



Nucleic acids

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, and parts of individual cells. The proteins that are made largely determine how you look. The proteins that will be made for your body are determined by the **sequence of DNA** in the nucleus.

What important polymer is located in the nucleus? _____

_____ is the instructions for making a cell's _____.

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 some organelles such as the **mitochondria** and **chloroplasts**. It is the DNA in the nucleus that actually controls the cell's workings.

_____ on chromosomes code for specific _____ in a cell.

DNA is also found in _____ and _____.

In 1953, **James Watson** and **Francis Crick** established the structure of DNA. The shape of DNA is a double helix, which is like a twisted ladder. The sides of the ladder are made of alternating sugar and phosphate

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molecules. The sugar is a pentose called deoxyribose. *Color* all the phosphates pink (one is labeled with a "p"). *Color* all the deoxyribose sugars blue (one is labeled with a "D").

What is meant by a double helix? _____

Name a pentose sugar. _____

The sides of DNA are made of _____ and _____.

The rungs of the ladder are pairs of 4 types of **nitrogen bases**. The bases are known by their coded letters --- **A, G, T, and 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 that 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.)

What makes up the "rungs" of DNA? _____

What will pair with adenine? _____

Color the thymines orange.

Color the adenines green.

Color the guanines purple.

Color the cytosines yellow.



Note 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

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single ringed and the **purines** are **double ringed**. **Color** the nucleotides using the same colors as you colored them in the double helix.

Nucleotides are made of a pentose _____, a _____, and a nitrogen-containing _____.

Name 2 bases with double C-N rings. _____

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.

_____ bonds between bases must be broken to copy DNA.

Copying DNA to make two, identical DNA molecule is called _____.

Messenger RNA

So, now, we know the **nucleus controls the cell's activities** through the chemical DNA, but how? It is the **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. This 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 (mRNA)**. 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. ↙ ↘

mRNA has a _____ strand of nucleotides.

_____ replaces _____ on RNA.

_____ is the pentose sugar on RNA.

_____, not DNA can leave the nucleus through _____ in the nuclear envelope.

Proteins are made at the _____.

The Blueprint of Life

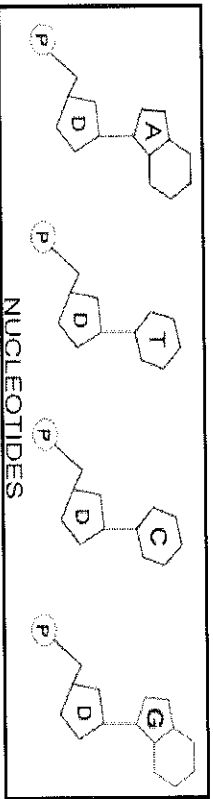
Every cell in your body has the same "blueprint" or the **same DNA**. Like the blueprints of a house tell the builders how to construct a house, the cellular DNA "blueprint" tells the cell how to build the organism. Yet, how can a heart be so different from a brain if all the cells contain the same instructions? 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**."

_____ are non-coding segments of DNA.

Questions:

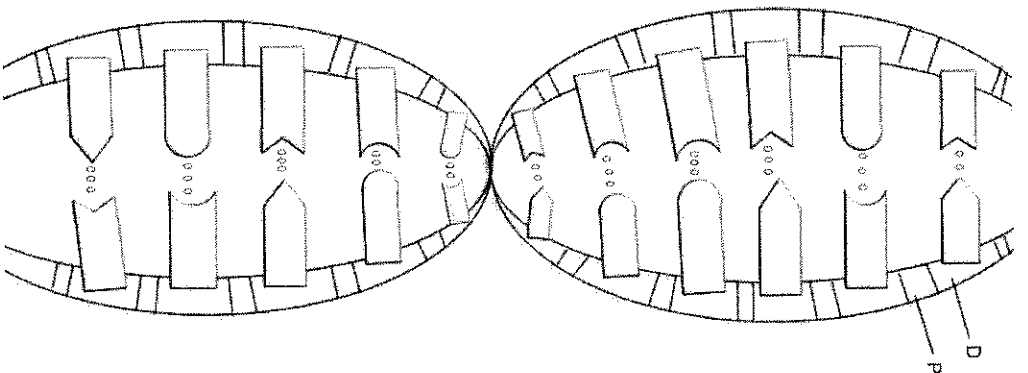
1. Write out the full name for DNA.

2. What is a gene?
3. Where in the cell are chromosomes located?
4. DNA can be found in what organelles in the cell?
5. What two scientists established the structure of DNA?
6. What is the shape of DNA?
7. The sides of the DNA ladder are composed of what?
8. The "rungs" of the DNA ladder are made of what?
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 _____ and _____.
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?
16. Why is the DNA molecule referred to as the "blueprint of life"?

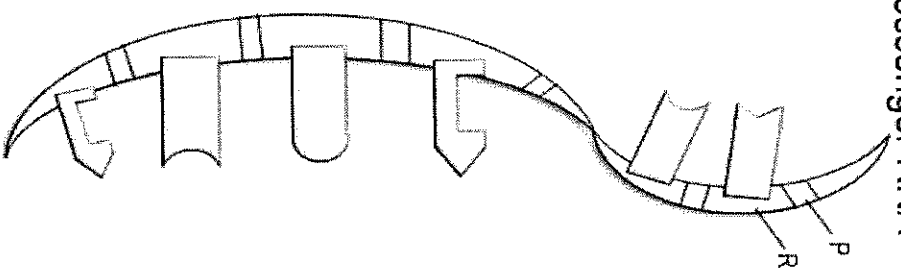


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DNA Molecule



Messenger RNA



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