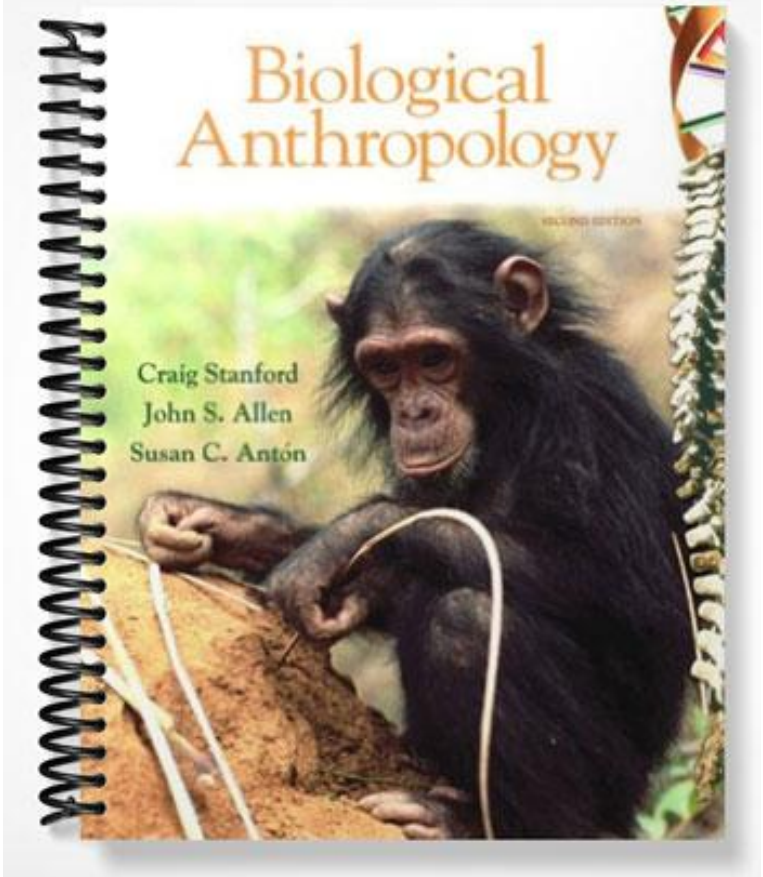
TEST BANK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CHAPTER TWO
GENETICS: CELLS AND MOLECULES

CHAPTER OUTLINE

GENETICS

The Study of Genetics
Genetic Metaphors: Blueprints, Recipes, or What?

THE CELL

Cell Anatomy
Insights and Advances: Cloning Controversies

DNA STRUCTURE AND FUNCTION

DNA Structure I: The Molecular Level
DNA Function I: Replication
DNA Function II: Protein Synthesis
DNA Structure II: Chromosomes and Cell Division
Innovations: The Wide World of RNA
Insights and Advances: Biochemical Individuality

MOLECULAR TOOLS FOR BIOANTHROPOLOGICAL RESEARCH

Indirect versus Direct Research Methods
PCR, Mitochondrial DNA, and Ancient DNA

CHAPTER OBJECTIVES

Based on thorough reading and careful consideration of Chapter Two, students should be able to:

1. Define the concept of genetics.
2. Explain the importance of the study of genetics.
3. Identify genetic metaphors.
4. Describe the anatomy of an animal cell.
5. Explain DNA structure and function at the molecular level.
6. Explain DNA in relationship to chromosomes and cell division.
7. Describe molecular tools for bioanthropological research, including indirect methods, direct sequencing methods, polymerase chain reaction, mitochondrial DNA (mtDNA), and ancient DNA.
8. Define and explain molecular genetics, including the following, terms: somatic cell, stem cell, gamete, chromosome, mitosis, and meiosis.

LECTURE AND DISCUSSION TOPICS

Each of these topics is intended to generate ideas for either a lecture/recitation format or discussion in the classroom. For most topics, students should be able to respond and participate in discussions based solely on reading the text. For others, you may need to provide further reading or other forms of information so that students can develop some personal perspective and become equipped to make independent decisions about the topics.

