Name _____ Class _____ Date _____

12 DNA

Big idea **Information and Heredity, Cellular Basis of Life**

Q: What is the structure of DNA, and how does it function in genetic inheritance?

	WHAT I KNOW	WHAT I LEARNED
12.1 How did scientists determine that DNA is responsible for storing, copying, and transmitting genetic		
12.2 How was the basic structure of DNA discovered?		
12.3 How do cells copy their DNA?		

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12.1 Identifying the Substance of Genes

Lesson Objectives

- Summarize the process of bacterial transformation.
- Describe the role of bacteriophages in identifying genetic material.
- Identify the role of DNA in heredity.

Lesson Summary

Bacterial Transformation In 1928, Frederick Griffith found that some chemical factor from heat-killed bacteria of one strain could change the inherited characteristics of another strain.

- He called the process **transformation** because one type of bacteria (a harmless form) had been changed permanently into another (a disease-carrying form).
- Because the ability to cause disease was inherited by the offspring of the transformed bacteria, he concluded that the transforming factor had to be a gene.

In 1944, Oswald Avery tested the transforming ability of many substances. Only DNA caused transformation. By observing bacterial transformation, Avery and other scientists discovered that the nucleic acid DNA stores and transmits genetic information from one generation of bacteria to the next.

Bacterial Viruses A **bacteriophage** is a kind of virus that infects bacteria. When a bacteriophage enters a bacterium, it attaches to the surface of the bacterial cell and injects its genetic material into it.

- In 1952, Alfred Hershey and Martha Chase used radioactive tracers to label proteins and DNA in bacteriophages.
- Only the DNA from the bacteriophage showed up in the infected bacterial cell.
- Hershey and Chase concluded that the genetic material of the bacteriophage was DNA.
- Their work confirmed Avery's results, convincing many scientists that DNA was the genetic material found in genes—not just in viruses and bacteria, but in all living cells.

The Role of DNA The DNA that makes up genes must be capable of storing, copying, and transmitting the genetic information in a cell.

Bacterial Transformation

1. What happened when Griffith injected mice with the pneumonia-causing strain of bacteria that had been heat-killed?

_____

2. What happened when Griffith injected mice with a mixture of heat-killed, pneumonia-causing bacteria and live bacteria of the harmless type?

_____

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3. What was the purpose of Oswald Avery's experiments?

_____

_____

4. What experiments did Avery do?

_____

_____

_____

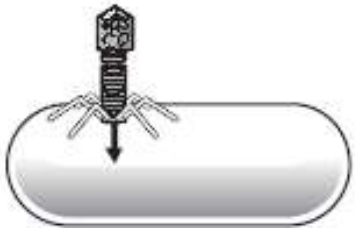
5. What did Avery conclude?

_____

Bacterial Viruses

6. Fill in the blanks to summarize the experiments of Hershey and Chase. (Note: The circles represent radioactive labels.)

