produce three different flower color phenotypes - red, pink, and white. The breeder makes a number of crosses and produces the following table:

Parents	F1 Phenotypes
pink X pink	1/4 red, 1/2 pink and 1/4 white
pink X white	1/2 pink and 1/2 white
pink X red	1/2 red and 1/2 pink
red X white	all pink

The next question refers to the above information.

4. What statement best explains the results shown in the above table?

- a) Pink flowered plants must be monohybrids.
- b) The pink allele is incompletely dominant to the white allele.
- c) Three alleles of one gene control the above flower color phenotypes in morning glory plants.
- d) Two genes control the above flower color phenotypes in morning glory plants.
- e) The red allele is incompletely dominant to the pink allele.

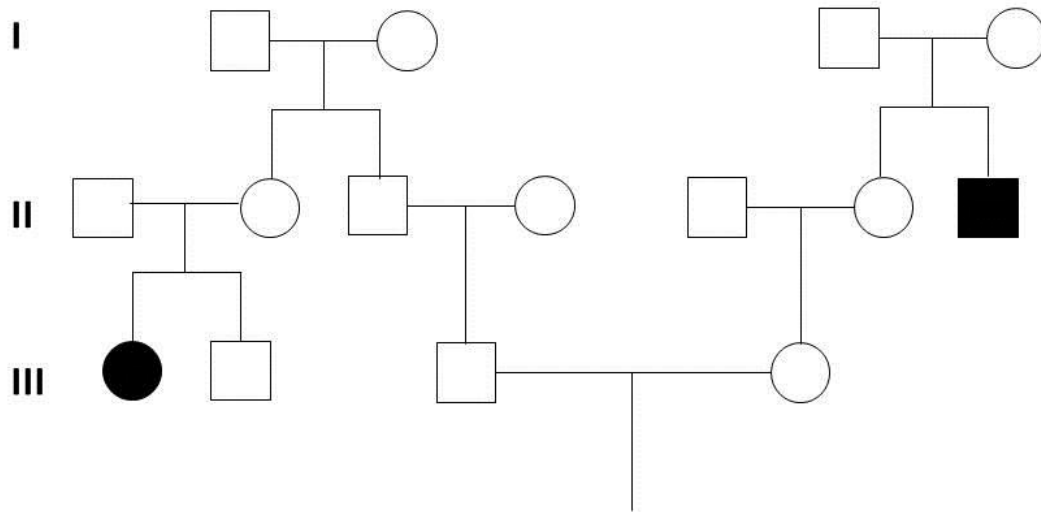
5. Bacterial transformation:

- a) is a process whereby bacteria swap genetic information, akin to eukaryotic mating.
- b) is a process by which bacteria take up DNA from their environment.
- c) is a process by which the bacteria take up nutrients from the environment.
- d) occurs when bacterial genes are carried by a phage.
- e) occurs when a phage carries the F plasmid.

6. Which of the following matings would most likely produce an F- cell with a new genetic makeup after conjugation?

- a) Hfr donor and F- recipient
- b) F+ donor and F- recipient
- c) F- donor and F+ recipient
- d) Hfr donor and F+ recipient
- e) F+ donor and Hfr recipient

You are a genetic counselor interviewing a phenotypically normal couple III-3 and III-4, each with a deadly autosomal recessive disease in their families. Shaded individuals died at a very young age. Assume that this trait is very rare.



7. What is the probability that III-3 and III-4 will have a child with this deadly disease?
- a) 1/16
 - b) 1/32
 - c) 1/64
 - d) 1/48**
 - e) none of the above

8. Genetic elements that can replicate independently or integrate with the main chromosome in bacteria are known as:
- a) fragments
 - b) episomes
 - c) plasmids
 - d) chromatids
 - e) none of these
9. Which of the following is true about double stranded DNA?
- a) It is 25% A, 25% T, 25% G, and 25% C.
 - b) 50% of the composition of DNA is C.
 - c) 50% of the bases are purines
 - d) $[A+T] = [G+C]$.
 - e) It will always be 25% T.
10. Each nucleosome core:
- a) also uses protamines for 30 nm fiber formation.
 - b) must use histones H2, H3a, H3b, and H4 for stabilization.
 - c) consists of the 30 nm fiber.
 - d) holds one negative supercoil.
 - e) has 146 nucleotide pairs of DNA wrapped around the octamer of histones.
11. In the fruit fly, recessive mutations in either of two independently assorting genes, *brown* and *purple*, prevent the synthesis of red pigment in the eyes. Thus, homozygotes for either of these mutations have brownish-purple eyes. However, heterozygotes for both of these mutations have dark red, that is, wild-type eyes. If such double heterozygotes are intercrossed, what kinds of progeny will be produced, and in what proportions?
- a) 3/4 dark red, 1/4 brownish-purple
 - b) 9/16 dark red, 7/16 brownish-purple
 - c) 9/16 dark red, 3/16 brownish-purple, 4/16 white
 - d) 1/4 dark red, 2/4 dark red-brownish purple blend, 1/4 brownish-purple
 - e) 12/16 dark red, 4/16 brownish-purple

