Name: _____ Class: _____ Date: _____ ID: A

3.A.1 & 3.A.2 (Formatives)

Multiple Choice
Identify the letter of the choice that best completes the statement or answers the question.

____ 1. Which of the following are nitrogenous bases of the pyrimidine type?
a. guanine and adenine
b. cytosine and uracil
c. thymine and guanine
d. ribose and deoxyribose
e. adenine and thymine

____ 2. Which of the following are nitrogenous bases of the purine type?
a. cytosine and guanine
b. guanine and adenine
c. adenine and thymine
d. thymine and uracil
e. uracil and cytosine

____ 3. A double-stranded DNA molecule contains a total of 120 purines and 120 pyrimidines. This DNA molecule could be comprised of
a. 120 adenine and 120 uracil molecules.
b. 120 thymine and 120 adenine molecules.
c. 120 cytosine and 120 thymine molecules.
d. 240 adenine and 240 cytosine molecules.
e. 240 guanine and 240 thymine molecules.

____ 4. The difference between the sugar in DNA and the sugar in RNA is that the sugar in DNA
a. is a six-carbon sugar and the sugar in RNA is a five-carbon sugar.
b. can form a double-stranded molecule.
c. has a six-membered ring of carbon and nitrogen atoms.
d. can attach to a phosphate.
e. contains one less oxygen atom.

____ 5. In the double helix structure of nucleic acids, cytosine hydrogen bonds to
a. deoxyribose.
b. ribose.
c. adenine.
d. thymine.
e. guanine.

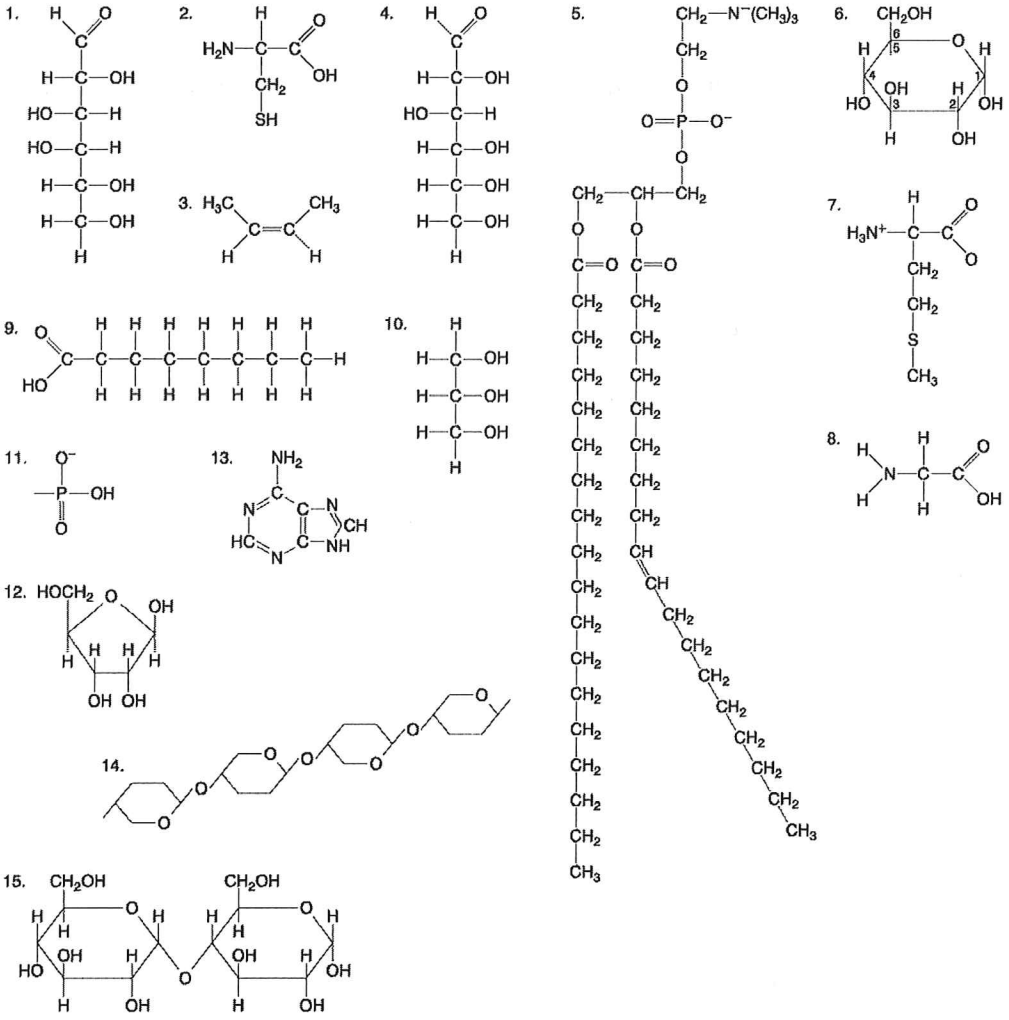
____ 6. The two strands making up the DNA double helix molecule
a. cannot be separated.
b. contain ribose and deoxyribose in opposite strands.
c. are held together by hydrogen bonds.
d. are attached through a phosphate to hold the strands together.
e. contain uracil but not thymine.

____ 7. If one strand of a DNA molecule has the sequence of bases 5'ATTGCA3', the other complementary strand would have the sequence
   a. 5'TAACGT3'.
   b. 3'TAACGT5'.
   c. 5'UAACGU3'.
   d. 3'UAACGU5'.
   e. 5'UGCAAU3'.

____ 8. The structural feature that allows DNA to replicate is the
   a. sugar-phosphate backbone.
   b. complementary pairing of the nitrogenous bases.
   c. disulfide bonding (bridging) of the two helixes.
   d. twisting of the molecule to form an á helix.
   e. three-component structure of the nucleotides.

____ 9. A new organism is discovered in the forests of Costa Rica. Scientists there determine that the polypeptide sequence of hemoglobin from the new organism has 72 amino acid differences from humans, 65 differences from a gibbon, 49 differences from a rat, and 5 differences from a frog. These data suggest that the new organism
   a. is more closely related to humans than to frogs.
   b. is more closely related to frogs than to humans.
   c. may have evolved from gibbons but not rats.
   d. is more closely related to humans than to rats.
   e. may have evolved from rats but not from humans and gibbons.

The following questions are based on the 15 molecules illustrated below. Each molecule may be used once, more than once, or not at all.