_____ with radioactive label



_____

_____

_____ with radioactive label

_____

_____

7. What did Hershey and Chase conclude? Why?

_____

_____

8. How did Hershey and Chase confirm Avery's results?

_____

_____

_____

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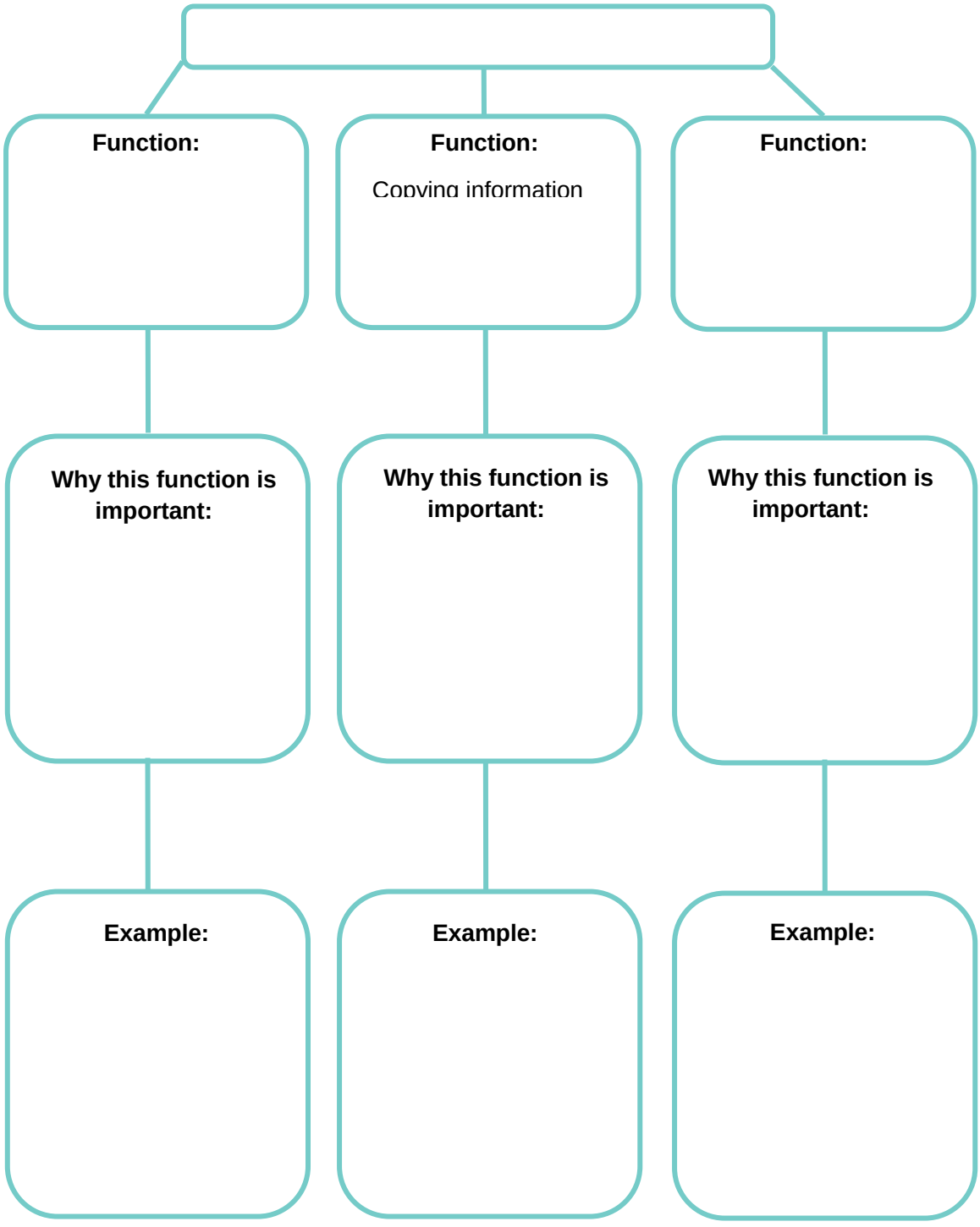
The Role of DNA

9. Complete this graphic organizer to summarize the assumptions that guided research on DNA in the middle of the twentieth century. Use an oak tree to give an example of each function.



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VISUAL ANALOGY

10. DNA is like a book titled *How to Be a Cell.* Explain why that title is appropriate for each of DNA's three functions.

a. _____

_____

_____

_____

_____

b. _____

_____

_____

_____

_____

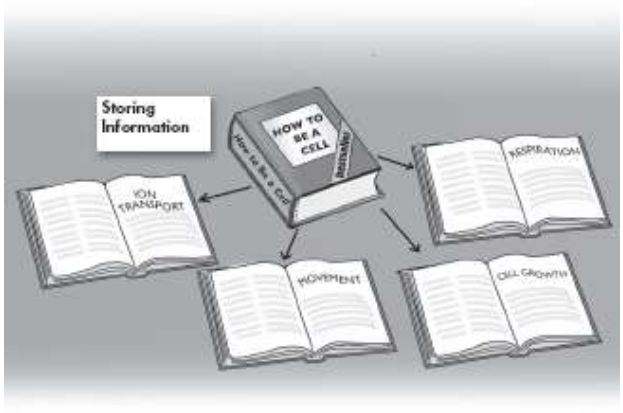
c. _____

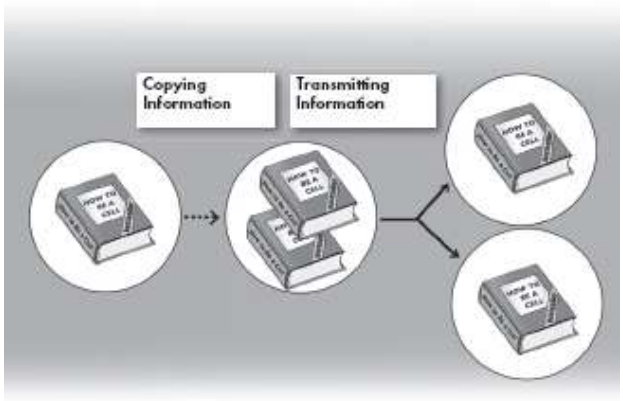
_____

_____

_____

_____





Apply the Big idea

11. By 1952, many scientists were convinced that genes are made of DNA, but they did not yet know how DNA worked. Why was it important to determine the structure of DNA to understand how DNA stored, copied, and transmitted information?

