Name: Period:

**_Lab Activity: DNA Origami_**

**_Objectives:_**

*What smaller molecules make up the DNA macromolecule?*
*How (in what order) are these "sub-units" connected to make the DNA macromolecule?*
*What is the tertiary (3-D) shape of DNA?*

**_Materials:_**

DNA template Scissors
Colored pencils

**_Background:_** Organic molecules often form "ringed" structures as carbons bond with other atoms in the molecule.

**_Procedure:_**

1) While referencing the "KEY" page, Answer analysis questions 1 – 7
2) Comparing the shapes of the nitrogen bases on your flat model to the "KEY", determine which shapes are each nitrogen base. Write an "A" in all adenines (in one of the rings). Write a "G" in all guanines (one of the rings). Write a "C" in all cytosines. Write a "T" in all thymines.
3) Color each of the nitrogen bases on the flat DNA model page a different color. Color the "KEY" page according to how you colored the flat DNA model.
4) Answer analysis questions 8 - 11.
5) Select a fifth color and color in the deoxyribose sugars (pentagon shapes) on the flat DNA model. Record your color choice in the data section.
6) Answer analysis questions 12 - 19
7) Follow the Directions to fold your Origami DNA

**_Analysis:_**

1) What are the SIX parts of a DNA molecule?
   a.
   b.
   c.
   d.
   e.
   f.

   (c–f: types of nitrogen bases)

2) What difference in basic structure distinguishes a nitrogen base as a purine versus a pyrimidine?

   Purines:

   Pyrimidines:

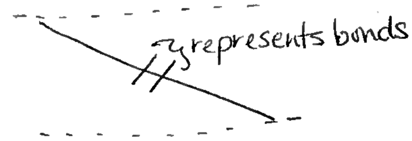
3) Which nitrogen bases are purines?
4) Which nitrogen bases are pyrimidines?
5) What are **two** differences between adenine and guanine?

6) What are **two** differences between cytosine and thymine?

7) Which nitrogen base pairs with Adenine?
   With Guanine?
   With Thymine?
   With Cytosine?

**Refer to STEPS TWO - FOUR in your procedure at this time!**

Look at the flat model (the page that we will be folding)




8) How many bonds connect Adenine and Thymine? ______

9) How many bonds connect Cytosine and Guanine? ______

10) What do you notice about the *types* of nitrogen bases that pair together?

11) What would happen to the diameter of a molecule of DNA if two purines paired and then two pyrimidines paired?

**Refer to STEP FIVE in your procedure at this time!**

12) Note the small black boxes surrounded by four black circles (on your flat model):

   a) What part of the DNA structure does this represent? (refer to the "KEY" page!) ________________

   b) What element do the black boxes represent? ________________

   c) What element do the four black circles represent? ______________

13) What do we call the combination of a deoxyribose sugar, black box with 4 circles, and a nitrogen base attached to the sugar? A ______________________________

14) How many nucleotides are in your model? (looking at just the front or just the back) __________

15) How many of each nitrogen base are found in your model?

Adenine: _____________ Thymine: ____________

Guanine: _____________ Cytosine: ____________

16) What is the basic shape of your flattened DNA model or the diagram below?

17) What subunits (molecules) make up the sides of your model?

   a)

   b)

18) What subunits (molecules)make up the center/middle/steps/rungs of your model?

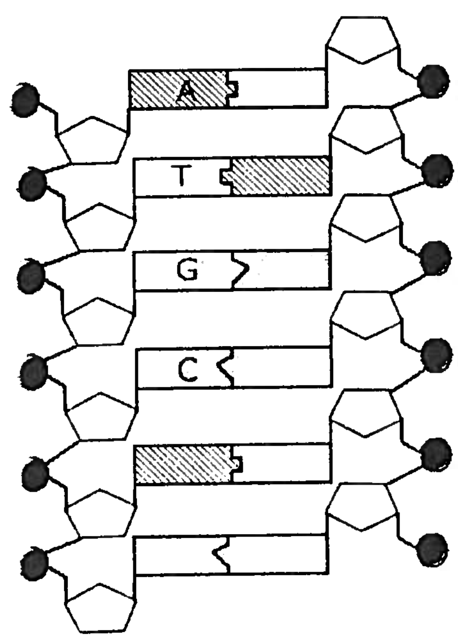
19) LABEL the diagram by Pointing to or circling each of the following:

Phosphate group

Deoxyribose sugar

Nitrogen base

Nucleotide




Identify ALL of the nitrogen bases (A, G, C, T)

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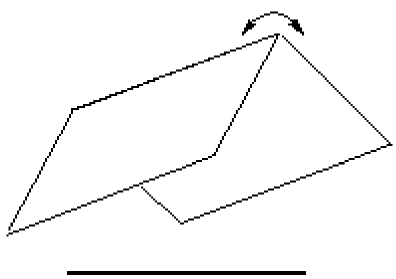
# Origami DNA model

Adapted from Yen, T., 1995, Make your own DNA. *Trends in Biochemical Sciences*, **20**: 94.

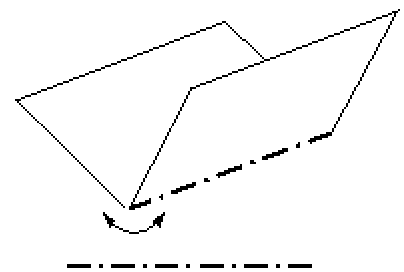
### Folds for your DNA model

Mountain fold



Solid lines are “mountains” and are to be folded away from you with the peak pointing towards you.

Valley fold

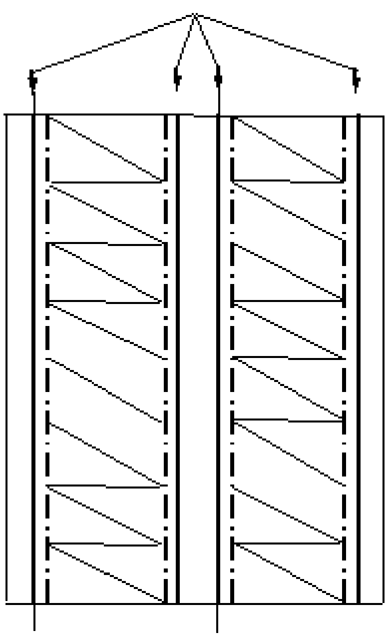


Dashed lines are “valleys” and are to be folded towards you with the peak pointed away from you.

### Making your DNA model

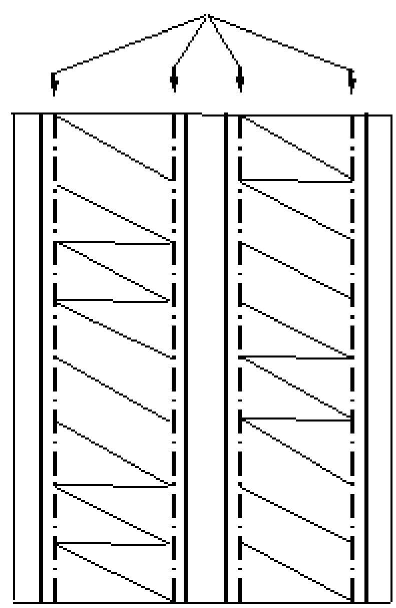
1. Fold all solid lines going lengthwise down the page into "mountain folds".

Mountain folds along solid lines.



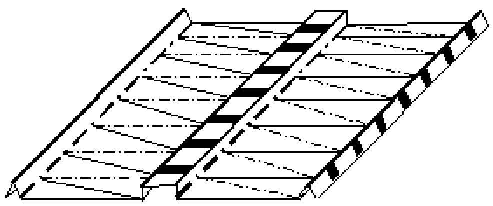
2. Fold all dashed lines going lengthwise down the page into "valley folds".

Valley folds along dashed lines.