1. The following are topics from the text that may benefit from additional explanation in lecture: dominant and recessive traits, alleles, homozygous, heterozygous, genotype, phenotype, principle of independent assortment, and principle of segregation. Sickle-cell anemia is discussed in the text and is a useful example of a public health problem.

2. Refer to the Insights and Advances Box: Cloning Controversies. Review the methodology of cloning, the advantages of cloning in agriculture and some of the drawbacks to animal cloning. Furthermore, you may want to review the reasoning for and against human cloning.

3. Introduce the concept of PCR (polymerase chain reaction) and direct sequencing and their uses in modern forensic sciences. It would be interesting to share several murder cases with students that were solved with these techniques or to show how these techniques have cleared many convicted felons of their supposed crimes.

4. Show one of several films on molecular biology. Discuss the importance of the interactions of the various cell organelles. A discussion of the origin of the mitochondrion in the animal cell would be an interesting example of evolutionary process here.

5. Discuss the statement made by Roger Williams that "…everyone deviated from the norm in some way." Even though this statement was made in the 1950s, it is interesting that further developments in DNA studies support this reasoning.

CLASSROOM ACTIVITIES

1. If you have a biotechnology program on your campus or if you have a course in microbiology, it would be of interest to your students to see how an electrophoresis gel is created and how it is run to create DNA sequences. Essentially, you could have an "in-school" field trip.

2. Invite a biologist into class to lecture about a biological understanding of evolution. Check your library or rental catalogs for films on evolution and natural selection, DNA, molecular genetics, forensics, and DNA fingerprinting. Such films can often provide visual explanations that are clearer and more complete than simple lecture or text information.

3. Invite a philosopher to discuss the philosophy of science, with emphasis on the discussion of the scientific revolution brought about by Darwin and Mendel.

4. Arrange a trip to one of your biology labs to have students view stained slides of eukaryotic and prokaryotic cells. Have them identify and draw the individual structures of the cell.

5. Invite a forensic scientist from a government or private lab to speak about modern techniques such as PCR or DNA fingerprinting.

RESEARCH AND WRITING TOPICS

Encourage your students to utilize the free tool OneSearch with Research Navigator™, included with this textbook as a supplement. They will have to register to use this service. Once registered, students can use this tool to research the Internet to find valid sources for research papers, saving them much time in their efforts to identify relevant sources.

1. Have students research the various possible uses of cloning in both plants and animals. This could lead to a vibrant discussion or a term paper assignment.

2. Have your students complete written or oral biographical reports on one of the following people and how their scientific ideas contributed to our modern understanding of biology: James Watson, Francis Crick, Rosalind Franklin, and Linus Pauling.

3. Have students replicate some of the genetics experiments of Mendel using quick growing plants or quick breeding animals (e.g., fruit flies).

4. Divide the class into two parts and have half of the students argue in favor of reproductive human cloning while the other half argue against after researching the subject.

5. Have your students draw (in color) cell structures while labeling all of the organelles. Ask them to write out a description of the function of each organelle.

6. Ask students to prepare a short essay on the similarities and differences between sex cells, somatic cells, and stem cells.

PRINT RESOURCES

MADDOX, BRENDA. 2003. *Rosalind Franklin: The Dark Lady of DNA.* New York, Perennial.

RIDLEY, MATT. 2000. *Genome.* New York, HarperCollins.

WATSON, JAMES D. 2001. *The Double Helix: A Personal Account of the Discovery of the Structure of DNA.* New York, Touchstone Books.

