

## MULTIPLE-CHOICE QUESTIONS

**Questions 1-4**

Questions 1-4 refer to the following four choices.

- (A) Translation
- (B) Replication
- (C) Transcription
- (D) Transformation

1. The process in which DNA makes messenger RNA
2. The process in which DNA is synthesized from a template strand
3. The process in which foreign DNA is taken up by a bacterial cell
4. The process in which a polypeptide strand is synthesized using mRNA as a template
5. All of the following are true about electrophoresis EXCEPT
  - (A) it can be used only to analyze DNA
  - (B) the heavier the fragment, the slower it moves
  - (C) the fragments of DNA are negatively charged and migrate to the positive pole
  - (D) a buffer must cover the gel to allow a current to pass through the system
6. *EcoRI* is
  - (A) a bacterium
  - (B) a bacteriophage
  - (C) a type of DNA used extensively in research
  - (D) a restriction enzyme
7. In DNA replication, the role of DNA polymerase is to
  - (A) bring two separate strands back together after new ones are formed
  - (B) join the RNA nucleotides together to make the primer
  - (C) build a new strand of DNA from 5' to 3'
  - (D) unwind the tightly wound helix
8. Which is NOT used in the normal replication of DNA?
  - (A) RNA primer
  - (B) ligase
  - (C) restriction enzymes
  - (D) polymerase
9. DNA replication can best be described as
  - (A) semiconservative
  - (B) conservative
  - (C) degenerate
  - (D) comparative

**Questions 10-13**

Questions 10-13 refer to these scientists famous for their work with DNA.

- (A) Hershey and Chase
- (B) Griffith
- (C) Meselson and Stahl
- (D) Rosalind Franklin

10. Discovered transformation in bacteria
11. Proved that DNA replicates by semiconservative replication
12. Proved that the nuclear material in a bacteriophage, not the protein coat, infects a bacterium
13. The first to analyze DNA by X-ray crystallography

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14. If a segment of DNA is 5'-TGA AGA CCG-3', the RNA that results from the transcription of this segment will be

- (A) 5'-TGA AGA CCG-3'
- (B) 3'-ACU UCU GGC-5'
- (C) 3'-ACT TCT GGC-5'
- (D) 3'-CGG UCU UCA-5'

15. Once transcribed, eukaryotic RNA normally undergoes substantial alteration that results primarily from

- (A) removal of exons
- (B) removal of introns
- (C) addition of introns
- (D) combining of RNA strands by a ligase

16. Which of the following contain a pyrimidine and a purine?

- (A) adenine and guanine
- (B) uracil and thymine
- (C) cytosine and uracil
- (D) adenine and cytosine

17. What happens when T7 bacteriophages are grown in radioactive phosphorus?

- (A) They can no longer infect bacteria.
- (B) They die.
- (C) Their DNA becomes radioactive.
- (D) Their protein coat becomes radioactive.

18. Which of the following acts as a primer that initiates the synthesis of a new strand of DNA?
- (A) single-strand binding protein
  - (B) RNA
  - (C) DNA
  - (D) topoisomerases
19. If guanine makes up 28% of the nucleotides in a sample of DNA from an organism, then thymine would make up \_\_\_\_ % of the nucleotides.
- (A) 28
  - (B) 56
  - (C) 22
  - (D) 44
20. If AUU is the codon, what is the anticodon?
- (A) AUU
  - (B) TAA
  - (C) UUA
  - (D) UAA
21. Which of the following is an example of wobble?
- (A) amino acids carried to the ribosome to form a polypeptide chain
  - (B) the excision of introns from mRNA
  - (C) the binding of a primer to DNA
  - (D) four codons can all code for the same amino acid
22. Which of the following is TRUE about sickle cell anemia?
- (A) It is caused by a chromosome mutation that resulted from nondisjunction.
  - (B) It is common in people from the Middle East.
  - (C) It is caused by a point mutation.
  - (D) A person with sickle cell anemia is resistant to many other genetic disorders.
23. A particular triplet code on DNA is AAA. What is the anticodon for it?
- (A) AAA
  - (B) TTT
  - (C) UUU
  - (D) CCC
24. What are the regions of DNA called that code for proteins?
- (A) introns
  - (B) codons
  - (C) anticodons
  - (D) exons

25. Prions are
- (A) bacteriophages that cause disease
  - (B) infectious proteins
  - (C) a bacterium that infects viruses
  - (D) the cause of sickle cell anemia
26. Which word would **best** describe the operon?
- (A) respiration
  - (B) transport
  - (C) regulation
  - (D) nutrition

**Questions 27–30**

Questions 27–30 refer to the operon.

