Chapter 12 **DNA and RNA** **Name _____**

Worksheet Physical Structure of DNA

Information

Deoxyribonucleic acid, or more simply DNA, is a complex molecule found in all living organisms. It is the chemical of which genes are composed. An understanding of the organization of this molecule has answered many questions. Scientists now know how chromosomes can duplicate themselves during cell division and transfer their genetic information to form new chromosomes. Scientists also understand how chromosomes can direct the formation of specific proteins outside the nucleus while still remaining in the nucleus.

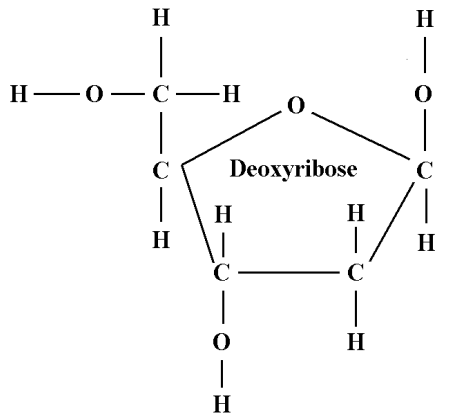
Procedure

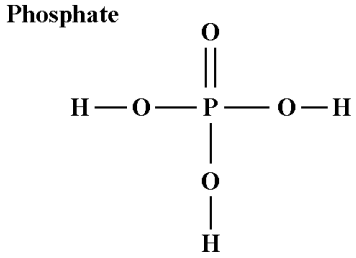
Part A. Structure of a DNA Nucleotide

The molecules which make up DNA are a sugar called deoxyribose, a phosphate, and a nitrogen base. There are four bases in DNA molecule. Each nitrogen base, guanine, thymine, cytosine, and adenine, is chemically joined to a molecule of deoxyribose. A phosphate molecule is also joined to the sugar deoxyribose. These three molecules form a group called a nucleotide.

1. Examine the structural formula for deoxyribose. Fill in the subscripts for this molecule. C H O

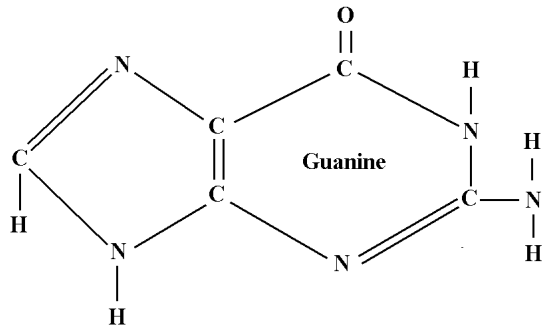
2. The molecular formula for ribose is $C_5H_{10}O_5$. How does a ribose sugar differ from a deoxyribose sugar?

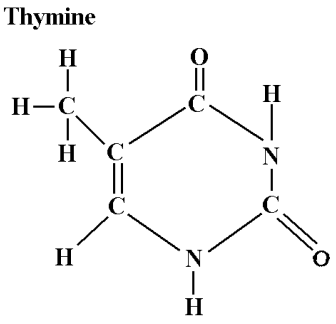


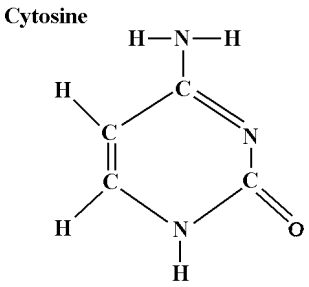


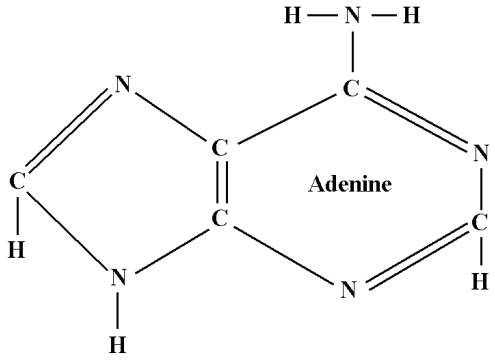
3. Examine the structural formulas for the four nitrogen bases. Two of the bases are larger. They consist of double rings. The other two bases are of a single ring structure. When DNA pairs up to form a double stranded molecule, it is the nitrogen bases that come together and form weak hydrogen bonds. The double ring nitrogen bases are called purines and the single ring bases are called pyrimidines. Always pair a purine base with a pyrimidine base. Never pair a purine base to a purine base or a pyrimidine base to a pyrimidine base. This would cause the DNA molecule to take on an unusual shape. It would bulge out at some places and constrict at others. Which two nitrogen bases are purines and which are pyrimidines?

