



DNA Detectives

What is your DNA Alias?

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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 part 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 on page 2 to help you convert your name into its DNA Alias.

Step 1: Find each letter of your name.

Step 2: Look at the Codon column to find the DNA code for each letter.

Step 3: Replace each letter of your name with its three-letter codon:





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

(The table shows simplified versions of the codons.
Most amino acids are actually represented by multiple codons).



Teacher Information

Preparation

- Copy 1 blank bingo card for each student or team (included). If they wish to make different cards and you are amenable to that you will need more than one card per student.
- Copy a set of the "codon game cards" (included).
- Cut these "codon game cards" into individual squares and place in a bingo basket for drawing.
- Decide if students will play alone or in paired teams.

Instructions for Playing Codon Bingo

1. Provide each student or team with the following:
 - 1 bingo card
 - several markers (pennies work well)
 - 1 codon chart with RNA codons and their respective amino acids (found in texts)
 - 1 list of the twenty amino acids (found in texts)
 - colored pencils
2. Direct the team or individual to write the name of all 20 amino acids on their cards. They may choose where they wish to position them. They will have some amino acids on their cards twice as there are 24 empty spaces to fill.
3. Once the bingo cards are ready, draw 1 "codon game card" from the basket and read the DNA triplet code to the class. {Please note: on the "codon game cards" the small 'D' is the DNA triplet (sense strand) and the small 'R' is the mRNA codon.} They must then transcribe the DNA base pair triplet into the RNA transcript. Then using a codon chart, they translate the mRNA codon into an amino acid. If they have that amino acid on their card somewhere they may place a marker on that space.
4. Discard the used "codon game card" by laying it to one side. You will need it for the checking process. Give the students enough time before drawing the next card - especially in the beginning of the game.
5. Continue drawing and reading cards until someone yells "Bingo!" At this point check his or her decoding by having the student read the four or five marked amino acids. Point out that this is now a polypeptide. While the student reads out the amino acids, check for accuracy in the discard pile. If a student has made a mistake and marked an inappropriate amino acid, he or she is out of the game for this round.
6. Reward the winner(s) in some way to enhance motivation. Play the next round.

Variation #1: When preparing the cards, allow the students to choose as many or as few of the amino acids as they like and position them on the bingo cards. {Note: It might be wise to restrict them from using fewer than two or three amino acids.}

Variation #2: The pace of the game can be slow or fast depending on the student population. After a few rounds of practice, picking up the pace can add a new challenge.

Variation #3: Instead of calling out the DNA triplet code on the "codon game card" call out the RNA codon and have them only translate into an amino acid. This is an easier variation and might be a way you would want to begin the first few rounds of the game for beginners.

The teacher and students can create all sorts of variations and rules to add interest.

CODON BINGO

		FREE SPACE		

CONDO BINGO

Name:

Period:

Date:

Write the name of all 20 amino acids on their bingo cards and choose where you would like to position them.
Since there are 24 spaces, some amino acids will be written twice.

			Free Space			

D AAG R UUC phenylalanine	D TAA R AUU isoleucine	D AGA R UCU serine	D TGA R ACU threonine
D AAU R UUA leucine	D TAG R AUC isoleucine	D AGG R UCC serine	D TGG R ACC threonine
D AAC R UUG leucine	D TAU R AUA isoleucine	D AGU R UCA serine	D TGU R ACA threonine
D GAA R CUU leucine	D TAC R AUG methionine	D AGC R UCG serine	D TGC R ACG threonine
D GAG R CUC leucine	D CAA R GUU valine	D GGA R CCU proline	D CGA R GCU alanine
D GAT R CUA leucine	D CAG R GUC valine	D GGG R CCC proline	D CGG R GCC alanine
D AAA R UUU phenylalanine	D CAU R GUA valine	D GGU R CCA proline	D CGU R GCA alanine
D GAC R CUG leucine	D CAC R GUG valine	D GGC R CCG proline	D CGC R GCG alanine
D ATA R UAU tyrosine	D TUA R AUU isoleucine	D CUU R GAA glutamic acid	D TCA R AGU serine
D ATG R UAC tyrosine	D TUG R AUC isoleucine	D CTC R GAG glutamic acid	D TCG R AGC serine
D ATT R UAA stop pick another card	D TTU R AAA lysine	D ACA R UGA stop pick another card	D TCT R AGA arginine
D ATC R UAG stop	D TTC R AAG leucine	D ACC R UGG tryptophan	D TCC R AGG serine

DNA - The Double Helix

Recall that the nucleus is a small spherical, dense body in a cell. It is often called the "control center" because it controls all the activities of the cell including cell reproduction, and heredity. Chromosomes are microscopic, threadlike strands composed of the chemical DNA (short for deoxyribonucleic acid). In simple terms, DNA controls the production of proteins within the cell. These proteins in turn, form the structural units of cells and control all chemical processes within the cell. Think of proteins as the building blocks for an organism, proteins make up your skin, your hair, parts of individual cells. How you look is largely determined by the proteins that are made. The proteins that are made is determined by the sequence of DNA in the nucleus.

