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. How does it do this? The nucleus controls these activities by the chromosomes. 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.

Chromosomes are composed of genes. A gene 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 structure is a double helix, which is like a twisted ladder. The rungs of the ladder are pairs of 4 types of nitrogen bases. Two of the bases are purines - adenine and guanine. The pyrimidines are thymine and cytosine. The bases are known by their coded letters A, G, T, C and 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.) The sides of the ladder are made of alternating sugar and phosphate molecules. The sugar is deoxyribose.

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

The combination of a single base, a deoxyribose sugar, and a phosphate make up a nucleotide. DNA is actually a molecule or repeating nucleotides. Examine the nucleotides closer. 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. The two sides of the DNA ladder are held together loosely by hydrogen bonds. In the diagram notice that there are two hydrogen bonds between A&T and three hydrogen bonds between C&G.

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 it, 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? Each 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 is nonsense and codes for nothing. These regions of DNA that do not code for proteins are called **introns** or junk DNA. The sections of DNA that do actually code for proteins are called **exons**.

The form and function that all living things exhibit are dictated by DNA. DNA is considered by scientists to be the basic building block or blueprint of life. In this project you will be asked to think about the form and the structure that DNA assumes, as well as what materials it is composed of as you enter your design problem. You have been hired by the local museum to create a scaled up model of DNA and an accompanying visual aid that are needed for a museum display. You will be working in a team of two or three to create a 3-D model of DNA.

*Parameters of the 3D Model*

* Double helix shape
* Proper base pairing with purines being larger than pyrimidines
* Correct number of hydrogen bonds between base pairs
* Backbone made of sugars and phosphates
* Sugars are larger than phosphates
* Bases are connected to sugars of the backbone
* 10 bases per turn with at least 1 full turn present
* Proper scale
* Model is not taller than 60 cm
* Legend/key showing which materials represent each part of the DNA (scale bar included)

*Evaluation of DNA Exhibits*

* You will first grade your own team’s DNA exhibit including evaluated the work each person in the group completed. Each team member must complete his/her own evaluation.
* You will grade three DNA exhibits designed by other students.
* Each model and visual display will also be graded by a teacher for accuracy, creativity, and neatness
  + The model should be artistic and show creativity. It should be able to stand on its own.
  + Obvious time and effort should go into your model and it should be of high quality

*Engineering Notebook- This will be part of your participation grade*

* Colored diagrams should be taped in
* Sketch of your DNA model design with labeled materials
* Daily record of work that was accomplished each day
* Changes made to original design with explanation of why changes were made

**Conclusion Questions** *(Answer in your engineering notebook)*

1. Describe the work your group went through in order to get to the final DNA model.
2. How is creating a model useful in science, business, or any other industry?
3. Based on what you know about hydrogen bonds between bases, which pair (A&T or C&G) would you expect there to be a shorter distance between the bases? Why?

Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Hour: \_\_\_\_\_

**Checkpoint Questions**

1. Why is the nucleus called the “control center” of the cell?

2. What is a gene?

3. Where in the cell are chromosomes located?

4. DNA can be found in what organelles?

5. What two scientists established the structure of DNA?

6. What are the sides of the ladder made of?

7. What three parts make up a single nucleotide?

8. What are the four bases that make up the rungs of the DNA ladder?

9. What is the base-pair rule?

10. What sugar is found in DNA?

11. What is DNA called the blueprint of life?

12. How is it possible for your cells to have the same genetic code but turn out to be very different (i.e. the genes in a lung cell are the same as the genes in a liver cell but they do a different job)?