Chapter 3: Nucleotides, Nucleic Acids, and Genetic Information

Matching

A) diploid
B) phosphodiester
C) probe
D) pyrimidine
E) introns
F) cloning
G) transformed
H) exons
I) ampicillin
J) autoradiography
K) chain-terminator
L) purine
M) ester

1. Cytosine, uracil, and thymine are derivatives of _____.
Ans: D
Section 3.1
Difficulty: Easy
Learning Objective: **Nucleotides**

2. Nucleic acids are composed of nucleotides that are linked by _____ linkages.
Ans: B
Section 3.2.A
Difficulty: Easy
Learning Objective: **Introduction to Nucleic Acid Structure**

3. Organisms composed of cells with two sets of chromosomes are called _____ organisms.
Ans: A
Section 3.3.A
Difficulty: Easy
Learning Objective: **Overview of Nucleic Acid Function**

4. Eukaryotic genes often contain regions that are transcribed and later excised from the RNA, called _____.
Ans: E
Section 3.5.D
Difficulty: Moderate
Learning Objective: **Overview of Nucleic Acid Function**

5. Experiments by Avery and colleagues proved that DNA was the substance that _____ a non-pathogenic pneumococcus strain into a virulent strain.
Ans: G
Section 3.3.A
Difficulty: Moderate
Learning Objective: **Overview of Nucleic Acid Function**

6. The method that Sanger developed for DNA sequencing using dideoxy nucleotides is called the _____ method.
Ans: K
Section 3.4.C
Difficulty: Easy
Learning Objective: **Nucleic Acid Sequencing**

7. Plasmids are small, circular DNA molecules that are used in _____.
Ans: F
Section 3.5.A
Difficulty: Easy
Learning Objective: **Manipulating DNA**

8. Certain plasmids contain genes that confer resistance to _____.
Ans: I
Section 3.5.A
Difficulty: Easy
Learning Objective: **Manipulating DNA**

9. A small fragment of labeled DNA or RNA used in a hybridization experiment is called a _____.
Ans: C
Section 3.5.B
Difficulty: Easy
Learning Objective: **Manipulating DNA**

10. After hybridization, the fragment of interest can be detected by _____.
Ans: J
Section 3.5.B
Difficulty: Easy
Learning Objective: **Manipulating DNA**

Multiple Choice

11. Nucleotides play a central role in living organisms because
A) they mediate transport of energy within the cell.
B) they are involved in oxidation-reduction reactions.
C) they are involved in intracellular signaling.
D) they function as building blocks for nucleic acids.
E) all of the above

Ans: E
Section 3.1
Difficulty: Easy
Learning Objective: **Nucleotides**

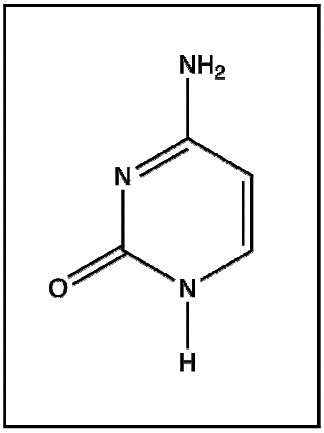
12. Which of the following statements about nucleotides is false?
A) Nucleotides mediate transport of energy within the cell.
B) Nucleotides are involved in oxidation-reduction reactions.
C) Nucleotides store genetic information.
D) Nucleotides are involved in biosynthetic reactions.
E) none of the above

Ans: C
Section 3.1
Difficulty: Easy
Learning Objective: **Nucleotides**

13. What group is attached to the pyrimidine ring in thymine and is not present in uracil?
A) ribose
B) —CH_3
C) —NH_2
D) deoxyribose
E) none of the above

Ans: B
Section 3.1
Difficulty: Moderate
Learning Objective: **Nucleotides**

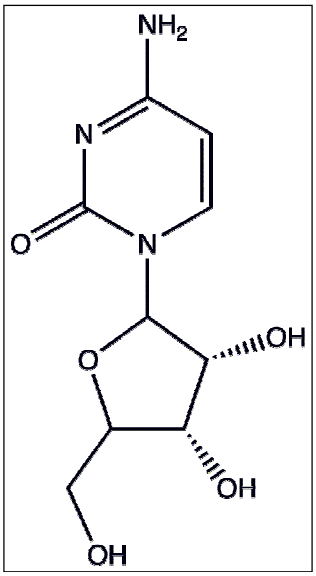
14. The molecule shown in the diagram is a