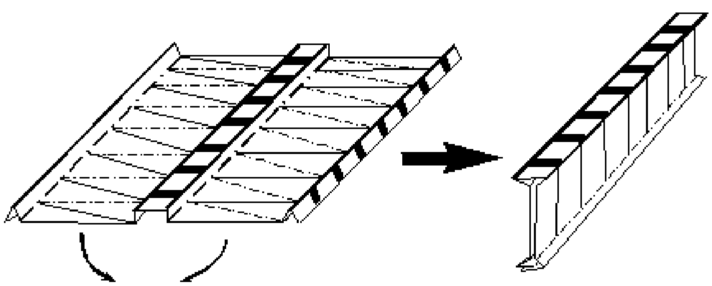


Name: Date:

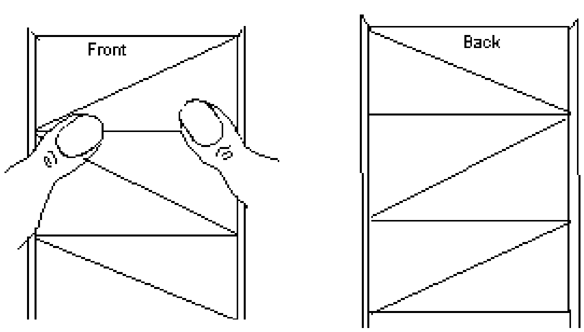
At this point, the paper should look like this:



3. Bring the two sides of the model together, similar to an "I" beam.

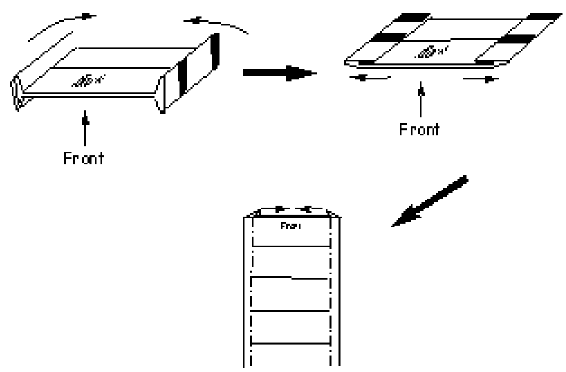


4. Look for the words "front" and "back" at the top of your model. Hold the model with the front side facing you.

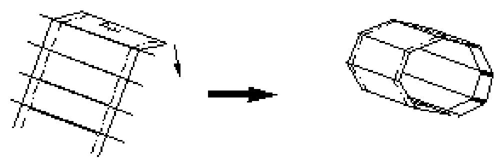



This side should be facing you.

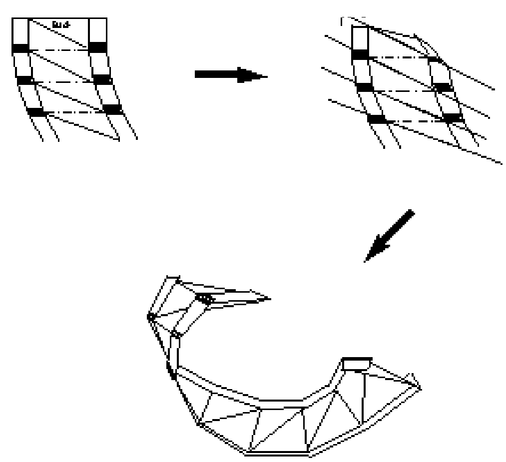
5. Fold the two sides of the DNA model so that the "front" side is flat.




6. Crease each solid, horizontal line into a mountain fold (away from you).



7. Flip the model to the "back" side. Crease each solid diagonal line into a mountain fold (away from you).



Your model should look like this.