____ 10. Which of the following combinations could be linked together to form a nucleotide?
a. 1, 2, and 11
b. 3, 7, and 8
c. 5, 9, and 10
d. 11, 12, and 13
e. 12, 14, and 15

____ 11. Which of the following molecules is a saturated fatty acid?
a. 1
b. 5
c. 6
d. 8
e. 9

____ 12. Which of the following molecules is a purine type of nitrogenous base?
a. 2
b. 3
c. 5
d. 12
e. 13

____ 13. Which of the following molecules act as building blocks (monomers) of polypeptides?
a. 1, 4, and 6
b. 2, 7, and 8
c. 7, 8, and 13
d. 11, 12, and 13
e. 12, 13, and 15

____ 14. Which of the following molecules is an amino acid with a hydrophobic R group or side chain?
a. 3
b. 5
c. 7
d. 8
e. 12

____ 15. Which of the following molecules could be joined together by a peptide bond as a result of a dehydration reaction?
a. 2 and 3
b. 3 and 7
c. 7 and 8
d. 8 and 9
e. 12 and 13

____ 16. Which of the following molecules could be joined together by a phosphodiester type of covalent bond?
a. 3 and 4
b. 3 and 8
c. 6 and 15
d. 11 and 12
e. 11 and 13

____ 17. Which of the following molecules is the pentose sugar found in RNA?
a. 1
b. 4
c. 6
d. 12
e. 13

____ 18. Which of the following molecules consists of a hydrophilic "head" region and a hydrophobic "tail" region?
a. 2
b. 5
c. 7
d. 9
e. 11

____ 19. For a couple of decades, biologists knew the nucleus contained DNA and proteins. The prevailing opinion was that the genetic material was proteins, and not DNA. The reason for this belief was that proteins are more complex than DNA. This is because
a. proteins have a greater variety of three-dimensional forms than does DNA.
b. proteins have two different levels of structural organization; DNA has four.
c. proteins are made of 20 amino acids and DNA is made of four nucleotides.
d. Only A and C are correct.
e. A, B, and C are correct.

____ 20. In his transformation experiments, Griffith observed that
a. mutant mice were resistant to bacterial infections.
b. mixing a heat-killed pathogenic strain of bacteria with a living nonpathogenic strain can convert some of the living cells into the pathogenic form.
c. mixing a heat-killed nonpathogenic strain of bacteria with a living pathogenic strain makes the pathogenic strain nonpathogenic.
d. infecting mice with nonpathogenic strains of bacteria makes them resistant to pathogenic strains.
e. mice infected with a pathogenic strain of bacteria can spread the infection to other mice.

____ 21. What does transformation involve in bacteria?
a. the creation of a strand of DNA from an RNA molecule
b. the creation of a strand of RNA from a DNA molecule
c. the infection of cells by a phage DNA molecule
d. the type of semiconservative replication shown by DNA
e. assimilation of external DNA into a cell

____ 22. Avery and his colleagues purified various chemicals from pathogenic bacteria and showed that ____ was (were) the transforming agent.
a. DNA
b. protein
c. lipids
d. carbohydrates
e. phage

____ 23. In trying to determine whether DNA or protein is the genetic material, Hershey and Chase made use of which of the following facts?
a. DNA does not contain sulfur, whereas protein does.
b. DNA contains phosphorus, but protein does not.
c. DNA contains nitrogen, whereas protein does not.
d. A and B only
e. A, B, and C

Match the investigator(s) to the appropriate discovery of about the nature of genes.

A. Frederick Griffith
B. Alfred Hershey and Martha Chase
C. Oswald Avery, Maclyn McCarty, and Colin MacLeod
D. Erwin Chargaff
E. Matthew Meselson and Franklin Stahl

____ 24. Chemicals from heat-killed S cells were purified. The chemicals were tested for the ability to transform live R cells. The transforming agent was found to be DNA.
a. A
b. B
c. C
d. D
e. E

____ 25. In DNA from any species, the amount of adenine equals the amount of thymine, and the amount of guanine equals the amount of cytosine.
a. A
b. B
c. C
d. D
e. E

____ 26. When T2 phages infect bacteria and make more viruses in the presence of radioactive sulfur, what is the result?
a. The viral DNA will be radioactive.
b. The viral proteins will be radioactive.
c. The bacterial DNA will be radioactive.
d. both A and B
e. both A and C

____ 27. Cytosine makes up 38% of the nucleotides in a sample of DNA from an organism. Approximately, what percentage of the nucleotides in this sample will be thymine?
a. 12
b. 24
c. 31
d. 38
e. It cannot be determined from the information provided.

____ 28. Chargaff's analysis of the relative base composition of DNA was significant because he was able to show that
a. the relative proportion of each of the four bases differs from species to species.
b. the human genome is more complex than that of other species.
c. the amount of A is always equivalent to T, and C to G.
d. both A and C
e. both B and C

____ 29. All of the following can be determined directly from X-ray diffraction photographs of crystallized DNA *except* the
a. diameter of the helix.
b. helical shape of DNA.
c. sequence of nucleotides.
d. spacing of the nitrogenous bases along the helix.
e. number of strands in a helix.

____ 30. The DNA double helix has a uniform diameter because ____, which have two rings, always pair with ____, which have one ring.
a. purines; pyrimidines
b. pyrimidines; purines
c. deoxyribose sugars; ribose sugars
d. ribose sugars; deoxyribose sugars
e. nucleotides; nucleoside triphosphates

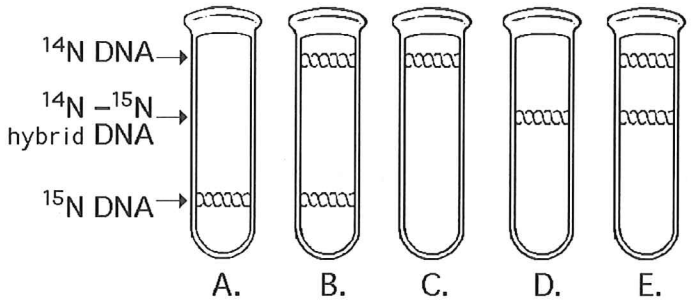
____ 31. What kind of chemical bond is found between paired bases of the DNA double helix?
a. hydrogen
b. ionic
c. covalent
d. sulfhydryl
e. phosphate

____ 32. Which of the following statements does not apply to the Watson and Crick model of DNA?
a. The two strands of the DNA form a double helix.
b. The distance between the strands of the helix is uniform.
c. The framework of the helix consists of sugar-phosphate units of the nucleotides.
d. The two strands of the helix are held together by covalent bonds.
e. The purines form hydrogen bonds with pyrimidines.

____ 33. In an analysis of the nucleotide composition of DNA, which of the following is *true*?
a. A = C
b. A = G and C = T
c. A + C = G + T
d. G + A = T + C
e. both C and D

____ 34. The strands that make up DNA are antiparallel. This means that
a. the twisting nature of DNA creates nonparallel strands.
b. the 5' to 3' direction of one strand runs counter to the 5' to 3' direction of the other strand.
c. base pairings create unequal spacing between the two DNA strands.
d. one strand is positively charged and the other is negatively charged.
e. one strand contains only purines and the other contains only pyrimidines.

Use the figure below to answer the following questions.



____ 35. In the late 1950s, Meselson and Stahl grew bacteria in a medium containing "heavy" nitrogen (15N) and then transferred them to a medium containing 14N. Which of the results in the figure above would be expected after one DNA replication in the presence of 14N?
a. A
b. B
c. C
d. D
e. E

____ 36. What determines the nucleotide sequence of the newly synthesized strand during DNA replication?
a. the particular DNA polymerase catalyzing the reaction
b. the relative amounts of the four nucleoside triphosphates in the cell
c. the nucleotide sequence of the template strand
d. the primase used in the reaction
e. both A and D

____ 37. What is the function of DNA polymerase?
a. to unwind the DNA helix during replication
b. to seal together the broken ends of DNA strands
c. to add nucleotides to the end of a growing DNA strand
d. to degrade damaged DNA molecules
e. to rejoin the two DNA strands (one new and one old) after replication

____ 38. Which of the following is *least* related to the others on the list?
a. Okazaki fragments
b. replication fork
c. telomerase
d. DNA polymerase
e. semiconservative model

____ 39. 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
a. leading strands and Okazaki fragments.
b. lagging strands and Okazaki fragments.
c. Okazaki fragments and RNA primers.
d. leading strands and RNA primers.
e. RNA primers and mitochondrial DNA.