FILMS, VIDEOS, AND OTHER NONPRINT RESOURCES

Films from Penn State Audio-Visual Services, (Phone: 800/826-0132) unless otherwise noted:

Cell Division: Mitosis and Meiosis (22 minutes)
Cell Structure (22 minutes)
Children of Eve (58 minutes)
Continental Drift: The Theory of Plate Tectonics (21 minutes)
Drifting of the Continents (51 minutes)
The Living Machine (60 minutes) University of Minnesota
The Living Planet: A Portrait of the Earth: 1--Building of the Earth Parts 1 and 2 (57 minutes)
The Not-So-Solid Earth (30 minutes)
Charles Darwin (24 minutes) University of Minnesota, 800/847-8251
Darwin's Finches (11 minutes)
The Day the Universe Changed: 8--Darwin's Revolution (53 minutes)
Evolution and the Origin of Life (36 minutes)
Evolution: Origins of Change, 1--Heredity and Mutation (21 minutes)

Double Helix (1 hour 48 minutes) 1987. Films for the Humanities and Sciences.

RESEARCH NAVIGATOR™ EXERCISES

1. Please review the Insights and Advances Box titled "Cloning Controversies." What problems exist with the cloning of animals? Look over many videos and articles on cloning at the following website: http://www.globalchange.com/clonlink.htm. Is human cloning strictly a scientific question? What ethical systems are important in understanding the questions that surround human cloning? What are the drawbacks to human cloning? What are the advantages to human cloning?

2. Review the Insights and Advances Box titled "Biochemical Individuality." Review the article of Forensic Serology on the following website: http://www.policensw.com/info/forensic/forensic6a.html. How can an understanding of blood type and forensic serology help avoid false criminal charges? What other uses exist for this practice?

3. Look at the websites on polymerase chain reaction (PCR) at the following sites: http://www.faseb.org/opa/bloodsupply/pcr.html, http://www.accessexcellence.org/RC/VL/GG/polymerase.html, http://users.rcn.com/jkimball.ma.ultranet/BiologyPages/P/PCR.html. What are the advantages of PCR?" Summarize how it is performed.

TEST QUESTIONS

Chapter 2 Genetics: Cells and Molecules

1. A basic understanding of heredity _____.

a. is a relatively new phenomena
b. did not happen until we fully understood DNA
c. can be found in almost all human societies
d. requires a thorough understanding of genetics and reproduction

(Answer c; page 37)

2. The term "gene" was coined by _____.

a. Jean Lamarck
b. Wilhelm Johannsen
c. Charles Lyell
d. Gregor Mendel

(Answer b; page 38)

3. The term "gene" was coined after DNA was observed.

a. True
b. False

(Answer b; page 38)

4. Cellular and molecular genetics involves the study of _____.

a. pedigrees of related individuals
b. how species divide into populations
c. the evolutionary relationships among species
d. cells and DNA

(Answer d; page 38)

5. Scientists working on genetic therapies for disease are working in which genetic field?

a. phylogenetics
b. population genetics
c. Mendelian genetics
d. molecular genetics

(Answer d; page 38)

6. Classical or Mendelian genetics involves the study of _____.

a. pedigrees of related individuals
b. how individuals vary within populations
c. the evolutionary relationships among groups of species
d. cells and DNA

(Answer a; page 38)

7. Classical geneticists focus more on _____ than _____.

a. molecules/ pedigrees
b. cells/ populations
c. traits/ molecules
d. populations/ traits

(Answer c; page 38)

8. A geneticist tracking how various traits are passed from one generation to the next is engaged in _____.

a. phylogenetics
b. population genetics
c. Mendelian genetics
d. molecular genetics

(Answer c; page 38)

9. Population genetics involves the study of _____.

a. pedigrees of related individuals
b. how individuals vary within populations
c. the evolutionary relationships among species
d. cells and DNA

(Answer b; page 38)

10. A geneticist studying the variation between different groups of organisms of the same species is engaged in _____.

a. phylogenetics
b. population genetics
c. Mendelian genetics
d. behavioral genetics

(Answer b; page 38)

11. Population geneticists only study traits at the molecular level.

a. True
b. False

(Answer b; page 38)

12. The genetic field of phylogenetics is concerned with _____.

a. determining evolutionary relationships between species
b. studying varying groups within the same species
c. constructing pedigrees
d. none of these

(Answer a; page 38)

13. A geneticist constructing tree-like diagrams that visually indicate relationships between species is engaged in _____.