A) purine.
B) dinucleotide.
C) nucleoside.
D) nucleotide.
E) none of the above

Ans: E
Section 3.1
Difficulty: Easy
Learning Objective: **Nucleotides**

15. What is the name of the molecule shown in the diagram?



A) adenosine
B) cytosine
C) cytidine
D) cytidine monophosphate
E) uridine

Ans: C
Section 3.1
Difficulty: Easy
Learning Objective: **Nucleotides**

16. Nucleotides contain one or more phosphate groups that are usually attached to the:
A) C3′ or C5′ atoms
B) C3 or C3′ atoms
C) C5 or N3 atoms
D) C1′ or N3 atoms
E) none of the above

Ans: A
Section 3.1
Difficulty: Moderate
Learning Objective: **Nucleotides**

17. ‘AMP’ is used to refer to
A) adenosine.
B) adenylic acid.
C) adenomethyl purine.
D) adenine.
E) all of the above

Answer: B
Section 3.1
Difficulty: Difficult
Learning Objective: **Nucleotides**

18. Inside our cells, free nucleotides are almost always associated with _____.
A) proteins
B) cholesterol
C) Cl^- counterions
D) fatty acids
E) Mg^{2+} counterions

Answer: E
Section 3.1
Difficulty: Moderate
Learning Objective: **Nucleotides**

19. Humans typically recycle approximately _____ of ATP each day.
A) 50 kg
B) 50 mg
C) 50 g
D) 50 μg
E) 500 kg

Answer: A
Section 3.1
Difficulty: Easy
Learning Objective: **Nucleotides**

20. Nucleoside triphosphates are useful for energy transfer because the phosphoanhydride bonds are relatively _____.
A) stable
B) high energy
C) biocompatible
D) large
E) low energy

Answer: B
Section 3.1
Difficulty: Easy
Learning Objective: **Nucleotides**

21. Nucleoside triphosphates carry energy in the form of
A) glycosidic bonds
B) phosphoester bonds
C) phosphoanhydride bonds
D) hydrogen bonds
E) amide linkages

Answer: C
Section 3.1
Difficulty: Moderate
Learning Objective: **Nucleotides**

22. The major carrier of energy in the cell is:

A) adenosine monophosphate
B) adenosine diphosphate
C) adenosine triphosphate
D) adenosine tetraphosphate
E) flavin adenine dinucleotide

Answer: C
Section 3.1
Difficulty: Easy
Learning Objective: **Nucleotides**

23. Which of the following nucleotides contain energy rich bonds?
A) ATP
B) TTP
C) GTP
D) CTP
E) all of the above

Answer: E
Section 3.1
Difficulty: Easy
Learning Objective: **Nucleotides**

24. Which of the following molecules does not contain an energy rich phosphoanhydride bond?
A) ADP
B) GDP
C) AMP
D) CDP
E) all of the above

Answer: C
Section 3.1
Difficulty: Easy
Learning Objective: **Nucleotides**

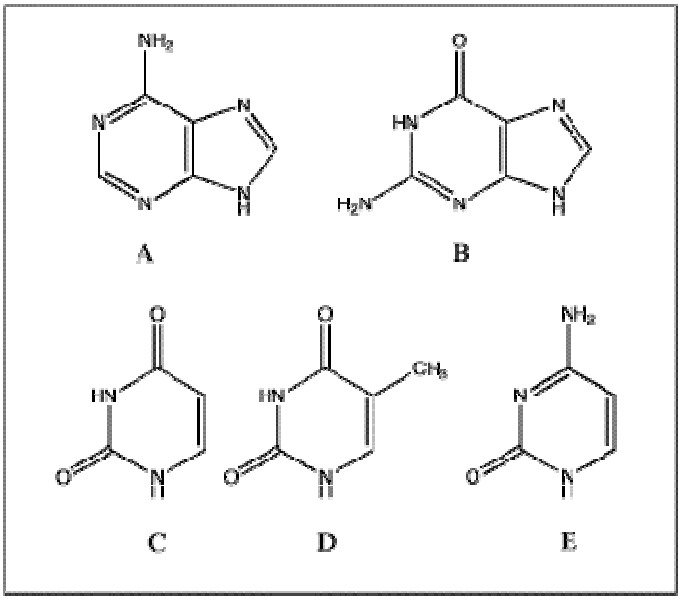
25. By convention, the sequence of nucleotide residues in a nucleic acid is written _____ starting with the ____ end.
A) left to right; 3′
B) right to left; 3′
C) left to right; 5′
D) right to left; 3′
E) top to bottom; 3′

