Name _____

Date _____ Hour _____

OBSERVATIONS

1. Describe the appearance of the liquids in the two tubes.

_____

_____

2. Can you tell which of the tubes contains DNA? How?

_____

_____

3. Describe what happened when you first twirled the stick in or near the DNA-alcohol interface.

_____

_____

4. When you lifted the stick out of the tube and a fiber of DNA followed, did you think that this was a single molecule of DNA? Why?

_____

_____

5. How would you describe the appearance of DNA to someone who has never seen it?

_____

_____

6. What do you think it is about the biology of salmon and sperm cells that makes it easy to isolate a large quantity of DNA from salmon sperm?

_____

_____

Name _____

Date _____ Hour _____

OBSERVATIONS

Describe what you see as you perform the steps to isolate DNA.

1. What does the "thymus soup" look like? _____

_____

2. How does its appearance change as you add the detergent and swirl it in? _____

_____

3. What do you think is happening at this step? _____

_____

4. Does the appearance of the mixture change as you add the meat tenderizer and swirl it in? If so, how?

_____

5. What do you think is happening at this step? _____

_____

6. Describe the appearance of the mixture just after you added the alcohol. _____

_____

7. What do you think is happening at this step? _____

_____

8. What did you see as you twirled the stick at the interface? _____

_____

9. What do you think is happening at this step? _____

_____

10. What happens as you slowly pull the stick out of the tube? _____

_____

11. What does DNA look like? _____

Name _____

Date _____ Hour _____

DISCUSSION AND CONCLUSIONS

1. Explain why DNA is so important to study.

2. Describe in your own words how one isolates DNA from animal tissue.

3. Explain the function of the following reagents: Woolite, Adolph's Meat Tenderizer, and alcohol.

4. What does the DNA look like at the end of the procedure?

Name _____

Date _____ Hour _____

ANALYSIS AND CONCLUSIONS

1. Do you see any consistent relationship between the DNA bases (puzzle pieces) in one strand of your puzzle and the bases with which they are paired in the other strand? If so, state the nature of the relationship(s) you see.

_____

_____

2. Half of the puzzle pieces that you were given (the A's and G's) were much larger than the other pieces (the C's and T's). Did this size difference cause your DNA model to be significantly wider in some parts than in others? If not, why not?

_____

_____

3. Is there any consistent difference in the way that the pieces in the right-hand strands and the left-hand strands of your model are oriented? If so, what is the difference?

_____

_____

4. How can you account for the fact that no matter which bases were selected for the left-hand strand of a DNA molecule, everyone had just the right pieces left over to assemble a matching right-hand strand?

_____

_____

Do Part B of the puzzle before you answer the next two questions.

5. Are the two DNA puzzles you now have the same or different? How can you account for this?

_____

_____

6. What do you suppose biologists call this process of making two identical double-stranded DNA molecules from one when it occurs in cells?

_____

_____

Name _____

Date _____ Hour _____

ANALYSIS AND CONCLUSIONS

YOU HAVE NOW built two models of double-stranded DNA: the flat one in the puzzle at the beginning of this exercise that you used to deduce the base-pairing rules and how DNA is replicated (which we will call "model A"), and the one you have just built with straws and connectors (which we will call "model B"). As mentioned earlier, often two models of the same thing will be simplified in different ways to emphasize different features of the object they are representing.

1. What feature or features of a double-stranded DNA molecule are represented better in model A than in model B?

_____

_____

_____

2. What feature or features of a double-stranded DNA molecule are represented better in model B than in model A?

_____

_____

_____

3. What feature or features of a double-stranded DNA molecule that you read about in the excerpt from the Cartoon Guide to Genetics are not well represented in either model A or model B?

