Section 18.1 Review Answers

Student Textbook page 635

1. Several answers are possible. Experiments are described below in date order.

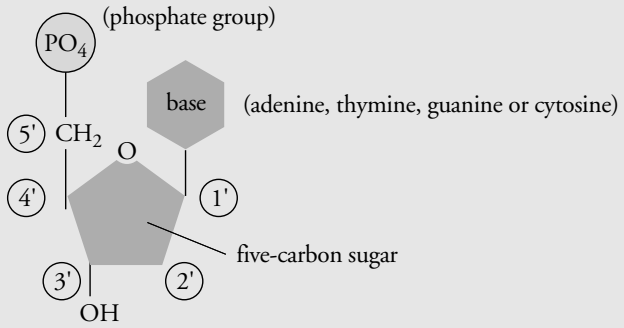
- In 1928, Frederick Griffith studied *Streptococcus pnemoniae,* a pathogenic bacterium that was responsible for pneumonia. Griffith used dead bacteria as a control. The dead pathogenic bacteria had passed on their disease-causing properties to live, non-pathogenic bacteria. Griffith called this phenomenon the transforming principle, because something from the heat-killed pathogenic bacteria must have transformed the living non-pathogenic bacteria to make them disease-causing.
- In 1944, Oswald Avery, Colin MacLeod, and Maclyn McCarty conducted a series of experiments and discovered:
  - When they treated heat-killed pathogenic bacteria with a protein-destroying enzyme, transformation still occurred.
  - When they treated heat-killed pathogenic bacteria with a DNA-destroying enzyme, transformation did not occur. These results provided evidence for DNA's role in transformation.
- Alfred Hershey and Martha Chase used radioactive labelling to show that genes are made of DNA. Hershey and Chase used a strain of virus known as a T2 bacteriophage, which consists of a protein coat surrounding a length of DNA. This virus attaches to a bacterial cell and injects genetic information into the cell. The infected cell manufactures new viruses, and then it bursts. The newly released viruses go on to infect other cells. To determine whether viral protein or viral DNA was responsible for taking over the genetic machinery of the host cell, Hershey and Chase produced two batches of the virus. In one batch, they labelled the protein coat using radioactive sulfur. In the other batch, they labelled the DNA with radioactive phosphorus. The labelled viruses were allowed to infect bacterial cells. The cells were then agitated in a blender to separate the viral coats from the bacterial cells. Each medium was tested for radioactivity. The results demonstrated that viral DNA, not viral protein, enters the bacterial cell.

2. (a) While studying DNA in the early 1900s, Phoebus Levene reported that the nucleotides were present in equal amounts, and that they appeared in chains in a constant and repeated sequence of nitrogen bases. Therefore, most scientists thought that the great variety of proteins was an important factor, and must be the hereditary material. Scientists assumed that the molecular structure of DNA was just too simple to provide the great variation in inherited traits.

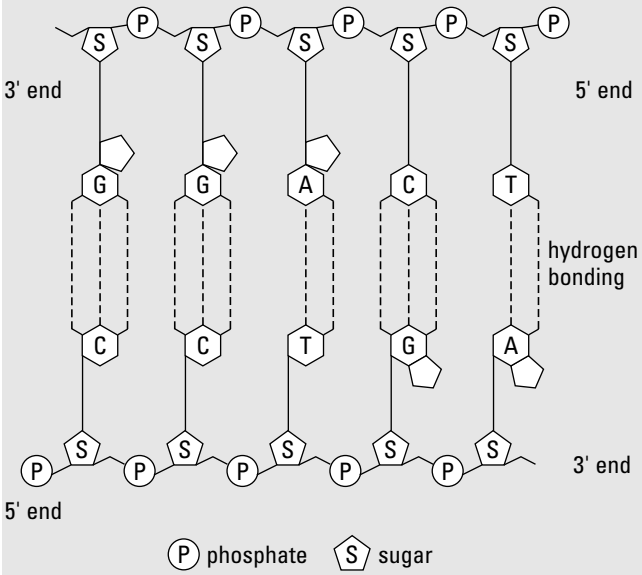
(b) In 1944, Oswald Avery, Colin MacLeod, and Maclyn McCarty conducted a series of experiments and discovered:

- When they treated heat-killed pathogenic bacteria with a protein-destroying enzyme, transformation still occurred.
- When they treated heat-killed pathogenic bacteria with a DNA-destroying enzyme, transformation did not occur. These results provided evidence that genetic information was carried on DNA.

3.



4.



5. In Linus Pauling's model, DNA replication would have to occur without nitrogen base pairing. Student answers may provide other possible differences. Accept any well-reasoned answer.

6. Sample B is the viral DNA because the percentages of adenine and thymine are not the same, and similarly the percentages of guanine and cytosine are not the same, as they are in sample A, which shows complementary base pairing of these respective bases. Complementary base parring does not occur in a single-stranded DNA virus.

7.

Characteristic	DNA	RNA
Strands	Double stranded	Single stranded, but may fold on back itself
Phosphate	PO_4	PO_4
5-Carbon Sugar	Deoxyribose sugar	Ribose sugar
Nitrogen bases	Adenine-Thymine Guanine-Cytosine (only DNA has thymine)	Adenine-Uracil Guanine-Cytosine (only RNA has uracil)
Forms	One type of DNA	Three types of RNA
Location	Only in the nucleus and mitochondria of eukaryotes; also found in bacteria	In the nucleus, mitochondria, and cytoplasm of eukaryotes; also found in bacteria

8. In the semi-conservative replication of the double-stranded DNA, each new molecule of DNA contains one strand of the original DNA molecule and one new strand made from nucleotides. Thus, each new DNA molecule conserves half of the original molecule.

9. The steps involved in the synthesis of the DNA molecule are as follows: Replication begins with a specific nucleotide sequence called the replication origin. A eukaryotic cell may contain thousands of these sequences, while the chromosome of a prokaryote has only a single replication origin. A group of enzymes, called the helicases, bind to the DNA at each replication origin. The helicases cleave and unravel a section of the original double helix, creating Y-shaped areas (replication forks) at the end of the unwound areas, which form a replication bubble. These single strands serve as templates for the semi-conservative replication of DNA. New DNA strands are produced when an enzyme called DNA polymerase inserts into the replication bubble. A primase enzyme synthesizes an RNA primer that serves as the starting point of new nucleotide attachment by DNA polymerase. DNA polymerase can only synthesize the new nucleotide chain in the 5′ to 3′ direction. As a result, one strand (the leading strand) is replicated continuously in the 5′ to 3′ direction in the same direction that the replication fork is moving. The other strand, known as the lagging strand, is replicated in short segments, still in the 5′ to 3′ direction, but away from the replication fork. These fragments, called Okazaki fragments, are spliced together by DNA ligase. When replication is complete, DNA polymerase dismantles the RNA primer and proofreads the nitrogen base pairing of the two new DNA molecules. Each new molecule of DNA contains one parent strand and one new strand.

10. The object of Human Genome Project was to determine the sequence of nitrogen bases for the DNA in the chromosomes of the entire human genome. The Human Genome Project is an important step in understanding how genes determine our genetic characteristics. This understanding can be applied to medical genetics and the treatment of disease, as well as to other sciences.