Answer: C
Section 3.2.A
Difficulty: Easy
Learning Objective: **Introduction to Nucleic Acid Structure**

26. Chargaff's rules state that:
A) The amount of guanine plus cytosine in mammalian genomes varies from about 39 to 46%.
B) DNA is always double stranded and RNA is always single stranded.
C) DNA contains two grooves, a major groove and a minor groove.
D) In DNA the number of adenine residues is identical to the number of thymine residues and the number of guanine residues is identical to the number of cytosine residues.
E) DNA contains two strands that run in opposite directions.

Answer: D
Section 3.2.B
Difficulty: Easy
Learning Objective: **Introduction to Nucleic Acid Structure**

27. Which of the following bases pairs with guanine?



Answer: E
Section 3.2.B
Difficulty: Easy
Learning Objective: **Introduction to Nucleic Acid Structure**

28. The Watson and Crick model of a double-helical structure for DNA was based, in part, on evidence from
A) NMR (nuclear magnetic resonance) spectroscopy.
B) IR (infrared) spectroscopy.
C) atomic force microscopy.
D) electron microscopy.
E) X-ray diffraction .

Answer: E
Section 3.2.B
Difficulty: Easy
Learning Objective: **Introduction to Nucleic Acid Structure**

29. Knowledge about the tautomeric forms of the bases of nucleic acids is needed
A) to understand H-bonding between the complementary bases
B) to understand how the bases are linked to ribose.
C) to understand how bases are linked to deoxyribose.
D) to understand the ability of nucleotides to act as energy carriers.
E) to distinguish the 5'-end of a DNA strand from the 3'-end.

Answer: A
Section 3.2.B
Difficulty: Easy
Learning Objective: **Introduction to Nucleic Acid Structure**

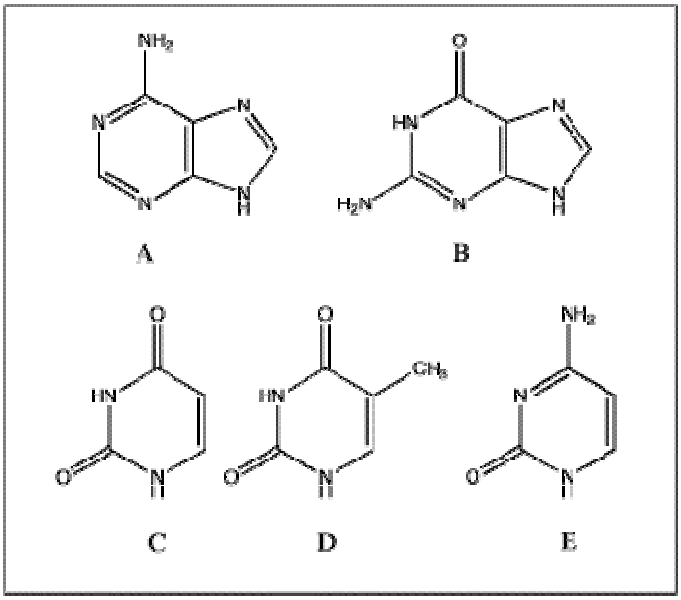
30. Nucleotides in a DNA molecule are linked together through
A) glycosidic bonds.
B) amide linkages.
C) hydrogen bonds.
D) phosphoanhydride bonds.
E) phosphodiester bonds.

