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# 40 DNA and RNA

## PURPOSE

To learn how the components of DNA and RNA molecules interact.

## MATERIALS

cellophane tape

scissors

## INTRODUCTION

Two nucleic acids play important roles in biology—deoxyribonucleic acid, or DNA, and ribonucleic acid, or RNA.

The building blocks of nucleic acids are nucleotides. Each nucleotide is made up of a sugar, a phosphate group, and a nitrogen base.

The sugar in DNA is called deoxyribose. Its formula is $C_5H_{10}O_4$. The sugar in RNA is ribose. Its formula is $C_5H_{10}O_5$. By comparing the two formulas you should be able to tell what the "deoxy-" part of DNA refers to.

The phosphate groups on all the nucleotides are the same.

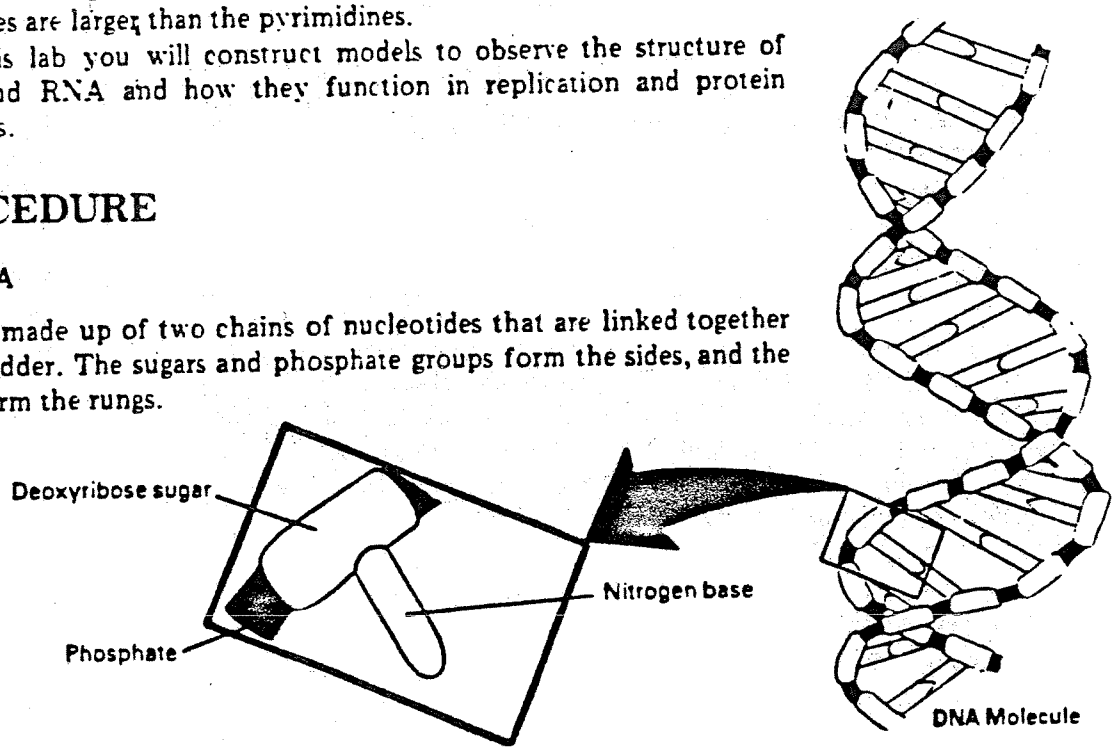
There are four nitrogen bases in DNA and four in RNA. The bases occur in two groups: the purines and the pyrimidines. The purine molecules are larger than the pyrimidines.

In this lab you will construct models to observe the structure of DNA and RNA and how they function in replication and protein synthesis.

## PROCEDURE

### A. DNA

DNA is made up of two chains of nucleotides that are linked together like a ladder. The sugars and phosphate groups form the sides, and the bases form the rungs.



The four nitrogen bases in DNA are adenine, thymine, guanine, and cytosine. They are usually referred to by their initials: *A*, *T*, *G*, and *C*.

Cut out the 24 DNA nucleotides on page 207.

1. Which two bases belong to the purine group?

_____

2. Which two bases belong to the pyrimidine group?

_____

Choose six of the nucleotides, making certain that you have at least one *A*, *T*, *G*, and *C*. Place the six nucleotides face down on your desk and mix them up. Now turn over one nucleotide. This will be the first link of a nucleotide chain (one strand of DNA). *Randomly* turn over the other nucleotides, one by one, and link each to the chain. Tape the chain together along the sugar-phosphate "backbone."

