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Exam

Name_____

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

1) Living organisms are categorized into two major groups based on the presence or absence of a nucleus. What group is defined by the presence of a nucleus? 1) _____
   A) mitochondrial organism
   B) virus
   C) prokaryotic organism
   D) bacterium
   E) eukaryotic organism

2) What is the name of the membranous structure that compartmentalizes the cytoplasm of eukaryotic organisms? 2) _____
   A) nucleoid
   B) ribosome
   C) mitochondria
   D) endoplasmic reticulum
   E) cytosol

3) You have identified a mutant in human cells that when shifted to 37°C, the microfilaments depolymerize (fall apart). Which of the following would be true about this mutant at 37°C? 3) _____
   A) The cells would change shape.
   B) The mitochondria would no longer work.
   C) The sister chromatids would no longer be attached to each other.
   D) The endoplasmic reticulum could still import polypeptides but could no longer synthesize lipids.
   E) The cells would no longer be able to produce ATP.

4) Name two cellular organelles, each containing genetic material, which are involved in either photosynthesis or respiration. 4) _____
   A) chloroplast and endoplasmic reticulum
   B) lysosome and chloroplast
   C) rough and smooth endoplasmic reticula
   D) chloroplasts and mitochondria
   E) peroxisomes and mitochondria

5) The nucleolus organizer region (NOR) is responsible for production of what type of cell structure? 5) _____
   A) nucleolus
   B) endoplasmic reticulum
   C) chromatids
   D) mitochondria
   E) ribosome

6) The diploid chromosome number of an organism is usually represented as 2n. Humans have a diploid chromosome number of 46. What would be the expected haploid chromosome number in a human? 6) _____
   A) 16 B) 23 C) 12 D) 92 E) 24

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7) Which chromosome has a telomere but the p arm is much shorter than the q arm? 7) _____
A) sex chromosome
B) acrocentric
C) submetacentric
D) metacentric
E) telocentric

8) Which of the following is true about sex-determining chromosomes? 8) _____
A) They have the same gene configuration and same loci.
B) They do not participate in meiosis.
C) They are independent during meiosis.
D) They are always metacentric.
E) They act like homologous chromosomes during meiosis so each gamete will get one sex chromosome.

9) What significant genetic function occurs in the S phase of the cell cycle? 9) _____
A) centromere division
B) DNA synthesis
C) karyokinesis
D) cytokinesis
E) chromosome condensation

10) During interphase of the cell cycle, _____. 10) _____
A) DNA content essentially doubles
B) RNA replicates
C) sister chromatids move to opposite poles
D) DNA recombines
E) the nuclear membrane disappears

11) The house fly, *Musca domestica*, has a haploid chromosome number of 6. How many chromatids should be present in a diploid, somatic, metaphase cell? 11) _____
A) 12 B) 6 C) 24 D) 3 E) 18

12) How many haploid sets of chromosomes are present in a diploid individual cell with a chromosome number of 32? 12) _____
A) 32 B) 16 C) 8 D) 2 E) 1

13) How many haploid sets of chromosomes are present in an individual cell that is pentaploid (5n)? 13) _____
A) 4
B) 2
C) 3
D) 5
E) It is impossible to tell with the information given.

14) You may have heard through various media of an animal alleged to be the hybrid of a rabbit and a cat. Given that the cat (*Felis domesticus*) has a diploid chromosome number of 38 and a rabbit (*Oryctolagus cuniculus*) has a diploid chromosome number of 44, what would be the expected chromosome number in the somatic tissues of this alleged hybrid? 14) _____
A) 82 B) 44 C) 40 D) 41 E) 38

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15) Which of the follow could occur if a cell cycle checkpoint was missed? 15) _____
A) The cell cycle would be arrested until the error could be corrected.
B) An unreplicated chromosome could be put through mitosis.
C) Cohesin could not function correctly.
D) DNA would mutate during G2.
E) The spindle apparatus would not form.