Answer: E
Section 3.2.B
Difficulty: Easy
Learning Objective: **Introduction to Nucleic Acid Structure**

31. A double stranded DNA fragment contains 12% adenine residues. Calculate the percentage cytosine residues.
A) 12%
B) 24%
C) 38%
D) 50%
E) 78%

Answer: C
Section 3.2.B
Difficulty: Moderate
Learning Objective: **Introduction to Nucleic Acid Structure**

32. Which of the following bases is <u>not</u> present in RNA?



Answer: D
Section 3.2.C
Difficulty: Easy
Learning Objective: **Introduction to Nucleic Acid Structure**

33. RNA occurs primarily as single stranded molecules that can give rise to _____ structures.
A) diploid
B) stem-loop
C) parallel
D) tautomeric
E) haploid

Answer: B
Section 3.2.C
Difficulty: Easy
Learning Objective: **Introduction to Nucleic Acid Structure**

34. In 1944 Avery, MacLeod, and McCarty did experiments with Diplococcus pneumoniae that proved that
A) DNA is double stranded.
B) DNA contains deoxyribose.
C) DNA can be transcribed into RNA.
D) DNA can permanently transform a non-pathogenic strain into a pathogenic strain.
E) The structure of DNA provides a mechanism for reliable replication.

Answer: D
Section 3.3.A
Difficulty: Easy
Learning Objective: **Overview of Nucleic Acid Function**

35. In living organisms, genetic information is most often stored in the form of
A) ribonucleic acid.
B) deoxyribonucleic acid.
C) proteins.
D) enzymes.
E) deoxynucleotides.

Answer: B
Section 3.3.A
Difficulty: Easy
Learning Objective: **Overview of Nucleic Acid Function**

36. It is impossible for RNA to store genetic information, because
A) RNA does not base pair and therefore cannot be replicated.
B) enzymes cannot process genetic information in the form of RNA.
C) RNA forms complex folded structures.
D) RNA is very unstable.
E) None of the above answers is correct; RNA *can* store genetic information.

Answer: E
Section 3.3.A
Difficulty: Difficult
Learning Objective: **Overview of Nucleic Acid Function**

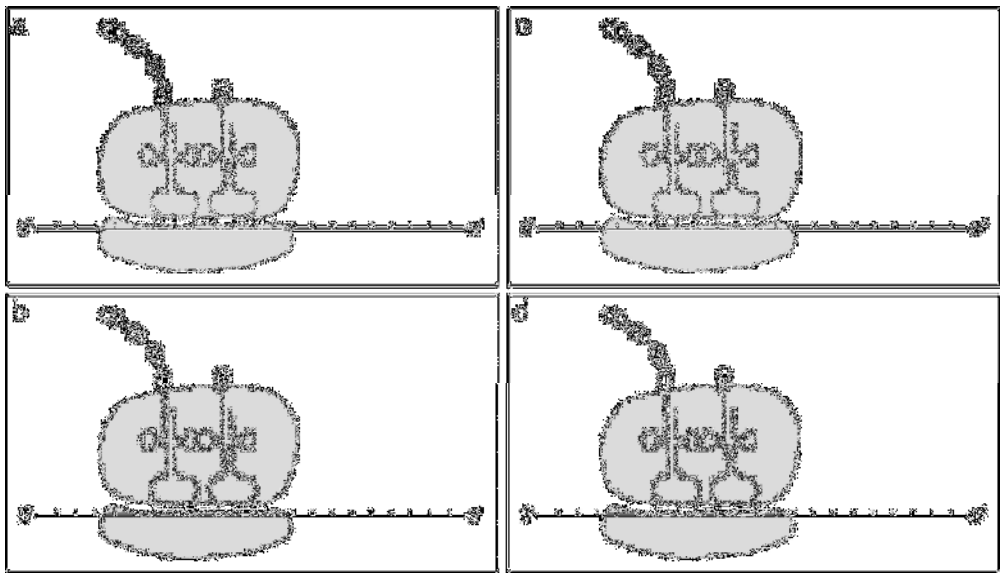
37. Genomic DNA is _____, resulting in the production of _____.
A) transcribed; mRNA
B) translated; tRNA
C) transcribed; protein
D) translated; protein
E) translated; rRNA