12. A variety of limes called "Samoa" is a sterile autotriploid with $3N=45$. What could be observed in cells undergoing meiosis I?

- a) 10 trivalents, 5 bivalents and 5 univalents
- b) 45 bivalents
- c) 1 trivalents, 15 bivalents, and 12 univalents
- d) 4 trivalents, 10 bivalents, and 13 univalents
- e) more than one of the above

13. Under some conditions individuals with a wildtype/normal genotype can express a mutant phenotype; and conversely, individuals with a mutant genotype can be phenotypically normal/wildtype. These are examples, respectively, of the phenomena known as:

- a) variable expressivity and incomplete penetrance
- b) phenocopy and incomplete penetrance
- c) incomplete penetrance and variable expressivity
- d) variable expressivity and phenocopy
- e) none of the above

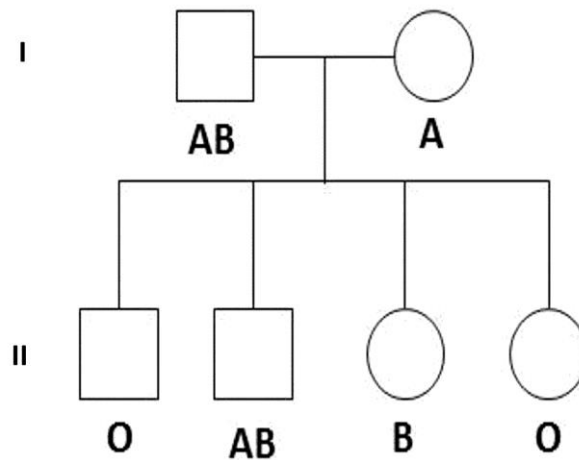
14. In a species of mouse, the Y allele produces yellow fur and is dominant to the y allele that produces white fur when homozygous. When you cross two yellow mice, you always observe roughly twice as many yellow progeny than white. Your knowledge of Mendelian genetics suggests that you should be observing three times as many yellow mice. What could be a possible explanation?

- a) Recessive epistasis
- b) Recessive lethal allele
- c) Two genes are affecting fur color in this species
- d) Variable expressivity
- e) A dominant negative allele

15. A single gene can be responsible for a number of distinct clinical symptoms. This is an example of:

- a) pleiotropy
- b) penetrance
- c) phenocopy effect
- d) incomplete expressivity
- e) genetic anticipation

A small number of type O individuals have the Bombay blood phenotype. Individuals with the Bombay blood phenotype always appear to have type O blood because they are homozygous recessive for the gene, H, which is epistatic to gene I. As long as at least one dominant H allele is present, the ABO blood type associated with the person's ABO genotype will be expressed. Individuals who are homozygous hh always have type O blood. The pedigree below includes two individuals with the Bombay blood phenotype.



Use the above information to answer the next two questions.

16. The genotype of I-2 is:

- a) $I^A I^A Hh$
- b) $I^A i Hh$**
- c) $I^A i HH$
- d) $I^A i hh$
- e) more than one of the above is possible

17. What is a possible genotype for II-1?

- a) $I^A I^A Hh$
- b) $I^B I^B Hh$
- c) $ii hh$
- d) $I^A I^A hh$**
- e) $I^B i Hh$

The fescue grass, *F. sativa* ($2N=20$) was pollinated by *F. punctoria* ($2N=12$) and this cross produced many hybrid plants. Most of the hybrids were infertile except for a few plants which were very robust with long leaves, long stems and large seeds. Breeders decided that the fertile hybrids were polyploids and gave them the name *F. titanica*.

The next three questions refer to this information.