Refer to the list of enzymes below to answer the following questions. The answers may be used once, more than once, or not at all.

A. helicase
B. nuclease
C. ligase
D. DNA polymerase I
E. primase

____ 40. removes the RNA nucleotides from the primer and adds equivalent DNA nucleotides to the 3' end of Okazaki fragments
a. A
b. B
c. C
d. D
e. E

____ 41. separates the DNA strands during replication
a. A
b. B
c. C
d. D
e. E

____ 42. covalently connects segments of DNA
a. A
b. B
c. C
d. D
e. E

____ 43. DNA-cutting enzymes used in the repair of DNA damage
a. A
b. B
c. C
d. D
e. E

____ 44. The difference between ATP and the nucleoside triphosphates used during DNA synthesis is that
a. the nucleoside triphosphates have the sugar deoxyribose; ATP has the sugar ribose.
b. the nucleoside triphosphates have two phosphate groups; ATP has three phosphate groups.
c. ATP contains three high-energy bonds; the nucleoside triphosphates have two.
d. ATP is found only in human cells; the nucleoside triphosphates are found in all animal and plant cells.
e. triphosphate monomers are active in the nucleoside triphosphates, but not in ATP.

____ 45. The Y-shaped structure where the DNA double helix is actively unwound during DNA replication is called the
a. replication fork.
b. replication Y.
c. elongation junction.
d. unwinding point.
e. Y junction.

____ 46. Which of the following best describes the addition of nucleotides to a growing DNA chain?
a. A nucleoside triphosphate is added to the 5' end of the DNA, releasing a molecule of pyrophosphate.
b. A nucleoside triphosphate is added to the 3' end of the DNA, releasing a molecule of pyrophosphate.
c. A nucleoside diphosphate is added to the 5' end of the DNA, releasing a molecule of phosphate.
d. A nucleoside diphosphate is added to the 3' end of the DNA, releasing a molecule of phosphate.
e. A nucleoside monophosphate is added to the 3' end of the DNA.

____ 47. A new DNA strand elongates only in the 5' to 3' direction because
a. DNA polymerase begins adding nucleotides at the 5' end of the template.
b. Okazaki fragments prevent elongation in the 3' to 5' direction.
c. the polarity of the DNA molecule prevents addition of nucleotides at the 3' end.
d. replication must progress toward the replication fork.
e. DNA polymerase can only add nucleotides to the free 3' end.

____ 48. Replicating the lagging strand of DNA-that is, adding bases in the 3' → 5' direction-utilizes which of the following?
a. DNA ligase
b. RNA primers
c. Okazaki fragments
d. A and B only
e. A, B, and C

____ 49. What kind of molecule or substance is the primer that is used to initiate the synthesis of a new DNA strand?
a. RNA
b. DNA
c. protein
d. phosphate
e. sulfur

____ 50. What is the role of DNA ligase in the elongation of the lagging strand during DNA replication?
a. synthesize RNA nucleotides to make a primer
b. catalyze the lengthening of telomeres
c. join Okazaki fragments together
d. unwind the parental double helix
e. stabilize the unwound parental DNA

____ 51. All of the following are functions of DNA polymerase in DNA replication *except*
a. covalently adding nucleotides to the new strands.
b. proofreading each added nucleotide for correct base pairing.
c. replacing RNA primers with DNA.
d. initiating a polynucleotide strand.
e. none of the above

____ 52. Which of the following help to hold the DNA strands apart while they are being replicated?
a. primase
b. ligase
c. DNA polymerase
d. single-strand binding proteins
e. exonuclease

The following questions refer to the following simple metabolic pathway:

enzyme A enzyme B
$A \rightarrow B$ $\rightarrow C$

____ 53. According to Beadle and Tatum's hypothesis, how many genes are necessary for this pathway?
a. 0
b. 1
c. 2
d. 3
e. It cannot be determined from the pathway.

____ 54. A mutation results in a defective enzyme *A*. Which of the following would be a consequence of that mutation?
a. an accumulation of A and no production of B and C
b. an accumulation of A and B and no production of C
c. an accumulation of B and no production of A and C
d. an accumulation of B and C and no production of A
e. an accumulation of C and no production of A and B

____ 55. If A, B, and C are all required for growth, a strain that is mutant for the gene encoding enzyme *A* would be able to grow on which of the following media?
a. minimal medium
b. minimal medium supplemented with nutrient "A"
c. minimal medium supplemented with nutrient "B"
d. minimal medium supplemented with nutrient "C"
e. Answers C and D are correct.

____ 56. If A, B, and C are all required for growth, a strain mutant for the gene encoding enzyme *B* would be capable of growing on which of the following media?
a. minimal medium
b. minimal medium supplemented with "A"
c. minimal medium supplemented with "B"
d. minimal medium supplemented with "C"
e. answers B and C

____ 57. We now know that the one gene-one enzyme hypothesis is not entirely accurate because
a. many genes code for proteins that are not enzymes.
b. a single gene codes for a single polypeptide chain, and many enzymes are made up of more than one polypeptide chain.
c. many genes code for RNA molecules that have no enzymatic activity.
d. A and B only
e. A, B, and C

____ 58. Which of the following represents a similarity between RNA and DNA?
a. Both are double-stranded.
b. the presence of uracil
c. the presence of an OH group on the 2' carbon of the sugar
d. nucleotides consisting of a phosphate, sugar, and nitrogenous base
e. Both are found exclusively in the nucleus.

____ 59. The nitrogenous base adenine is found in all members of which group?
a. proteins, triglycerides, and testosterone
b. proteins, ATP, and DNA
c. ATP, RNA, and DNA
d. alpha glucose, ATP, and DNA
e. proteins, carbohydrates, and ATP

____ 60. Using RNA as a template for protein synthesis instead of translating proteins directly from the DNA is advantageous for the cell because
a. RNA is much more stable than DNA.
b. RNA acts as an expendable copy of the genetic material, allowing the DNA to serve as a permanent, pristine repository of the genetic material.
c. many mRNA molecules can be transcribed from a single gene, increasing the potential rate of gene expression.
d. B and C only
e. A, B, and C