16) In which stage of the cell cycle is G0 located? 16) _____
A) anaphase B) M C) S D) G1 E) G2

17) When cells withdraw from the continuous cell cycle and enter a "quiescent" phase, they are said to be in what stage? 17) _____
A) S B) M C) G1 D) G2 E) G0

18) A typical G1 nucleus is 2n and contains 2C (two complements) of DNA. Which of the following is true? 18) _____
A) A cell in prophase is 2n and contains 2n of DNA.
B) A prophase cell is 4n and contains 4C of DNA.
C) A cell in G2 is 4n and contains 2C of DNA.
D) A cell in metaphase is 2n and contains 2C of DNA.
E) A cell in prophase is 2n and contains 4C of DNA.

19) Which part of interphase does DNA duplication take place? 19) _____
A) S B) G2 C) M D) G1 E) G0

20) The centromere of a chromosome separates during _____. 20) _____
A) anaphase
B) interphase
C) prometaphase
D) telophase
E) prophase

21) Normal diploid somatic (body) cells of the mosquito *Culex pipiens* contain six chromosomes. Assuming that all nuclear DNA is restricted to chromosomes and that the amount of nuclear DNA essentially doubles during the S phase of interphase, how much nuclear DNA would be present in metaphase I of mitosis? Note: Assume that the G1 nucleus of a mosquito cell contains 3.0×10^{-12} grams of DNA. 21) _____
A) 3.0×10^{-12} g
B) 12×10^{-12} g
C) 0.75×10^{-12} g
D) 1.5×10^{-12} g
E) 6.0×10^{-12} g

22) If a typical somatic cell has 64 chromosomes, how many chromosomes are expected in each gamete of that organism? 22) _____
A) 32 B) 64 C) 16 D) 8 E) 128

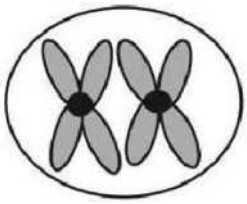
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23) In an organism with 60 chromosomes, how many bivalents would be expected to form during meiosis? 23) _____

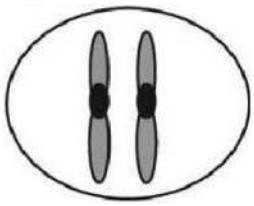
A) 240 B) 15 C) 120 D) 60 E) 30

24) The ant, *Myrmecia pilosula*, is found in Australia and is named bulldog because of its aggressive behavior. It is particularly interesting because it carries all its genetic information in a single pair of chromosomes. In other words, 2n = 2. (Males are haploid and have just one chromosome.) Which of the following figures would most likely represent a correct configuration of chromosomes in a metaphase I cell of a female? 24) _____

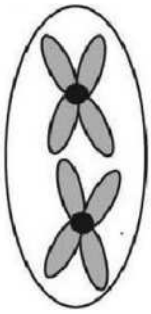
A)



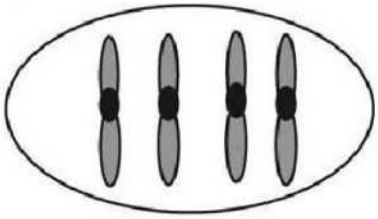
B)



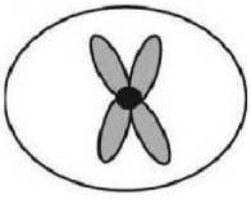
C)



D)



E)



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25) A G1 somatic cell nucleus in a female diploid *Myrmecia pilosula* (bulldog ant) contains 2 picograms of DNA. How much DNA would be expected in a metaphase I cell of a female? 25) _____

A) 8 picograms
B) 32 picograms
C) 16 picograms
D) 4 picograms
E) Not enough information is provided to answer the question.