Chromosomes are composed of genes, which is a segment of DNA that codes for a particular protein which in turn codes for a trait. Hence you hear it commonly referred to as the gene for baldness or the gene for blue eyes. Meanwhile, DNA is the chemical that genes and chromosomes are made of. DNA is called a nucleic acid because it was first found in the nucleus. We now know that DNA is also found in organelles, the mitochondria and chloroplasts, though it is the DNA in the nucleus that actually controls the cell's workings.

In 1953, James Watson and Francis Crick established the structure of DNA. The shape of DNA is a double helix (color the title black), which is like a twisted ladder. The sides of the ladder are made of alternating sugar and phosphate molecules. The sugar is deoxyribose. Color all the phosphates pink (one is labeled with a "p"). Color all the deoxyriboses blue (one is labeled with a "D").

The rungs of the ladder are pairs of 4 types of nitrogen bases. The bases are known by their coded letters A, G, T, C. These bases always bond in a certain way. Adenine will only bond to thymine. Guanine will only bond with cytosine. This is known as the "Base-Pair Rule". The bases can occur in any order along a strand of DNA. The order of these bases is the code the contains the instructions. For instance ATGCACATA would code for a different gene than AATTACGGA. A strand of DNA contains millions of bases. (For simplicity, the image only contains a few.)

Color the thymines orange.

Color the adenines green.

Color the guanines purple.

Color the cytosines yellow.

Note that that the bases attach to the sides of the ladder at the sugars and not the phosphate.

The DNA helix is actually made of repeating units called nucleotides. Each nucleotide consists of three molecules: a sugar (deoxyribose), a phosphate which links the sugars together, and then one of the four bases. Two of the bases are purines - adenine and guanine. The pyrimidines are thymine and cytosine. Note that the pyrimidines are single ringed and the purines are double ringed. Color the nucleotides using the same colors as you colored them in the double helix.

The two sides of the DNA ladder are held together loosely by hydrogen bonds. The DNA can actually "unzip" when it needs to replicate - or make a copy of itself. DNA needs to copy itself when a cell divides, so that the new cells each contain a copy of the DNA. Without these instructions, the new cells wouldn't have the correct information. The hydrogen bonds are represented by small circles. Color the hydrogen bonds grey.

Messenger RNA

So, now, we know the nucleus controls the cell's activities through the chemical DNA, but how? It is the

DNA - The Double Helix

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sequence of bases that determine which protein is to be made. The sequence is like a code that we can now interpret. The sequence determines which proteins are made and the proteins determine which activities will be performed. And that is how the nucleus is the control center of the cell. The only problem is that the DNA is too big to go through the nuclear pores. So a chemical is used to read the DNA in the nucleus. That chemical is messenger RNA. The messenger RNA (mRNA) is small enough to go through the nuclear pores. It takes the "message" of the DNA to the ribosomes and "tells them" what proteins are to be made. Recall that proteins are the body's building blocks. Imagine that the code taken to the ribosomes is telling the ribosome what is needed - like a recipe.

Messenger RNA is similar to DNA, except that it is a single strand, and it has no thymine. Instead of thymine, mRNA contains the base Uracil. In addition to that difference, mRNA has the sugar ribose instead of deoxyribose. RNA stands for **Ribonucleic Acid**. Color the mRNA as you did the DNA, except:

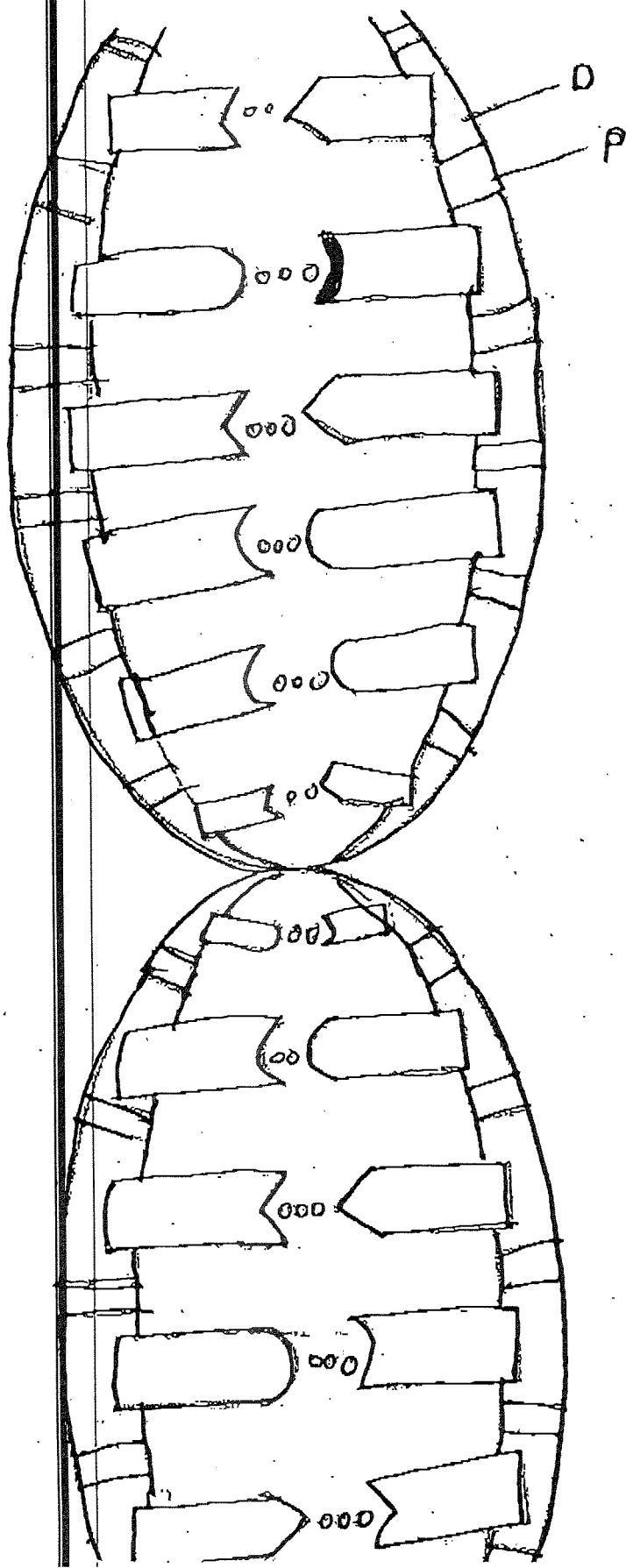
Color the ribose a **DARKER BLUE**, and the uracil brown. 

