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**DNA Modeling**

**Purpose:** To construct a model of DNA for a better understanding of its structure and the arrangements of its parts

**Background**

**History:**

In 1944, 3 American microbiologists, Oswald Avery, Colin McLeod and Maclyn McCarty, discovered that a substance called **deoxyribonucleic acid (DNA)** is the substance from which genes are made. None years later, James Watson and Francis Crick, working with molecular models and x-ray information supplied by Maurice Wilkins and Rosalind Franklin, identified the physical structure of DNA. In addition, Crick suggested a mechanism for DNA replication and how it works as the hereditary material.

**Structure:**

DNA, and another substance called **ribonucleic acid (RNA)**, are together referred to as nucleic **acids** because they were first discovered in the nuclei of cells. Each DNA nucleotide is composed of 3 parts: a **nitrogen-containing base**, a pentose (5 carbon) sugar called **deoxyribose**, and a **phosphate group** (phosphoric acid). The nitrogen-containing bases are cyclic compounds made of carbon, hydrogen, oxygen and nitrogen atoms. The bases are named **adenine (A)**, **thymine (T)**, **cytosine (C)**, and **guanine (G)**. A and G are double ringed structures called **purines**, whereas T and C are single ringed structures referred to at **pyrimidines**.

According to the model proposed by Watson and Crick, a DNA molecule consists of two long strands wrapped around each other to form a **double helix**. The double helix looks like a twisted ladder. Each strand of the DNA double helix is composed of many nucleotides.

Each strand of DNA composing the double helix has a ”backbone” consisting of alternating sugar and phosphate groups. The sugar of one nucleotide is joined to the phosphate group of the next nucleotide. The nitrogen containing bases make up the rungs of the ladder. \*Note: adenine is ALWAYS paired with thymine and cytosine is ALWAYS paired with guanine. The bases are held together with **hydrogen bonds**; A-T is held by 2 hydrogen binds and C-G is held by 3.

**Function:**

The order in which the nitrogen base pairs occur along the backbone is *extremely* specific and in fact contains the genetic instructions for the organism. A certain segment of a nucleotide chain makes up a gene, and a single DNA molecule may contain *thousands* of genes. Genes determine all heritable traits, and they control all the activities that take place within cells.

**Pre-lab Questions**

1. Who discovered the substance DNA is made of? Who discovered the structure?
2. What is the shape of DNA? What does this shape remind you of (besides DNA)?
3. What are the 3 parts that make up a nucleotide?
4. List the 4 types of nitrogenous bases. Which 2 are purines? Which 2 are pyrimidines?
5. How many rings does a purine have? How many rings does a pyrimidine have?
6. What 2 parts make up the “backbone” of the DNA ladder?
7. What parts make up the “rungs”? What type of bond holds these together?
8. What part of the DNA structure makes up (or codes for) a gene?

**Materials:**

* Two 12” pipe cleaners-same color
* 10 cut pipe cleaner pieces, all the same color
* 4 different colors of beads
  + 20 of color 1
  + 20 of color 2
  + 10 of color 3
  + 10 of color 4

**Procedures:**

1. Assign a bead color to each of the 4 nitrogenous bases.

**For example**:

Adenine-blue

Thymine-red

Cytosine-green

Guanine-yellow

1. Because **A and G are purines** and have **2 rings**, you will need to **use 2 beads** for these molecules. Make sure the color of bead that you assign to A and G is one of the two with 20 beads.
2. Thread the beads representing **adenine** and **thymine** onto 5 of the cut pipe cleaners. Remember to use **2 beads for A**. *The order in which these go on does not matter.*
3. Next do the same for **guanine** and **cytosine**, remembering to use **2 beads for G**.
4. Now connect each end of the short pipe cleaners to the long pieces by wrapping the ends around each of the long pipe cleaners. You can place the pairs along the “backbone” in any order you like-*this is your genetic code*.
5. When you are finished, you should have a long ladder with 10 rungs.
6. To make your double helix, twist your ladder gently so the molecule forms a spiral.

**Post-lab Questions**

1. List the sequence of the 10 nitrogenous bases on 1 of your DNA strands. (Ex: ATTCGCTTAC)
2. List the sequence of the 10 nitrogenous bases on the complementary strand (be sure to write them starting from the same end!)
3. What part of DNA does each element of your model represent? (long pipe cleaners, short pipe cleaners, beads)
4. What does adenine *always* pair with? What does guanine *always* pair with?
5. Explain to me how the DNA molecule can code for different genes.