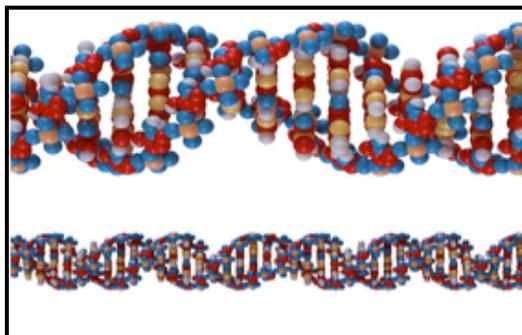




Name: _____ Date: _____ Group: _____

Heredity Relates to Structure

(Lexile 1080L)



- 1 What is DNA, and how does it relate to inheritance?
In the 1950s, scientists knew that the molecule deoxyribonucleic acid was a polymer. It is made of a nitrogenous base (a base that contains the element nitrogen), a pentose sugar known as deoxyribose, and a phosphate group. They also knew that the nitrogenous bases consisted of only four specific bases within the molecule. These are adenine (A), thymine (T), cytosine (C), and guanine (G). In 1947, a biologist named Erwin Chargaff noted that the number of certain nitrogenous bases within a species seemed to equal each other. More specifically, the number of adenine (A) and thymine (T) were relatively equal, and the percentage of cytosine (C) and guanine (G) were almost exactly equal. With this finding, he hypothesized that these bases must occur in pairs within the DNA molecule. The fact that $A = T$ and $C = G$ has become known as Chargaff's rule.
- 2 Scientists were also beginning to believe that the DNA molecule itself may be responsible for heredity. Previously, proteins had been thought to fill that role. Why? Scientists had closely observed the process of mitosis, or cell division, in eukaryotic cells. They noticed that not only was the DNA content of each cell precisely doubled, but it was also evenly distributed to each daughter cell created. What they did not know was how these components arranged themselves within the DNA molecule. They also did not know if (or how) the structure of DNA permitted it to be the carrier of genetic information. By the early 1950s, several scientists were taking all of the information known regarding DNA to answer these questions. They were determined to discover the true structure of the molecule, and how this structure may be involved in the passing of genetic information.
- 3 Scientists were using a process called X-ray crystallography to study the structure of the DNA molecule. In this process, images are produced from samples of the molecule that have been treated to form crystals. X-rays are passed through the crystals and then photographed as they are deflected from the crystalline structures. This deflection process is also known as X-ray diffraction. The diffracted images did not show the actual structure of the molecules. Instead, they showed distinct patterns that could be used to interpret the structure of molecules. Due to this process, a scientist named Linus Pauling had discovered that molecules may have helical shapes.