- (A) Lactose
  - (B) Repressor
  - (C) Regulator
  - (D) Promoter
27. Acts as an inducer in the *lac* operon
28. Binding site for RNA polymerase
29. Codes for the repressor
30. Binds at the operator
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31. Which is TRUE of biotechnology techniques?
- (A) PCR is used to cut DNA molecules.
  - (B) A DNA probe consists of a radioactive single strand of DNA.
  - (C) Restriction enzymes were first discovered in bacteriophage viruses.
  - (D) *EcoRI* is a name for a DNA probe.
32. Gel electrophoresis is used to
- (A) amplify small pieces of DNA
  - (B) make bacterial cells competent
  - (C) separate DNA that has already been cut up by restriction enzymes
  - (D) cause DNA to twist back into a helix after amplification
33. Mad cow disease is caused by a
- (A) virus
  - (B) prion
  - (C) bacterium
  - (D) genetic mutation

34. Which enzyme permanently seals together DNA fragments that have complementary sticky ends?

- (A) DNA polymerase
- (B) single-stranded binding protein
- (C) reverse transcriptase
- (D) DNA ligase

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### Answers to Multiple-Choice Questions

1. **(C)** Transcription is the process by which DNA makes RNA. There are three types of RNA; mRNA, tRNA and rRNA. Transcription occurs in three stages: initiation, elongation, and termination.
2. **(B)** DNA makes an exact copy of itself during replication. This process occurs in a semiconservative fashion, as proven by Meselson and Stahl.
3. **(D)** Griffith was the first to recognize the phenomenon of transformation while working with pneumococcus bacteria.
4. **(A)** Translation is the process by which the codons of mRNA sequence are changed into an amino acid sequence. Amino acids present in the cytoplasm are carried by tRNA molecules to the codons of the mRNA strand at the ribosome according to the base-pairing rules (A with U and C with G).
5. **(A)** Electrophoresis is commonly used in the separation of proteins as well as in the separation of DNA.
6. **(D)** *EcoRI* stands for *E. coli* restriction enzyme #1. It was the first restriction enzyme discovered.
7. **(C)** DNA polymerase builds a new strand of DNA from the 5' end to the 3' end (of the new strand). DNA polymerase can only add nucleotides to an existing strand of DNA.
8. **(C)** Restriction enzymes are a laboratory tool for cutting pieces of DNA at specific restriction sites.
9. **(A)** Replication of DNA is semiconservative. This means that when one double helix makes a copy of itself, the two new DNA molecules each consist of one new strand and one old strand. This was hypothesized by Watson and Crick and confirmed experimentally by Meselson and Stahl.
10. **(B)** Griffith discovered bacterial transformation in 1927.
11. **(C)** Semiconservative replication was hypothesized by Watson and Crick and confirmed experimentally by Meselson and Stahl.
12. **(A)** Hershey and Chase carried out experiments where they tagged bacteriophages with <sup>32</sup>P and <sup>35</sup>S. They proved that the DNA from the viral (phage) nucleus, not protein from the viral coat, was infecting bacteria and producing thousands of progeny.
13. **(D)** Rosalind Franklin, while working in the lab of Maurice Wilkins, carried out the X-ray crystallography analysis of DNA that showed DNA to be a helix.

