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MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

- 1) Which of the following occurs in meiosis but not in mitosis? 1) _____
 - A) synapsis of chromosomes
 - B) chromosome replication
 - C) alignment of chromosomes at the equator
 - D) condensation of chromosomes

- 2) Cytosine makes up 42% of the nucleotides in a sample of DNA from an organism. Approximately what percentage of the nucleotides in this sample will be thymine? 2) _____
 - A) 58%
 - B) 42%
 - C) 16%
 - D) 8%

- 3) When Thomas Hunt Morgan crossed his red-eyed F₁ generation flies to each other, the F₂ generation included both red- and white-eyed flies. Remarkably, all the white-eyed flies were male. What was the explanation for this result? 3) _____
 - A) The gene involved is on the Y chromosome.
 - B) The gene involved is on an autosome, but only in males.
 - C) Other male-specific factors influence eye color in flies.
 - D) The gene involved is on the X chromosome.

The following is a map of four genes on a chromosome.



- 4) Between which two genes would you expect the highest frequency of recombination? 4) _____
 - A) A and W
 - B) A and G
 - C) A and E
 - D) E and G

- 5) Males are more often affected by sex-linked traits than females because _____. 5) _____
 - A) male hormones such as testosterone often alter the effects of mutations on the X chromosome
 - B) males are hemizygous for the X chromosome
 - C) female hormones such as estrogen often compensate for the effects of mutations on the X chromosome
 - D) X chromosomes in males generally have more mutations than X chromosomes in females

- 6) A nonreciprocal crossover causes which of the following products? 6) _____
 - A) duplication only
 - B) deletion only
 - C) nondisjunction
 - D) deletion and duplication

- 7) Albinism is an autosomal (not sex-linked) recessive trait. A man and woman are both of normal pigmentation, but both have one parent who is albino (without melanin pigmentation). What is the probability that their first child will be an albino? 7) _____
 - A) 1/2
 - B) 1/4
 - C) 1
 - D) 0

- 8) A sexually reproducing animal has two unlinked genes, one for head shape (*H*) and one for tail length (*T*). Its genotype is *HhTt*. Which of the following genotypes is possible in a gamete from this organism? 8) _____
 - A) *Hh*
 - B) *HhTt*
 - C) *T*
 - D) *HT*

- 9) A new DNA strand elongates only in the 5' to 3' direction because _____. 9) _____
 A) DNA polymerase begins adding nucleotides at the 5' end of the template
 B) replication must progress toward the replication fork
 C) DNA polymerase can add nucleotides only to the free 3' end
 D) the polarity of the DNA molecule prevents addition of nucleotides at the 3' end
- 10) Which of the following is an example of polygenic inheritance? 10) _____
 A) white and purple flower color in peas B) the ABO blood group in humans
 C) skin pigmentation in humans D) pink flowers in snapdragons
- 11) Somatic cells of roundworms have four individual chromosomes per cell. How many chromosomes would you expect to find in an ovum from a roundworm? 11) _____
 A) a diploid number B) eight
 C) four D) two
- 12) What is the reason that closely linked genes are typically inherited together? 12) _____
 A) Alleles are paired together during meiosis.
 B) Genes align that way during metaphase I of meiosis.
 C) They are located close together on the same chromosome.
 D) The number of genes in a cell is greater than the number of chromosomes.

Use the figure and the following description to answer the question(s) below.

In a particular plant, leaf color is controlled by gene locus *D*. Plants with at least one allele *D* have dark green leaves, and plants with the homozygous recessive *dd* genotype have light green leaves. A true-breeding, dark-leaved plant is crossed with a light-leaved one, and the F₁ offspring is allowed to self-pollinate. The predicted outcome of the F₂ is diagrammed in the Punnett square shown in the figure, where 1, 2, 3, and 4 represent the genotypes corresponding to each box within the square.