The Blueprint of Life

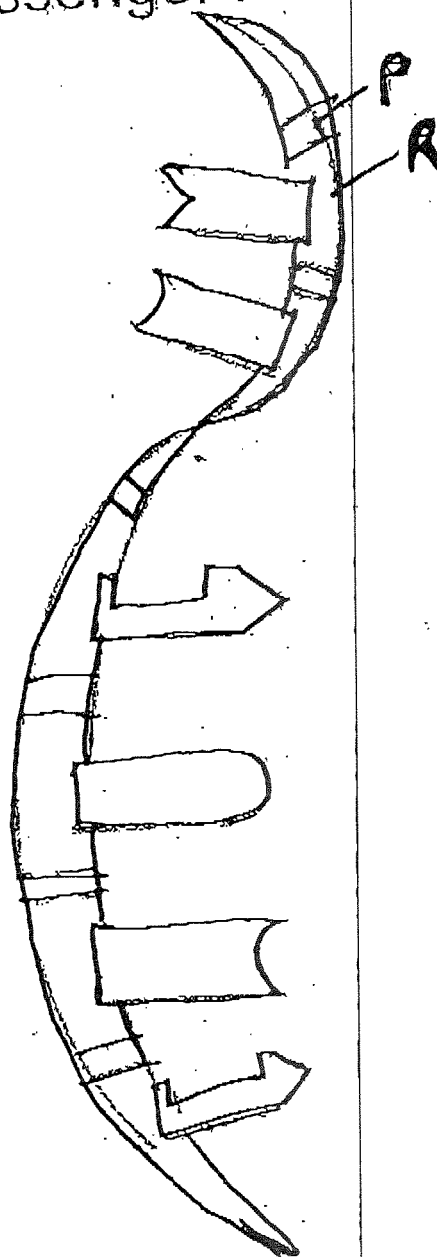
Every cell in your body has the same "blueprint" or the same DNA. Like the blueprints of a house tell the builders how to construct a house, the DNA "blueprint" tells the cell how to build the organism. Yet, how can a heart be so different from a brain if all the cells contain the same instructions? Although much work remains in genetics, it has become apparent that a cell has the ability to turn off most genes and only work with the genes necessary to do a job. We also know that a lot of DNA apparently is nonsense and codes for nothing. These regions of DNA that do not code for proteins are called "introns", or sometimes "junk DNA". The sections of DNA that do actually code for proteins are called "exons".

Color the images according to the instructions.

DNA - The Double Helix



Messenger RNA



Name _____

1. Write out the full name for DNA. _____
2. What is a gene? _____
3. Where in the cell are chromosomes located? _____
4. DNA can be found in what two organelles? _____
5. What two scientists established the structure of DNA? _____
6. What is the shape of DNA? _____
7. What are the sides of the DNA ladder made of? _____
8. What are the "rungs" of the DNA ladder made of? _____
9. What sugar is found in DNA? _____ In RNA? _____
10. How do the bases bond together? A bonds with _____ G bonds with _____
11. The two purines in DNA are _____
12. DNA is made of repeating units called _____
13. Why is RNA necessary to act as a messenger? Why can't the code be taken directly from the DNA?
14. Proteins are made where in the cell?
15. How do some cells become brain cells and others become skin cells, when the DNA in ALL the cells is exactly the same. In other words, if the instructions are exactly the same, how does one cell become a brain and another a skin cell?
16. Why is DNA called the "Blueprint of Life"?