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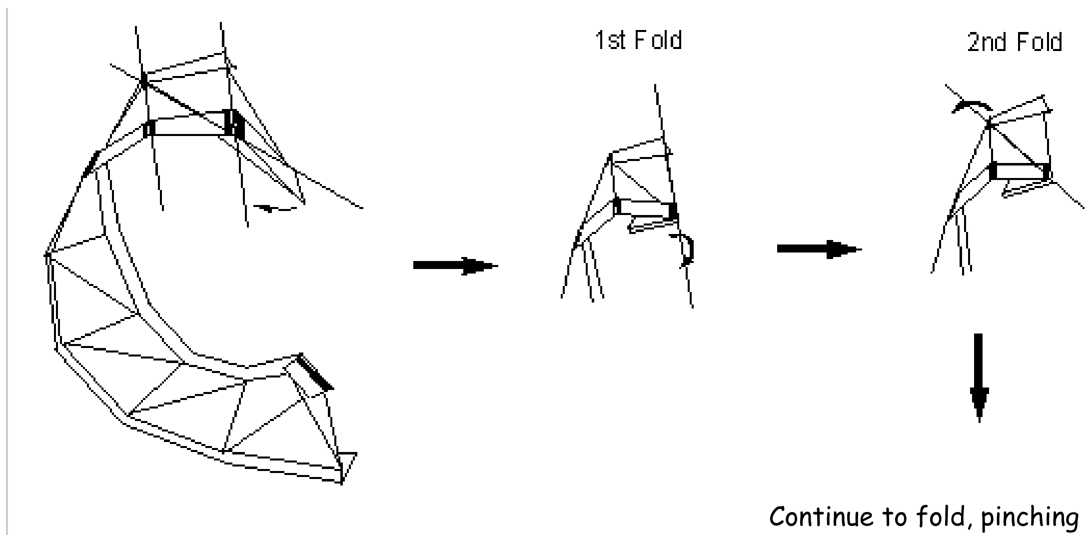
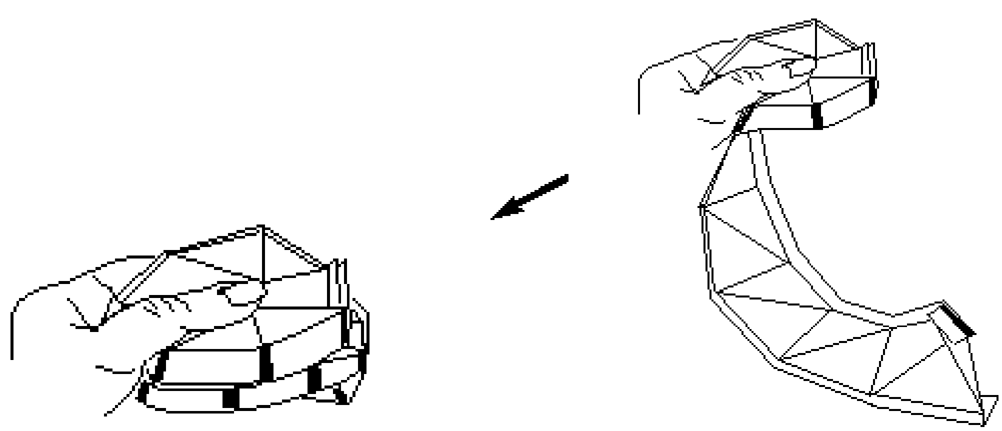
8. Fold ALL of the creases together in the directions of the folds made in steps 6 and 7. Your model will fold up like an accordion. While you are folding, pinch the middle of the model to keep it together to make a cyllindrical shape.

Fold ALL of the creases together like an accordion.
(The dotted lines in the diagrams below may help)

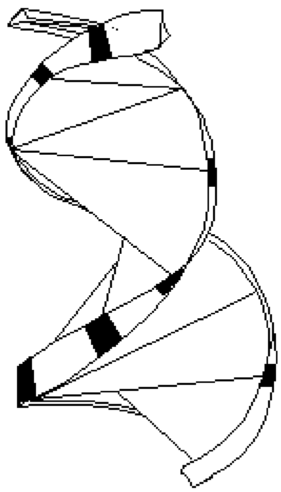



Continue to fold, pinching these folds together in the center as you go.