Purines _____ Pyrimidines _____









4. In the pairing of the bases, it helps to find a memory aid. What memory device will you use to remember that Cytosine always goes together with Guanine and Adenine always pairs with Thymine? Write a short paragraph about the rules of nitrogen bases pairing

5. What type of chemical bond holds the nitrogen bases together? _____ . Are they weak or strong bonds?

Part B. Structure of a DNA Molecule

A DNA molecule looks like a twisted ladder. Deoxyribose sugar and and phosphate molecules join to form the sides or uprights of the ladder. The nitrogen base molecules join together to form the rungs, or steps, of the ladder.

1. Cut out the 24 nucleotide models from the cut out pages. Remember to cut only along solid lines.

2. Connect six nucleotides together to form a backbone of DNA in the following sequence from top to bottom:

   Cytosine nucleotide
   Thymine nucleotide
   Guanine nucleotide
   Adenine nucleotide
   Guanine nucleotide
   Cytosine nucleotide

3. Tape these 6 nucleotides together but do not tape them to the paper. Let this represent the left half of the ladder, or the DNA molecule. Your model should now consist of one strand, or upright, plus six half rungs of nitrogen bases.

4. Name the two molecules which alternate to form the backbone, or side portion, of a DNA molecule.

5. Name the specific molecule to which each nitrogen base is attached.

6. Name the molecule part of the nucleotide which forms the half rungs of the ladder.

7. Complete the other side of the DNA ladder by matching the complimentary nitrogen bases to that of the first side which you just put together. It will be necessary to tip the cutouts upside down in order to join the nitrogen bases. Do not tape the complimentary bases together at this time. Just put both DNA strands together to resemble a ladder. Your completed model should look like a ladder with matched bases as the rungs. Besides being shaped like a ladder, a DNA molecule is twisted. It would look like a spiral staircase. However, your paper model cannot show this very well.

8. Is the order of half rung bases exactly the same from top to bottom on each side of your model?

9. Only two combinations of base pairings are possible for the rungs. Name these molecular combinations, or pairs.

10. With your knowledge of chemical bonds and the shape of the models, how might you explain the observation that only certain bases can combine to form complete rungs?

11. If four guanine bases appear in a DNA model, how many cytosine bases should there be?

12. Your DNA model has four guanine bases. Does the number of cytosine bases in your model agree with your prediction?

13. The following are the bases on the left side of a DNA molecule. List the bases that would make up the right side of a DNA molecule. The first pair is already done for an example and the number of hydrogen bonds are shown as either two or three horizontal lines separating the two bases. Figure out the correct number from the sample below.

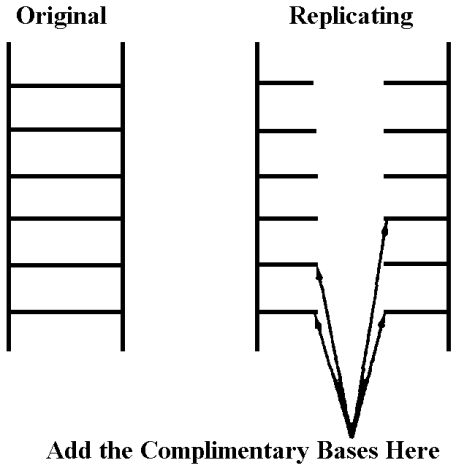
Thymine	=	Adenine
Adenine	=	_____
Guanine	≡	_____
Guanine	≡	_____
Cytosine	≡	_____
Thymine	=	_____
Cytosine	≡	_____
Adenine	=	_____

Part C. Chromosomes and How They Copy Themselves

Your DNA model represents a short length of the DNA portion found in a real chromosome . An entire chromosome has millions of rungs rather than only six. Although your model is only a small part of a chromosome, its replication process is the same as that of an entire chromosome during the S phase of the cell cycle.

1. Open your DNA model along the point of attachment between the nitrogen base pairs (rungs) and separate the two ladder halves. A real chromosome "untwists" and "unzips" in a similar way prior to replication. See Figure 1 below.

