Name _____ Date _____ Class _____

TAKS OBJECTIVE 2 ORGANIZATION OF LIVING SYSTEMS

The Structure and Function of Nucleic Acids

DNA

You might know that genes contain the information that determines an organism's traits. But did you ever wonder what genes look like and how they work?

For many years scientists knew that genes were located on **chromosomes**, structures found in the nucleus of most cells. Scientists also knew that genes were made of protein and **DNA** (deoxyribonucleic acid). But it wasn't until the 1950s that two researchers—James Watson and Francis Crick—were able to piece together the structure of DNA. This discovery was important because it enabled scientists to clarify *how* DNA determines traits and how the traits are passed from generation to generation.

Watson and Crick determined that DNA is a long, thin molecule that looks like a twisted ladder—a double helix. As you can see in Figure 5-1, the two sides of the ladder are made of **nucleotides**. Each nucleotide is made of three parts:

- a phosphate group,
- a five-carbon sugar molecule, and
- a nitrogen-containing base.

You can see in the diagram how these three parts are put together to form a nucleotide. Nucleotides are identical except for the bases, which can be **adenine**, **thymine**, **guanine**, or **cytosine**. Notice that the two sides of the DNA ladder are composed of alternating sugar and phosphate molecules. The rungs of the ladder are composed of pairs of nitrogen bases held together by weak hydrogen bonds.

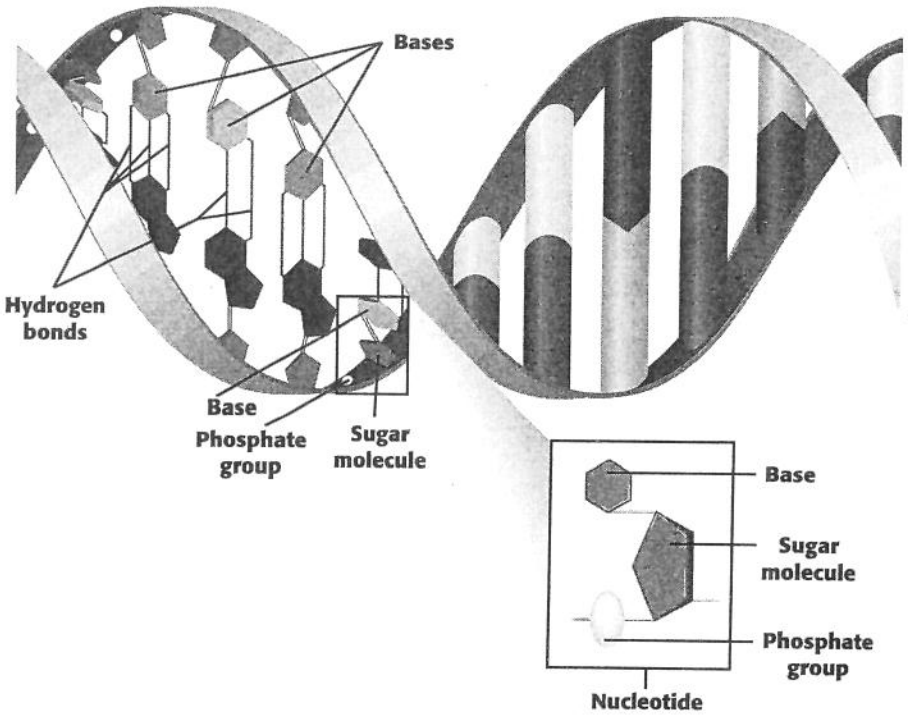

Figure 5-1

Name _____ Date _____ Class _____

How DNA stores information

A single DNA molecule may be composed of many thousands of nucleotides. In fact, a human cell has 46 chromosomes with more than 5 billion nucleotides! The DNA molecules in a single human cell contain information equal to the amount found in a thousand 500-page books. How does a tiny molecule like DNA accomplish such a feat?

Remember that the nucleotides in a DNA molecule are arranged so that the sugar molecules and phosphate groups make up the sides of the ladder, and four different nitrogen-carrying bases make up the rungs. These bases always pair up in a specific pattern: adenine (A) pairs only with thymine (T), and guanine (G) pairs only with cytosine (C). The sequence in which the nucleotides are arranged along the ladder is the **genetic code** that determines the characteristics of an organism.

The order in which the bases on one side of a DNA ladder are arranged determines the order of the bases on the other side of the ladder. In other words, the two sides—or strands—are **complementary**. For example, you can see in Figure 5-2 that on one section of a strand, a sequence of four bases is GACC. The sequence on the matching section of the other strand is CTGG. The reason that the bases only pair up in certain ways is because the hydrogen bonds can only form between thymine and adenine and between guanine and cytosine.

