DNA

OVERVIEW:

In this activity, students will examine the structure of DNA by constructing complementary strands.

CONCEPTS:

National Science foundation Standards:

Standard C: Life Science

Structure and Function in Living Systems

- Life functions in cells.

Reproduction and Heredity

- Genes, chromosomes, inherited human traits.
- Characteristics of an organism resulting from inheritance and from interactions with the environment.

Benchmark 5: The Living Environment

A Diversity of Life:

- Similarities among organisms are found in internal anatomical features, which can be used to infer the degree of relatedness among organisms. In classifying organisms, biologists consider details of internal and external structures to be more important than behavior or general appearance.
- For sexually reproducing organisms, a species comprises all organisms that can mate with one another to produce fertile offspring.

B Heredity:

- In some kinks of organisms, all genes come from a single parent, whereas in organisms that have sexes, typically half of the genes come from each parent.
- In sexual reproduction, a single specialized cell from a female merges with a specialized cell from a male. As the fertilized egg, carrying genetic information from each parent, multiplies to form the complete organism with about a trillion cells, the same genetic information is copied in each cell.

OBJECTIVES:

Students will:

- Identify the role DNA plays in our bodies.
- Construct a DNA model
- Identify their DNA alias using the letters in their name

PROCEDURES:

- Allow two hours to present background information and activities.
- Present background information.
- Complete activities (see Part A.)

- Follow up activity with discussion questions (see Part B). These questions can be used for assessment purposes

MATERIALS:

- DNA molecule
- Handouts: A Double Helix Model and

BACKGROUND:

We often hear people talking about DNA, but what do the letters in the word stand for? The letters DNA are short for **Deoxyribonucleic Acid.** Now let's take the word apart:

De = To take away
Oxy = Oxygen
Ribo = A type of sugar
Nucleic = Nucleus
Acid = Acid-like molecule; it has a lot of hydrogen molecules.

DNA is a molecule that carries the code for every protein manufactured in your body. It carries the code for every protein manufactured in your body. The DNA molecule is formed by subunits called nucleotides. There are four different nucleotides each containing a sugar, phosphate, and nitrogen containing base. The names of these four nitrogen-containing bases are:

- **Cytosine = Guanine = Red**
- **Thymine = Adenine = Blue**
- **Adenine = Thymine = Yellow**
- **Guanine = Cytosine = Green**

Chart 1: Base Pairs

Cytosine	Guanine
Adenine	Thymine

Chart 2: Base plus Base = Color

Nitrogenous Base	Nitrogenous Base	Color
Cytosine	Guanine	Red
Thymine	Adenine	Blue
Adenine	Thymine	Yellow
Guanine	Cytosine	Green

ACTIVITY:
Part A:

Activity 1: DNA: A Double Helix Model
(http://www.pbs.org/saf/1202/teaching/teaching3.htm)

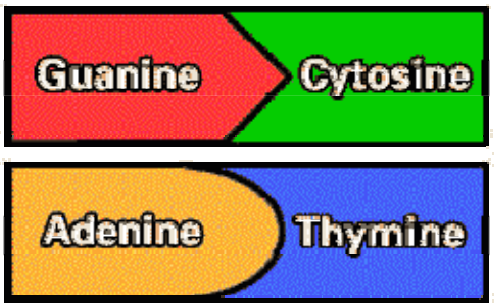
DNA is a special molecule that carries the code for every protein manufactured in your body. The DNA molecule is formed by subunits called nucleotides. There are four different nucleotides, each containing a sugar, phosphate, and nitrogen-containing base. The names of these four nitrogen-containing bases are cytosine, thymine, adenine, and guanine. Two side-by-side strands of these four bases join together to form a staircase-like structure called a double helix.

MATERIALS

- Color copies of nucleotide templates provided below
- Cotton swabs
- Straws
- Centimeter ruler
- Scissors
- Tape

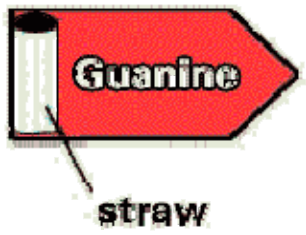
PROCEDURE
Part 1- The Basic Building Block

1. Use scissors to cut apart at least four groups of the four nitrogen containing bases of DNA shown in the diagram: Guanine, Cytosine, Adenine, and Thymine. (16 pieces of paper in total)



2. Cut out small segments of straws, each about 1 centimeter in length.

3. Use tape to attach a straw segment to the back of one of the cutouts as shown below.



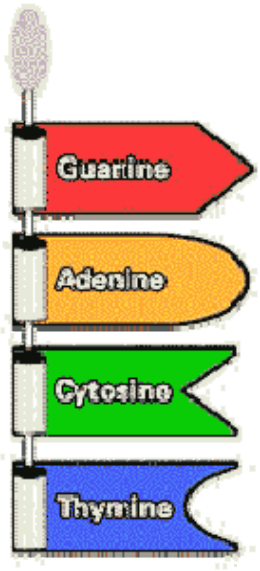
4. Remove and discard one of the tuffs from a cotton swab. Use tape to attached the shaft of this swab to the nucleotide on the side opposite the straw segment - SEE DIAGRAM