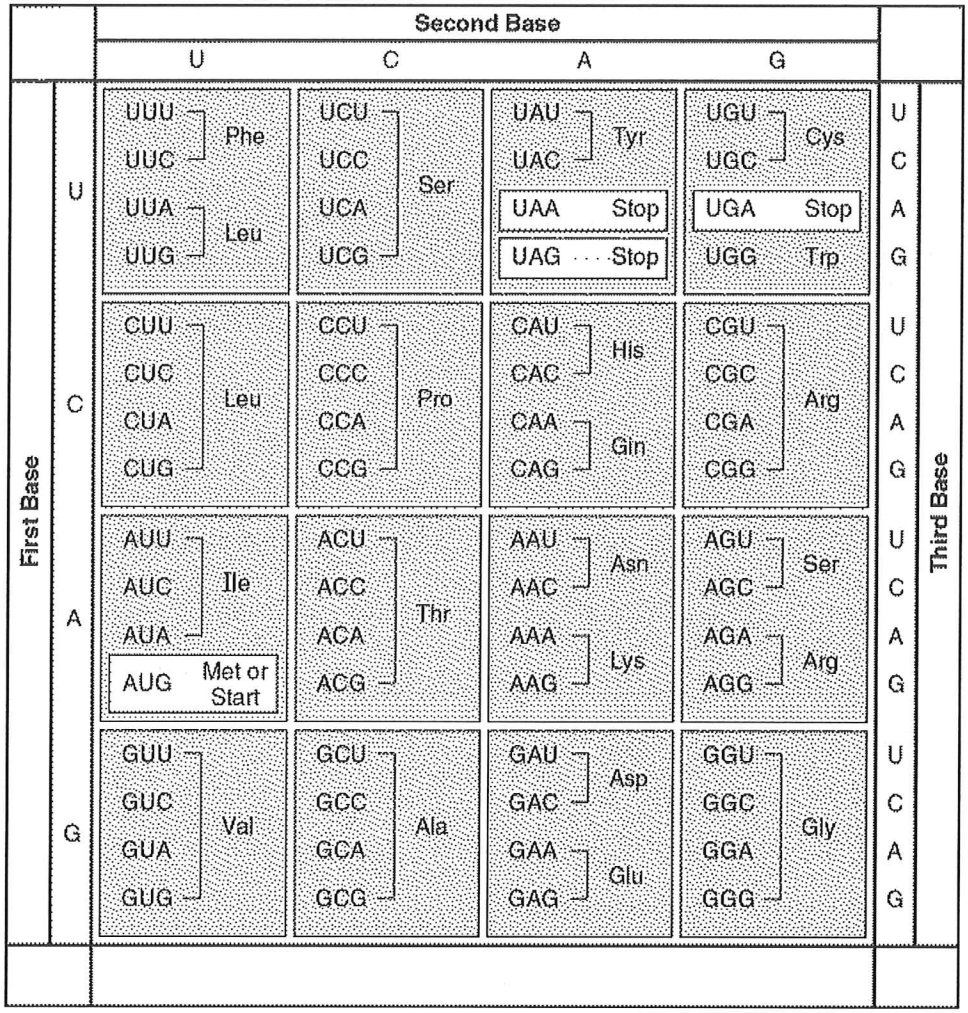
____ 61. If proteins were composed of only 12 different kinds of amino acids, what would be the smallest possible codon size in a genetic system with four different nucleotides?
a. 1
b. 2
c. 3
d. 4
e. 12

____ 62. An extraterrestrial life form is discovered. It has a genetic code much like that of organisms on Earth except that there are five different DNA bases instead of four and the base sequences are translated as doublets instead of triplets. How many different amino acids could be accommodated by this genetic code?
a. 5
b. 10
c. 25
d. 64
e. 32

____ 63. The enzyme polynucleotide phosphorylase randomly assembles nucleotides into a polynucleotide polymer. You add polynucleotide phosphorylase to a solution of adenosine triphosphate and guanosine triphosphate. The resulting artificial mRNA molecule would have ____ possible different codons if the code involved two-base sequences and ____ possible different codons if the code involved three-base sequences.
a. 2; 3
b. 2; 4
c. 4; 8
d. 4; 16
e. 16; 64

____ 64. A particular triplet of bases in the template strand of DNA is AGT. The corresponding codon for the mRNA transcribed is
a. AGT.
b. UGA.
c. TCA.
d. ACU.
e. either UCA or TCA, depending on wobble in the first base

Use the table of condons below to answer the following questions.



First Base	Second Base: U	Second Base: C	Second Base: A	Second Base: G	Third Base
U	UUU Phe	UCU Ser	UAU Tyr	UGU Cys	U
	UUC Phe	UCC Ser	UAC Tyr	UGC Cys	C
	UUA Leu	UCA Ser	UAA Stop	UGA Stop	A
	UUG Leu	UCG Ser	UAG Stop	UGG Trp	G
C	CUU Leu	CCU Pro	CAU His	CGU Arg	U
	CUC Leu	CCC Pro	CAC His	CGC Arg	C
	CUA Leu	CCA Pro	CAA Gln	CGA Arg	A
	CUG Leu	CCG Pro	CAG Gln	CGG Arg	G
A	AUU Ile	ACU Thr	AAU Asn	AGU Ser	U
	AUC Ile	ACC Thr	AAC Asn	AGC Ser	C
	AUA Ile	ACA Thr	AAA Lys	AGA Arg	A
	AUG Met or Start	ACG Thr	AAG Lys	AGG Arg	G
G	GUU Val	GCU Ala	GAU Asp	GGU Gly	U
	GUC Val	GCC Ala	GAC Asp	GGC Gly	C
	GUA Val	GCA Ala	GAA Glu	GGA Gly	A
	GUG Val	GCG Ala	GAG Glu	GGG Gly	G

____ 65. A possible sequence of nucleotides in the template strand of DNA that would code for the polypeptide sequence phe-leu-ile-val would be
a. 5' TTG-CTA-CAG-TAG 3'.
b. 3' AAC-GAC-GUC-AUA 5'.
c. 5' AUG-CTG-CAG-TAT 3'.
d. 3' AAA-AAT-ATA-ACA 5'.
e. 3' AAA-GAA-TAA-CAA 5'.

____ 66. What amino acid sequence will be generated, based on the following mRNA codon sequence?
5'AUG-UCU-UCG-UUA-UCC-UUG
a. met-arg-glu-arg-glu-arg
b. met-glu-arg-arg-gln-leu
c. met-ser-leu-ser-leu-ser
d. met-ser-ser-leu-ser-leu
e. met-leu-phe-arg-glu-glu

____ 67. A peptide has the sequence NH2-phe-pro-lys-gly-phe-pro-COOH. Which of the following sequences in the coding strand of the DNA codes for this peptide?
a. 3' UUU-CCC-AAA-GGG-UUU-CCC
b. 3' AUG-AAA-GGG-TTT-CCC-AAA-GGG
c. 5' TTT-CCC-AAA-GGG-TTT-CCC
d. 5' GGG-AAA-TTT-AAA-CCC-ACT-GGG
e. 5' ACT-TAC-CAT-AAA-CAT-TAC-UGA

____ 68. What is the sequence of a peptide based on the mRNA sequence 5' UUUUCUUAUUGUCUU 3' ?
a. leu-cys-tyr-ser-phe
b. cyc-phe-tyr-cys-leu
c. phe-leu-ile-met-val
d. leu-pro-asp-lys-gly
e. phe-ser-tyr-cys-leu

____ 69. A particular eukaryotic protein is 300 amino acids long. Which of the following could be the maximum number of nucleotides in the DNA that codes for the amino acids in this protein?
a. 3
b. 100
c. 300
d. 900
e. 1,800

____ 70. A codon
a. consists of two nucleotides.
b. may code for the same amino acid as another codon.
c. consists of discrete amino acid regions.
d. catalyzes RNA synthesis.
e. is found in all eukaryotes, but not in prokaryotes.

