**Determining DNA Structure**

One of the most important scientific breakthroughs of the twentieth century was the development of a model for the structure of DNA. By the middle of the 20th century it was well known that DNA was made of smaller building blocks called **nucleotides**. Each nucleotide consists of a molecule of sugar (called deoxyribose), a phosphate molecule, and a molecule of one of four bases called adenine, guanine, thymine and cytosine. During the 1940s and 1950s many scientists were working to determine the material of heredity, what its structure was, and how it worked.

Read the following paragraphs, which describe some of the information that was available at the time and based on the evidence develop a model of DNA.

**Erwin Chargaff’s observations:**

In 1950 Erwin Chargaff took DNA from the cells of a wide variety of animals, plants, fungi, bacteria and viruses, as well as a several human tissues. When he broke it down, he could see the relative amounts of each of the four bases.

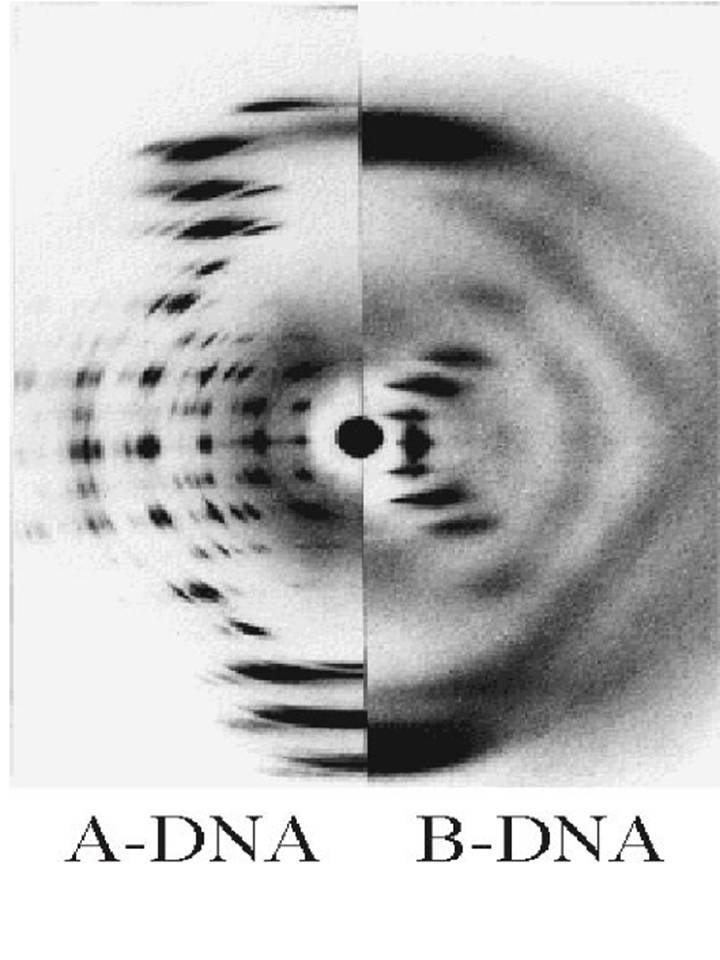
Instructions:

1. Examine the data in the table below, paying attention first to the percentages of each base within each species. Then look for a moment at percentage for each base between different species.
2. In the space below, write down any **patterns** that you can see in the data.

**Chargaff’s Data:** **DNA Content and Base Comparisons in Various Organisms**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Organism** | **Adenine** | **Guanine** | **Cytosine** | **Thymine** |
| Human | 31.0% | 19.1% | 18.4% | 31.5% |
| Rat | 29.7 | 20.2 | 20.9 | 29.1 |
| Chicken | 28.0 | 22.0 | 21.6 | 28.6 |
| Frog | 26.3 | 23.5 | 23.8 | 26.4 |
| Carp | 30.8 | 18.5 | 18.9 | 31.7 |
| Fruit fly | 27.3 | 22.5 | 22.5 | 27.6 |
| Protozoan (*Tetrahymena*) | 35.4 | 14.5 | 14.7 | 35.4 |
| Bacterium (*E. coli)* | 24.6 | 25.5 | 25.6 | 24.3 |
| Virus (*Herpes simplex*) | 13.8 | 37.7 | 35.6 | 12.8 |

**What are the patterns you see in Chargaff’s data?**

**Rosalind Franklin’s Pictures:** A key piece of the puzzle for Watson and Crick came from British scientist Rosalind Franklin. She studied the structure of DNA by taking x-ray pictures of crystallized samples of the compound. Watson and Crick thought the pictures suggested that DNA was made of two strands of nucleotides with the sugar and phosphates on the outside and the bases in the middle. (Two of her images are pictured at right. Don’t worry if you can’t see how she, Watson and Crick might see these patterns in the image: X-ray crystallography is a very clever way of “seeing” molecules, but it’s a complicated practice!)

**Hydrogen bonding:** Many large molecules are put together with *covalent* bonds, meaning the atoms within the molecule share electrons. Often these covalent bonds involve unequal sharing of electrons. As a result, the large molecule can end up with some areas that have a somewhat positive charge and some areas that have a somewhat negative charge. Positively charged areas of a molecule can attract negatively charged areas of the same molecule or a different molecule. This charge attraction between molecules forms a weak bond known as a ***hydrogen* bond.** Hydrogen bonds between areas of the same molecule can have important effects on the three dimensional shape of the molecule. Hydrogen bonds between different molecules can hold the molecules together to form larger molecules. In either case hydrogen bonds involve the attraction of oppositely charged areas of molecules.

**Your turn:** Cut out the nucleotides found on the pages labeled **“**Nucleotide Shapes”, cutting only on the dotted lines (do not cut any of the solid lines). Notice that each nucleotide contains a sugar, a phosphate, and a base. In the paper nucleotides, “base T” is thymine, “base G” is guanine, “base C” is cytosine, and “base A” is adenine. Try to put your sixteen nucleotides together in a way that is consistent with the observations of Chargaff and Franklin and is consistent with what you have just read about hydrogen bonding.

**Observations**: In the space below, describe as fully as you can the arrangement of the nucleotides. What are some “rules” for the structure of DNA?

**Conclusions from class discussion:**