a. behavioral genetics
b. molecular genetics
c. phylogenetics
d. population genetics

(Answer c; page 38)

14. Phylogenetic analysis often employs the methods of molecular genetics.

a. True
b. False

(Answer a; page 38)

15. Behavioral genetics is the study of how _____.

a. behavior influences genetics
b. pedigrees are influenced by genetic relationships
c. phylogenies effect behavior
d. genetics influence behavior

(Answer d; page 39)

16. Which of the following is the most controversial field?

a. behavioral genetics
b. molecular genetics
c. phylogenetics
d. population genetics

(Answer a; page 39)

17. Human biological variability arises from _____.

a. mostly genetic influences
b. mostly cultural influences
c. both of these
d. neither of these

(Answer c; page 39)

18. Which of the following is NOT a metaphor for genes used by modern scientists?

a. blueprint
b. homunculus
c. recipe
d. information storage

(Answer b; page 39)

19. Which of the following is the perfect metaphor for genes and how they behave?

a. homunculus
b. recipe
c. information storage
d. none of these

(Answer d; page 39)

20. The basic building block of life is the _____.

a. cell
b. gene
c. homunculus
d. organism

(Answer a; page 40)

21. Which of the following is an example of a multicellular organism?

a. bacteria
b. protozoa
c. worms
d. all of these

(Answer c; page 40)

22. The Marine sea slug is commonly studied because it possesses _____ cells.

a. larger
b. colored
c. more
d. fewer

(Answer d; page 40)

23. Which of the following is true of prokaryotes?

a. they are single-celled organisms
b. they lack intercellular compartments
c. they include bacteria
d. all of these

(Answer d; page 40)

24. A single-celled organism with a nucleus is an example of a _____.
a. prokaryote
b. eukaryote

(Answer b; page 40)

25. Organelles are common to _____.

a. prokaryotes
b. eukaryotes

(Answer b; page 40)

26. In eukaryotes, the piece of cellular anatomy that separates the genetic material from the rest of the cell is called the _____.

a. nucleus
b. cytoplasm
c. organelle
d. plasma membrane

(Answer a; page 40)

27. Prokaryotes are simple cells with just a nucleus but no organelles.

a. True
b. False

(Answer b; page 40)

28. A cell's plasma membrane _____.

a. separates the genetic material from the rest of the cell
b. is a fluid-filled space within a cell
c. contains a number of structures essential to cellular function
d. none of these

(Answer d; page 40)

29. A cell's nucleus _____.

a. separates the genetic material from the rest of the cell
b. is a fluid-filled space within a cell
c. contains a number of structures essential to cellular function
d. is the permeable outer boundary of the cell

(Answer a; page 40)

30. The part of the cell responsible for regulating the transport of materials into and out of the cell is the _____.

a. nucleus
b. cytoplasm
c. organelle
d. plasma membrane

(Answer d; page 40)

31. The _____ contains organelles.

a. prokaryote
b. nucleus
c. cytoplasm
d. all of these

(Answer c; page 40)

32. Fossil prokaryotes appeared before eukaryotes.

a. True
b. False

(Answer a; page 40)

33. The first eukaryotes appear in the fossil record around _____ years ago.

a. 3.4 billion
b. 1.5 billion
c. 850 million
d. 600 million

(Answer b; page 40)

34. Multicellular organisms have dominated most of the history of life on earth.

a. True
b. False

(Answer b; page 40)

35. Somatic cells _____.

a. are the sex cells
b. have the same function as gametes
c. are the cells of the body that are not gametes
d. only exist in prokaryotic organisms

(Answer c; page 40)

36. Tissues are comprised of _____.

a. somatic cells
b. stem cells
c. gametes
d. RNA

(Answer a; page 40)

37. The _____ are directly involved in reproduction.

a. somatic cells
b. gametes
c. stem cells
d. none of these

(Answer b; page 40)

38. Adult stem cells are totipotent.

a. True
b. False

(Answer b; page 40)