5. Repeat this procedure until you finished attaching cotton swabs and straw segments to all 16 cutouts.

Part 2- Build a Double Helix

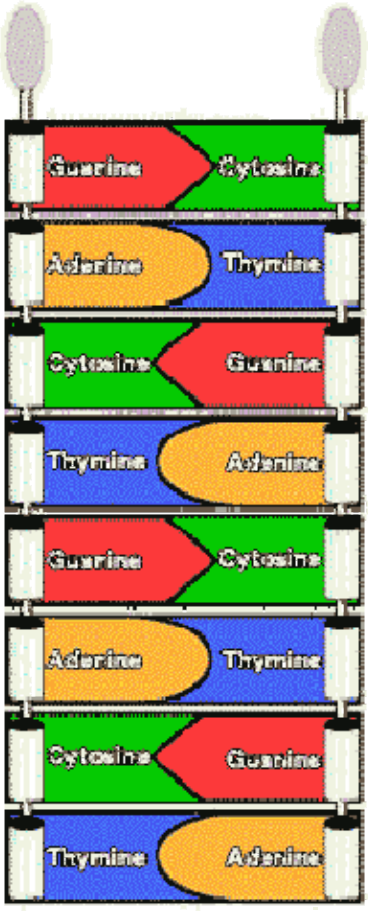
1. From these nucleotides attached with cotton swabs, choose four, one representing each base (ATGC).
2. Insert the cotton shaft of one into the straw segment of an adjoining nucleotide. Continue connecting the pieces until you have assembled a chain of four bases -

SEE DIAGRAM.



3. Construct a complementary strand of DNA. This complementary strand must have a base sequence that "pairs" with the already completed strand. For example, adenine must be paired with thymine.
4. Once the two strands have been assembled, use tape to connect them together.

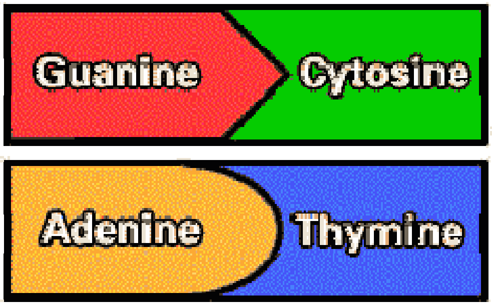
5. Repeat this procedure for your 8 remaining bases, attaching them first to each other and then to their matched pair as shown in the diagram.

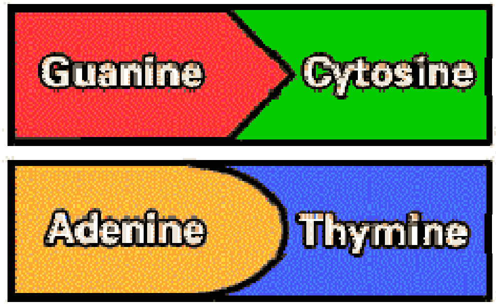


Next, attach the top most cotton balls to the underside of a desk. The rest of the model will hang freely. While supporting the model, put a slight twist in its shape. This twist creates the characteristic "double helix" of the DNA molecule.

ANALYSIS
Analyze Your Model

1. What is a nucleotide?
2. What are the three building blocks of a nucleotide?
3. How many different nitrogen bases are found in DNA?
4. How do the bases pair up?


Guanine
Cytosine
Adenine
Thymine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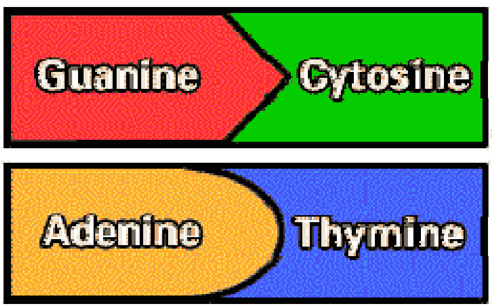
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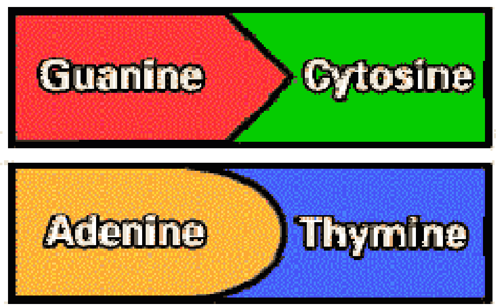
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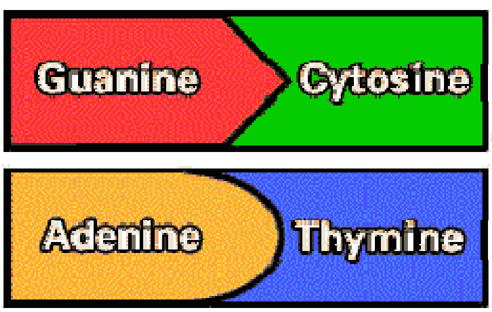
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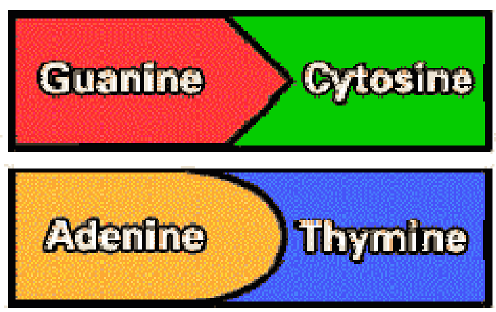
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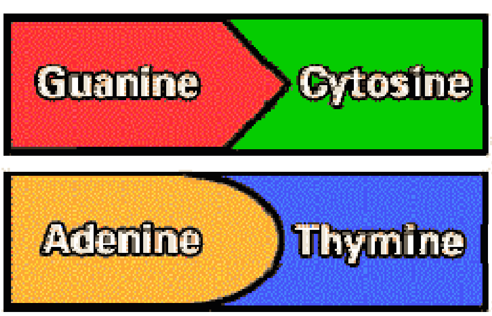
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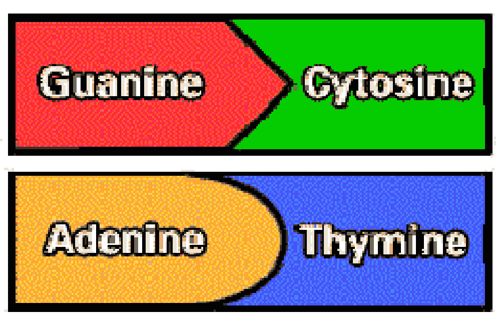
Guanine
Cytosine
Adenine
Thymine