Answer: A
Section 3.3.B
Difficulty: Moderate
Learning Objective: **Overview of Nucleic Acid Function**

38. Which of the following nucleic acids provides the key to decoding genetic information?
A) tRNA
B) rRNA
C) mRNA
D) DNA
E) None of the above

Answer: A
Section 3.3.B
Difficulty: Difficult
Learning Objective: **Overview of Nucleic Acid Function**

39. Which diagram depicts correctly a ribosome engaged in translation?



A.) a
B.) b
C.) c
D.) d

Answer: A
Section 3.3.B
Difficulty: Difficult
Learning Objective: **Overview of Nucleic Acid Function**

40. Transfer RNA molecules are involved in
A) transcription.
B) translation.
C) replication.
D) reverse transcription.
E) posttranslational processing.

Answer: B
Section 3.3.B
Difficulty: Easy
Learning Objective: **Overview of Nucleic Acid Function**

41. Which of the following DNA sequences is considered palindromic?
A) AAGCTT
B) GAACTT
C) GAACAA
D) AAGCAA
E) AAGTTC

Ans: A
Section 3.4.A
Difficulty: Moderate
Learning Objective: **Nucleic Acid Sequencing**

42. Which of the following DNA sequences (in which N is any nucleic acid residue) is palindromic?
A) ANAGCTT
B) AANGCTT
C) AAGNCTT
D) AAGCNTT
E) AAGCTNT

Ans: C
Section 3.4.A
Difficulty: Moderate
Learning Objective: **Nucleic Acid Sequencing**

43. Double stranded DNA molecules can be cleaved at specific recognition sites by
A) RNA polymerase.
B) DNA ligase.
C) DNA polymerase.
D) reverse transcriptase.
E) Type II restriction endonucleases.

Answer: E
Section 3.4.A
Difficulty: Moderate
Learning Objective: **Nucleic Acid Sequencing**

44. Which of the restriction enzymes listed in the table below produces blunt-end fragments?

Enzyme	Cleavage site
AluI	AG↓CT
HindIII	A↓AGCTT
BamHI	G↓GATCC
EcoRI	G↓AATTC
BglII	A↓GATCA

A) AluI
B) BamHI
C) BglII
D) EcoRI
E) HindIII

Answer: A
Section 3.4.A
Difficulty: Moderate
Learning Objective: **Nucleic Acid Sequencing**

45. Which of the enzymes listed in the table below produce identical sticky ends?

Enzyme	Cleavage site
AluI	AG↓CT
HindIII	A↓AGCTT
BamHI	G↓GATCC
EcoRI	G↓AATTC
BglII	A↓GATCA

A) AluI and HindIII
B) AluI and BamHI
C) HindIII and EcoRI
D) HindIII and BglII
E) BamHI and BglII

Answer: E
Section 3.4.A
Difficulty: Difficult
Learning Objective: **Nucleic Acid Sequencing**

46. Gel electrophoresis generally separates nucleic acids on the basis of
A) shape.
B) sequence.
C) size.
D) charge-density.
E) none of the above

Ans: C
Section 3.4.B
Difficulty: Easy
Learning Objective: **Nucleic Acid Sequencing**

47. DNA sequencing using the Sanger method requires
A) template, primer, DNA polymerase, mRNA, dNTPs, ddNTPs.
B) template, primer, DNA polymerase, dNTPs, ddNTPs.
C) template, primer, DNA polymerase, rRNA, dNTPs, ddNTPs.
D) template, primer, DNA polymerase, mRNA, dNTPs.
E) none of the above

Ans: B
Section 3.4.C
Difficulty: Moderate
Learning Objective: **Nucleic Acid Sequencing**

48. In Sanger dideoxy DNA sequencing, DNA polymerase I is used to add nucleotides to the ___ end of the growing polynucleotide chain.
A) sticky
B) blunt
C) 3′
D) 5′
E) dideoxy nucleotide containing

Answer: C
Section 3.4.C
Difficulty: Moderate
Learning Objective: **Nucleic Acid Sequencing**

49. DNA sequencing by the chain-termination method utilizes DNA polymerase I to make a complementary copy of the target or template DNA molecule. A reaction with a 20 bp template and dideoxyadenosine nucleotides as terminators results in the production of a 5 bp fragment. Based on this result, we can conclude that the template contains
A) a cytosine at position 5.
B) a thymine at position 5.
C) a cytosine at position 16.
D) a thymine at position 16.
E) a uracil at position 5.

