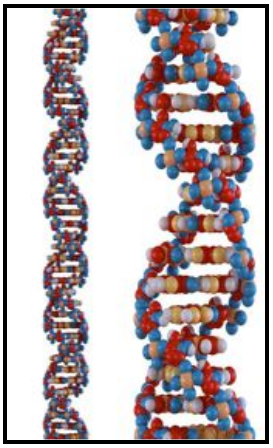
Reading Science

Name: _____ Date: _____

Structure, Function, and Heredity



1 What is DNA, and how does it relate to inheritance? Scientific research through the 1950s confirmed that deoxyribonucleic acid (DNA) was a polymer. These polymers consisted of three recurring parts: 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: adenine (*A*), thymine (*T*), cytosine (*C*), and guanine (*G*). An important observation by the biologist Erwin Chargaff in the late 1940s led to the understanding that each of these bases had an equal partnership with one of the other bases (adenine is equal to thymine, and cytosine is equal to guanine). Chargaff went further with a second observation, in which he concluded that the number of paired nitrogenous bases varied by species. The repeated observation became the second part of Chargaff's rule, which indicated that these varied numbers of paired bases were possibly the actual genetic material instead of proteins.

2 Erwin Chargaff's work, along with that of other scientists, allowed for a better understanding of the relationship and functions of nitrogenous base pairs and proteins. Proteins from earlier studies proved to be the catalysts for most cellular reactions along with the fact that each type of protein was structured for certain functions. There was a growing possibility that DNA was most likely the synthesis mechanism for proteins, hence the role of genetic material and heredity was shifted to DNA over proteins. Previous observations of the process of mitosis in eukaryotic cells had led scientists to assume the protein structure was the culprit in genetic transfer of information. Protein functions could be observed in cell processes, but not the transfer of information. Continued studies allowed them to notice that not only was the DNA content of each cell doubled exactly the same way each time, but it was also evenly distributed to each daughter cell created each time. The mystery was how these components arranged themselves within the DNA molecule as well as how the structure of DNA permitted it to be the carrier of genetic information.

3 The development of a process called *X-ray crystallography* was used to capture actual images and shapes of crystal structures. This made it possible for scientists 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. Linus Pauling had discovered that molecules may have helical shapes. Although his proposed model of DNA was incorrect, it was a starting point for discovering the helical shape of DNA.

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4 The history books would gain four important scientists in the discovery of the DNA structure in the 1950s and 1960s. Rosalind Franklin, a young, female crystallographer with a PhD in physical chemistry at King's College in London, along with her associate, Maurice Wilkins, who held a Ph.D. in physics, were in charge of refining the X-ray crystallography work with DNA. A long and tedious process led to many images of the DNA, none posing an obvious clue to solving the mystery of its structure. Franklin and Wilkins had not realized at the time that one of their own photographs held the key to that puzzle. Two other scientists that would come to study that particular photograph, James Watson and Francis Crick, would lead to an important discovery in the structure of DNA.

5 James Watson, an American scientist, arrived at the Cavendish Laboratory at Cambridge University in London to study and conduct research in the field of genetics. Watson had heard that X-ray crystallography images were being made of DNA. He partnered with Francis Crick, who was studying the crystallography images of blood cells. Maurice Wilkins shared with Watson some of the images Dr. Franklin had been refining. One image caught Watson and Crick’s attention. They noticed the structural pattern and began building test models to determine if their observations of the pattern were correct. They used this image to interpret the width of the helix and how the various bases were positioned within the molecule. They eventually constructed the correct model, which would lead to the discovery of the double helix. They concluded that it was the specific base pairing that allowed the DNA molecule to duplicate itself. This discovery validated the growing belief that the structure of DNA enables it to transfer genetic information during the process of replication, as seen in earlier studies of mitosis.

6 Watson and Crick were the first to solve the puzzle, using the work of Rosalind Franklin and the rules created by Erwin Chargaff. James Watson, Francis Crick, and Maurice Wilkins all received the Nobel Prize in Physiology and Medicine in the early 1960s for their discoveries of the DNA molecule and how its structure related to heredity. Unfortunately, Rosalind Franklin died of cancer in the late 1950s, never getting to see the reward of her accomplishments.

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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

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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

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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 5 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 were followed, then the bonds between bases were equal.

C. Specific base pairing allowed for the transfer of genetic information.

D. All of the above