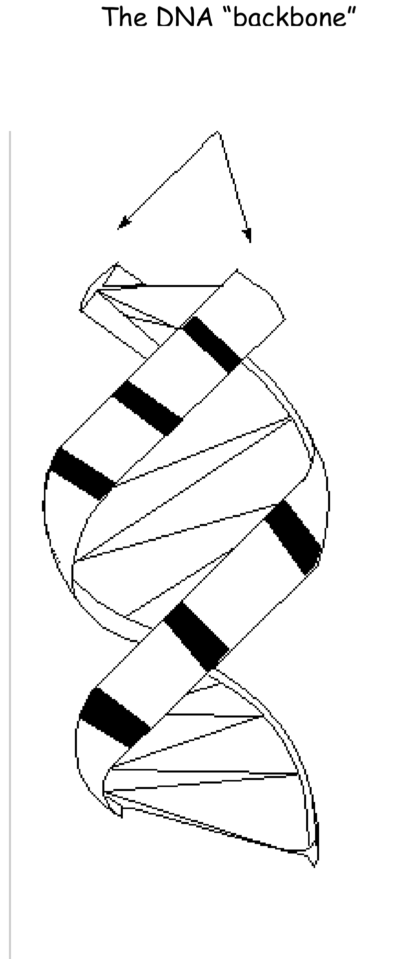
When you are done folding, the model should resemble the diagram above. You should be able to hold your model in one hand.

9. Release the model. You should be able to see the shape of a DOUBLE HELIX.



10. Straighten out the sides of the DNA model (the DNA "backbones" ) to make them perpendicular to the creases in the middle (as in step 3).

Take care not to uncurl the spiral shape.




*Fix your DNA model so that all the creases are neat. This will reinforce the spiral shape.

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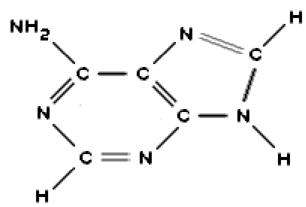
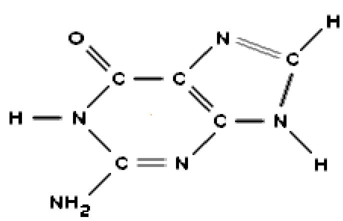
## The nitrogenous bases of DNA

**The purines**

Adenine

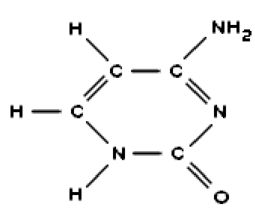


Guanine

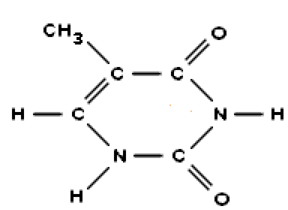


**The pyrimidines**

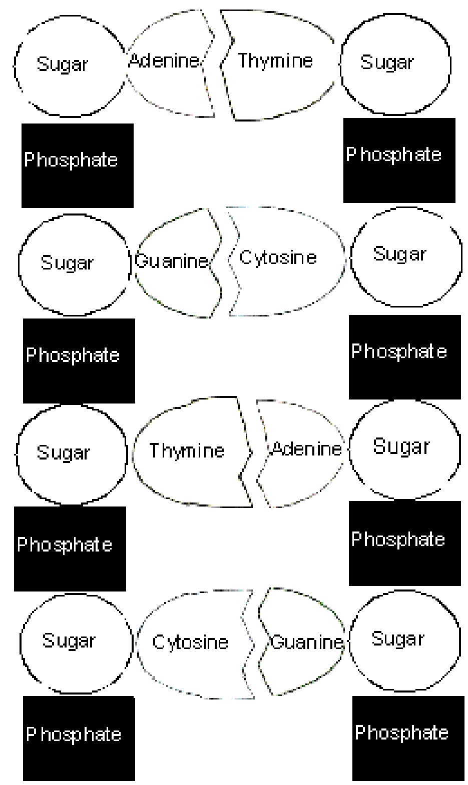
Cytosine



Thymine

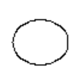


## The DNA molecule




**The DNA molecule is made of six parts:**

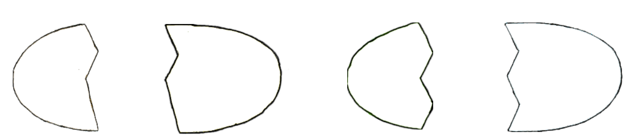
The phosphate-sugar backbone:



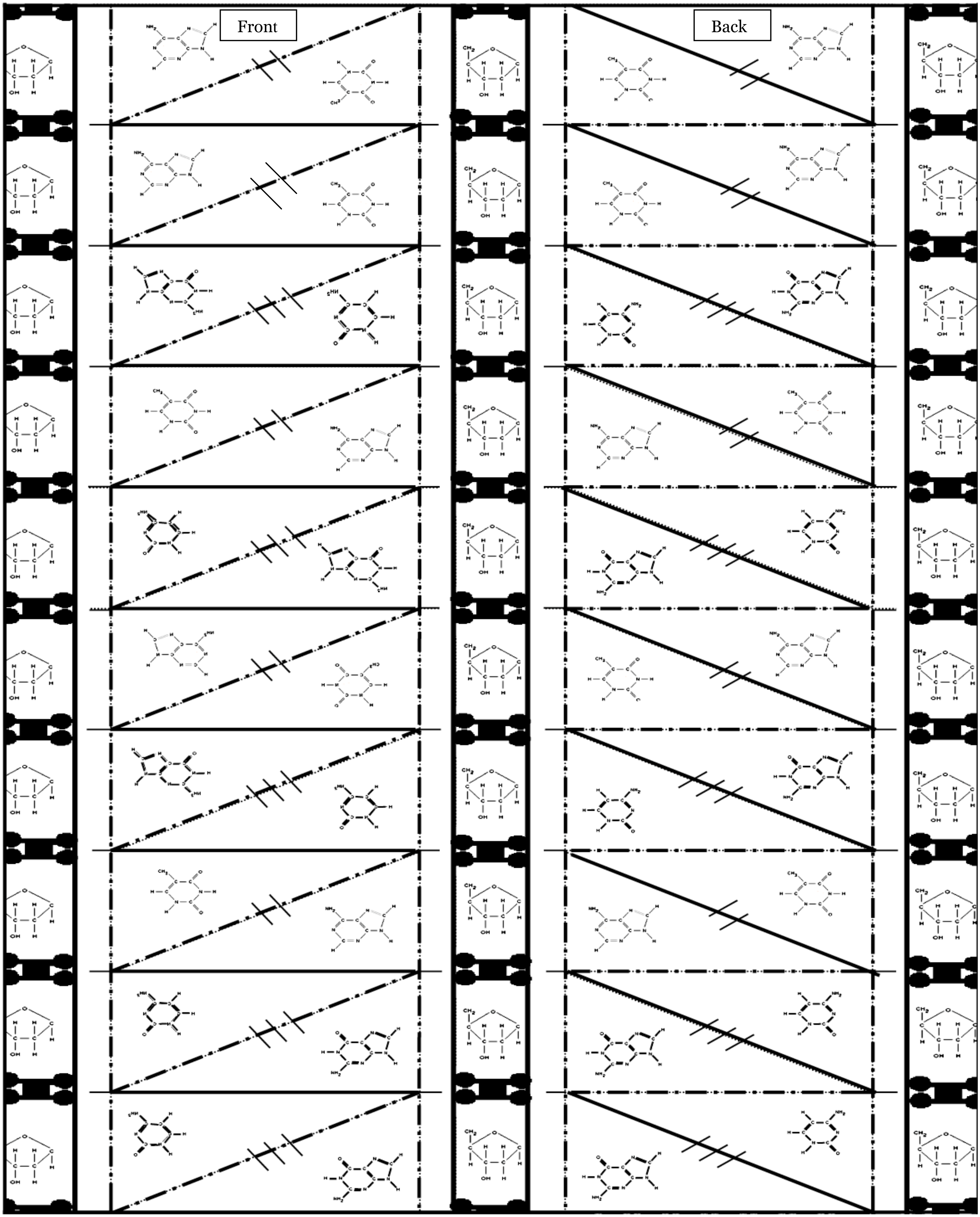
A sugar, called deoxyribose

A phosphate group

Four bases:



Adenine Thymine Guanine Cytosine




Adapted from Yen, T., 1995, Make your own DNA. *Trends in Biochemical Sciences*, **20**: 94.