- 4 It was at this time that four scientists stepped into the history books. The first were two scientists working at King's College in London, named Maurice Wilkins and Rosalind Franklin. Both had been working with the structure of the DNA molecule for quite a long time, but they could not solve the structural puzzle. In 1951, Rosalind Franklin, with a Ph.D. in physical chemistry, had been placed in charge of refining the X-ray crystallography work with DNA. Maurice Wilkins, with a Ph.D. in physics, worked with Franklin and her X-ray crystallography technique to study the structure of the DNA molecule.
- 5 During this time, a relatively unknown young American scientist named James Watson arrived at the Cavendish Laboratory at Cambridge University in London. He had a keen interest in genetics. Watson had heard that X-ray crystallography images were being made of DNA. At Cambridge, he met a young English physicist named Francis Crick, who was working on X-ray crystallography of blood cells. Wilkins showed Watson an X-ray crystallography image of a DNA molecule created by Franklin. Reportedly, Wilkins did this without Franklin's permission. This specific image was labeled "Photograph 51." It was this very image that allowed Watson to determine that the DNA molecule structure was double helical, or twisted.
- 6 He used this image to interpret the width of the helix and how the various bases were positioned within the molecule. Based on this information, Watson and Crick quickly built many models. They knew, based on Chargaff's rule, that the DNA molecule had specific base pairing. This was the key! Watson realized that if he paired the bases according to Chargaff's rule, then the bonds between the bases would be equal. This, in turn, made the rungs of the ladder of the double helix equal. Therefore, the sugar-phosphate backbone would be smooth. They concluded that it was the specific base pairing that allowed the DNA molecule to duplicate itself. Thus, the structure of DNA enables it to transfer genetic information during the process of replication, as seen in earlier studies of mitosis.
- 7 Watson and Crick were the first to solve the puzzle on February 21, 1953. Their findings were published in an article in the April 25, 1953, publication *Nature*. The article was called "Molecular Structure of Nucleic Acids: A Structure for Deoxyribose Nucleic Acid." However, it is important to note that Watson and Crick's findings were primarily based on the previous work of Wilkins and Franklin. Furthermore, Franklin and Wilson published two articles on the subject in that same issue of *Nature*. Nevertheless, Watson and Crick still received the credit for being the first to solve the puzzle. James Watson, Francis Crick, and Maurice Wilkins all received the Nobel Prize in Physiology or Medicine in 1962 for their discoveries of the DNA molecule and how its structure related to heredity. Unfortunately, Rosalind Franklin died of cancer in 1958 at the age of 37. Nobel Prizes are only awarded to the living. She was never able to receive this prestigious award, even though her image was the ultimate key to the puzzle.

<http://www.chemheritage.org/discover/online-resources/chemistry-in-history/themes/biomolecules/dna/watson-crick-wilkins-franklin.aspx>

http://www.nobelprize.org/nobel_prizes/medicine/laureates/1962/

- 1** Paragraph 1 discusses several important facts regarding the DNA molecule. Which of the following facts relates to Chargaff's rule?
- A** DNA contains a pentose sugar, nitrogenous bases, and a phosphate group.
 - B** DNA is a molecule in structure.
 - C** DNA contains adenine, thymine, cytosine, and guanine.
 - D** Cytosine and guanine appear in equal proportions in DNA.
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- 2** With any major scientific discovery, the previous work of many different scientists helps contribute to final conclusions. Which of the following scientists' work did not contribute to the discovery of the structure of the DNA molecule?
- A** Gregor Mendel
 - B** Linus Pauling
 - C** Erwin Chargaff
 - D** Rosalind Franklin



- 3** X-ray crystallography is a very important process that is used to help identify the structure of molecules. What exactly does this process show?
- A** A photograph of the molecule
 - B** The atoms within the molecule
 - C** Patterns that can be used to interpret structure
 - D** The crystal structure of the molecule
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- 4** In 1951, four scientists were working on solving the structural puzzle of the DNA molecule. Two of those scientists had worked for many years to try to solve the puzzle, and even though their work became the foundation for the actual discovery of the structure of DNA, they are not often remembered. Who were these two scientists?
- A** Watson and Crick
 - B** Chargaff and Pauling
 - C** Wilkins and Franklin
 - D** Mendel and Darwin



- 5** In 1962, three scientists who contributed to the discovery of the structure of the DNA molecule were awarded the Nobel Prize in Physiology and Medicine. The fourth scientist who contributed to this discovery, Rosalind Franklin, was not awarded the prize as she had died before this honor could be bestowed. What was her major contribution to this discovery?
- A** She determined that DNA was a crystal.
 - B** She captured the X-ray crystallography image that led to the discovery.
 - C** She determined that nitrogenous bases occurred in pairs.
 - D** She determined that DNA was a double helix.
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- 6** Paragraph 6 discusses the importance of the discovery of the structure of the DNA molecule. What did this discovery allow scientists to confirm?
- A** Specific base pairing allowed DNA to duplicate itself.
 - B** If Chargaff's rule was followed, then the bonds between bases were equal.
 - C** Specific base pairing allowed for the transfer of genetic information.
 - D** All of the above