39. Embryonic _____ may be helpful in curing cellular disorders like Parkinson's disease.

a. gametes
b. somatic cells
c. germ cells
d. stem cells

(Answer d; page 41)

40. Which of the following can be found within the nucleus of a eukaryotic cell?

a. mitochondria
b. ribosomes
c. RNA
d. all of these

(Answer c; page 43)

41. In most eukaryotic cells, the most prominent structure is the _____.

a. nucleus
b. mitochondria
c. ribosomes
d. DNA

(Answer a; page 41)

42. Deoxyribonucleic acid has one main function – protein synthesis.

a. True
b. False

(Answer b; page 43)

43. RNA is essential for carrying out the _____ function of DNA.

a. cell replication
b. energy production
c. cytoplasmic
d. protein synthesis

(Answer d; page 43)

44. The two main functions of DNA are _____.

a. protein synthesis and cell reproduction
b. protein synthesis and ATP production
c. ATP production and cell reproduction
d. there is only one function of DNA – protein synthesis

(Answer a; page 43)

45. Which of the following organelles is responsible for the production of ATP?

a. the nucleus
b. the endoplasmic reticulum
c. mitochondria
d. ribosomes

(Answer c; page 43)

46. Mitochondria have their own DNA separate from that within the cell's nucleus.

a. True
b. False

(Answer a; page 43)

47. Ribosomes appear as little knobs on the _____.

a. nucleus
b. mitochondria
c. cytoplasm
d. endoplasmic reticulum

(Answer d; page 43)

48. Ribosomes have their own DNA separate from that within the cell's nucleus.

a. True
b. False

(Answer b; page 43)

49. Proteins are synthesized in a cell's _____.

a. RNA
b. nucleus
c. mitochondria
d. ribosomes

(Answer d; page 43)

50. DNA has to be able to do three things. What are they?

a. replicate, create ATP, and synthesize proteins
b. coordinate the activity of proteins, make the cell's energy, and self-replicate
c. replicate, make proteins, and coordinate the activity of proteins
d. none of these

(Answer c; page 43)

51. The basic unit of DNA is a molecule called a _____.

a. nucleotide
b. base
c. thymine
d. prokaryotic cell

(Answer a; page 43)

52. Nucleotides come together to form _____.

a. proteins
b. cells
c. bases
d. none of these

(Answer d; pages 43, 44)

53. A nucleotide consists of three parts:

a. a phosphate, a sugar, and a ribosome
b. a sugar, a phosphate, and a base
c. a phosphate, a base, and a nucleus
d. a sugar, a base, and a ATP particle

(Answer b; page 43)

54. The two classes of bases include the _____.

a. cytosines
b. thymines
c. purines
d. adenines

(Answer c; page 43)

55. In DNA, _____ bond to _____.

a. sugars/ purines
b. thymines/ pyrimidines
c. phosphates/ uraciles
d. sugars/ phosphates

(Answer d; page 44)

56. DNA base combinations are always _____.

a. A-T or C-G
b. A-G or C-T
c. G-T or A-C
d. none of these

(Answer a; page 44)

57. RNA is a single stranded molecule.

a. True
b. False

(Answer a; page 44)

58. Which of the following bases is found only in RNA?

a. thymine
b. uracil
c. guanine
d. adenine

(Answer b; page 44)

59. Virtually every cell of the body contains the same copy of DNA.

a. True
b. False

(Answer a; page 45)

60. DNA replication requires an entire original strand of DNA to _____.

a. be destroyed
b. mutate
c. split
d. all of these

(Answer c; page 45)

61. Permanent changes in the DNA of a cell are called mutations.

a. True
b. False

(Answer a; pages 46)

62. Hormones, antibodies, and hemoglobin are all _____.

a. enzymes
b. amino acids
c. catalysts
d. proteins

(Answer d; pages 46, 47)

63. Proteins are comprised of long chains of _____.

a. hormones
b. amino acids
c. hemoglobin
d. enzymes

(Answer b; page 47)

