**What Is DNA?**

**I. Introduction**

Deoxyribonucleic acid (DNA) is a complex molecule found in all living organisms. DNA is the chemical of which genes are composed. An understanding of the organization of this molecule has answered many questions. Scientists now know how chromosomes can duplicate during cell division and transfer their genetic information to new chromosomes. Scientists also understand how chromosomes in the cell nucleus can direct the formation of specific proteins outside the nucleus.

In this investigation, you will learn the names of the molecules that make up DNA and use a simulation to construct a molecule of DNA.

**II. Procedure**

1. Start the activity by going to the following website :

<https://amino.bio/pages/what-is-dna> .

2. Click the “**Start**” button.

DNA is a strand of smaller molecules called nucleotides. Like a pearl necklace,

nucleotides are strung together to form a strand of DNA. Two strands of DNA side-by-

side bind together to form the double helix. A long DNA double helix can be called

a chromosome, and all the DNA of an organism’s cell (one or many chromosomes) is

what makes up a genome.

3. After reading the paragraph, click “**What is DNA made of?**”.

DNA is made up of elements from the periodic table. Carbon, hydrogen, oxygen,

phosphorous, and nitrogen (CHOPN) bond together create nucleotides, the building

blocks of DNA.

4. After reading the paragraph, click “**Learn about nucleotides**” and “**I remembered!**”.

Cells are able to put together atoms in the cell to first form molecules

called **Nucleosides**, which are then later turned into **Nucleotides**. The Nucleoside

molecules, Adenosine, Cytidine, Guanosine, and Thymidine are commonly

abbreviated as A, C, G, T. If you look closely at these molecules, you won’t see

any “P” (phosphorous) in them.

To form a nucleotide, you also need phosphate! Phosphate, is a molecule made

up of phosphorus surrounded by oxygen atoms. When the cell adds a phosphate to

a nucleoside, it can then be called a nucleotide. Nucleotides are what make up a

DNA strand.

5. After reading the paragraphs, click “**Where’s Phosphorus?**”, “**Got it**”, and “**Got it**”.

The Nucleotide molecules, Adenosine, Cytidine, Guanosine, and Thymidine are

commonly abbreviated as A, C, G, T. These are the "Building Blocks" of DNA.

A DNA strand is a string of nucleotides. The A’s, T’s, C’s, and G’s can go in any

order and the DNA strand can be hundreds of millions of nucleotides long! The

order of the nucleotides is the secret information that the cell knows how to read

and write. 

The phosphate of one nucleotide becomes bonded to the ribose sugar ring of

another nucleotide. This often referred to as the sugar-phosphate backbone.

6. After reading the paragraph, click “**How do they fit together?**”, “**Show me the backbone**”,

and “**Got it**”.

When a cell assembles DNA using a protein enzyme called “DNA polymerase”, it

assembles nucleotides (which have phosphates attached).

7. Click “**Start Building a Strand!**” and “**Got it**”.

8. Drag Adenosine, Cytosine, Guanine, Thymine, and Phosphorus to their correct positions.

9. Click “**Learn About Double Helix**”.

Two DNA strands can come together to form “double stranded DNA”. This is also the

infamous Double Helix structure that was discovered in 1953 at the University of

Cambridge due to work by Francis Crick, James Watson, Rosalind Franklin, and Maurice

Wilkens.

10. Click “**Build a Double Helix**”.

All atoms can bond with other atoms. Bonding is an attractive force between

atoms. One very important kind of bond is called a hydrogen bond. Hydrogen

bonds make use of the fact that (+) charges are attracted to (-) charges.

Certain hydrogen atoms (H) in DNA are (+) charged and interact with other oxygen and

nitrogen atoms in DNA, which are (-) charged. Two DNA Strands, like the one you

made can zip together  via hydrogen bonds.

11. After reading the paragraph, click “**View Hydrogen Bonds**”.

12. Click “**Rules of Zipping**” and “**Got it**”.

There are rules on how two strands of DNA can "zip" together. Two strands together are

called “Complementary Strands”.

CHARGAFF’S RULES :

Before the structure of DNA was discovered, a famous scientist called Erwin Chargaff

discovered that the amount of A’s and T’s in organism's DNA were similar, and G’s and

C’s were similar.

This led Francis Crick and James Watson to realize that, in a double helix:

A’s must bind T’s (and T’s bind A’s)  
 G’s must bind C’s (and C’s bind Gs)

13. Click on “ **Build a Complementary Strand**” by moving “A”, “C”, “T”, and “G” to their

correct positions.

14. Click “**What about Genomes?**”.

You just built a short double stranded DNA molecule that has four nucleotides in each

strand. Complementary pairs of nucleotides (*e.g.* A-T, C-G) are sometimes

called **base pairs**. In other words, your double stranded DNA wasfour**base pairs**long**.**

Long strings of double-stranded DNA are what make up **plasmids** and **chromosomes**.

Some organisms (like humans) have many chromosomes of DNA. All of the DNA in an

organism make up its **genome**.

15. After reading the paragraph, click “**See Genomes**”.

A virus is a microscopic infectious agent that is only able to “grow” and replicate when it

is inside the cell of a living organism (such as bacteria, plant cells, or human cells).

Viruses are non-living.

The Lambda Phage is a virus that infects bacteria. The genome of Lambda Phage

is 48,502 base pairs long. That is more than 10,000 times longer than the DNA you

created!

You’ve probably heard of viruses like Chicken Pox. Like Lambda Phage, they have their

own genomes of comparable sizes.

16. After reading the paragraph, click “**Locate Viral Genome**” and then “**Next : Bacteria**

**Genome**”.

Bacteria are more complicated than viruses. Bacteria are able to grow and function

independently. 

Bacteria, like E. coli bacteria have a single large chromosome that is 4,600,000 base pairs

long and is responsible for growth and maintenance of the cell.  E. coli  and other bacteria

can also have extra small circular pieces of DNA called plasmids that are ~5,000 base

pairs long. These plasmids can have extra information that give the bacteria an

advantage, such as antibiotic resistance.  

The E. coli genome is about 100x larger than a viral genome.

17. After reading the paragraph, click “**Locate Bacterium Genome**” and then “**Next : Human**

**Genome**”.

Humans are made up of an estimated one trillion cells. There are hundreds to thousands

of different types of cells that make up the human body.

With the exception of mature Red Blood Cells, each human cell has a copy of that

person’s genome.

Human cells are much more complicated than bacteria cells and this shows in the size of

a human genome. The human genome is about 3,000,000,000 base pairs long. This is

about 1000x larger than bacterial genomes!

Unlike how an E. coli bacterium genome is one chromosome, a human genome is made

up of 46 chromosomes.

18. After reading the paragraph, click “**Locate Genome In Human**” and then “**Next : Plant**

**Genome**”.

The largest known genome is 150,000,000,000 base pairs. That’s right, the largest

genome we know of is in a plant!  

This genome is 50 times larger than the human genome.

19. After reading the paragraph, click “**Locate Genome in Plant Cell**” and then “**Next**”.

20. Review the **Summary** page and click “**Next**”.

**III. Analysis**

1. Match the correct nitrogenous base (adenine, cytosine, guanine, thymine) with its

complementary base.

G –

C –

T –

T –

A –

C –

A –

G –

G –

G –

T –

A –

C –

G –

T –

C –

A –