Bruns: Fundamentals of Molecular Diagnostics

Test Bank

Chapter 1: Principles of Molecular Biology

MULTIPLE CHOICE

1. Following the attachment of a number of cofactors to a strand of DNA, the enzyme required for the actual process of transcription to occur is
   a. RNase.
   b. DNA polymerase III.
   c. RNA polymerase II.
   d. transcriptase.

   ANS: C
   Rationale: Transcription requires separation of the duplex DNA strands and uses a polymerase to copy the template DNA strand. For transcription the polymerase is RNA polymerase II, which binds to sequences in the promoter.

   DIF: Cognitive level: 1 PAGE: 10 OBJ: Objective: 8, 9

2. In regard to replication, the "parent" strand of DNA
   a. is completely excised by exonuclease enzymes when replication of the strand is complete.
   b. has a sequence that is complementary (opposite) to the daughter strand being replicated.
   c. is also referred to as the "leading" strand.
   d. will be copied by DNA polymerase I to form a new daughter DNA strand.

   ANS: B
   Rationale: Owing to the laws of base pairing, the sequence of a single strand of DNA dictates the sequence of its complementary strand, which during replication is the "daughter" strand.

   DIF: Cognitive level: 2 PAGE: 9 OBJ: Objective: 8

3. A nucleic acid is
   a. a nucleotide.
   b. DNA or RNA.
   c. a base pair.
   d. a trinucleotide sequence.

   ANS: B

Rationale: Nucleic acids include a sugar moiety (2-deoxyribose in the case of DNA), a phosphoric acid, and purine or pyrimidine base; deoxyribonucleic acid is DNA and ribonucleic acid is RNA.

DIF: Cognitive level: 1 PAGE: 4, 5 OBJ: Objective: 4, 5

4. In regard to the components of the genetic code, a "codon" is
   a. a sequence of nucleotides that codes for a protein.
   b. a polymeric molecule composed of nucleic acids.
   c. a phosphate group, a ribose sugar, and nitrogen.
   d. a sequence of three nucleotides.

ANS: D
Rationale: Each amino acid is encoded by a triplet nucleotide code, which is three nucleotides in length. This triplet code is referred to as a "codon."

DIF: Cognitive level: 1 PAGE: 3, 5 OBJ: Objective: 1

5. The conversion of mRNA nucleotide sequences and the transfer RNA (tRNA)-attached amino acids into a polypeptide is referred to as
   a. replication.
   b. transcription.
   c. translation.
   d. restriction.

ANS: C
Rationale: Translation is the process whereby the mRNA codon sequence directs amino acid sequence during protein synthesis. Translation takes place on ribosomes, which bind to the initiation site on mRNA. During synthesis codons are "read" by tRNA, and anticodons are bound to the amino acid molecule specified by the codon.

DIF: Cognitive level: 1 PAGE: 4, 10 OBJ: Objective: 8

6. In regard to molecular genetics, the "central dogma" states that
   a. all DNA sequences in the human genome are perpetuated by their expression as RNAs.
   b. genes are perpetuated as sequences of nucleic acid, but function by being expressed in the form of protein.
   c. there are specific nucleotide triplets that code for specific amino acids.
   d. the main function of genes is to store and transmit genetic information.

ANS: B

Rationale: Only genes (not all DNA sequences) are expressed as protein, and specific sequences of nucleic acid make up a gene.

DIF: Cognitive level: 2 PAGE: 9 OBJ: Objective: 1

7. In regard to DNA, an "exon" is defined as
   a. a segment of DNA that is represented in a mature strand of mRNA and is translated into protein.
   b. a sequence of nucleotides recognized by RNA polymerase as the initiation point of transcription.
   c. a segment of DNA that is transcribed but removed from mRNA by excision and is not translated into protein.
   d. a sequence of three base pairs that signal initiation or termination of replication.

ANS: A
Rationale: The coding region of a gene is divided into segments called exons, and coding regions specify the amino acid sequence of a protein.

DIF: Cognitive level: 1 PAGE: 3, 10 OBJ: Objective: 3

8. During replication the addition of bases occurs
   a. in the 5' to 3' direction.
   b. in the 3' to 5' direction.
   c. in both the 5' to 3' and 3' to 5' directions.
   d. only at the methylated end of a DNA strand.