Answer: D
Section 3.4.C
Difficulty: Difficult
Learning Objective: **Nucleic Acid Sequencing**

50. DNA fragments are usually inserted into a plasmid vector and cloned before they are analyzed by chain termination sequencing because
A) DNA fragments need to be pure in order to obtain an unambiguous sequence.
B) a large number of identical fragments is needed in a sequencing reaction in order to generate detectable amounts of products.
C) plasmid vectors have known sequences that can be used for design and annealing of the primer oligonucleotides, which are used to initiate the sequencing reaction.
D) all of the above
E) none of the above

Answer: D
Section 3.4.C
Difficulty: Moderate
Learning Objective: **Nucleic Acid Sequencing**

51. Which of the following conclusions about the human genome is (are) true?
A) Only about 80% of the human genome is transcribed to RNA.
B) Only about 1-2% of the human genome codes for proteins.
C) Most of the proteins found in humans are also found in many other animals.
D) Nearly half of the human genome consists of repetitive DNA sequences.
E) All of the above.

Ans: E
Section 3.4.D
Difficulty: Difficult
Learning Objective: **Nucleic Acid Sequencing**

52. Which of the following conclusions about the human genome is false?
A) Only about 80% of the genome is transcribed to RNA.
B) Most of the proteins found in humans are unique to vertebrates.
C) Nearly half of the human genome consists of repetitive DNA sequences.
D) The genomes of any two people are likely to be 99.9% identical
E) None of the above

Ans: B
Section 3.4.D
Difficulty: Difficult
Learning Objective: **Nucleic Acid Sequencing**

53. Alterations in genetic information can be caused by
A) mistakes made during replication.
B) faulty recombination.
C) transposition of genes.
D) damage caused by chemicals or radiation.
E) all of the above

Ans: E
Section 3.4.E
Difficulty: Moderate
Learning Objective: **Nucleic Acid Sequencing**

54. Alterations in genetic information cannot be caused by
A) mistakes made during replication
B) faulty recombination.
C) transposition of genes.
D) mistakes made during translation.
E) all of the above

Ans: D
Section 3.4.E
Difficulty: Moderate
Learning Objective: **Nucleic Acid Sequencing**

55. Mutations leading to changes that can be inherited by the next generation have to be introduced into at the _____ level.
A) DNA
B) rRNA
C) protein
D) mRNA
E) tRNA

Answer: A
Section 3.4.E
Difficulty: Easy
Learning Objective: **Nucleic Acid Sequencing**

56. The production of multiple identical organisms from a single ancestor is called _____.
A) DNA ligation
B) phenotyping
C) cloning
D) transcription
E) sequencing

Answer: C
Section 3.5.A
Difficulty: Easy
Learning Objective: **Manipulating DNA**

57. Small circular DNA molecules used to carry foreign DNA fragments are called _____.
A) mRNAs
B) bacteriophage
C) clones
D) plasmids
E) nucleotides

Answer: D
Section 3.5.A
Difficulty: Easy
Learning Objective: **Manipulating DNA**

58. In molecular cloning, transformed organisms must be identified. One common method for accomplishing this involves the inclusion of _____ in the plasmid.
A) a restriction site
B) a nuclease gene
C) a deletion
D) an origin of replication
E) an antibiotic resistance gene

Answer: E
Section 3.5.A
Difficulty: Moderate
Learning Objective: **Manipulating DNA**

59. A genomic library
A) is a collection of protein structures from a specific organism.
B) is a collection of cloned DNA fragments representing all of an organism's DNA.
C) contains only protein-coding DNA sequences.
D) is best constructed from very short DNA fragments.
E) is built from mRNA by reverse transcription.