Figure 1



2. Using the left half of your model as a pattern, add new nucleotides to form a new right side. Tape the nitrogen bases together to form a complete DNA model. Build a second DNA model by adding new nucleotides to the right half of the original model. Tape the two DNA models to a piece of paper provided by your teacher.

3. Do the two new molecules contain the same number of rungs?

4. Compare the two DNA models. Is the order from the top to bottom of nitrogen base pairs different or the same?

5. How many molecules of adenine and thymine are in each DNA molecule? _____ Do the numbers agree?

6. Are the two DNA molecules exact copies of each other?

7. Explain how the pairing of bases serves as a pattern or template for producing exact chromosome copies during cell division.

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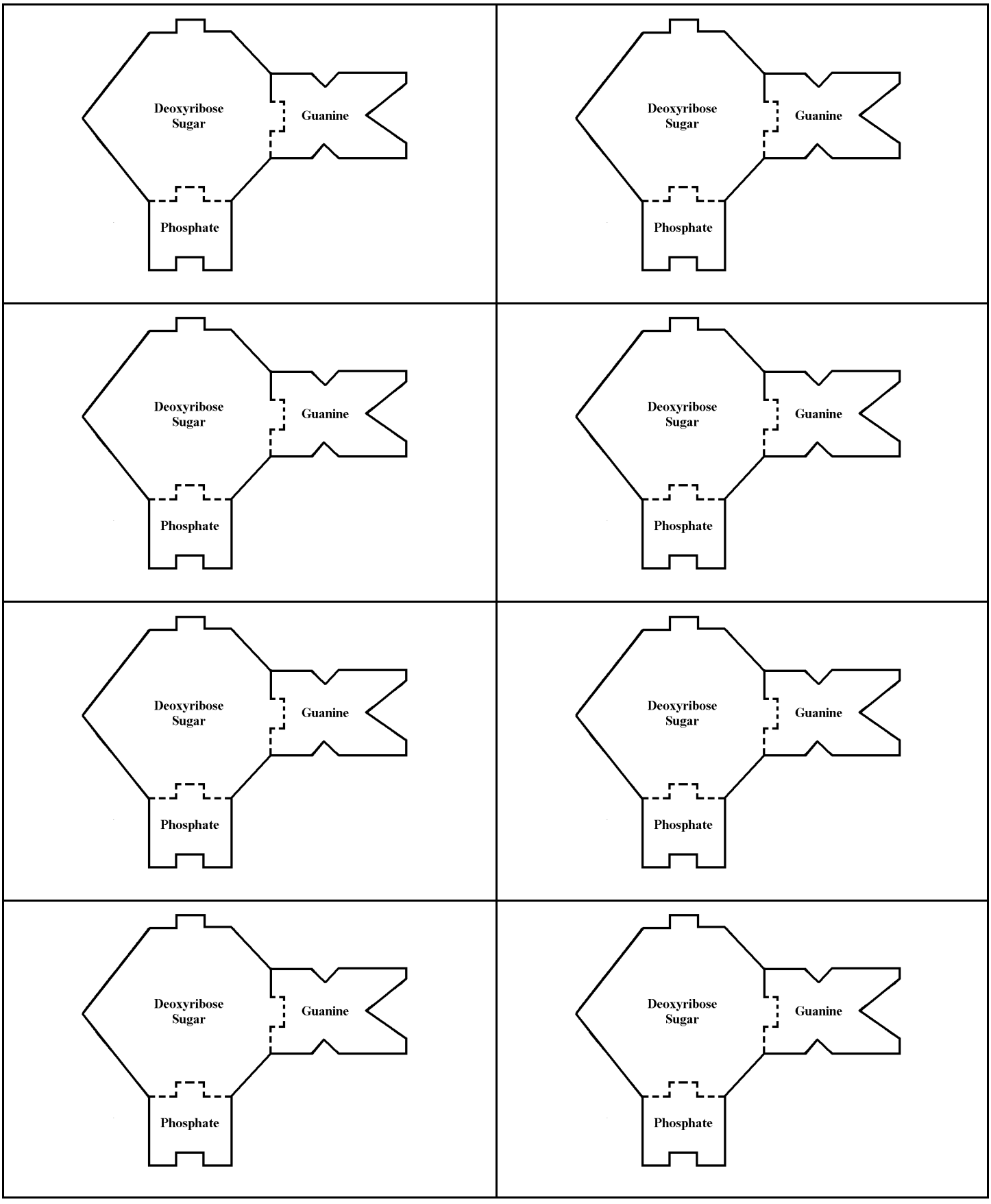