The letter code of your six nucleotides is written in order of their placement on the chain, in groups of three. The code of the illustrated example is: ATT, GCT.

3. Write the letter code of your chain in the space below and on the chalkboard.

_____

When everyone has done this, see if there are any duplications.

4. Probably each chain is unique. Explain why.

_____

_____

You made the chain by linking the nonlettered sides of the molecules—sugars to phosphates. The lettered parts—the nitrogen bases—also fit together. Using the unlinked nucleotides, find out which kinds of bases fit together.

5. What purine-pyrimidine pairs can you form?

_____

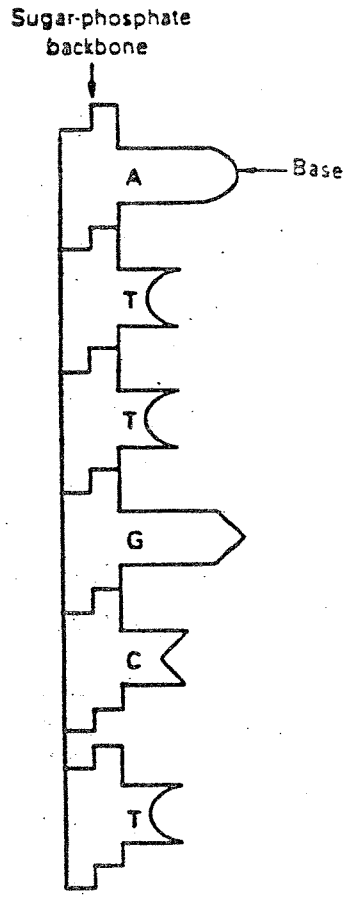
Find six unlinked nucleotides whose bases fit the bases of the nucleotides in your six-member chain. As you fit the bases, note that the sugars and phosphates of the new nucleotides link to form another chain. The end result should look like a ladder—a DNA ladder.

Tape the new sugar-phosphate backbone together. Leave the bases (the rung of the ladder) untaped.

6. Compare the positions of the new nucleotides with the positions of the original ones.

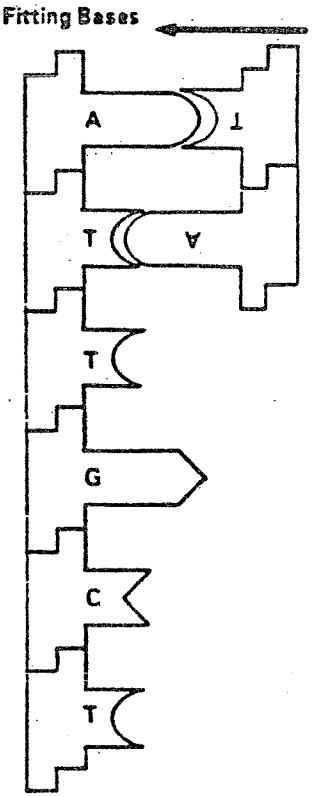
_____

Example of Nucleotide Chain




(The order of nucleotides in your chain will probably be different.)

Fitting Bases



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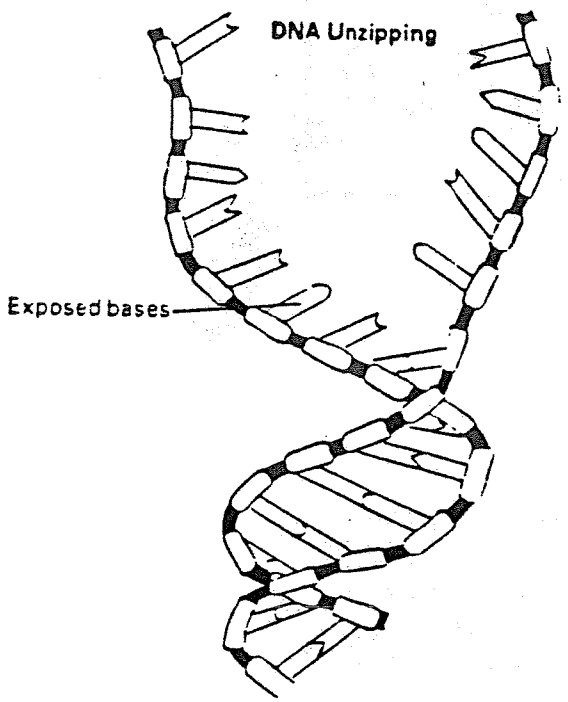
## B. DNA Replication

Exactly the same sequences of DNA (packaged in chromosomes) are found in every cell nucleus of an organism. That is possible because before each cell division, each DNA ladder makes a copy—a replica—of itself. The copying process is called replication.