64. Some of the amino acids essential to creating proteins cannot be synthesized by the body.

a. True
b. False

(Answer a; page 47)

65. The base-pair sequence of DNA is known as _____.

a. a polypeptide
b. a hormone
c. the genetic code
d. none of these

(Answer c; page 48)

66. The genetic code is comprised of _____, each representing _____.

a. amino acids, polypeptides
b. codons, genes
c. polypeptides, genes
d. codons, amino acids

(Answer d; page 48)

67. Most of the amino acids are represented by more than one codon.

a. True
b. False

(Answer a; page 48)

68. Which of the following structures is smallest?

a. gene
b. codon
c. organelle
d. cell

(Answer b; page 48)

69. Which of the following best defines a gene?

a. a three-base code for an amino acid
b. a three-base code for a polypeptide
c. a multiple-codon code for an amino acid
d. a multiple-codon code for a polypeptide

(Answer d; page 48)

70. Protein synthesis is a two-step process involving _____.

a. transcription and replication
b. replication and translation
c. transcription and translation
d. mutation and replication

(Answer c; page 48)

71. Transcription occurs in the _____.

a. cytoplasm
b. ribosome
c. messenger RNA
d. nucleus

(Answer d; page 48)

72. mRNA _____.

a. carries genetic information from the nucleus to the cytoplasm
b. splits a DNA molecule during transcription
c. is completed replicated
d. carries amino acids to a ribosome to be attached to other amino acids

(Answer a; page 49)

73. tRNA _____.

a. carries genetic information from the nucleus to the cytoplasm
b. splits a DNA molecule during transcription
c. is completed replicated
d. carries amino acids to a ribosome to be attached to other amino acids

(Answer d; page 50)

74. mRNA post-transcriptional processing involves the mRNA losing exons and keeping introns.

a. True
b. False

(Answer b; page 50)

75. The majority of DNA does not do anything but replicate.

a. True
b. False

(Answer a; page 51)

76. Most of time, DNA is in its chromatin state. That is to say, it is _____.

a. coiled into chromosomes
b. tightly packed
c. in its diploid state
d. existing in uncoiled strands

(Answer d; page 51)

77. During cell division, the DNA exists _____.

a. as chromosomes
b. in its chromatin state
c. outside the cell
d. as RNA

(Answer a; page 51)

78. Sex cells possess a half of the chromosomes of the somatic cells. This is referred to as the _____. number of chromosomes.

a. homologous
b. heterozygous
c. haploid
d. homozygous

(Answer c; page 51)

79. Which of the following best defines the term *allele*?

a. a sex cell
b. the location of a gene on a chromosome
c. the state of the DNA before replication
d. a version of a gene

(Answer d; page 51)

80. Diploid cells have the full amount of chromosomes.

a. True
b. False

(Answer a; page 51)

81. An individual who is homozygous for a gene has _____.

a. different alleles for the gene
b. no alleles for that gene
c. two of the same alleles for that gene
d. only one locus for that particular gene

(Answer c; page 51)

82. Two identical daughter cells result from which process?

a. mitosis
b. translation
c. mutation
d. meiosis

(Answer a; page 51)

83. Messenger RNA brings the amino acids to the ribosome to be assembled into protein chains.

a. True
b. False

(Answer b; page 52)

84. MicroRNA affect gene expression by _____ mRNAs.

a. destabilizing
b. splitting
c. stabilizing
d. none of the above

(Answer a; page 53)

85. Every cell in an individual's body has the same number of chromosomes.

a. True
b. False

(Answer b; page 54)

86. DNA is replicated during which phase of the cell cycle?

a. prophase
b. anaphase
c. telophase
d. interphase

(Answer d; page 55)

87. During prophase _____.

a. the nucleus is destroyed
b. chromosomes form
c. the cell orients for division
d. all of these

(Answer d; page 56)

88. Complete diploid daughter cells at each end of the cell exist directly following which phase of the cell-cycle?

a. anaphase
b. metaphase
c. interphase
d. telophase

(Answer a; page 57)

