

1. A researcher is studying three closely related species of ferns. Species A has 12 chromosomes in its somatic cells and species B has 24 chromosomes in its somatic cells. Species C has 36 chromosomes in its somatic cells. The researcher hypothesizes that species C is an allotetraploid produced by crosses that occurred between A and B. What piece of evidence would **best** support his hypothesis?

A B C
 $12 + 24 = 36$

- a) Species C is completely infertile. \times
- b) Species C always produces 12 trivalents during meiosis I. \times
- c) Species C always produces 9 tetravalents during meiosis I. \times
- d) Hybrids between species A and species C form 6 bivalents and 12 univalents and hybrids between species B and species C form 12 bivalents and 6 univalents.
- e) Species A and species B cannot produce seeds. \times

2. Lysogens are bacteria with plasmid DNA integrated within the bacterial chromosome.

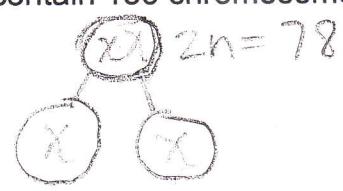
- a) Above statement is true Phage b) Above statement is false

3. A plant is $2N=32$. How many chromosomes would be found in the leaves, endosperm and spores of this plant?

- $3n$ n $n=16$
 $3n=48$
- a) 32, 16 and 16 respectively
 - b) 32, 32 and 16 respectively
 - c) 64, 16 and 16 respectively
 - d) 32, 48, and 16 respectively
 - e) none of the above

4. Sperm obtained from a rooster (a male chicken) have 39 chromosomes. Which of the following statements is/are true?

- a) Half of the sperm produced by this bird will have a Z chromosome and half will have a W chromosome.
- b) After S phase of the cell cycle, this bird's somatic cells contain 156 chromosomes.
- c) 78 bivalents are formed during meiosis I in this bird.
- d) This bird is $2N=78$.
- e) more than one of the above is true.



5. If the diploid number of an organism is $2N=52$, then there would be 78 chromosomes in a triploid.

- a) Above statement is true b) Above statement is false

In the snail, *Cepaea nemoralis*, an autosomal allele causing banded shells, *b*, is recessive to the allele *B* for unbanded shells. Another autosomal gene controls the background colour of the shell with allele *y* producing yellow shells and allele *Y* producing brown shells. A dihybrid snail is test-crossed. Use this information to answer the following 3 questions.

6. If the genes that control banding and colour are 20 map units apart on chromosome 1, which of the following results represent the offspring of a dihybrid test-cross? Assume the alleles are in the *trans* configuration in the dihybrid.

- 80% yellow unbanded + banded/brown 20% yellow banded
- a) 160 with banded, yellow shells, 160 with unbanded, brown shells, 40 with unbanded, yellow shells and 40 with banded, brown shells.
 - b) 100 with unbanded, brown shells and 100 banded, yellow shells.
 - c) 40 with banded, brown shells, 40 with unbanded, yellow shells, 10 with unbanded, brown shells and 10 with banded, yellow shells. —
 - d) 40 with banded, yellow shells, 40 with unbanded, brown shells, 20 with unbanded, yellow shells and 20 with banded brown shells.
 - e) None of the above

7. If the gene that controls shell banding maps to chromosome 3 and the gene that controls shell colour maps to chromosome 7, which of the following results represent the offspring of a dihybrid test-cross? recombination 4 map units

- a) 100 with banded, yellow shells and 100 with unbanded, brown shells
- b) 100 with banded, brown shells and 100 unbanded, yellow shells.
- c) 115 with unbanded, brown shells, 38 with unbanded, yellow shells, 38 with banded, brown shells, and 15 with banded, yellow shells.
- d) 50 with banded, yellow shells, 50 with banded, brown shells, 50 with unbanded, yellow shells and 50 with unbanded brown shells.
- e) None of the above

8. If the genes that control banding and colour are very tightly linked, which of the following results represent the offspring of a dihybrid test-cross? Assume the alleles are in the *cis* configuration in the dihybrid.

- a) 100 with banded, yellow shells and 100 with unbanded, brown shells. ✓
- b) 100 with banded, brown shells and 100 unbanded, yellow shells.
- c) 50 with banded, yellow shells, 50 with banded, brown shells, 50 with unbanded, yellow shells and 50 with unbanded brown shells.
- d) 115 with unbanded, brown shells, 38 with unbanded, yellow shells, 38 with banded, brown shells, and 15 with banded, yellow shells.
- e) None of the above

$\frac{BY}{by} \times \frac{by}{by}$

$\frac{BY}{by}$ or $\frac{by}{by}$

9. Chloroplasts are found only in plant cells and mitochondria are found only in animal cells.

- a) Above statement is true b) Above statement is false

10. A student has a culture of tryptophan auxotrophs. These bacteria are able to survive in media that lacks tryptophan. ^{tryp}