_____

_____

_____

_____

12. Why was the fact of transformation so important to the study of DNA's role? What did transformation demonstrate?

_____

_____

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12.2 The Structure of DNA

Lesson Objectives

- Identify the chemical components of DNA.
- Discuss the experiments leading to the identification of DNA as the molecule that carries the genetic code.
- Describe the steps leading to the development of the double-helix model of DNA.

Lesson Summary

The Components of DNA DNA is a nucleic acid made up of nucleotides joined into long strands or chains by covalent bonds. Nucleotides may be joined in any order.

- A DNA nucleotide is a unit made of a nitrogenous base, a 5-carbon sugar called deoxyribose, and a phosphate group.
- DNA has four kinds of nitrogenous bases: adenine, guanine, cytosine, and thymine.

Solving the Structure of DNA

- Erwin Chargaff showed that the percentages of adenine and thymine are almost always equal in DNA. The percentages of guanine and cytosine are also almost equal.
- Rosalind Franklin's X-ray diffraction studies revealed the double-helix structure of DNA.
- James Watson and Francis Crick built a model that explained the structure of DNA.

The Double-Helix Model The double-helix model explains Chargaff's rule of base pairing and how the two strands of DNA are held together. The model showed the following:

- The two strands in the double helix run in opposite directions, with the nitrogenous bases in the center.
- Each strand carries a sequence of nucleotides, arranged almost like the letters in a fourletter alphabet for recording genetic information.
- Hydrogen bonds hold the strands together. The bonds are easily broken allowing DNA strands to separate.
- Hydrogen bonds form only between certain base pairs–adenine with thymine, and cytosine with guanine. This is called **base pairing.**

The Components of DNA

For Questions 1–5, complete each statement by writing in the correct word or words.

1. The building blocks of DNA are _____.
2. Nucleotides in DNA are made of three basic components: a sugar called _____,a _____, and a nitrogenous_.
3. DNA contains four kinds of nitrogenous bases: _____, _____, _____, and _____.
4. In DNA, _____ can be joined in any order.
5. The nucleotides in DNA are joined by _____ bonds.

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Solving the Structure of DNA

6. Complete the table to describe each scientist's contribution to solving the structure of DNA.

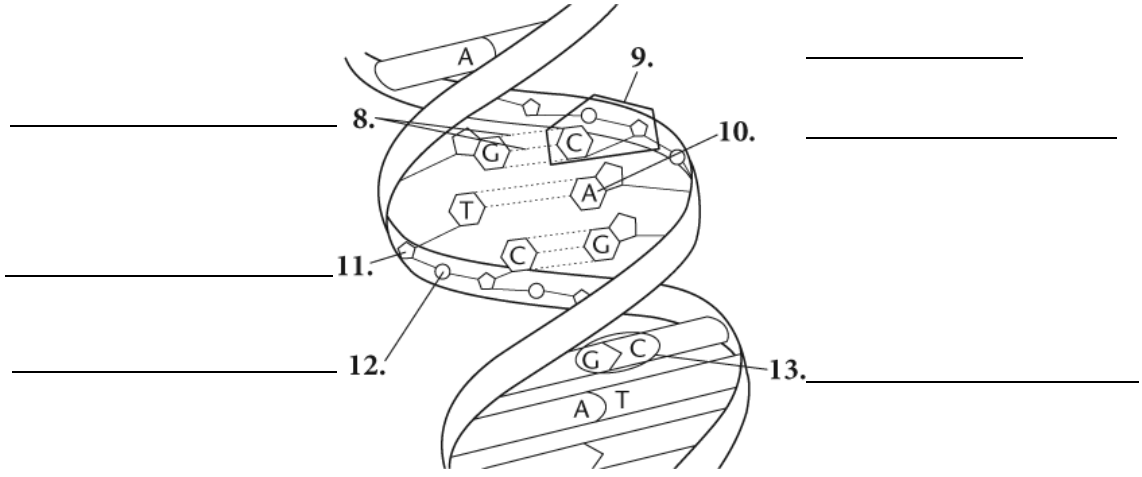
Scientist	Contribution
Erwin Chargaff	
Rosalind Franklin	
James Watson and Francis Crick	

7. Complete the table by estimating the percentages of each based on Chargaff's rules.

DNA sample	Percent of adenine	Percent of thymine	Percent of guanine	Percent of cytosine
1	31.5			
2		30	20	
3				17

The Double-Helix Model

For Questions 8–13, on the lines provided, label the parts of the DNA molecule that correspond to the numbers in the diagram.