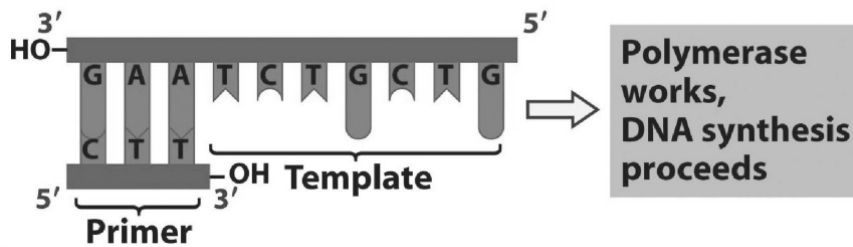
	<i>D</i>	<i>d</i>
<i>D</i>	1	2
<i>d</i>	3	4

- 13) Which of the boxes marked 1-4 correspond to plants with a heterozygous genotype? 13) _____
 A) 2, 3, and 4 B) 1, 2, and 3 C) 1 D) 2 and 3
- 14) Which of the boxes marked 1-4 correspond to plants with dark leaves? 14) _____
 A) 1 only B) 1, 2, and 3 C) 4 only D) 2 and 3
- 15) A woman who has blood type A positive has a daughter who is type O positive and a son who is type B negative. Rh positive is a trait that shows simple dominance over Rh negative. Which of the following is a possible phenotype for the father? 15) _____
 A) O negative B) B positive C) A negative D) AB negative

16) What is an adaptive advantage of recombination between linked genes? 16) _____
 A) Recombination is required for independent assortment.
 B) Recombination must occur or genes will not assort independently.
 C) The forces on the cell during meiosis II results in recombination.
 D) New allele combinations are acted upon by natural selection.

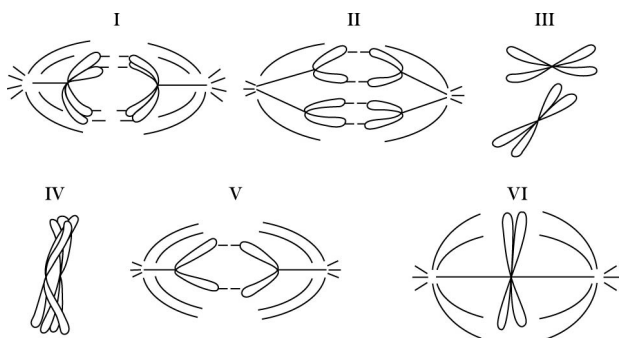
17) What is a major difference between eukaryotic DNA replication and prokaryotic DNA replication? 17) _____
 A) DNA polymerases of prokaryotes can add nucleotides to both 3' and 5' ends of DNA strands, while those of eukaryotes function only in the 5' → 3' direction.
 B) DNA replication in prokaryotic cells is conservative. DNA replication in eukaryotic cells is semi-conservative.
 C) Prokaryotic chromosomes have a single origin of replication, while eukaryotic chromosomes have multiple origins of replication.
 D) Prokaryotic replication does not require a primer.

Single strand as a template plus 3' end to start DNA synthesis



18) Refer to the figure above. What bases will be added to the primer as DNA replication proceeds? 18) _____
 The bases should appear in the new strand in the order that they will be added starting at the 3' end of the primer.
 A) A, G, A, C, G, A, C
 B) T, C, T, G, C, T, G
 C) C, A, G, C, A, G, A
 D) G, T, C, G, T, C, T

Refer to the drawings in the figure below of a single pair of homologous chromosomes as they might appear during various stages of either mitosis or meiosis, and answer the following questions.



19) Which diagram represents anaphase I of meiosis? 19) _____
 A) I
 B) II
 C) IV
 D) V

- 20) The human X and Y chromosomes _____. 20) _____
A) include genes that determine an individual's sex
B) are called autosomes
C) are both present in every somatic cell of males and females
D) are the same size and have the same number of genes
- 21) Mendel's observation of the segregation of alleles in gamete formation has its basis in which of the following phases of cell division? 21) _____
A) prophase I of meiosis
B) metaphase II of meiosis
C) anaphase I of meiosis
D) anaphase II of meiosis
- 22) Suppose you are provided with an actively dividing culture of *E. coli* bacteria to which radioactive thymine has been added. What would happen if a cell replicates once in the presence of this radioactive base? 22) _____
A) Neither of the two daughter cells would be radioactive.
B) One of the daughter cells, but not the other, would have radioactive DNA.
C) DNA in both daughter cells would be radioactive.
D) All four bases of the DNA would be radioactive.
- 23) In *E. coli*, which enzyme catalyzes the elongation of a new DNA strand in the 5' → 3' direction? 23) _____
A) helicase
B) DNA polymerase III
C) primase
D) DNA ligase
- 24) In humans, clear gender differentiation occurs, not at fertilization, but after the second month of gestation. What is the first event of this differentiation? 24) _____
A) activation of *SRY* in females and feminization of the gonads
B) activation of *SRY* in male embryos and masculinization of the gonads
C) formation of testosterone in male embryos
D) formation of estrogens in female embryos
- 25) Which of the following is a true statement about sexual vs. asexual reproduction? 25) _____
A) In asexual reproduction, offspring are produced by fertilization without meiosis.
B) Asexual reproduction produces only haploid offspring.
C) Asexual reproduction, but not sexual reproduction, is characteristic of plants and fungi.
D) In sexual reproduction, individuals transmit half of their nuclear genes to each of their offspring.
- 26) In the cross $AaBbCc \times AaBbCc$, what is the probability of producing the genotype $AABBCC$? 26) _____
A) 1/16
B) 1/8
C) 1/4
D) 1/64
- 27) What is the role of DNA ligase in the elongation of the lagging strand during DNA replication? 27) _____
A) It stabilizes the unwound parental DNA.
B) It unwinds the parental double helix.
C) It synthesizes RNA nucleotides to make a primer.
D) It joins Okazaki fragments together.
- 28) The fastest way for organisms to adapt to a changing environment involves _____. 28) _____
A) mutation
B) sexual reproduction
C) asexual reproduction