89. Meiosis results in _____.

a. haploid cells
b. gametes
c. sex cells
d. all of these

(Answer d; page 57)

90. A zygote has the haploid number of chromosomes.

a. True
b. False

(Answer b; page 57)

91. The *reduction division* is another term for the _____.

a. first meiotic division
b. second meiotic division
c. meiotic prophase
d. none of these

(Answer a; page 57)

92. During the first meiotic prophase, the genes are shuffled between chromosomes in a process called _____.

a. crossing over
b. recombination
c. interphase
d. meiotic division

(Answer a; page 57)

93. Which of the following best describes the results of the second meiotic division?

a. two daughter cells all with the exact same chromosomes
b. four daughter cells with tetrad chromosomes
c. four haploid gametes
d. two diploid daughter cells

(Answer c; pages 57, 58)

94. A karyotype is a photograph of chromosomes.

a. True
b. False

(Answer b; page 58)

95. What is the diploid number of human chromosomes?

a. 22
b. 46
c. 32
d. 2

(Answer b; page 58)

96. Monosomy and trisomy are examples of _____.

a. mutations
b. types of DNA
c. nondisjunctive errors
d. autosomes

(Answer c; page 59)

97. An individual with trisomy 21 has _____ of chromosome 21.

a. no copies
b. only one copy
c. two copies of
d. three copies

(Answer c; page 59)

98. Studying genetics via phenotype is inferior because _____.

a. environment plays a strong role in governing phenotype
b. there is no relationship between phenotype and genes
c. genes do not actually affect phenotypes all that much
d. none of these

(Answer a; page 60)

99. _____ is used to discover protein variation within the same species.

a. The immunological method
b. Protein sequencing
c. Protein electrophoresis
d. DNA sequencing

(Answer c; page 60)

100. The most direct form of direct DNA analysis is _____.

a. DNA sequencing
b. protein sequencing
c. cytogenetics
d. the immunological method

(Answer a; page 61)

101. The most common form of direct DNA analysis is _____.

a. DNA sequencing
b. protein sequencing
c. cytogenetics
d. PCR

(Answer b; page 61)

102. Which of the following best defines polymerase chain reaction?

a. the process of replicating or amplifying small segments of DNA
b. studying immune system proteins to learn the relationship between species
c. the process of mapping an organism's entire DNA sequence
d. studying chromosome structure

(Answer a; pages 62)

103. All of your mtDNA comes from your mother.

a. True
b. False

(Answer a; page 63)

104. Which of the following is NOT true of mitochondrial DNA?

a. it contains much 'unused' genetic material
b. it varies little from generation to generation
c. it is inherited clonally from generation to generation
d. it gets all its variation from a crossing-over phase during meiosis

(Answer d; pages 62, 63)

105. Contamination is of large concern when working with samples of _____.

a. ancient DNA
b. mtDNA in general
c. non-human DNA
d. non-human mtDNA

(Answer a; page 64)

106. The ancient DNA studied is usually mtDNA because mtDNA

a. is more durable
b. varies so little from generation to generation
c. is so abundant
d. is much bigger than nuclear DNA

(Answer c; page 63)

107. Ancient DNA is usually studied using the _____ method.

a. indirect
b. protein synthesis
c. PCR
d. hybridization

(Answer c; page 63)

Short Essay

108. Explain the various types of genetics outlined in your text.

109. Outline the "blueprint" and "recipe" metaphors for genetics. What are the strengths and weaknesses of each?

110. What are stem cells? Explain their medical significance.

111. Describe the structure of DNA. Relate this structure to DNA's functions.

112. Describe specifically how proteins are created from the information encoded in DNA. Be sure to use the terms *gene*, *mRNA*, and *ribosome*.

113. Outline the life cycle of a somatic cell from prophase to interphase.

114. In what ways does meiosis differ from mitosis?

115. How does meioses contribute to variation within a species?

116. Describe two chromosomal abnormalities, one due to monosomy and one due to trisomy.

117. Explain two ways DNA may be directly used in bioanthropological research.