Answer: B
Section 3.5.B
Difficulty: Moderate
Learning Objective: **Manipulating DNA**

60. Radioactively labeled, single-stranded oligonucleotides are often used in *in situ* hybridization. Which of the probes listed below would work best, when probing for a RNA molecule containing the sequence 5′-AGCTAACGGG-3′?
A) 5′-AGCTAACGGG-3′
B) 5′-GGGCAATCGA-3′
C) 5′-CCCGTTAGCT-3′
D) 5′-TCGATTGCCC-3′
E) all of the above

Answer: C
Section 3.5.B
Difficulty: Moderate
Learning Objective: **Manipulating DNA**

61. In order to perform PCR, which of the following describes the reagents that must be included in the reaction mixture?
A) DNA fragment, primers flanking the region of interest, dNTPs, DNA polymerase
B) DNA fragment, primers flanking the region of interest, dNTPs, ddNTPS, DNA polymerase
C) DNA fragment, one primer, dNTPs, DNA polymerase, DNA ligase
D) DNA fragment, primers flanking the region of interest, dNTPs, DNA Ligase
E) none of the above

Ans: A
Section 3.5.C
Difficulty: Moderate
Learning Objective: **Manipulating DNA**

62. Which of the following statements about PCR is (are) true?
A) Small amounts of DNA can be easily amplified to millions of copies.
B) PCR is often used in forensics laboratories.
C) PCR reaction products can be used in molecular cloning.
D) PCR is used in clinical laboratories.
E) All of the above.

Ans: E
Section 3.5.C
Difficulty: Difficult
Learning Objective: **Manipulating DNA**

63. DNA polymerase from *Thermus aquaticus* is used in PCR because
A) it is a soluble protein.
B) the genes from *Thermus aquaticus* are readily distinguished from those of 'normal' organisms.
C) the enzyme is readily deactivated by heat, effectively halting the reaction.
D) it is stable at high temperatures.
E) it is not infectious.

Answer: D
Section 3.5.C
Difficulty: Easy
Learning Objective: **Manipulating DNA**

64. A gene knockout is
A) a gene that has been inactivated or removed from an organism.
B) a dominant gene that *knocks-out* expression of other genes.
C) a gene inserted in place of another gene.
D) a gene present on a YAC.
E) none of the above

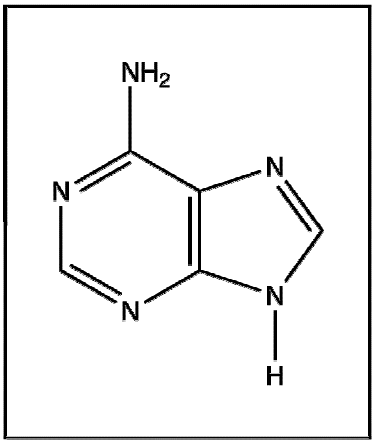
Ans: A
Section 3.5.D
Difficulty: Moderate
Learning Objective: **Manipulating DNA**

65. Recombinant DNA technology can be used for
A) constructing mutant proteins.
B) the industrial production of useful proteins.
C) producing transgenic organisms.
D) correcting genetic defects.
E) all of the above

Answer: E
Section 3.5.D
Difficulty: Easy
Learning Objective: **Manipulating DNA**

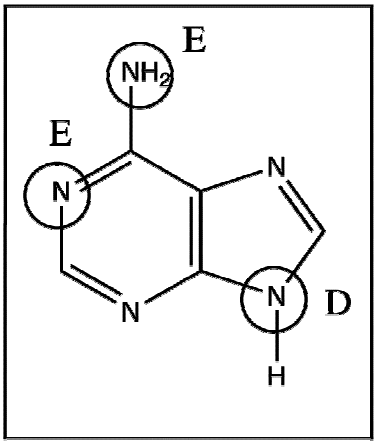
Short Answer

66. This is the structure of adenine.

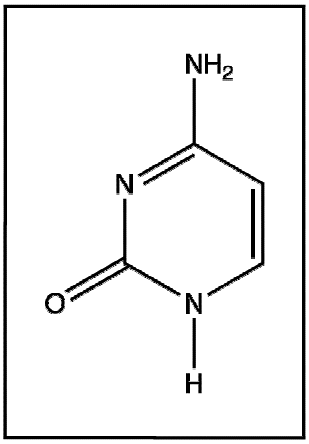


a. Is adenine a purine or a pyrimidine?
b. Which base does adenine base-pair (H-bond) with in DNA?
c. What is the name of the molecule that is composed of adenine linked to the C1' of ribose?
d. Indicate on the drawing through which atom adenine is connected to ribose or deoxyribose.
e. Indicate on the drawing which groups on adenine are involved in base-pairing or H-bonding with its complementary base.