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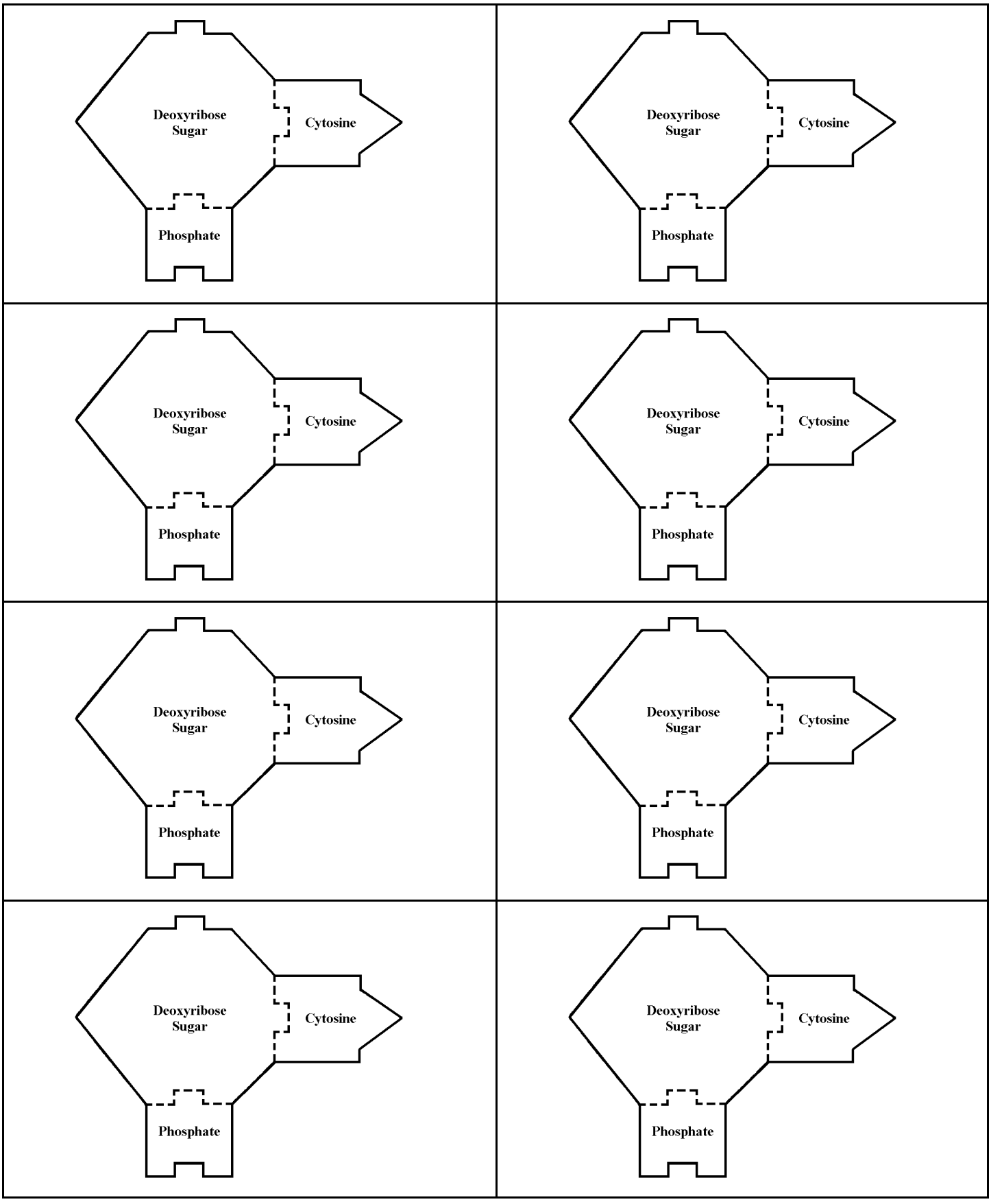

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