

Make a DNA Model

Introduction

Construct a simple DNA model using common household items.



Biological Concepts

- DNA structure
- Complementary base-pairing
- Nitrogenous bases

Background

DNA is the common acronym for deoxyribonucleic acid. DNA is considered the molecular “blueprint” that the body uses for creating new proteins. The DNA structure is universal. All organisms from bacteria to plants to animals have DNA. The DNA molecule is made up of several components—phosphate groups, deoxyribose sugars and nitrogenous bases. The phosphate groups are the “backbone” of the DNA structure that link together the deoxyribose sugars (a pentose, or five-carbon monosaccharide). Each sugar is bonded with a nitrogenous base. Four types of nitrogen bases are present in DNA—adenine, cytosine, thymine and guanine. The bases on opposite strands in the double-stranded structure of DNA are complementary, meaning that adenine only pairs with thymine and cytosine only pairs with guanine in DNA. This specific pairing assists in creating the famous helical structure of DNA, known as a double helix. A simplified diagram of a short section of DNA is shown in Figure 1. The diagrammed segment contains seven base pairs. A real chromosome may contain a single DNA molecule with as many as 10^8 (100 million) base pairs!

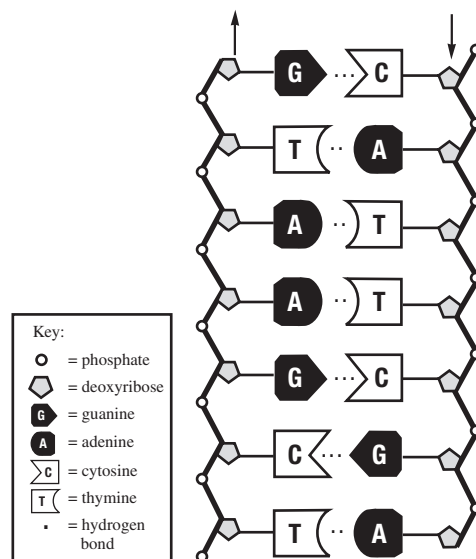


Figure 1. Short DNA Sequence

Materials

Beads, large hole (pony beads), preferably the same color, ≈ 30 (optional)

Chenille wires (pipe cleaners), black, 4

Tape, labeling/masking, 4 different colors, ≈ 1 foot per color

Safety Precautions

The materials used in this activity are considered nonhazardous. Please follow all normal classroom safety guidelines.

Procedure

1. Wrap the ends of two chenille wires together to create a 2-foot-long chain.
2. Repeat step 1 for the other chenille wires.
3. Lay the chenille wires parallel on the tabletop approximately $\frac{1}{2}$ – $\frac{3}{4}$ of an inch apart. Place a piece of tape over one end of each wire to secure the wires to the table.
4. Decide which color tape will be used to represent each nitrogen base (A, C, T, G).
5. Cut approximately a 1–1½" piece of tape and center it on one of the chenille wires about 1½" from the taped end of the wire. Fold the tape over the chenille wire and press the sticky surfaces together. See Figure 2.
6. Repeat step 4 on the second wire, using a “complementary” color of tape. Leave a $\frac{1}{4}$ " or so of the sticky side of the tape exposed and overlap the sticky edge with the piece of tape on the opposite strand. Make sure all bases are paired with a complementary match (see Figure 3).
7. (Optional) Add a pony bead to each wire and move it all the way down the wire to the tape to represent a phosphate group.
8. Repeat steps 5–7, positioning the tape about $\frac{1}{2}$ " below the last set of base pairs, or right below the pony beads if they are being used (see Figure 4).
9. Continue to repeat steps 5–8 until approximately 1½" of free wire is left.
10. Remove the tape that is holding down the wires to the tabletop.

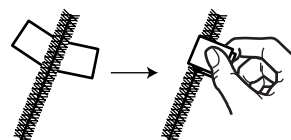


Figure 2.

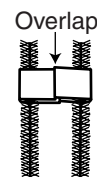


Figure 3.

11. Holding both ends of the double-stranded DNA in opposite hands, twist the two ends in opposite directions like a “corkscrew.” The result resembles a double helix.

Disposal

Extra materials may be saved for future use. Consult your teacher for storage procedures.

Tips

- Decide which color tape will represent each nitrogenous base. You may wish to write this information on the board to remind students as they work on the activity.
- This model is intended to familiarize students with DNA components and structure in a simple manner. Show students an accurate picture or model of a DNA structure, or refer them to a website or textbook.



Figure 4.

Extensions

Deoxyribose sugars and/or hydrogen bonds (three hydrogen bonds for the guanine–cytosine pair, two for the adenine–thymine pair) may also be represented on the model. Be creative and use materials, such as stickers (e.g., a five-pointed star sticker), to represent deoxyribose sugars, or simply draw them on the tape.

Show mutations by incorrectly matching base pairs, eliminate select base pairs to show deletions or generate additions by adding extra sets of base pairs.

To simulate semi-conservative replication, unwind the DNA, separate the two strands and make a new strand to match each of the old strands.

To illustrate transcription, unwind the DNA double helix and pair one of the strands with a complementary RNA strand (remember to add a fifth tape color to represent uracil in place of thymine), creating a single-stranded length of messenger RNA (mRNA).

The activity can be taken even further by assigning particular DNA sequences for students to encode in their models. Have them continue through the processes of transcription and translation (using a genetic code chart) and check amino acid sequences at the end of the activity for accuracy.

NGSS Alignment

This laboratory activity relates to the following Next Generation Science Standards (2013):

Disciplinary Core Ideas: Middle School

MS-LS3 Heredity: Inheritance and Variation of Traits

LS3.A: Inheritance of Traits

LS3.B: Variations of Traits

Disciplinary Core Ideas: High School

HS-LS1 From Molecules to Organisms: Structures and Processes

LS1.A: Structure and Function

HS-LS3 Heredity: Inheritance and Variation of Traits

LS3.A: Inheritance of Traits

LS3.B: Variations of Traits

Science and Engineering Practices

Developing and using models

Crosscutting Concepts

Patterns

Systems and system models

Materials for *Make a DNA Model* are available from Flinn Scientific, Inc.

Catalog No.	Description
AP8862	Chenille Wires, Black
AP1292	Labeling Tape, ½", Red, 120 ft
AP1367	Labeling Tape, ½", Yellow, 120 ft
FB1663	Genetic Code at Work Poster
AP6317	Flinn DNA Molecular Model Set, 11-Tier
AP6318	Flinn DNA Molecular Model Set, 22-Tier
FB1127	DNA Model

Consult your *Flinn Scientific Catalog/Reference Manual* for current prices.