During replication, the DNA molecule "unzips" by breaking the bonds that hold the pairs of bases together. The ladder comes apart at the middle of each rung. As this happens, free nucleotides floating in the surrounding area are attached to the exposed nucleotides of the DNA strand.




You can see how this works on your DNA model. Separate the DNA molecule you made into two halves lengthwise (the untaped part). The nitrogen bases should now be exposed. The sugar-phosphate backbones should remain taped together.

Take the remaining 12 DNA nucleotides that you cut out. Match their bases to the newly exposed bases of your DNA ladder. Continue the process until all the bases are connected. Tape together the sugar-phosphate backbones of the nucleotides you added. Do not tape the bases.

7. How does each new nucleotide chain compare to the one on which it was formed?

_____

8. What is the result of DNA replication?

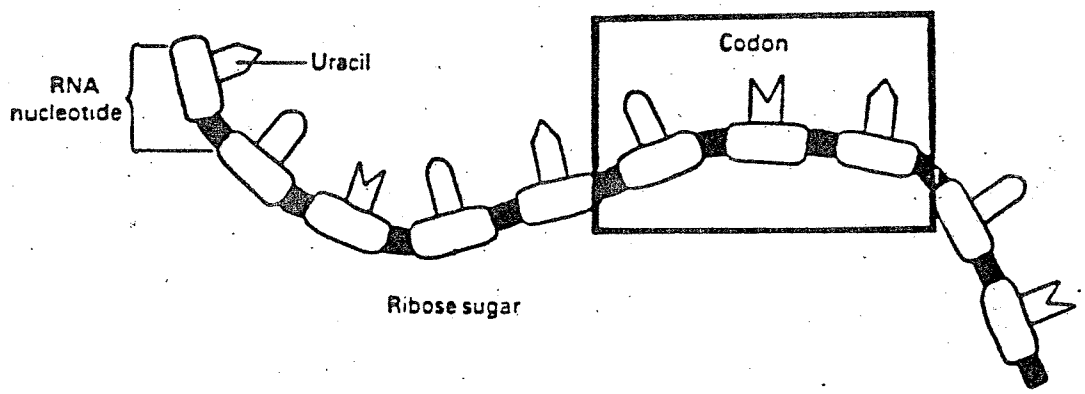
_____

9. How much of your new DNA chain is from your original DNA molecule?

_____

C. Messenger RNA

Messenger RNA (mRNA) carries the DNA code out of the cell nucleus to the ribosomes, and there directs the synthesis of proteins.




Messenger RNA

The structure of RNA nucleotides differs from DNA. In addition to having a different sugar, RNA has the base uracil instead of thymine.

Messenger RNA is a single strand, formed on one of the halves of the DNA ladder which serves as a pattern. The DNA molecule unzips part way, and the RNA nucleotides attach to one of the DNA strands. Only one strand of DNA is ever "read" by the mRNA.

- Cut out the 12 RNA nucleotides on page 207.

10. Which two bases belong to the purine group?

_____

11. Which two bases belong to the pyrimidine group?

_____

12. Are the purines the same as the DNA purines? If not, how are they different?

_____

13. Are the pyrimidines the same as the DNA pyrimidines? If not, how are they different?

_____

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Unzip one of your DNA ladders. Attach six RNA nucleotides to your one DNA chain, matching the bases. Tape the sugar-phosphate backbone of the RNA strand.

14. Which RNA bases attach to which DNA bases?

_____

Remove the RNA strand from the DNA. Put the DNA chain back together with its matching chain, as before.

Each three-letter nucleotide sequence of the mRNA molecule you just formed is called a *base triplet*, or *codon*. This is the form in which mRNA carries the message, or code, from the DNA to the ribosomes.

15. How many mRNA codons have you formed?

_____

16. List your mRNA codons in the space below and on the chalkboard.

_____

In this lab you made a model of DNA. You replicated your model and used it to form mRNA codons. Your cells do this routinely, as do the cells of every living thing.

## ANALYSIS

17. What are the building blocks of nucleic acids?

_____

18. What is replication?

_____

_____

19. How is the formation of RNA similar to DNA replication?

_____

_____

20. How are the two processes different?

_____

21. What is the message that DNA contains and mRNA carries?

_____

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