18. How many bivalents would be observed in *F. titanica* cells during Prophase I?

- a) 32
- b) 8
- c) 18
- d) 16
- e) none of the above

19. In the laboratory, *F. titanica* plants were back-crossed to *F. sativa* to produce an infertile hybrid. How many chromosomes would be found in the somatic cells of the infertile hybrid?

- a) 48
- b) 32
- c) 24
- d) 26
- e) none of the above

20. Germ cells from the infertile hybrid produced in question 19 do attempt meiosis. What would you expect to see at Prophase I?

- a) There are no homologous chromosomes so pairing would not be seen
- b) 10 bivalents and 6 univalents
- c) 20 bivalents and 6 univalents
- d) 8 bivalents and 8 univalents
- e) 10 bivalents and 12 univalents

21. Genes a and b are 20 cM apart. An $a^+ b^+//a^+ b^+$ individual was mated with an $a b//a b$ individual. If the F1 was crossed to $a b//a b$ individuals, what offspring would be expected, and in what proportions?

- a) 30% $a^+ b^+//a b$, 30% $a b//a b$, 20% $a^+ b//a b$, 20% $a b^+//a b$
- b) 40% $a^+ b^+//a^+ b^+$, 40% $a b//a b$, 10% $a^+ b//a b$, 10% $a b^+//a b$
- c) 40% $a^+ b//a b$, 40% $a b^+//a b$, 10% $a^+ b^+//a b$, 10% $a b//a b$
- d) 30% $a^+ b^+//a^+ b^+$, 30% $a b//a b$, 20% $a^+ b//a b$, 20% $a b^+//a b$
- e) 40% $a^+ b^+//a b$, 40% $a b//a b$, 10% $a^+ b//a b$, 10% $a b^+//a b$

22. You are told that two genes A and B are 73.2 map units apart on chromosome 6 of a pea plant. When crossing a dihybrid $AB//ab$ with a homozygous recessive $ab//ab$ plant, what proportion of recombinant progeny would you expect?

- a) 36.6%
- b) 73.2%
- c) 0%
- d) 18.3%
- e) None of the above

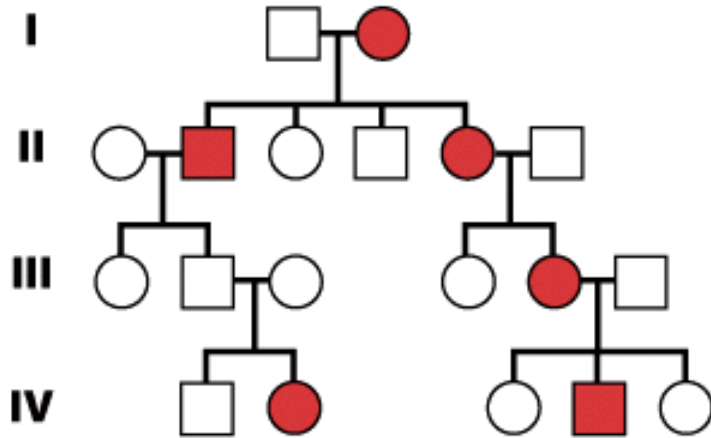
23. Of the following aneuploid karyotypes, which could ONLY arise from a nondisjunction event during meiosis II?

- a) Klinefelter Syndrome
- b) Down Syndrome
- c) Turner Syndrome
- d) XYY
- e) XXX

24. An allotetraploid derived from 2 closely related species is $4N=24$. What would be observed in cells undergoing meiosis I?

- a) 8 trivalents
- b) 6 tetravalents
- c) 20 bivalents and 1 tetravalent
- d) 12 bivalents
- e) more than one of the above

The following pedigree shows the inheritance of ataxia, a rare dominant neurological disorder characterized by uncoordinated movements.



25. Individual III-2 is an example of:

- a) Variable expressivity
- b) Incomplete penetrance
- c) Pleiotropy
- d) Haplosufficiency
- e) Complementation

26. A phenotypically normal female (with no family history of X-linked colourblindness) and a colourblind male have a child with Klinefelter Syndrome who is $XX^{cb}Y$. Which of the following statements describes the meiotic event that gave rise to this child?