- a) Above statement is true b) Above statement is false

In cucumbers, the allele controlling heart-shaped leaves, *hl*, is recessive to normal leaves, *Hl*. Another allele, *sp*, controls the presence of numerous spines and is recessive to the allele, *Sp*, for the absence of spines. Both genes are autosomal. Dihybrid plants were test-crossed. The following offspring were produced:

Phenotype	Numbers
<i>sp hl</i> Spiny, heart-shaped leaves	R 64
<i>sp Hl</i> Spiny, normal leaves	P 133
<i>Sp Hl</i> Spineless, normal leaves	R 67
<i>Sp hl</i> Spineless, heart shaped leaves	P 136
(Total progeny = 400)	

The next 3 questions refer to the above information.

11. What is/are the genotype/s of the above dihybrid parents?

- a) $\frac{Sp Hl}{sp Hl}$ b) $\frac{Sp hl}{sp Hl}$ c) $\frac{Sp Hl}{Sp hl}$ d) $\frac{Sp Hl}{sp hl}$ e) more than one of the foregoing

can see from parentals

12. The distance between genes *Sp* and *Hl* would be

- a) more than 40 map units
 b) between 30 and 40 map units
 c) between 20 and 30 map units
 d) between 10 and 20 map units
 e) less than 10 map units

$$\frac{67 + 64}{400} \times 100 = 32.75$$

13. What is/are the genotype/s of the offspring with normal leaves and no spines?

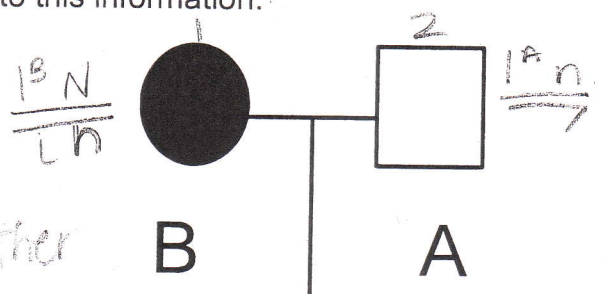
- a) $\frac{Sp Hl}{sp Hl}$ b) $\frac{Sp hl}{Sp Hl}$ c) $\frac{sp Hl}{Sp hl}$ d) $\frac{Sp Hl}{sp hl}$ e) more than one of the foregoing

autosomal dominant

The genes that control nail-patella syndrome and the ABO blood group map to chromosome 9. Imagine that these two genes are **12 map units** apart. Examine the pedigree below. (Note: individuals affected with nail-patella syndrome are indicated by solid symbols). The next three questions refer to this information.

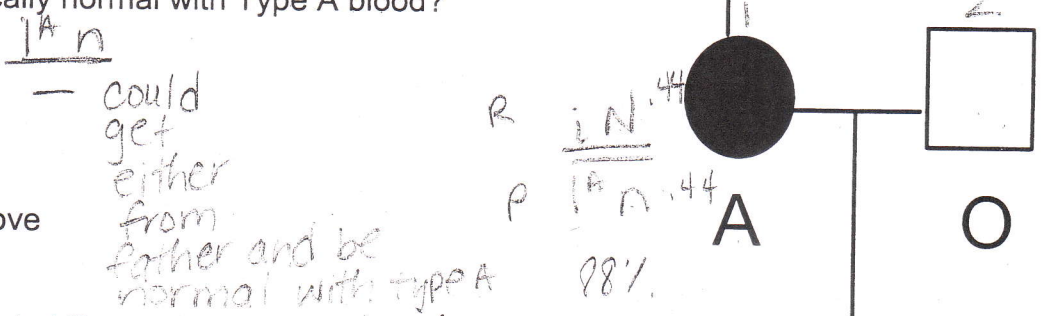
14. What is the genotype of II-1?

- a) $I^A N // i N$
- b) $I^A N // i n$ ✓
- c) $I^A n // I^A N$
- d) $I^A n // i N$ ✓ must be $I^A n$ b/c from father
- e) more than one of the above is possible



15. What is the probability that the first child of II-1 and II-2 will be phenotypically normal with Type A blood?

- a) 6%
- b) 12%
- c) 44% ✓
- d) 88%
- e) none of the above



16. What is the probability that II-1 will produce $I^A N$ gametes?

- a) 6%
- b) 12%
- c) 44%
- d) 88%
- e) none of the above

recombinant
 $I^A N .06$
 $i n .06$
 12%

17. Individuals with Down Syndrome typically have 3 copies of chromosome

- a) 12.
- b) 13.
- c) 18.
- d) 22.
- e) 21. ✓

Read over the following statements.