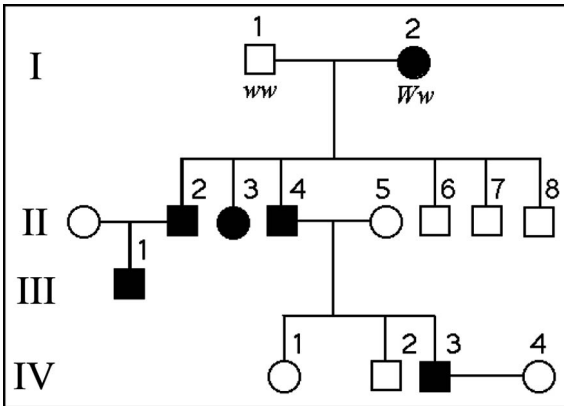
- 29) Which of the following statements is true of linkage? 29) _____
- A) The closer two genes are on a chromosome, the lower the probability that a crossover will occur between them.
 - B) Linked genes are found on different chromosomes.
 - C) The observed frequency of recombination of two genes that are far apart from each other has a maximum value of 100%.
 - D) All of the traits that Mendel studied—seed color, pod shape, flower color, and others—are due to genes linked on the same chromosome.
- 30) The leading and the lagging strands differ in that _____. 30) _____
- A) the leading strand is synthesized in the same direction as the movement of the replication fork, and the lagging strand is synthesized in the opposite direction
 - B) the leading strand is synthesized by adding nucleotides to the 3' end of the growing strand, and the lagging strand is synthesized by adding nucleotides to the 5' end
 - C) the leading strand is synthesized at twice the rate of the lagging strand
 - D) the lagging strand is synthesized continuously, whereas the leading strand is synthesized in short fragments that are ultimately stitched together
- 31) Asexual reproduction occurs during _____. 31) _____
- A) meiosis
 - B) mitosis
 - C) chromosome exchange between organisms of different species
 - D) fertilization
- 32) What do we mean when we use the terms *monohybrid cross* and *dihybrid cross*? 32) _____
- A) A dihybrid cross involves organisms that are heterozygous for two characters that are being studied, and a monohybrid cross involves organisms that are heterozygous for only one character being studied.
 - B) A monohybrid cross results in a 9:3:3:1 ratio whereas a dihybrid cross gives a 3:1 ratio.
 - C) A monohybrid cross involves a single parent, whereas a dihybrid cross involves two parents.
 - D) A monohybrid cross is performed for one generation, whereas a dihybrid cross is performed for two generations.
- 33) A given organism has 46 chromosomes in its karyotype. Therefore, we can conclude that it must _____. 33) _____
- A) be human
 - B) reproduce sexually
 - C) have gametes with 23 chromosomes
 - D) be an animal

For the following questions, match the key event of meiosis with the stages listed below.

- | | |
|-----------------|--------------------|
| I. Prophase I | V. Prophase II |
| II. Metaphase I | VI. Metaphase II |
| III. Anaphase I | VII. Anaphase II |
| IV. Telophase I | VIII. Telophase II |

- 34) Homologous chromosomes are aligned at the equator of the spindle. 34) _____
- A) VI
 - B) II
 - C) IV
 - D) I
- 35) Centromeres of sister chromatids disjoin and chromatids separate. 35) _____
- A) III
 - B) IV
 - C) V
 - D) VII

The following questions refer to the pedigree chart in the figure below for a family, some of whose members exhibit the dominant trait, *W*. Affected individuals are indicated by a dark square or circle.