____ 71. The genetic code is essentially the same for all organisms. From this, one can logically assume all of the following *except*
a. a gene from an organism could theoretically be expressed by any other organism.
b. all organisms have a common ancestor.
c. DNA was the first genetic material.
d. the same codons in different organisms usually translate into the same amino acids.
e. different organisms have the same number of different types of amino acids.

____ 72. Which of the following is *true* for both prokaryotic and eukaryotic gene expression?
a. After transcription, a 3' poly-A tail and a 5' cap are added to mRNA.
b. Translation of mRNA can begin before transcription is complete.
c. RNA polymerase binds to the promoter region to begin transcription.
d. mRNA is synthesized in the 3' ? 5' direction.
e. The mRNA transcript is the exact complement of the gene from which it was copied.

____ 73. Which of the following are transcribed from DNA?
a. protein
b. exons
c. rRNA
d. B and C only
e. A, B, and C

____ 74. RNA polymerase and DNA polymerase differ in that
a. RNA polymerase uses RNA as a template, and DNA polymerase uses a DNA template.
b. RNA polymerase binds to single-stranded DNA, and DNA polymerase binds to double-stranded DNA.
c. RNA polymerase is much more accurate than DNA polymerase.
d. RNA polymerase can initiate RNA synthesis, but DNA polymerase requires a primer to initiate DNA synthesis.
e. RNA polymerase does not need to separate the two strands of DNA in order to synthesize an RNA copy, whereas DNA polymerase must unwind the double helix before it can replicate the DNA.

____ 75. Which of the following is *not* a part of the eukaryotic transcription initiation complex?
a. promoter
b. RNA polymerase
c. transcription factors
d. snRNP
e. TATA box

____ 76. RNA polymerase moves along the template strand of DNA in the ____ direction, and adds nucleotides to the ____ end of the growing transcript.
a. 3' to 5'; 5'
b. 3' to 5'; 3'
c. 5' to 3'; 5'
d. 5' to 3'; 3'

____ 77. All of the following are found in prokaryotic mRNA *except*
a. the AUG codon.
b. the UGA codon.
c. introns.
d. uracil.
e. cytosine.

____ 78. Which of the following helps to stabilize mRNA by inhibiting its degradation?
a. TATA box
b. spliceosomes
c. 5' cap
d. poly-A tail
e. both C and D

____ 79. What is a ribozyme?
a. An enzyme that uses RNA as a substrate
b. An enzyme made up of RNA
c. An enzyme that catalyzes the association between the large and small ribosomal subunits
d. An enzyme that synthesizes RNA as part of the transcription process
e. An enzyme that synthesizes RNA primers during DNA replication

____ 80. What are the coding segments of a stretch of eukaryotic DNA called?
a. introns
b. exons
c. codons
d. replicons
e. transposons

____ 81. A transcription unit that is 8,000 nucleotides long may use 1,200 nucleotides to make a protein consisting of 400 amino acids. This is best explained by the fact that
a. many noncoding nucleotides are present in mRNA.
b. there is redundancy and ambiguity in the genetic code.
c. many nucleotides are needed to code for each amino acid.
d. nucleotides break off and are lost during the transcription process.
e. there are termination exons near the beginning of mRNA.

____ 82. Introns are significant to biological evolution because
a. their presence allows exons to be moved around more easily, creating proteins with new combinations of functional domains.
b. they protect the mRNA from degeneration.
c. they are translated into essential amino acids.
d. they maintain the genetic code by preventing incorrect DNA base pairings.
e. they correct enzymatic alterations of DNA bases.

____ 83. A mutation in which of the following parts of a gene is likely to be most damaging to a cell?
a. intron
b. exon
c. 5' UTR
d. 3' UTR
e. All would be equally damaging.

____ 84. All of the following are directly involved in translation *except*
a. mRNA.
b. tRNA.
c. ribosomes.
d. DNA.
e. aminoacyl-tRNA synthetase enzymes.

____ 85. Accuracy in the translation of mRNA into the primary structure of a protein depends on specificity in the
a. binding of ribosomes to mRNA.
b. shape of the A and P sites of ribosomes.
c. bonding of the anticodon to the codon.
d. attachment of amino acids to tRNAs.
e. both C and D

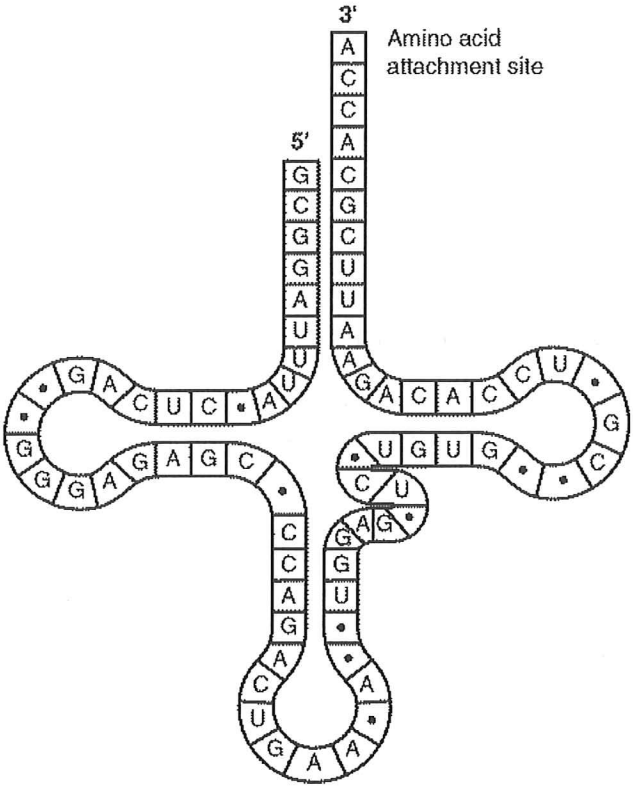
____ 86. What is an anticodon part of?
a. DNA
b. tRNA
c. mRNA
d. a ribosome
e. an activating enzyme

____ 87. A part of an mRNA molecule with the following sequence is being read by a ribosome: 5' CCG-ACG 3' (mRNA). The following activated transfer RNA molecules (with their anticodons shown in the 3' to 5' direction) are available. Two of them can correctly match the mRNA so that a dipeptide can form.

tRNA Anticodon	Amino Acid
GGC	Proline
CGU	Alanine
UGC	Threonine
CCG	Glycine
ACG	Cysteine
CGG	Alanine

The dipeptide that will form will be
a. cysteine-alanine.
b. proline-threonine.
c. glycine-cysteine.
d. alanine-alanine.
e. threonine-glycine.