26) *Myrmecia pilosula* (the bulldog ant) actually consists of several virtually identical, closely related species, with females having chromosome numbers of 18, 20, 32, 48, 60, 62, and 64. Assume one crossed a female of species (A) with 32 chromosomes and a male of species (B) with 9 chromosomes (males are haploid, and each gamete contains the *n* complement). How many chromosomes would one expect in the body (somatic) cells of the female offspring? 26) _____

A) 4.5 B) 32 C) 9 D) 25 E) 41

27) What is the outcome of synapsis, a significant event in meiosis? 27) _____

A) side–by–side alignment of nonhomologous chromosomes
B) side–by–side alignment of homologous chromosomes
C) monad movement to opposite poles
D) dyad formation
E) chiasma segregation

28) Which of the following is true about the second meiotic division? 28) _____

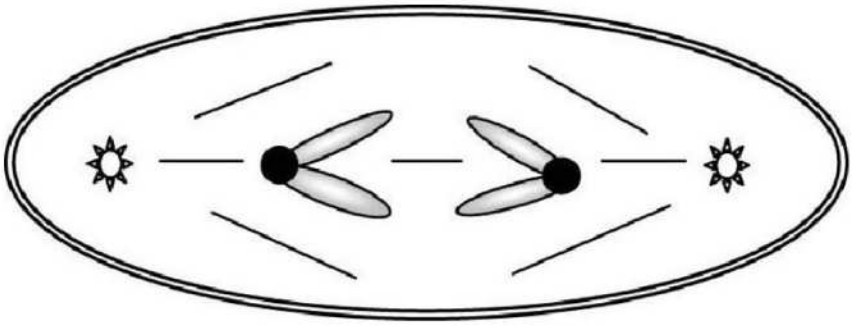
A) Homologous chromosomes are pulling apart.
B) The products are four identical gametes.
C) Synapsis occurring in the second meiotic division.
D) Nondisjunction would lead to extra bivalents forming.
E) Sister chromatids are pulling apart.

29) Which if the following is not a source of genetic variation in meiosis? 29) _____

A) tetrad formation
B) law of independent assortment
C) the random lining up of chromosomes on the metaphase plate
D) crossing over
E) polar body formation

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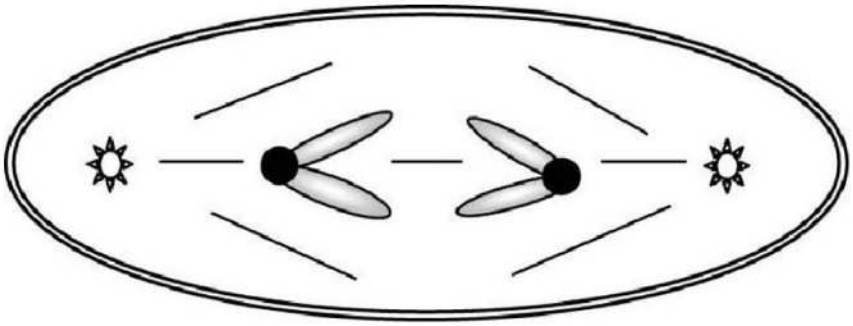
30) The accompanying sketch depicts a cell from an organism in which 2n = 2 and each chromosome is metacentric. 30) _____



Which of the following is the correct stage for this sketch?

A) anaphase of mitosis
B) anaphase of meiosis I
C) telophase of meiosis II
D) anaphase of meiosis II
E) telophase of mitosis

31) Given that each G1 nucleus from this organism contains 16 picograms of DNA, how many picogram 31) _____
chromosomal DNA would you expect in the cell shown below?