- a) A meiosis I nondisjunction occurred in the female parent.
- b) A meiosis II nondisjunction occurred in the female parent.
- c) A meiosis II nondisjunction occurred in the male parent.
- d) A meiosis I nondisjunction occurred in the male parent.
- e) None of the above

Consider two genes in the rabbit. One gene controls pigmentation. Allele C produces rabbits with full pigmentation. The recessive allele c^h produces the Himalayan phenotype (pigmentation restricted to the extremities). The second gene controls the color of the fat. Allele Y produces rabbits with white fat and the recessive allele, y , produces yellow fat. A dihybrid rabbit is crossed to a Himalayan with yellow fat. The following progeny are produced:

Phenotype	Number
Himalayan with white fat	220
Full color with white fat	32
Himalayan with yellow fat	36
Full color with yellow fat	212

Use the above information to answer the following 2 questions.

27. What is the map distance between genes C and Y ?

- a) 6.8 map units
- b) 13.6 map units
- c) 27.2 map units
- d) more than 50 map units
- e) none of the above

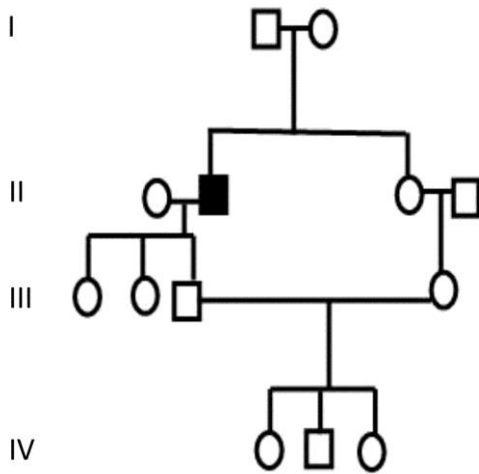
28. What is the genotype of the dihybrid?

- a) $y c^h // Y C$
- b) $Y c^h // y c^h$
- c) $Y y // C c^h$
- d) $y C // Y c^h$
- e) none of the above

29. A woman is a reciprocal translocation carrier. The chromosomes involved in the translocation are 3 and 7. The following would be observed during prophase I of meiosis:

- a) 1 tetravalent and 21 bivalents
- b) 23 bivalents
- c) 22 bivalents and 1 tetravalent
- d) 2 tetravalents and 20 bivalents
- e) none of the above

30. The pedigree below illustrates a rare trait controlled by a single gene, gene A. What is the genotype of individual III-4?



- a) $1/3 AA ; 1/3 Aa$
- b) $1/3 AA ; 2/3 Aa$
- c) $1/2 AA ; 1/2 Aa$
- d) $2/3 AA ; 1/3 Aa$
- e) none of the above

31. In mice, the allele C for colored fur is dominant over the allele c for white fur, and the allele V for normal behavior is dominant over the allele v for waltzing behavior, a form of discoordination. Give the genotypes of the parents in the following cross: Colored, normal mice mated with white, normal mice produced 29 colored, normal and 10 colored, waltzing progeny.

- a) $CC VV$ and $cc Vv$
- b) $Cc Vv$ and $Cc Vv$
- c) $CC Vv$ and $ccVV$
- d) $CC Vv$ and $cc Vv$
- e) $CC VV$ and $cc vv$

You cross a white cat with a brown cat and all of the progeny are white colored. Now you cross two of these white cats and in the F_2 progeny you see 1013 white colored cats, 450 brown colored cats and now, in addition, you see 338 black colored cats. The parental genotypes are $AA BB$ (white) and $aa bb$ (brown). Use the above information to answer the next two questions.

32. What term best describes the genetic interaction based on the phenotypes in the F_2 generation?

- a) Complete dominance
- b) Dominant epistasis
- c) Recessive lethal allele
- d) Complementation
- e) Recessive epistasis

33. Of the following options, which is NOT a possible genotype of the brown colored cat?

- a) $AA Bb$
- b) $aa BB$
- c) $aa Bb$
- d) $AA bb$
- e) More than one of the above

34. What are the possible offspring from a mother with type A blood and a father with type AB blood?

- a) A, B, AB, and O
- b) AB only
- c) A and AB
- d) A only
- e) A, B, and AB

35. The ability to taste PTC is due to a single dominant allele "T". You sampled 215 individuals in your biology class and determined that 150 could detect the bitter taste of PTC and 65 could not. What is the allele frequency of "T"?

- a) 0.50
- b) 0.30
- c) 0.20
- d) 0.55
- e) 0.45

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