____ 88. The figure below represents tRNA that recognizes and binds a particular amino acid (in this instance, phenylalanine). Which codon on the mRNA strand codes for this amino acid?



a. UGG
b. GUG
c. GUA
d. UUC
e. CAU

____ 89. There are 61 mRNA codons that specify an amino acid, but only 45 tRNAs. This is best explained by the fact that
a. some tRNAs have anticodons that recognize two or more different codons.
b. the rules for base pairing between the third base of a codon and tRNA are flexible.
c. many codons are never used, so the tRNAs that recognize them are dispensable.
d. A and B only
e. A, B, and C

____ 90. What are ribosomes composed of?
a. rRNA only
b. proteins only
c. both rRNA and protein
d. mRNA, rRNA, and protein
e. mRNA, tRNA, rRNA, and protein

____ 91. Where is eukaryotic ribosomal RNA transcribed?
a. the Golgi apparatus
b. ribosomes
c. the nucleolus
d. X chromosomes
e. prokaryotic cells only

____ 92. What is the most abundant type of RNA?
a. mRNA
b. tRNA
c. rRNA
d. pre-mRNA
e. hnRNA

____ 93. From the following list, which is the first event in translation in eukaryotes?
a. elongation of the polypeptide
b. base pairing of activated methionine-tRNA to AUG of the messenger RNA
c. binding of the larger ribosomal subunit to smaller ribosomal subunits
d. covalent bonding between the first two amino acids
e. Both B and D occur simultaneously.

____ 94. Choose the answer that has these events of protein synthesis in the proper sequence.
1. An aminoacyl-tRNA binds to the A site.
2. A peptide bond forms between the new amino acid and a polypeptide chain.
3. tRNA leaves the P site, and the P site remains vacant.
4. A small ribosomal subunit binds with mRNA.
5. tRNA translocates to the P site.
a. 1, 3, 2, 4, 5
b. 4, 1, 2, 5, 3
c. 5, 4, 3, 2, 1
d. 4, 1, 3, 2, 5
e. 2, 4, 5, 1, 3

____ 95. Which of the following is *not* directly involved in the process of translation?
a. ligase
b. tRNA
c. rRNA
d. mRNA
e. aminoacyl-tRNA synthetase

____ 96. Which of the following components are present upon the completion of translation initiation?
a. small ribosomal subunit
b. large ribosomal subunit
c. initiator tRNA
d. A and C only
e. A, B, and C

____ 97. During translation, chain elongation continues until what happens?
a. No further amino acids are needed by the cell.
b. All tRNAs are empty.
c. The polypeptide is long enough.
d. A stop codon is encountered.
e. The ribosomes run off the end of mRNA.

____ 98. As a ribosome translocates along an mRNA molecule by one codon, which of the following occurs?
a. The tRNA that was in the A site moves into the P site.
b. The tRNA that was in the P site moves into the A site.
c. The tRNA that was in the P site moves to the E site and is released.
d. The tRNA that was in the A site departs from the ribosome.
e. Both A and C are correct.

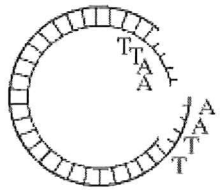
____ 99. Which of the following does *not occur during the termination phase of translation?*
a. A termination codon causes the A site to accept a release factor.
b. The newly formed polypeptide is released.
c. A tRNA with the next amino acid enters the P site.
d. The two ribosomal subunits separate.
e. Translation stops.

____ 100. When does translation begin in prokaryotic cells?
a. after a transcription initiation complex has been formed
b. during transcription
c. after the 5' caps are converted to mRNA
d. once the pre-mRNA has been converted to mRNA
e. as soon as the DNA introns are removed from the template

____ 101. Which of the following is (are) *true* about RNA?
a. snoRNA aids in processing pre-rRNA transcripts in the nucleolus.
b. SRP RNA is an essential component of spliceosomes.
c. It has functional groups that allow it to act as a catalyst (ribozyme).
d. Only A and C are true.
e. A, B, and C are true.

____ 102. Which of the following statements are true about protein synthesis in prokaryotes?
a. Translation can begin while transcription is still in progress.
b. Extensive RNA processing is required before prokaryotic transcripts can be translated.
c. Prokaryotic cells have complicated mechanisms for targeting proteins to the appropriate cellular organelles.
d. Only A and B are true.
e. A, B, and C are true.

____ 103. Which enzyme was used to produce the molecule in the figure below?



a. ligase
b. transcriptase
c. a restriction enzyme
d. RNA polymerase
e. DNA polymerase

____ 104. What is a cloning vector?
a. an enzyme that cuts DNA into restriction fragments
b. a DNA probe used to locate a particular gene in the genome
c. an agent, such as a plasmid, used to transfer DNA from an *in vitro solution into a living cell*
d. the laboratory apparatus used to clone genes
e. the sticky end of a DNA fragment

____ 105. Bacteria containing recombinant plasmids are often identified by which process?
a. examining the cells with an electron microscope
b. using radioactive tracers to locate the plasmids
c. exposing the bacteria to an antibiotic that kills cells lacking the plasmid
d. removing the DNA of all cells in a culture to see which cells have plasmids
e. producing antibodies specific for each bacterium containing a recombinant plasmid

____ 106. The polymerase chain reaction is important because it allows us to
a. insert eukaryotic genes into prokaryotic plasmids.
b. incorporate genes into viruses.
c. make DNA from RNA transcripts.
d. make many copies of a targeted segment of DNA.
e. insert regulatory sequences into eukaryotic genes.

____ 107. The polymerase chain reaction (PCR) has been used to amplify DNA from which of the following?
a. fossils
b. fetal cells
c. viruses
d. bacteria
e. all of the above

The following questions refer to the techniques, tools, or substances listed below. Answers may be used once, more than once, or not at all.

A. restriction enzymes
B. gene cloning
C. DNA ligase
D. gel electrophoresis
E. reverse transcriptase

____ 108. ____ produces multiple identical copies of a gene for basic research or for large-scale production of a gene product
a. A
b. B
c. C
d. D
e. E

____ 109. ____ separates molecules by movement due to size and electrical charge
a. A
b. B
c. C
d. D
e. E

____ 110. Restriction fragments of DNA are typically separated from one another by which process?
a. filtering
b. centrifugation
c. gel electrophoresis
d. PCR
e. electron microscopy

____ 111. What is a chromatid?
a. a chromosome in G_1 of the cell cycle
b. a replicated chromosome
c. a chromosome found outside the nucleus
d. a special region that holds two centromeres together
e. another name for the chromosomes found in genetics

____ 112. What is the name for the special region on a duplicated chromosome that holds the sister chromatids together?
a. centrosome
b. centromere
c. kinetochore
d. desmosome
e. microtubule organizer region

____ 113. If there are 20 chromatids in a cell, how many centromeres are there?
a. 10
b. 20
c. 30
d. 40
e. 80

____ 114. Which of the following statements is *not* true?
a. Mitosis produces new nuclei with exactly the same chromosomal endowment as the parent nucleus.
b. Mitosis may occur without cytokinesis.
c. Mitosis and cytokinesis are required for asexual reproduction.
d. All cells come from a preexisting cell.
e. The mitotic spindles in prokaryotic cells are composed of microtubules.

Use the data in the table below to answer the following questions.

The data were obtained from a study of the length of time spent in each phase of the cell cycle by cells of three eukaryotic organisms designated beta, delta, and gamma.

Minutes Spent in Cell Cycle Phases

Cell Type	G_1	S	G_2	M
Beta	18	24	12	16
Delta	100	0	0	0
Gamma	18	48	14	20

____ 115. Of the following, the best conclusion concerning the difference between the S phases for beta and gamma is that
a. gamma contains more DNA than beta.
b. beta and gamma contain the same amount of DNA.
c. beta contains more RNA than gamma.
d. gamma contains 48 times more DNA and RNA than beta.
e. beta is a plant cell and gamma is an animal cell.