- 36) What is the genotype of individual II-5? 36) _____
 A) *WW* B) *ww* or *Ww* C) *ww* D) *Ww*
- 37) In cats, black fur color is caused by an X-linked allele; the other allele at this locus causes orange color. The heterozygote is tortoiseshell. What kinds of offspring would you expect from the cross of a black female and an orange male? 37) _____
 A) tortoiseshell females; tortoiseshell males B) orange females; black males
 C) tortoiseshell females; black males D) black females; orange males
- 38) It became apparent to Watson and Crick after completion of their model that the DNA molecule could carry a vast amount of hereditary information in which of the following? 38) _____
 A) sequence of bases B) complementary pairing of bases
 C) side groups of nitrogenous bases D) phosphate-sugar backbones
- 39) Which of the following is true of a species that has a chromosome number of $2n = 16$? 39) _____
 A) Each diploid cell has eight homologous pairs.
 B) The species is diploid with 32 chromosomes per cell.
 C) A gamete from this species has four chromosomes.
 D) The species has 16 sets of chromosomes per cell.
- 40) What does a frequency of recombination of 50% indicate? 40) _____
 A) All of the offspring have combinations of traits that match one of the two parents.
 B) The genes are located on sex chromosomes.
 C) Abnormal meiosis has occurred.
 D) The two genes are likely to be located on different chromosomes.
- 41) How many unique gametes could be produced through independent assortment by an individual with the genotype *AaBbCCDdEE*? 41) _____
 A) 16 B) 4 C) 64 D) 8
- 42) How do we describe transformation in bacteria? 42) _____
 A) assimilation of external DNA into a cell
 B) the creation of a strand of DNA from an RNA molecule
 C) the creation of a strand of RNA from a DNA molecule
 D) the infection of cells by a phage DNA molecule

- 43) Which of these is a karyotype? 43) _____
A) the appearance of an organism
B) a display of all of the cell types in an organism
C) a display of a cell's mitotic stages
D) organized images of a cell's chromosomes
- 44) You briefly expose bacteria undergoing DNA replication to radioactively labeled nucleotides. When you centrifuge the DNA isolated from the bacteria, the DNA separates into two classes. One class of labeled DNA includes very large molecules (thousands or even millions of nucleotides long), and the other includes short stretches of DNA (several hundred to a few thousand nucleotides in length). These two classes of DNA probably represent _____. 44) _____
A) lagging strands and Okazaki fragments B) Okazaki fragments and RNA primers
C) leading strands and RNA primers D) leading strands and Okazaki fragments
- 45) What was the most significant conclusion that Gregor Mendel drew from his experiments with pea plants? 45) _____
A) There is considerable genetic variation in garden peas.
B) Recessive genes occur more frequently in the F₁ generation than do dominant ones.
C) Traits are inherited in discrete units and are not the results of "blending."
D) Genes are composed of DNA.
- 46) The DNA of telomeres has been highly conserved throughout the evolution of eukaryotes. This most likely reflects _____. 46) _____
A) that new mutations in telomeres have been advantageous
B) the low frequency of mutations occurring in this DNA
C) continued evolution of telomeres
D) a critical function of telomeres
- 47) A couple has a child with Down syndrome. The mother is 39 years old at the time of delivery. Which of the following is the most probable cause of the child's condition? 47) _____
A) The mother most likely underwent nondisjunction during gamete production.
B) The mother had a chromosomal duplication.
C) One member of the couple underwent nondisjunction in somatic cell production.
D) The woman inherited this tendency from her parents.
- 48) Which of the following defines a genome? 48) _____
A) the complete set of an organism's polypeptides
B) the complete set of a species' polypeptides
C) a karyotype
D) the complete set of an organism's genes and other DNA sequences
- 49) In an analysis of the nucleotide composition of DNA, which of the following will be found? 49) _____
A) $A + C = G + T$ B) $A = C$
C) $G + C = T + A$ D) $A = G$ and $C = T$
- 50) Which of the following is the best statement of the use of the addition rule of probability? 50) _____
A) the probability of producing two or more heterozygous offspring
B) the likelihood that a trait is due to two or more meiotic events
C) the probability that either one of two independent events will occur
D) the probability that two or more independent events will both occur