ANS: A
Rationale: DNA polymerase III synthesizes a daughter strand only in this direction because nucleotides can only be added to the 3' carbon end.

DIF: Cognitive level: 1 PAGE: 9 OBJ: Objective: 8

9. The "genetic code" refers to
   a. the complementary pairing of bases along a double strand of DNA.
   b. the statement that genes are perpetuated as nucleic acid, but function in the form of protein.
   c. the relationship between a nucleotide sequence of DNA and the corresponding gene sequence of DNA.
   d. the relationship between a three-nucleotide sequence of mRNA and the corresponding amino acid.

ANS: D

Rationale: The list of nucleotide codons and the amino acids or actions they "code" for; there are 64 codons that make up the genetic code, which in turn code for 21 amino acids.

DIF: Cognitive level: 1 PAGE: 4, 5 OBJ: Objective: 1

10. Which one of the following sequences would signal that the translation of a protein being synthesized must stop?
    a. 5' GUG ACU AGG UAA CGA CCC UAU 3'
    b. 5'AAC CGA CUC AUC CAG GUA UAG 3'
    c. 5' ACC CGA CCA UCC AGG CUG AGG 3'
    d. 5' AGC CGA CUC AUC AGG UAA GAU 3'

ANS: B
Rationale: The codon "UAG" is a stop codon that signals the end of translation of a polypeptide chain. A UAG sequence at the 3' end of an mRNA strand terminates translation.

DIF: Cognitive level: 2 PAGE: 11 OBJ: Objective: 3, 8

11. The protective units of repeating sequences at the ends of chromosomes tend to decrease in somatic cells after a number of replication events; however, in malignant cells, an enzyme maintains the chromosome end perpetuating cell life. This enzyme is referred to as
    a. polymerase.
    b. replicase.
    c. telomerase.
    d. anaphase.

ANS: C
Rationale: Telomerase is the enzyme that adds the telomere's repetitive sequence onto the ends of the heterochromatin. In somatic cells, telomerase does not perform this function leading to shortened chromosome ends and eventual cell death.

DIF: Cognitive level: 1 PAGE: 9 OBJ: Objective: 7

12. Transfer RNA (tRNA)
    a. contains the anticodon region that binds to mRNA codon in the ribosome.
    b. is a macromolecular complex containing ribosomal RNA.
    c. contains the codon sequence that synthesizes an amino acid.
    d. is a noncoding RNA.

ANS: A
Rationale: A three-nucleotide codon within an mRNA will bind to its anticodon on a specialized tRNA molecule, which then carries the attached amino acid to a ribosome to be added to a growing peptide chain.

DIF: Cognitive level: 1 PAGE: 11 OBJ: Objective: 8

13. An example of a promoter sequence on a DNA strand is the TATA box. Promoters are
    a. codons that signal specific enzymes to terminate replication.
    b. segments of DNA that are represented in mature RNA and are translated into protein.
    c. sequences of nucleotides that are recognized by RNA polymerase II and that control the initiation of transcription.
    d. codons that signal the initiation of replication.

ANS: C
Rationale: For transcription to occur, RNA polymerase II must bind to sequences within a thymine-rich region of the DNA strand referred to as a promoter region. Initiation of transcription requires other cofactors to bind to the polymerase after it is bound to the promoter.

DIF: Cognitive level: 1 PAGE: 4, 10 OBJ: Objective: 3

14. A female individual inherits both X chromosomes from her mother and develops a specific disease syndrome. A second female receives one X chromosome from her father and the other from her mother and develops a much milder form of the disease. This is likely an effect of
    a. genometastasis.
    b. genomic imprinting.
    c. histone deacetylation.
    d. mitochondrial mutation.

ANS: B
Rationale: Genomic imprinting is an epigenetic phenomenon whereby the function of particular alleles on a chromosome is determined by whether it is paternally or maternally inherited.

DIF: Cognitive level: 2 PAGE: 11 OBJ: Objective: 10

15. Which one of the following statements concerning the difference between DNA and RNA is **correct?**
    a. The four nucleotide building blocks of RNA include thymosin **{AU: edit ok?},** cytosine, guanine, and adenine.
    b. RNA exists typically as a single-stranded polymer that is much shorter than double-stranded DNA.
    c. DNA is composed of a sugar unit, ribose, with an added hydroxyl group at the 2' position.
    d. DNA molecules can interact to form complex tertiary structures related to the novel functions of DNA.