____ 116. The best conclusion concerning delta is that the cells
a. contain no DNA.
b. contain no RNA.
c. contain only one chromosome that is very short.
d. are actually in the G_0 phase.
e. divide in the G_1 phase.

____ 117. Where do the microtubules of the spindle originate during mitosis in both plant and animal cells?
a. centromere
b. centrosome
c. centriole
d. chromatid
e. kinetochore

____ 118. All of the following occur during mitosis *except* the
a. condensing of chromosomes.
b. uncoupling of chromatids at the centromere.
c. formation of a spindle.
d. synthesis of DNA.
e. disappearance of the nucleolus.

____ 119. Regarding mitosis and cytokinesis, one difference between higher plants and animals is that in plants
a. the spindles contain microfibrils in addition to microtubules, whereas animal spindles do not contain microfibrils.
b. sister chromatids are identical, but they differ from one another in animals.
c. a cell plate begins to form at telophase, whereas animals a cleavage furrow is initiated at that stage.
d. chromosomes become attached to the spindle at prophase, whereas in animals chromosomes do not become attached until anaphase.
e. spindle poles contain centrioles, whereas spindle poles in animals do not.

____ 120. The formation of a cell plate is beginning across the middle of a cell and nuclei are re-forming at opposite ends of the cell. What kind of cell is this?
a. an animal cell in metaphase
b. an animal cell in telophase
c. an animal cell undergoing cytokinesis
d. a plant cell in metaphase
e. a plant cell undergoing cytokinesis

____ 121. Which of the following organisms does *not* reproduce cells by mitosis and cytokinesis?
a. cow
b. bacterium
c. mushroom
d. cockroach
e. banana tree

____ 122. Measurements of the amount of DNA per nucleus were taken on a large number of cells from a growing fungus. The measured DNA levels ranged from 3 to 6 picograms per nucleus. In which stage of the cell cycle was the nucleus with 6 picograms of DNA?
a. G_0
b. G_1
c. S
d. G_2
e. M

____ 123. A group of cells is assayed for DNA content immediately following mitosis and is found to have an average of 8 picograms of DNA per nucleus. Those cells would have ____ picograms at the end of the S phase and ____ picograms at the end of G_2.
a. 8; 8
b. 8; 16
c. 16; 8
d. 16; 16
e. 12; 16

____ 124. The somatic cells derived from a single-celled zygote divide by which process?
a. meiosis
b. mitosis
c. replication
d. cytokinesis alone
e. binary fission

____ 125. If mammalian cells receive a go-ahead signal at the G_1 checkpoint, they will
a. move directly into telophase.
b. complete the cycle and divide.
c. exit the cycle and switch to a nondividing state.
d. show a drop in MPF concentration.
e. complete cytokinesis and form new cell walls.

____ 126. Cells that are in a nondividing state are in which phase?
a. G_0
b. G_2
c. G_1
d. S
e. M

The following questions consist of five phrases or sentences related to the control of cell division. For each one, select the term below that is most closely related to it. Each term may be used once, more than once, or not at all.

A. PDGF
B. MPF
C. protein kinase
D. cyclin
E. Cdk

____ 127. a protein synthesized at specific times during the cell cycle that associates with a kinase to form a catalytically active complex
a. A
b. B
c. C
d. D
e. E

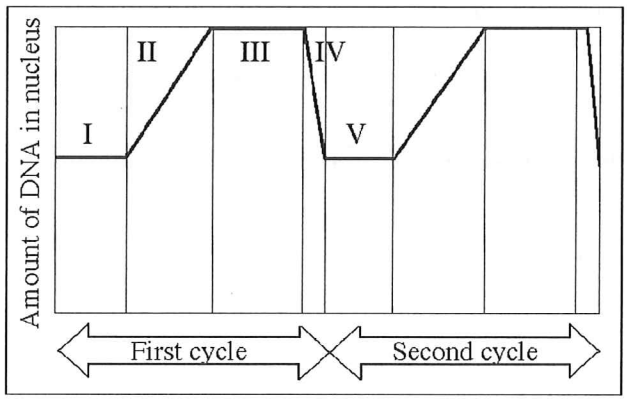
____ 128. a protein maintained at constant levels throughout the cell cycle that requires cyclin to become catalytically active
a. A
b. B
c. C
d. D
e. E

The questions below consist of five phrases or sentences concerned with the cell cycle. For each one, select the answer below that is most closely related to it. Each answer may be used once, more than once, or not at all.

A. G_0
B. G_1
C. S
D. G_2
E. M

____ 129. Nerve and muscle cells are in this phase.
a. A
b. B
c. C
d. D
e. E

Use the figure below to answer the following question.



____ 130. Mitosis is represented by which number?
a. I
b. II
c. III
d. IV
e. V

____ 131. Which number represents DNA synthesis?
a. I
b. II
c. III
d. IV
e. V

____ 132. Which number represents the point in the cell cycle during which the chromosomes are replicated?
a. I
b. II
c. III
d. IV
e. V

____ 133. What is a genome?
a. the complete complement of an organism's genes
b. a specific sequence of polypeptides within each cell
c. a specialized polymer of four different kinds of monomers
d. a specific segment of DNA that is found within a prokaryotic chromosome
e. an ordered display of chromosomes arranged from largest to smallest

____ 134. Which of the following statements about genes is *incorrect*?
a. Genes correspond to segments of DNA.
b. Many genes contain the information needed for cells to synthesize enzymes and other proteins.
c. During fertilization, both the sperm and the ovum contribute genes to the resulting fertilized egg.
d. Under normal circumstances, each chromosome contains precisely one gene.
e. Genetic differences can result from changes in the DNA called mutations.

____ 135. What is a karyotype?
a. the set of unique physical characteristics that define an individual
b. the collection of all the mutations present within a genome
c. a unique combination of chromosomes found in a gamete
d. a system of classifying cell nuclei
e. a display of every pair of homologous chromosomes within a cell, organized according to size and shape

____ 136. Which of the following is the term for a human cell that contains 22 pairs of autosomes and two X chromosomes?
a. an unfertilized egg cell
b. a sperm cell
c. a male somatic cell
d. a female somatic cell
e. both A and D

____ 137. Which of these statements is *false*?
a. In humans, each of the 22 maternal autosomes has a homologous paternal chromosome.
b. In humans, the 23rd pair, the sex chromosomes, determines whether the person is female (XX) or male (XY).
c. Single, haploid (n) sets of chromosomes in ovum and sperm unite during fertilization, forming a diploid ($2n$), single-celled zygote.
d. At sexual maturity, ovaries and testes produce diploid gametes by meiosis.
e. Sexual life cycles differ with respect to the relative timing of meiosis and fertilization.

____ 138. In animals, somatic cells are produced by mitosis and ____ are produced by meiosis.
a. gametes
b. clones
c. zygotes
d. spores
e. diploid cells

____ 139. After telophase I of meiosis, the chromosomal makeup of each daughter cell is
a. diploid, and the chromosomes are composed of a single chromatid.
b. diploid, and the chromosomes are composed of two chromatids.
c. haploid, and the chromosomes are composed of a single chromatid.
d. haploid, and the chromosomes are composed of two chromatids.
e. tetraploid, and the chromosomes are composed of two chromatids.