_____

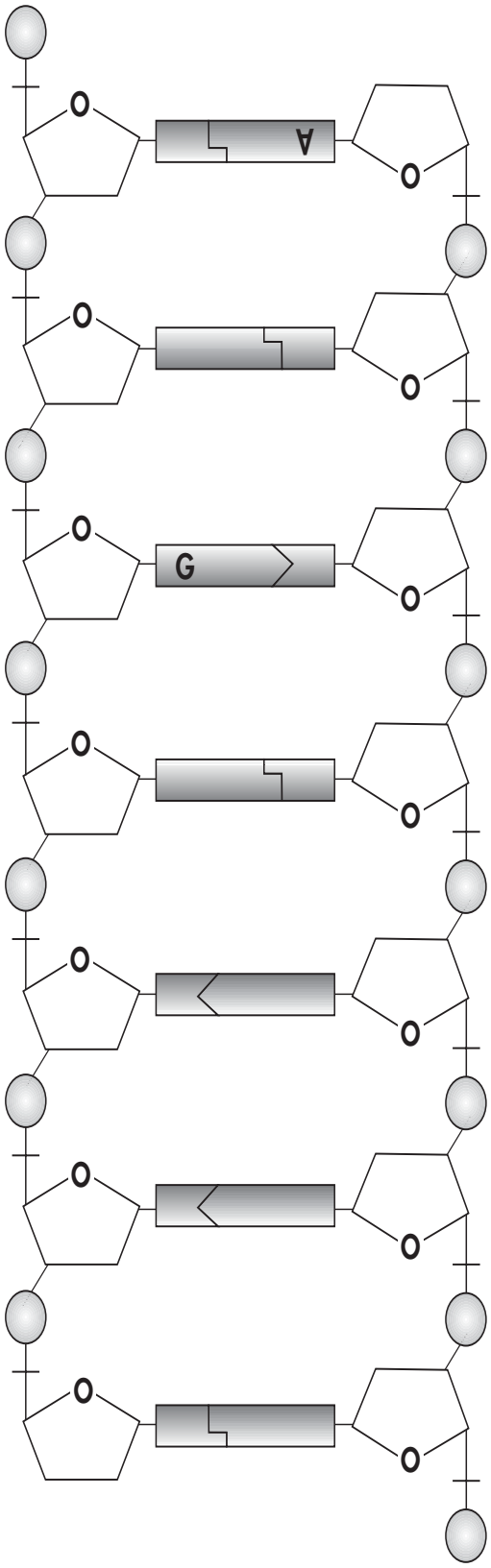
_____

_____

Name _____

Date _____ Hour _____

DNA Model Questions



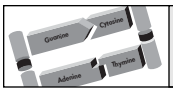
THE DIAGRAM ON THE left represents an untwisted, double-stranded DNA molecule.

1. Label each sugar group on the diagram with a letter S.
2. Label each phosphate group with a letter P.
3. One adenine (A) and one guanine (G) have already been labeled. Label the rest of the nitrogenous bases.
4. Circle one nucleotide. What three things go together to make a nucleotide?

   _____

   _____

   _____
5. The sides of the DNA ladder are made up of alternating _____ and _____ groups.
6. The rungs of the DNA ladder are made up of _____
7. A is always paired with _____
8. G is always paired with _____
9. Paired bases are held together by weak bonds called _____ bonds.
10. When the DNA ladder twists the way it normally does, the shape of the molecule is called a _____



C.6

Name _____

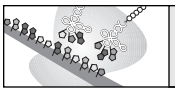
Date _____ Hour _____

DNA Word Search

FIND AND CIRCLE the words that go with each of the clues given below. Then write the answers on the lines next to the clues.

