14 | DNA STRUCTURE AND FUNCTION

REVIEW QUESTIONS

1 Who was the first person to isolate the material that came to be known as nucleic acids?

A Frederick Griffith

B Friedrich Miescher

C James Watson

D Oswald Avery

Solution The solution is (B). DNA was first isolated from white blood cells by Friedrich Miescher.

2 What is bacterial transformation?

A The transformation of a bacterium occurs during replication.

B It is the transformation of a bacterium into a pathogenic form.

C Transformation of bacteria involves changes in its chromosome.

D Transformation is a process in which external DNA is taken up by a cell, thereby changing morphology and physiology.

Solution The solution is (D). Transformation is a process in which external DNA is taken up by a cell, thereby changing morphology and physiology.

3 What type of nucleic acid material is analyzed the most frequently in forensics cases?

A Cytoplasmic rRNA

B Mitochondrial DNA

C Nuclear chromosomal DNA

D Nuclear mRNA

Solution The solution is (C). Forensics looks at the nuclear genetic material.

4 The experiments by Hershey and Chase helped confirm that DNA was the hereditary material on the basis of the finding of what?

A Radioactive phages were found in the pellet.

B Radioactive cells were found in the supernatant.

C Radioactive sulfur was found inside the cell.

D Radioactive phosphorus was found in the cell.

Solution The solution is (D). Radioactive phosphorous was found in the heavier particles that settled as pellets. The heavier bacterial cells settled down and formed pellets.

5 If DNA of a particular species was analyzed and it was found that it contains 27 percent A, what would be the percentage of T?

A 23%

B 27%

C 30%

D 54%

Solution The solution is (B). Because A binds to T, there is the same proportion of A and T in each DNA molecule.

6 If the sequence of the 5′ to 3′ strand is AATGCTAC, then the complementary sequence has which sequence?

A 3′-AATGCTAC-5′

B 3′-CATCGTAA-5′

C 3′-TTACGATG-5′

D 3′-GTAGCATT-5′

Solution The solution is (C). A binds to T and C binds to G in DNA molecules.

7 The DNA double helix does NOT have what?

A Antiparallel configuration

B Complementary base pairing

C Major and minor grooves

D Uracil

Solution The solution is (D). Uracil is a nucleotide base that is present in RNA and not in DNA.

8 What is a purine?

A A double-ring structure with a six-membered ring fused to a five-membered ring

B A single six-membered ring

C A six-membered ring

D Three phosphates covalently bonded by phosphodiester bonds

Solution The solution is (A). A double-ring structure with a six-membered ring fused to a five-membered ring.

9 What is the name of the method developed by Fred Sanger to sequence DNA?

A Dideoxy chain termination

B Double helix determination

C Polymerase chain reaction

D Polymer gel electrophoresis

Solution The solution is (A). The Dideoxy Chain Termination method was developed by Fred Sanger. It is a sequencing method based on the use of chain terminators.

10 What happens when a dideoxynucleotide is added to a developing DNA strand?

A The chain extends to the end of the DNA strand.

B The DNA stand is duplicated.

C The chain is not extended any further.

D The last codon is repeated.

Solution The solution is (C). If a ddNTP is added to a growing a DNA strand, the chain is not extended any further because the free 3'OH group needed to add another nucleotide is not available.

11 In eukaryotes, what is DNA wrapped around?

A Histones

B Polymerase

C Single-stranded binding proteins

D Sliding clamp

Solution The solution is (A). In eukaryotes, the DNA is wrapped around proteins known as histones to form structures called nucleosomes.

12 Which enzyme is only found in prokaryotic organisms?

A DNA gyrase

B Helicase

C Ligase

D Telomerase

Solution The solution is (A). DNA gyrase helps to maintain the supercoiled structure in prokaryotes.

13 Where is uracil found?

A Chromosomal DNA

B Helicase

C Mitochondrial DNA

D mRNA

Solution The solution is (D). Uracil is a nitrogenous base found in mRNA molecules. Its complementary base pair is adenine.