A) 16 B) 4 C) 2 D) 8 E) 32

32) The horse (*Equus caballus*) has 32 pairs of chromosomes, whereas the donkey (*Equus asinus*) has 31 pairs of chromosomes. How many chromosomes would be expected in the somatic tissue of a mule, which is a hybrid of these two animals? 32) _____

A) 64 B) 62 C) 63 D) 126 E) 60

33) Which of the following are the areas where chromatids intertwine during meiosis? 33) _____

A) tetrad
B) nondisjunction
C) bivalent
D) synapsis
E) chiasma

34) After meiosis II, _____ would be formed. 34) _____

A) chiasma B) monads C) synapsis D) dyads E) tetrads

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35) Which of the following would occur if there was no chiasma formation in prophase I? 35) _____
A) All gametes would have the same genotype.
B) In a heterozygote, there would only be a 1:1:1:1 formation after meiosis II, never a 2:2.
C) Mosaic chromosomes would form.
D) In a heterozygote, there would only be a 2:2 formation after meiosis II, never a 1:1:1:1.
E) All gametes would have the same phenotype.

36) Which term describes meiosis I? 36) _____
A) middling
B) multiplicative
C) confrontational
D) reducational
E) equinational

37) Which if the following is true? 37) _____
A) Cells are 4n after S phase.
B) A chromosome always contains the same number of chromatids, regardless of phase of the mitotic or meiotic cell cycle.
C) Cells are considered to be 2n after meiosis I.
D) Sister chromatids in mitosis are not identical.
E) A chromosome may contain one or two chromatids in different phases of the mitotic or meiotic cell cycle.

38) If a typical G1 nucleus contains 2C (two complements) of DNA, a gamete that is haploid (n) contains _____ of DNA. 38) _____
A) 4C B) 3C C) 2C D) 0.5C E) 1C

39) During meiosis, chromosome number reduction takes place in _____. 39) _____
A) anaphase I
B) anaphase II
C) telophase II
D) metaphase I
E) prophase I

40) A bivalent at prophase I contains _____ chromatids. 40) _____
A) two B) four C) eight D) one E) three

41) The meiotic cell cycle involves _____ number of cell division(s) and _____ number of DNA replication(s). 41) _____
A) two; one B) two; two C) one; two D) two; zero E) one; one

42) An organism with a haploid number of 10 will produce _____ combinations of chromosomes at the end of meiosis. 42) _____
A) 32 B) 1024 C) 100 D) 10,000 E) 10

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43) An organism with a diploid chromosome number of 46 will produce _____ combinations of chromosomes at the end of meiosis. 43) _____

A) 23
B) 529
C) 8388608
D) 46
E) 7.04×10^{13}

44) The stage at which "sister chromatids go to opposite poles" immediately follows which of the stages listed below? 44) _____

A) mitotic metaphase
B) metaphase of meiosis I
C) metaphase of meiosis II
D) A and B
E) A and C

45) *Drosophila melanogaster*, the fruit fly, has a 2n chromosome number of 8. Assuming that a somatic G2 nucleus from one of the individuals in this scenario contains about 8.0 picograms of DNA, how much nuclear DNA would you expect in a fly egg? 45) _____

A) 4 pg B) 2 pg C) 8 pg D) 1 pg E) 16 pg

46) In a healthy female, how many secondary oocytes would be expected to form from 100 primary oocytes? How many first polar bodies would be expected from 100 primary oocytes? 46) _____

A) 100; 100 B) 50; 50 C) 100; 50 D) 200; 50 E) 200; 300

47) In a healthy male, how many sperm cells would be expected to be formed from (a) 400 primary spermatocytes? (b) 400 secondary spermatocytes? 47) _____

A) (a) 400; (b) 400
B) (a) 100; (b) 800
C) (a) 1600; (b) 800
D) (a) 1600; (b) 1600
E) (a) 800; (b) 800

48) There is about as much nuclear DNA in a primary spermatocyte as in _____ spermatids. 48) _____

A) 1 B) 2 C) 0.5 D) 3 E) 4

49) List, in order of appearance, all the cell types expected to be formed during spermatogenesis. 49) _____

A) spermatogonia, spermatozoa, spermatid, primary spermatocyte, secondary spermatocyte
B) primary spermatocyte, secondary spermatocyte, spermatozoa, spermatid, spermatogonia
C) primary spermatocyte, secondary spermatocyte, spermatid, spermatozoa, spermatogonia
D) spermatogonia, primary spermatocyte, secondary spermatocyte, spermatid, spermatozoa
E) spermatozoa, spermatid, spermatogonia , primary spermatocyte, secondary spermatocyte