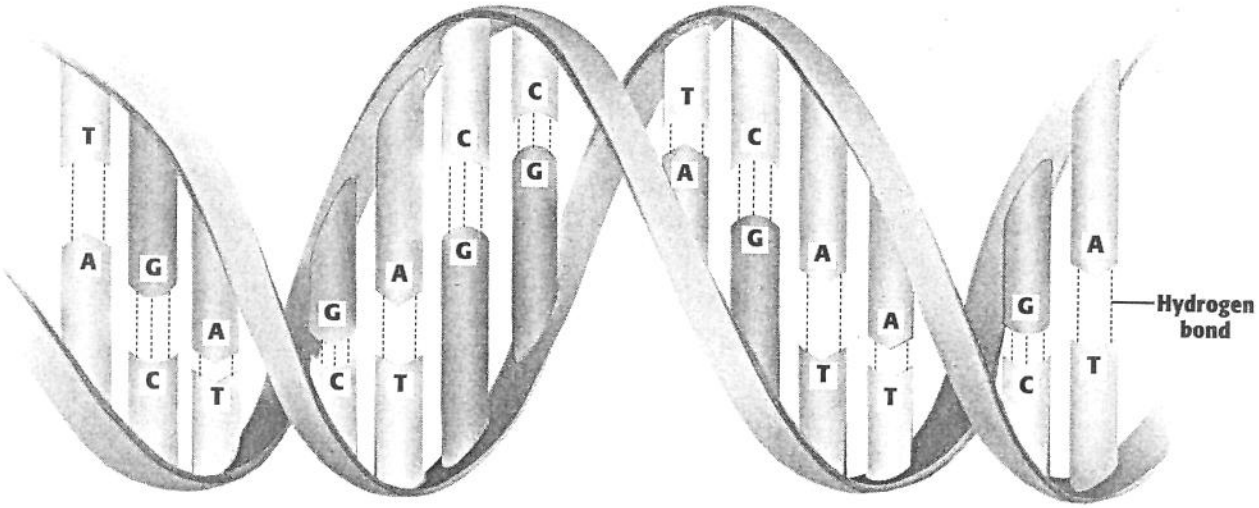

Figure 5-2

Name _____ Date _____ Class _____

DNA replication

Look at Figure 5-3. Notice that the two strands of DNA are separating. This important characteristic of the DNA molecule is what enables it to build new, exact copies of itself. This process is called **DNA replication**. Replication is important because it enables cells to pass genetic material to offspring. The diagram shows how DNA replicates before cell division. Follow along in the diagram as you read the steps of replication.

Step 1 The hydrogen bonds that connect the complementary bases are broken by enzymes called DNA helicases. Additional proteins attach to each strand to hold them apart and keep them from twisting back into their double helix shape. The DNA molecule separates down the middle.

Step 2 Enzymes called DNA polymerases move along each DNA strand and add nucleotides to the exposed nitrogen bases from a supply of "free-floating" nucleotides in the nucleus. As the DNA polymerases move along, two new double helixes begin to form.

Step 3 Every T (thymine) pairs with an A (adenine), and every G (guanine) pairs with a C (cytosine). There are now two DNA molecules, each containing one old and one new strand.

The DNA polymerases constantly "proofread" each new DNA strand as it forms. They can add nucleotides to a growing strand only if the previous nucleotide is correctly paired to its complementary base. They also can remove an incorrect nucleotide and replace it with the correct one. In this way errors are prevented. In fact, only one error per 1 billion nucleotides typically occurs. These errors are called **mutations**.

You might think that replication begins at one end of a chromosome and proceeds to the other end, but that process would be too slow. In a human chromosome it would take 33 days. Instead, each human chromosome is replicated in about 100 sections that are 100,000 nucleotides long, each with its own starting point—in about 8 hours!

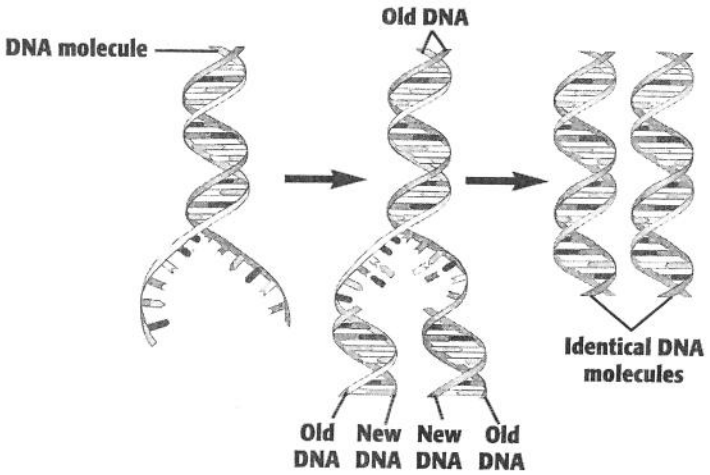

Figure 5-3

Name _____ Date _____ Class _____

TAKS OBJECTIVE

2 TAKS PRACTICE QUESTIONS

1 Where in a cell are all the traits of an organism encoded by a set of instructions?

A Cytoplasm

B DNA

C Vacuoles

D tRNA

	D	d
D	DD	Dd
?	D?	d?

2 The Punnett square above shows a cross between two individuals that are heterozygous for a trait. What is the missing parental allele?

F *d*

G *D*

H *Dd*

J *DD*

3 A change in which part of a gene is the result of a mutation?

A Hydrogen bonds

B Sugar molecule

C Phosphate molecule

D Base sequence

4 Which sequence of bases will pair with the base sequence CTAGGATTC in a DNA molecule?

F GATCCTAAG

G ATGTTGCCA

H CTAGGATTC

J CAATCCTAG

GO ON