14 What prevents the further development of a DNA strand in Sanger sequencing?

A The addition of DNA reductase

B The addition of dideoxynucleotides

C The elimination of DNA polymerase

D The addition of uracil

Solution The solution is (B). If a ddNTP is added to a growing DNA strand, the chain is not extended any further because the free 3'OH group needed to add another nucleotide is not available. ddNTP lack the 3'OH group on the five-carbon sugar.

15 What is NOT one of the proteins involved during the formation of the replication fork?

A Helicase

B Ligase

C Origin of replication

D Single-stranded binding proteins

Solution The solution is (C). The origin of replication is the point at which the DNA unwinds.

16 In which direction does DNA replication take place?

A 5' to 3'

B 3' to 5'

C 5'

D 3'

Solution The solution is (A). DNA polymerase adds nucleotides from 5' to 3' direction.

17 Meselson and Stahl's experiments proved that DNA replicates by which mode?

A Conservative

B Converse

C Dispersive

D Semiconservative

Solution The solution is (D). The semiconservative mode of replication suggested that each of the two parental DNA strands act as a template for new DNA to be synthesized. After replication, each double-stranded DNA includes one parental or "old" strand and one "new" strand.

18 Which set of results was found in Meselson and Stahl's experiments?

A The original chromosome was kept intact and a duplicate was made.

B The original chromosome was split and half went to each duplicate.

C The original chromosome was mixed with new material and each duplicate strand contained both old and new.

D The original chromosome was used as a template for two new chromosomes and discarded.

Solution The solution is (B). The semiconservative method suggested that each of the two parental DNA strands act as a template for new DNA to be synthesized. After replication, each double-stranded DNA includes one parental or "old" strand and one "new" strand. It was found in Meselson and Stahl's experiment.

19 Which enzyme initiates the splitting of the double DNA strand during replication?

A DNA gyrase

B Helicase

C Ligase

D Telomerase

Solution The solution is (B). Helicase opens the DNA helix by breaking hydrogen bonds between the nitrogenous bases ahead of the replication fork.

20 Which enzyme is most directly responsible for the main process of producing a new DNA strand?

A DNA pol I

B DNA pol II

C DNA pol III

D DNA pol I, DNA pol II, and DNA pol III

E **Solution** The solution is (C). DNA polymerase III is the main enzyme in DNA replication that adds nucleotides in 5’ to 3’ direction.

CRITICAL THINKING QUESTIONS

34. Explain Griffith’s transformation experiments. What did he conclude from them?

A Two strains of *S. pneumoniae* were used for the experiment. Griffith injected a mouse with heat-inactivated S strain (pathogenic) and R strain (nonpathogenic). The mouse died and S strain was recovered from the dead mouse. He concluded that external DNA is taken up by a cell that changed morphology and physiology.

B Two strains of *Vibrio cholerae* were used for the experiment. Griffith injected a mouse with heat-inactivated S strain (pathogenic) and R strain (nonpathogenic). The mouse died and S strain was recovered from the dead mouse. He concluded that external DNA is taken up by a cell that changed morphology and physiology.

C Two strains of *S. pneumoniae* were used for the experiment. Griffith injected a mouse with heat-inactivated S strain (pathogenic) and R strain (nonpathogenic). The mouse died and R strain was recovered from the dead mouse. He concluded that external DNA is taken up by a cell that changed morphology and physiology.

D Two strains of *S. pneumoniae* were used for the experiment. Griffith injected a mouse with heat-inactivated S strain (pathogenic) and R strain (nonpathogenic). The mouse died and S strain was recovered from the dead mouse. He concluded that mutation occurred in the DNA of the cell that changed morphology and physiology.

Solution The solution is (A). Two strains of *S. pneumoniae* were used in Griffith’s transformation experiments. The R strain is nonpathogenic. The S strain is pathogenic and causes death. When Griffith injected a mouse with the heat-inactivated S strain and a live R strain, the mouse died. The S strain was recovered from the dead mouse. Thus, Griffith concluded that something had passed from the heat-killed S strain to the R strain, transforming the R strain into S strain in the process.

35. Which answer best explains why radioactive sulfur and phosphorus were used to label bacteriophages in the Hershey and Chase experiments?