Ans: a. purine
b. thymine
c. adenosine
d. see diagram
e. see diagram
Level of Difficulty: Difficult
Section 3.2
Learning objective: **Introduction to Nucleic Acid Structure**

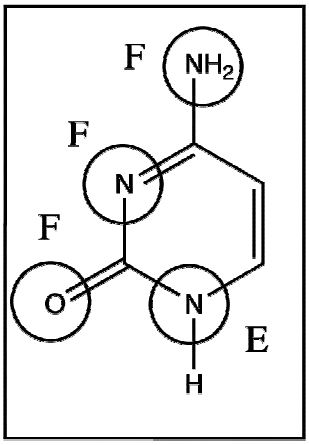


67. This is the structure of cytosine.



a. What are the names of the other three bases that are found in DNA.
b. Is cytosine a purine or a pyrimidine?
c. Give the name and the one letter abbreviation of the base cytosine base-pairs (H-bonds) with in DNA?
d. Indicate on the drawing through which atom cytosine is connected to ribose or deoxyribose.
e. What is the name of the molecule composed of cytosine linked to ribose?
f. Indicate on the drawing which groups on cytosine are involved in base-pairing (H-bonding) with its complementary base.

Ans: a. adenine, guanine, and thymine
b. pyrimidine
c. guanine, G
d. cytidine
e. see diagram
f. see diagram
Level of Difficulty: Difficult
Section 3.2
Learning objective: **Introduction to Nucleic Acid Structure**



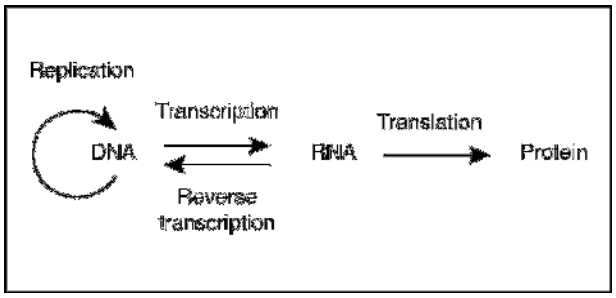
68. Describe the structure of a DNA molecule by listing 6 characteristics.

Ans:
1. DNA forms a double helix
2. the two strands run anti-parallel
3. the sugar is deoxyribose
4. the sugar-phosphate groups are on the outside of the helix
5. the bases are in the center of the helix
6. the bases are planar and their plane is orientated perpendicular to the axis of the helix
6. there are four bases: Adenine, Guanine, Cytosine and Thymine
7. The strands are held together by H-bonding between complementary bases: Adenine-Thymine and Guanine-Cytosine
8. The helix has a minor and a major groove on its surface.

Level of Difficulty: Difficult
Section 3.2
Learning objective: **Introduction to Nucleic Acid Structure**

69. Describe the central dogma of molecular biology (to do this draw a diagram of the central dogma and describe all the arrows).

Ans:



Level of Difficulty: Difficult
Section 3.3B
Learning objective: **Overview of Nucleic Acid Function**

70. There are three types of RNA that are directly involved in translation.
a. Name these three types of RNA
b. Briefly describe the function of each of these types of RNA.

Ans: a. mRNA, tRNA, rRNA.
b. mRNA moves genetic information from the nucleus to the ribosomes in the cytoplasm. tRNA decodes the genetic message, it matches sequences of three nucleotides to amino acids. rRNA is involved in the catalysis of amide bond formation.
Level of Difficulty: Difficult
Section 3.3B
Learning objective: **Overview of Nucleic Acid Function**