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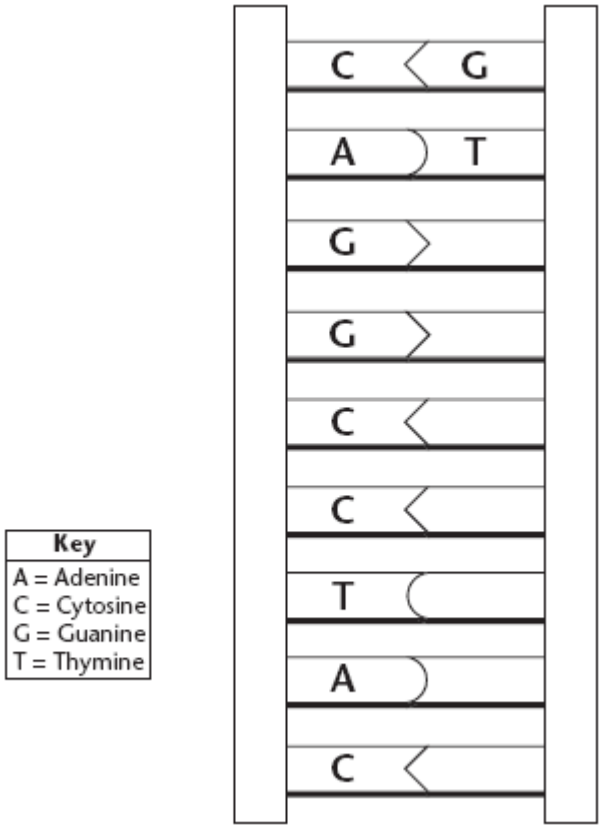
THINK VISUALLY

The drawing below shows half of a DNA molecule. Fill in the appropriate letters for the other half. Explain why you drew your sketch the way you did.



Apply the Big idea

14. Complete this table to show how the structure of the DNA molecule allows it to perform each essential function.

Function	Structure of the Molecule
Store information	
Copy information	
Transmit information	

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12.3 DNA Replication

Lesson Objectives

- Summarize the events of DNA replication.
- Compare DNA replication in prokaryotes with that of eukaryotes.

Lesson Summary

Copying the Code Each strand of the double helix has all the information needed to reconstruct the other half by the mechanism of base pairing. Because each strand can be used to make the other strand, the strands are said to be complementary. DNA copies itself through the process of **replication:**

- The two strands of the double helix unzip, forming replication forks.
- New bases are added, following the rules of base pairing (A with T and G with C).
- Each new DNA molecule has one original strand and one new strand.
- **DNA polymerase** is an enzyme that joins individual nucleotides to produce a new strand of DNA.
- During replication, DNA may be lost from the tips of chromosomes, which are called **telomeres.**

Replication in Living Cells The cells of most prokaryotes have a single, circular DNA molecule in the cytoplasm. Eukaryotic cells have much more DNA. Nearly all of it is contained in chromosomes, which are in the nucleus.

- Replication in most prokaryotic cells starts from a single point and proceeds in two directions until the entire chromosome is copied.
- In eukaryotic cells, replication may begin at dozens or even hundreds of places on the DNA molecule, proceeding in both directions until each chromosome is completely copied.

Copying the Code

1. Why are the strands of a DNA molecule said to be complementary?

_____

2. What is the first step in eukaryotic DNA replication?

_____

_____

3. If the base sequence on a separated DNA strand is CGTAGG, what will the base sequence on its complementary strand be?

_____

4. What enzyme joins individual nucleotides to produce the new strand of DNA?

_____

Name_____ Class _____ Date _____

5. What enzyme makes it less likely that DNA will be lost from telomeres during replication?

_____

6. How does this enzyme work?

_____

7. What is a replication fork?

_____

8. Does DNA replication take place in the same direction along both strands of the DNA molecule that is being replicated? Explain your answer. (Hint: Look at the illustration of DNA replication in your textbook.)

_____

_____

9. Make a sketch of the double helix of DNA. Show how it unzips for replication and how complementary strands are built. Label the nitrogenous bases, replication fork, DNA polymerase, the original strand, and the new strand.

Name_____ Class _____ Date _____

Replication in Living Cells

10. Complete the table to compare and contrast DNA replication in prokaryotes and eukaryotes.

	Prokaryotes	Eukaryotes
Location of DNA		
Amount of DNA		
Starting Point(s) for Replication		

11. Is DNA replication always a foolproof process? Explain your answer.

_____

_____

_____

Apply the Big idea

12. Why is the pairing of bases during replication essential for the transmission of inherited traits from parent to offspring?

_____

_____

_____

_____