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50) List, in order of appearance, all the cell types expected to be formed during oogenesis. 50) _____
A) oogonium, primary oocyte, secondary oocyte and first polar body, ootid and second polar body
B) primary oocyte, secondary oocyte and first polar body, second polar body, ootid, oogonium
C) primary oocyte, secondary oocyte and first polar body, ootid, second polar body, oogonium
D) oogonium, primary oocyte, second polar body and ootid, secondary oocyte and first polar body
E) primary oocyte, secondary oocyte and first polar body, oogonium, second polar body and ootid

51) In plants, which stage is haploid? 51) _____
A) spermatozoa
B) polar body
C) sporophyte
D) gametophyte
E) germ cell

52) Which of the following is diploid? 52) _____
A) sperm
B) megaspore
C) zygote
D) gametophyte
E) egg

53) Electron microscopy of metaphase chromosomes demonstrated various degrees of coiling. What was the name of the model that depicted this process? 53) _____
A) double–stranded
B) folded–fiber
C) packing
D) chromatid folding
E) condensation

54) During the transition from interphase to metaphase chromosome, the DNA undergoes how much compaction? 54) _____
A) 50 fold B) 10 fold C) 2 fold D) 5000 fold E) 500 fold

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1) E
2) D
3) A
4) D
5) E
6) B
7) B
8) E
9) B
10) A
11) C
12) D
13) D
14) D
15) B
16) D
17) E
18) E
19) A
20) A
21) E
22) A
23) E
24) A
25) D
26) D
27) B
28) E
29) E
30) D
31) A
32) C
33) E
34) B
35) D
36) D
37) B
38) E
39) A
40) B
41) A
42) B
43) C
44) E
45) A
46) A
47) C
48) E
49) D
50) A

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51) D
52) C
53) B
54) D

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Exam

Name_____

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

1) VNTRs are useful in DNA forensics because _____. 1) _____
A) the VNTRs have very little variation in length
B) the number of VNTRs varies between people
C) the VNTRs have exactly the same sequence between people
D) the VNTRs act as an identifier for a group of individuals

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

2) Justify the FBI's use of only 20 short tandem repeats (STRs) as their core set of STRs for forensic analysis. 2) _____

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

3) The development of which biotechnology revolutionized the field of DNA forensics? 3) _____
A) Sanger sequencing
B) GWAS
C) PCR
D) capillary electrophoresis

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

4) Present evidence supporting the argument that Y chromosome STR profiling is not sufficient for proper DNA profiling. 4) _____

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

5) Mitochondrial DNA profiling is useful in developing DNA profiles from samples that are in less than ideal condition. What is a major limitation of using mitochondrial DNA profiling? 5) _____
A) It is present in high copy number.
B) It is useful in identifying victims of disasters when relatives are available for reference.
C) It is possible to differentiate between maternal relatives.
D) It is not possible to differentiate between maternal relatives.

6) Single–nucleotide polymorphisms (SNPs) are being used more and more in forensic analysis yet have not been fully embraced. However, SNPs have found an exemplary use in which of the following fields? 6) _____
A) evolution studies
B) VNTR copy number studies
C) protein stability studies
D) epigenetic regulation studies

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

7) DNA phenotyping represents an emerging technology that uses SNPs to determine physical features. Describe why DNA phenotyping faces skepticism in court rooms and from other scientists with regard to its accuracy. 7) _____

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

8) DNA phenotyping poses several concerns as an emerging technology. Which of the following is not a concern with DNA phenotyping? 8) _____
A) racial profiling
B) its ability to help identify missing persons
C) intellectual property of the company's methodologies
D) privacy violations

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

9) Provide support for using the product rule in generating a high confidence that an individual has a unique DNA profile using multiple STRs. 9) _____