A Protein was labeled with radioactive sulfur and DNA was labeled with radioactive phosphorus. Phosphorus is found in DNA, so it will be tagged by radioactive phosphorus.

B Protein was labeled with radioactive phosphorus and DNA was labeled with radioactive sulfur. Phosphorus is found in DNA, so it will be tagged by radioactive phosphorus.

C Protein was labeled with radioactive sulfur and DNA was labeled with radioactive phosphorus. Phosphorus is found in DNA, so DNA will be tagged by radioactive sulfur.

D Protein was labeled with radioactive phosphorus and DNA was labeled with radioactive sulfur. Phosphorus is found in DNA, so DNA will be tagged by radioactive sulfur.

Solution The solution is (A). Hershey and Chase labeled one batch of phage with radioactive sulfur, 35S, to label the protein coat. Another batch of phage was labeled with radioactive phosphorus, 32P. Because phosphorus is found in DNA, but not protein, the DNA and not the protein would be tagged with radioactive phosphorus.

36. How can Chargaff's rules be used to identify different species?

A The amount of adenine, thymine, guanine, and cytosine varies from species to species and is not found in equal quantities. They do not vary between individuals of the same species and can be used to identify different species.

B The amount of adenine, thymine, guanine, and cytosine varies from species to species and is found in equal quantities. They do not vary between individuals of the same species and can be used to identify different species.

C The amount of adenine and thymine is equal to guanine and cytosine and is found in equal quantities. They do not vary between individuals of the same species and can be used to identify different species.

D The amount of adenine, thymine, guanine, and cytosine varies from species to species and is not found in equal quantities. They vary between individuals of the same species and can be used to identify different species.

Solution The solution is (A). The content of DNA is different indifferent species and the amounts of adenine, thymine, guanine, and cytosine are found in different quantities. Therefore, the amounts of adenine, thymine, guanine, and cytosine are consistent for a species and can be used to identify that species.

37. In the Avery, Macleod, and McCarty experiments, what conclusion would the scientists have drawn if the use of proteases prevented the transformation of R strain bacteria?

Solution The conclusion would be that proteins are the heritable material in cells instead of nucleic acids.

38. Describe the structure and complementary base pairing of DNA.

A DNA is made up of two strands that are twisted around each other to form a helix. Adenine pairs up with thymine and cytosine pairs with guanine. The two strands are antiparallel in nature; that is, the 3′ end of one strand faces the 5′ end of the other strand. Sugar, phosphate, and nitrogenous bases contribute to the DNA structure.

B DNA is made up of two strands that are twisted around each other to form a helix. Adenine pairs up with cytosine and thymine pairs with guanine. The two strands are antiparallel in nature; that is, the 3′ end of one strand faces the 5′ end of the other strand. Sugar, phosphate, and nitrogenous bases contribute to the DNA structure.

C DNA is made up of two strands that are twisted around each other to form a helix. Adenine pairs up with thymine and cytosine pairs with guanine. The two strands are parallel in nature; that is, the 3′ end of one strand faces the 3′ end of the other strand. Sugar, phosphate, and nitrogenous bases contribute to the DNA structure.

D DNA is made up of two strands that are twisted around each other to form a helix. Adenine pairs up with thymine and cytosine pairs with guanine. The two strands are antiparallel in nature; that is, the 3′ end of one strand faces the 5′ end of the other strand. Only sugar contributes to the DNA structure.

Solution The solution is (A). DNA is made up of two strands that are twisted around each other to form a right-handed helix. Base pairing takes place between a purine and pyrimidine; namely, A pairs with T and G pairs with C. Adenine and thymine are complementary base pairs, and cytosine and guanine are also complementary base pairs. The base pairs are stabilized by hydrogen bonds; adenine and thymine form two hydrogen bonds and cytosine and guanine form three hydrogen bonds. The two strands are anti-parallel in nature; that is, the 3′ end of one strand faces the 5′ end of the other strand. The sugar and phosphate of the nucleotides form the backbone of the structure, whereas the nitrogenous bases are stacked inside.