ANS: B
Rationale: DNA is a double-stranded polymer of nucleotides that exists only in single-stranded form during replication and transcription. RNA molecules are shorter than DNA because of their regulated function in transcription.

DIF: Cognitive level: 2 PAGE: 4, 6 OBJ: Objective: 3

16. The chromosomes in a eukaryotic cell
    a. are in their most compact state and appear as fingerlike structures during the cell division stage called metaphase.
    b. contain genomic regions that are rich in genes, less compactly organized, and are termed heterochromatin.
    c. contain two specialized regions of euchromatin, telomeres, and centromeres.
    d. are highly ordered structures of a single RNA molecule, compacted many times with the aid of structural RNA-binding proteins.

ANS: A
Rationale: This is the only correct answer; answer b is incorrect because the gene-rich regions are euchromatin; answer c is incorrect because telomeres and centromeres are heterochromatin, and answer d is incorrect because chromosomes are composed of DNA.

DIF: Cognitive level: 1 PAGE: 7 OBJ: Objective: 5, 6

17. Which one of the following statements concerning mitochondrial DNA (mtDNA) is **incorrect?**
    a. Pseudogenes are small pieces of nuclear DNA that share significant homology with mtDNA.
    b. mtDNA is circular and contains approximately 16,500 base pairs.
    c. mtDNA is inherited from the mother because only ovum contain mitochondria, typically not sperm.
    d. The mutation rate of mtDNA is 20 times lower than that of nuclear DNA.

ANS: D
Rationale: All other answers (a to c) are correct; d is incorrect because the mutation rate of mitochondrial DNA is much higher than that of nuclear DNA.

DIF: Cognitive level: 1 PAGE: 13 OBJ: Objective: 11

18. In the determination of parentage, a laboratory chooses to perform genotyping instead of phenotyping. Which of the following lab studies would fall into the category of genotype studies?
    a. Red cell antigen groups
    b. Enzyme systems
    c. Allele sequences of specific genes
    d. Electrophoretic variations in hemoglobin type

ANS: C
Rationale: Genotyping consists of analysis of specific gene sequences to assess a human disease or trait; the remaining answers are typical phenotyping assessments.

DIF: Cognitive level: 2 PAGE: 5 OBJ: Objective: 2

19. Analysis of the presence of nucleic acids found in the blood circulation is important in monitoring
    a. possible sex-linked disorders of a fetus.
    b. cancer-related neoplasm.
    c. graft rejections following tissue transplant.
    d. All of the above answers are correct.

ANS: D
Rationale: Circulating nucleic acids arise from a number of sources, including dead cells from a malignant tumor, fetal cells in maternal blood, and transplanted organs. These nucleic acids can be used clinically to monitor or assess a number of different dysfunctions.

DIF: Cognitive level: 1 PAGE: 13 OBJ: Objective: 12

20. What is the significance of the observation of circulating mRNA versus the observation of circulating DNA?
    a. The presence of circulating DNA indicates that protein synthesis has already occurred.
    b. The presence of circulating mRNA indicates that a message has been transcribed and will likely result in the synthesis of new protein.
    c. Circulating DNA indicates that the entire genome of a malignant cell is metastasizing throughout the body.
    d. There is no difference between circulating RNA and circulating DNA.

ANS: B
Rationale: When any mRNA is observed, it indicates that transcription has occurred and a protein will likely be synthesized. This is one step further from observing the presence of DNA, which only indicates that a certain cell type is present; however, in some cases this is the only thing needed to provide a clinical diagnosis.

DIF: Cognitive level: 3 PAGE: 13, 14 OBJ: Objective: 12

21. How much of the human genome actually codes for protein production?
    a. 95%
    b. 50%
    c. 25%

d. 1.2%

ANS: D
Rationale: More than half of the human genome is repeated sequences and much of the remaining DNA is involved in regulation of the replication and transcription. Only a very small fraction of human DNA actually is transcribed and translated into protein.

DIF: Cognitive level: 1 PAGE: 14 OBJ: Objective: 13