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

10) Which of the following contribute to an increased probability of a random match of a DNA profile in a population? 10) _____
A) a population containing limited VNTR variation
B) a random population with many relatives
C) a population with a small number of identical twins
D) a population with inbreeding

11) CODIS (Combined DNA Index System) is a database that contains DNA profiles from all of the following EXCEPT _____. 11) _____
A) crime scene evidence
B) unidentified remains
C) public servants
D) people convicted of certain crimes

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

12) There are several concerns with using DNA profiling in forensics with the advent of cheaper synthesis methods for DNA. Propose a mechanism to determine if crime scene evidence is natural or synthetic. 12) _____

13) Why does DNA profiling pose potential ethical problems when a partial match occurs in CODIS? 13) _____

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

14) When using DNA profiling in prosecuting criminal cases, lawyers must be very thorough in their investigation of the DNA evidence. Which of the following could cause issues with the DNA evidence presented in a court case? 14) _____
A) quantity
B) deference
C) transference
D) recombination

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

15) Explain why Identical twins can have the same STRs in a DNA profile yet still exhibit differing phenotypes. 15) _____

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

16) Using the values in TABLE ST 2.2; what is the expected genotype frequency for the two loci profile consisting of D8S1179 and D5S818? 16) _____

A) 0.019 B) 0.001936 C) 0.000421 D) 0.102

17) STRs are repeated elements in the genome. They have _____ nucleotides per repeat compared to VNTRs. 17) _____

A) the same number B) fewer
C) precisely two times the number D) more

18) One of the advantages of STR profiling over VNTR profiling is that _____. 18) _____

A) it requires much less DNA because PCR can be used to amplify small samples
B) STRs are not variable in the number of repeats, whereas VNTRs are
C) it presents more variable sequences reducing false positive matches
D) STRs are variable in the number of repeats, whereas VNTRs are not

19) Mitochondrial DNA profiling is used to trace the maternal side of family trees. Why is this done using mtDNA? 19) _____

A) The mtDNA undergoes recombination allowing allelic mixture.
B) The mtDNA under low selective pressure mutates readily.
C) The mtDNA only comes from the father so all differences are from the mother.
D) The mtDNA is supplied to the zygote only from the egg.

20) Mitochondrial DNA profiling is primarily used to differentiate _____. 20) _____

A) siblings B) mothers from daughters
C) mothers and sons D) unrelated individuals

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1) B
2) By characterizing 20 STRs, the analysis covers over two billion combinations even if each STR only exhibits four alleles each. This is highly unlikely as STRs vary in repeats from 7 to 40 times.
3) C
4) Y chromosomal STR profiling is not sufficient for DNA profiling as it only focuses on the Y chromosome of individuals. As Y chromosomes do not undergo recombination, they are directly inherited from father to son and as such, all males of the same patrilineage will be identified by the same STR pattern.
5) D
6) A
7) DNA phenotyping faces scrutiny and skepticism due to its reliance on multiple genes as well as multiple SNPs in those genes to provide a rather low probability of a correct identification.
8) B
9) The product rule states that the probability of an individual having certain alleles in a population is the result of the product of each of the individual allelic frequencies in the population. As such, one STR locus with two alleles at a frequency of 0.361 and 0.141 would have a 10% chance of being unique in a population. However, by examining a second locus containing one allele at a frequency of 0.243, we can demonstrate that the likelihood of an individual having both STRs is ~0.6%.
10) D
11) C
12) Testing evidence for methylation patterns and comparing those patterns to those seen in natural DNA samples.
13) A partial match in CODIS could lead investigating agencies to focus on family members of the partial match. The ethical issue arises when it is considered right to suspect someone of a crime based on his or her DNA.
14) C
15) While the DNA sequence of identical twins is the same, there is evidence that environmental factors affect the epigenetic regulation of genes that could result in differing phenotypes.
16) B
17) B
18) A
19) D
20) D

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