Activity 2: DNA Alias

(http://www.nature.ca/genome/05/051/0511/0511_m205_e.cfm)

What is Your DNA Alias?

We use four letters to code all the information contained in DNA: A, T, C and G. The letters are used in groups of three. A group is called a codon.

DNA contains the information that is needed by your body to make proteins. The different proteins have specific functions, such as making our hearts, hair, eyes and ears. The smallest parts of proteins are amino acids. There are 20 amino acids. One or more can make up a protein, depending on the specific protein.

Each amino acid is represented by at least one codon. Because each codon is coded with three letters, the string of letters used to represent the amino acids in a specific protein can get pretty long. To avoid this, scientists have made a kind of shorthand, and have given each amino acid its own letter, corresponding to our alphabet.

Using this shorthand to represent the amino acids in a protein is a way of describing, or "spelling" this part of the protein. Written in this shorthand, the code is called the DNA Alias; each letter in the DNA Alias actually represents a group of three letters (a codon).

When scientists see the DNA Alias of a particular protein, they can find the protein's DNA sequence by reversing the coding process. For fun, we can perform the same process on any word by converting each letter to the corresponding codon, and in so doing, find its "DNA sequence". Let's try it with your name.

Write each letter of your name on the lines below:

_____ _____ _____ _____ _____ _____ _____ _____ _____ _____ _____ _____

Use the table below to help you convert your name into its DNA Alias.

Step 1: Find each letter of your name.
Step 2: Look at the Simplified Codon column to find the DNA code for each letter.
Step 3: Replace each letter of your name with its three-letter codon:

___,___,___	___,___,___	___,___,___	___,___,___	___,___,___
___,___,___	___,___,___	___,___,___	___,___,___	___,___,___
___,___,___	___,___,___	___,___,___	___,___,___	___,___,___

Base colors:	**A** = green
	T = red
	C = blue
	G = yellow

Our Alphabet	Amino Acid Name	Simplified Codon
A	Alanine	GCT
B		GCA (Alanine)
C	Cysteine	TGC
D	Aspartic acid	GAT
E	Glutamic acid	GAG
F	Phenylalanine	TTT
G	Glycine	GGG
H	Histidine	CAT
I	Isoleucine	ATA
J		ATC (Isoleucine)
K	Lysine	AAG
L	Leucine	CTC
M	Methionine	ATG
N	Asparagine	GAC
O		GAT (Asparagine)
P	Proline	CCC
Q	Glutamine	GAG
R	Arginine	CGT
S	Serine	TCA
T	Threonine	ACT
U		ACG (Threonine)
V	Valine	GTC
W	Tryptophan	TGG
X		GTA (Valine)
Y	Tyrosine	TAC
Z		TAT (Tyrosine)

Answers: Activity 1 DNA: A Double Helix Model

Analyze Your Model:

1. What is a nucleotide?
   (the basic subunit of the DNA molecule)
2. What are the three building blocks of a nucleotide?
   (sugar, phosphate group, and a nitrogen containing base).
3. How many different nitrogen bases are found in DNA?
   (four)
4. How do the bases pair up?
   (cytosine pairs with guanine, thymine pairs with adenine)

Part B:
Ask the following questions and allow time for discussion.

Share:

- Share some of your traits that are similar to your parent/parents?

Process:

- How are DNA, chromosomes, and heredity traits related?
- How are proteins related to DNA?

Generalize:

- Why are we all different?

Apply:

- How do we become who we are?
- Why is it important for us to know about DNA?
- What happens if DNA is not made properly?

Reference: Scientific American Frontiers Teaching Guide: *DNA activities for Grades 5-8*