____ 140. How do cells at the completion of meiosis compare with cells that have replicated their DNA and are just about to begin meiosis?
a. They have twice the amount of cytoplasm and half the amount of DNA.
b. They have half the number of chromosomes and half the amount of DNA.
c. They have the same number of chromosomes and half the amount of DNA.
d. They have half the number of chromosomes and one-fourth the amount of DNA.
e. They have half the amount of cytoplasm and twice the amount of DNA.

____ 141. Centromeres uncouple and chromatids are separated from each other.
a. A
b. B
c. C
d. D
e. E

____ 142. Independent assortment of chromosomes occurs.
a. A
b. B
c. C
d. D
e. E

____ 143. Which sample of DNA might be from a nerve cell arrested in G_0 of the cell cycle?
a. I
b. II
c. III
d. either I or II
e. either II or III

____ 144. Which sample might represent an animal cell in G_2 phase of the cell cycle?
a. I
b. II
c. III
d. both I and II
e. both II and III

____ 145. Which sample might represent a sperm cell?
a. I
b. II
c. III
d. either I or II
e. either II or III

3.A.1 & 3.A.2
Answer Section

MULTIPLE CHOICE

1. ANS: B TOP: Concept 5.5
2. ANS: B TOP: Concept 5.5
3. ANS: B TOP: Concept 5.5
4. ANS: E TOP: Concept 5.5
5. ANS: E TOP: Concept 5.5
6. ANS: C TOP: Concept 5.5
7. ANS: B TOP: Concept 5.5
8. ANS: B TOP: Concept 5.5
9. ANS: B TOP: Concept 5.5
10. ANS: D TOP: Concept 5.5
11. ANS: E TOP: Concept 5.3
12. ANS: E TOP: Concept 5.5
13. ANS: B TOP: Concept 5.4
14. ANS: C TOP: Concept 5.4
15. ANS: C TOP: Concept 5.4
16. ANS: D TOP: Concept 5.3
17. ANS: D TOP: Concept 5.5
18. ANS: B TOP: Concept 5.3
19. ANS: D TOP: Concept 16.1
20. ANS: B TOP: Concept 16.1
21. ANS: E TOP: Concept 16.1
22. ANS: A TOP: Concept 16.1
23. ANS: D TOP: Concept 16.1
24. ANS: C TOP: Concept 16.1
25. ANS: D TOP: Concept 16.1
26. ANS: B TOP: Concept 16.1
27. ANS: A TOP: Concept 16.1
28. ANS: D TOP: Concept 16.1
29. ANS: C TOP: Concept 16.1
30. ANS: A TOP: Concept 16.1
31. ANS: A TOP: Concept 16.1
32. ANS: D TOP: Concept 16.1
33. ANS: E TOP: Concept 16.1
34. ANS: B TOP: Concept 16.2
35. ANS: D TOP: Concept 16.2
36. ANS: C TOP: Concept 16.2
37. ANS: C TOP: Concept 16.2
38. ANS: C TOP: Concept 16.2
39. ANS: A TOP: Concept 16.2

40. ANS: D TOP: Concept 16.2
41. ANS: A TOP: Concept 16.2
42. ANS: C TOP: Concept 16.2
43. ANS: B TOP: Concept 16.2
44. ANS: A TOP: Concept 16.2
45. ANS: A TOP: Concept 16.2
46. ANS: B TOP: Concept 16.2
47. ANS: E TOP: Concept 16.2
48. ANS: E TOP: Concept 16.2
49. ANS: A TOP: Concept 16.2
50. ANS: C TOP: Concept 16.2
51. ANS: D TOP: Concept 16.2
52. ANS: D TOP: Concept 16.2
53. ANS: C TOP: Concept 17.1
54. ANS: A TOP: Concept 17.1
55. ANS: E TOP: Concept 17.1
56. ANS: D TOP: Concept 17.1
57. ANS: E TOP: Concept 17.1
58. ANS: D TOP: Concept 17.1
59. ANS: C TOP: Concept 17.1
60. ANS: D TOP: Concept 17.1
61. ANS: B TOP: Concept 17.1
62. ANS: C TOP: Concept 17.1
63. ANS: C TOP: Concept 17.1
64. ANS: D TOP: Concept 17.1
65. ANS: E TOP: Concept 17.1
66. ANS: D TOP: Concept 17.1
67. ANS: C TOP: Concept 17.1
68. ANS: E TOP: Concept 17.1
69. ANS: D TOP: Concept 17.1
70. ANS: B TOP: Concept 17.1
71. ANS: C TOP: Concept 17.1
72. ANS: C TOP: Concept 17.2
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74. ANS: D TOP: Concept 17.2
75. ANS: D TOP: Concept 17.2
76. ANS: B TOP: Concept 17.2
77. ANS: C TOP: Concept 17.2
78. ANS: E TOP: Concept 17.3
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83. ANS: B TOP: Concept 17.3

84. ANS: D TOP: Concept 17.4
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87. ANS: B TOP: Concept 17.4
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96. ANS: E TOP: Concept 17.4
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99. ANS: C TOP: Concept 17.4
100. ANS: B TOP: Concept 17.4
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102. ANS: A TOP: Concept 17.6
103. ANS: C TOP: Concept 20.1
104. ANS: C TOP: Concept 20.1
105. ANS: C TOP: Concept 20.1
106. ANS: D TOP: Concept 20.1
107. ANS: E TOP: Concept 20.1
108. ANS: B TOP: Concept 20.1
109. ANS: D TOP: Concept 20.2
110. ANS: C TOP: Concept 20.2
111. ANS: B TOP: Concept 12.1
112. ANS: B TOP: Concept 12.1
113. ANS: A TOP: Concept 12.1
114. ANS: E TOP: Concept 12.2
115. ANS: A TOP: Concept 12.2
116. ANS: D TOP: Concept 12.2
117. ANS: B TOP: Concept 12.2
118. ANS: D TOP: Concept 12.2
119. ANS: C TOP: Concept 12.2
120. ANS: E TOP: Concept 12.2
121. ANS: B TOP: Concept 12.2
122. ANS: D TOP: Concept 12.2
123. ANS: D TOP: Concept 12.2
124. ANS: B TOP: Concept 12.2
125. ANS: B TOP: Concept 12.3
126. ANS: A TOP: Concept 12.3
127. ANS: D TOP: Concept 12.3

128. ANS: E TOP: Concept 12.3
129. ANS: A TOP: Concept 12.3
130. ANS: D TOP: Concept 12.2
131. ANS: B TOP: Concept 12.2
132. ANS: B TOP: Concept 12.2
133. ANS: A TOP: Concept 13.1
134. ANS: D TOP: Concept 13.1
135. ANS: E TOP: Concept 13.2
136. ANS: D TOP: Concept 13.2
137. ANS: D TOP: Concept 13.2
138. ANS: A TOP: Concept 13.2
139. ANS: D TOP: Concept 13.3
140. ANS: D TOP: Concept 13.3
141. ANS: E TOP: Concept 13.3
142. ANS: B TOP: Concept 13.3
143. ANS: A TOP: Concept 13.3
144. ANS: B TOP: Concept 13.3
145. ANS: C TOP: Concept 13.3