$X^a X^b$

two

- I. Calico and tortoiseshell cats are typically females who are heterozygous for one sex-linked coat colour gene.
- II. In prophase II of meiosis in humans there are 23 chromosomes in a secondary spermatocyte.
- III. Individuals with Tay Sachs Disease are often homozygous for null alleles of the hexosaminidase gene.
- IV. Wildtype bacteria are susceptible to antibiotics.
- V. The stop codons (UAA, UGA, UAG) terminate transcription in the nucleus

18. Of the above statements, only one statement is **incorrect** (false). Identify the incorrect statement.

- ✓
- a) Statement I is incorrect
 - b) Statement II is incorrect
 - c) Statement III is incorrect
 - d) Statement IV is incorrect
 - e) Statement V is incorrect

19. Individuals with Turner Syndrome

- X
- a) have somatic cells with 45 chromosomes.
 - b) have somatic cells with two copies of chromosome 21.
 - c) are females who lack ovaries. XO
 - d) have somatic cells with one heterochromatic X chromosome.
 - e) More than one of the above

20. Two phenotypically normal parents have a child who is $X^{cb} X Y$. Which of the following statements describes the meiotic event/s 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 I nondisjunction occurred in the male parent.
 - d) A meiosis II nondisjunction occurred in the male parent.
 - e) More than one of the above is possible
- $X^{cb} X^{cb} XY$
 XX
 XX

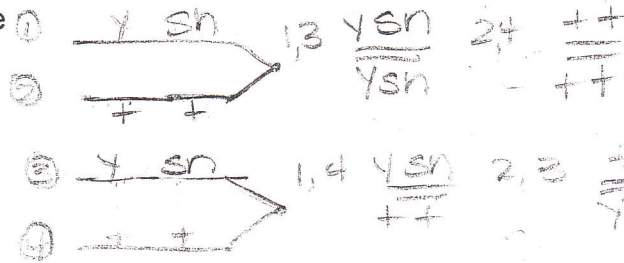
21. Transformation is the process by which bacteria take up exogenous DNA fragments.

- ✓
- a) Above statement is true
 - b) Above statement is false

Two X-linked recessive alleles in *Drosophila* are *sn* and *y*. Flies homozygous or hemizygous for the allele *y* have yellow bodies. Flies homozygous or hemizygous for *sn* have singed bristles (bristles curled and short). Wildtype flies have grey bodies and normal bristles. The *sn* locus is closer to the centromere than the *y* locus. (Map order: centromere.....*sn*.....*y*) Use this information to answer the following question.

22. A female fly has the genotype *sn y* // + +. Mitotic recombination occurs between 2 chromatids by means of a cross-over between gene *sn* and the centromere. The two cells produced by this event could genotypically be

- X
- a) *sn y* // + + and + + // *sn y*
 - b) *sn* + // *sn* + and + *y* // + *y*
 - c) + + // + + and *sn y* // *sn y*
 - d) + *y* // *sn y* and *sn* + // *sn y*
 - e) more than one of the above is possible



23. A variety of limes called "Tahiti" is a sterile autotriploid with $3N=27$. What could be observed in cells undergoing meiosis I?

- ✓
- a) 13 bivalents and 1 univalent
 - b) 1 trivalent, 11 bivalents, and 2 univalents
 - c) 3 trivalents, 6 bivalents, and 6 univalents ✓
 - d) 5 trivalents, 5 bivalents and 2 univalents
 - e) more than one of the above

$n=9$

bivalents and univalents must be equal

24. Some members of a family have a very rare mtDNA disorder called Leigh Syndrome (LS). A woman from this family is severely affected with LS. She marries a man who has no family history of LS and they consider having children. What is the probability that their first child will be affected with LS?

- ✓
- a) 100% if the child is a female; 0% if the child is a male.
 - b) 0% if the child is a female; 100% if the child is a male.
 - c) 50%
 - d) 0%
 - e) none of the above

100% to all children

25. The disease Retinoblastoma is associated with tumours in the eye. It is controlled by a single gene, *RB*, which maps to chromosome 13. Tumours develop in eye cells that are homozygous for recessive alleles of the *RB* gene. A child is heterozygous *RB rb*. What events would cause this child to develop Retinoblastoma?

- a) In the eye cells of the child, a second mutation occurs in the mutant *rb* allele. ✓
- b) In the germ-line cells of the child a mutation occurs in either the *rb* allele or *RB* allele.
- c) In the eye cells of the child, a mutation occurs in the normal *RB* allele.
- d) A mitotic recombination event (involving the *RB* genes) occurs in the eye cells of the child. ✓
- e) More than one of the above

RBrb

26. Epigenetic modifications never involve changes to the DNA sequence of a gene.

- a) Above statement is true
- b) Above statement is false

$$\frac{20}{26} \quad 77\%$$

$$\frac{19.25}{25} + \frac{15}{25} = \frac{34.25}{50} \quad 69\%$$