14. **(B)** You are given a strand of DNA, which makes a strand of mRNA. Follow the base-pairing rules: T with A, C with G, C with G, and A with U. Remember, RNA contains uracil instead of thymine. If the DNA segment is 5'-TGA AGA CCG-3', then the mRNA strand complementary to that is 3'-ACU UCU GGC-5'.
15. **(B)** Once transcription has occurred, the new RNA molecule undergoes RNA processing. During this process, introns (intervening sequences) are removed with the help of snRNPs and a 5' cap and poly(A) tail are added.
16. **(D)** Pyrimidines often have the letter y in them. They are thymine, cytosine, and uracil, which replaces thymine in RNA. Adenine is the purine; thymine is the pyrimidine.
17. **(C)** A bacteriophage virus consists of nuclear material surrounded by a protein coat. Proteins contain sulfur, and DNA contains phosphorus (in the phosphates). When a phage virus is grown in radioactive phosphorus, the phosphorus gets incorporated into the DNA, not into the protein coat.
18. **(B)** DNA polymerase can only add nucleotides to an existing strand of nucleotides. RNA primer binds to the DNA, and DNA polymerase attaches nucleotides to the RNA primer.
19. **(C)** If guanine makes up 28% of the DNA, then there must be an equal amount of cytosine (28%), for a total of 56%. That leaves 44% for adenine and thymine. Divide 44 by 2 = 22%, which is the percentage of thymine in the DNA.
20. **(D)** The codon is the nucleotide triplet associated with mRNA; the anticodon is the nucleotide sequence associated with tRNA. Codons and anticodons are complementary to each other.
21. **(D)** The pairing rules are not as strict for the third codon in mRNA as they are for the first two. One example is that UUU and UUA both code for phenylalanine.
22. **(C)** Sickle cell anemia is caused by a gene mutation in the gene that codes for hemoglobin. Sickle cell disease is common where malaria is endemic, in West Africa and southeast Asia. People who are carriers for the sickle cell trait are resistant to malaria. Sickle cell disease does occur in the Middle East but is not common there. Sickle cell does occur in Caucasians, but rarely.
23. **(A)** DNA (triplet code) makes RNA (codon) makes protein (anticodon). If the triplet in DNA is AAA, then the codon on mRNA is UUU, and the anticodon on tRNA is AAA.
24. **(D)** The regions of DNA that code for proteins are called exons or expressed sequences.
25. **(B)** A prion is a misfolded version of a protein normally found in the brain. Prions are infectious. If they get into the brain, they will convert the normal proteins to abnormal ones. They have been identified as the infectious agent in several diseases, including scrapie in sheep, Creutzfeldt-Jakob in humans, and mad cow disease.
26. **(C)** The operon is the means by which prokaryotes regulate gene expression. An operon consists of a cluster of related genes and the DNA that controls them, such as, a promoter and operator.

27. (A)
28. (D)
29. (C)
30. (B)
31. (B) A DNA probe is a single radioactive strand of DNA used to tag and identify a specific sequence in a strand of DNA. PCR is a cell-free system that amplifies small pieces of DNA rapidly. Restriction enzymes are found in bacteria. *EcoRI* was the first restriction enzyme discovered. Every person has a unique set of RFLPs.
32. (C) Restriction enzymes cut DNA at specific recognition sites. Gel electrophoresis separates DNA that has already been cut up by restriction enzymes. Single-stranded binding proteins, helicases, and topoisomerases help DNA twist during replication.
33. (B) A prion is a misfolded and infectious protein. See question 25.
34. (D) DNA ligase seals together DNA fragments that have complementary sticky ends.

### FREE-RESPONSE QUESTIONS

**Directions:** Answer all questions. You must answer the question in essay—not outline—form. You may use labeled diagrams to supplement your essay, but diagrams alone are *not* sufficient. Before you start to write, read each question carefully so that you understand what the question is asking.

1. Explain the process by which DNA makes proteins.
2. By using techniques of genetic engineering, scientists are able to learn more about the human genome and to use these techniques for the betterment of humankind. Describe these techniques or procedures below, and explain how each contributes to our understanding of the human genome or for what practical purpose it can be used.
  - a. Polymerase chain reaction
  - b. Restriction fragment length polymorphism (RFLP) analysis
  - c. Gene cloning
3. All humans are almost genetically identical. However, every person has a unique DNA fingerprint. Explain this contradiction.