I	J	Y	R	L	W	X	B	V	X	M	I	U	R	W	Y	T	Q	W	D
U	S	P	G	P	Y	J	W	L	S	V	Q	E	H	B	K	D	N	I	I
B	E	L	D	K	E	Z	P	H	O	S	P	H	A	T	E	L	C	T	U
N	S	N	P	E	E	D	Y	W	B	L	T	T	Q	O	U	A	S	H	K
B	A	E	I	N	Y	E	O	X	I	F	C	H	X	N	C	Q	Y	J	R
E	B	D	A	S	Z	K	M	C	R	R	Q	L	S	I	D	D	G	A	T
O	S	D	B	R	O	H	A	K	C	P	R	M	E	P	R	N	G	D	I
C	U	A	W	M	O	T	C	J	H	I	X	L	G	O	L	U	L	E	S
Z	O	L	W	N	I	V	Y	N	B	N	C	N	G	V	S	B	F	N	L
H	N	D	V	O	O	L	D	C	U	U	K	E	N	E	W	I	S	I	Q
T	E	E	N	R	X	O	S	C	N	Y	N	U	N	I	S	N	N	N	L
Q	G	T	A	E	B	E	L	O	F	B	Q	I	V	E	B	O	Q	E	I
T	O	S	D	O	G	E	B	J	O	E	N	I	M	Y	H	T	B	N	X
X	R	I	S	A	O	I	W	N	P	A	L	B	S	P	D	Q	Q	N	R
C	T	W	B	T	R	S	D	G	U	A	H	B	J	Z	Z	Y	F	O	P
V	I	T	I	Y	S	S	T	G	M	T	S	R	A	U	H	S	X	A	V
E	N	D	X	B	A	S	E	P	A	I	R	X	Y	Z	O	C	Y	N	Y
D	E	O	Y	E	Y	O	W	X	I	L	E	H	E	L	B	U	O	D	Q
I	E	J	S	E	A	I	E	Q	V	W	Q	X	M	L	C	B	X	P	V
D	A	X	F	M	N	H	G	K	N	X	I	I	A	F	R	R	G	M	Y

1. The nitrogenous base A _____
2. The nitrogenous base C _____
3. The nitrogenous base G _____
4. The nitrogenous base T _____
5. The genetic material inside all cells _____ (abbreviation)
6. The full name for DNA _____ _____
7 The scientific name for the shape of the DNA molecule _____ _____ (two words)
8. The arrangement of two bases in the DNA molecule forms a _____ _____ (two words)
9. The name of the bonds that hold the two strands of DNA together (between the bases) _____ (two words)
10. Pairs of these molecules form the steps or rungs in the DNA molecule _____ _____ (two words)
11. This subunit of DNA has three parts: a phosphate, a sugar and a nitrogenous base _____
12. The long backbones of the DNA molecule are made of alternating sugar and _____ bonds.
13. This process occurs when DNA makes a copy of itself _____



D.2

Name _____

Date _____ Hour _____

QUESTIONS ON "HOW DNA CODES FOR PROTEINS"

AFTER YOU HAVE read about protein synthesis in your excerpt from the *Cartoon Guide to Genetics,* answer the following questions.

1. What is the relationship between genes and proteins? _____

   _____

2. How does RNA differ from DNA? _____

   _____

3. What is the molecule that carries the information from a gene to the place

   where a protein will be made? _____

4. What is the process by which such a molecule is made? _____

5. What is the enzyme that mediates the process named above? _____

6. What is the structure on which proteins are made? _____

7. How many bases form one "word" of the RNA message? _____

8. What is the technical name for such a group of bases found on mRNA? _____

9. What is another term for protein synthesis? _____

10. What is the group of molecules that translates the genetic code? _____

11. What is an anticodon? _____

12. At the tail end of each tRNA molecule, an _____ attaches the appropriate

    _____ molecule to the tRNA.

13. What happens when two tRNAs are side by side on a ribosome? _____

    _____

14. The first codon on an mRNA always is _____.

15. This codes for the amino acid called _____.

Name _____

Date _____ Hour _____

Paper Proteins: Models for Simulating Gene Expression

MATERIALS

For each student or pair of students:
1 set of paper-protein puzzle pieces

PROCEDURE

Follow the directions below to model the processes of transcription and translation, and to make a paper protein.

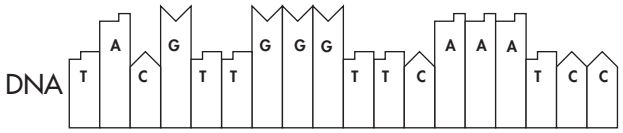


Figure 1

1. Place the DNA strip on the desk so that the letters read properly for you (fig. 1).

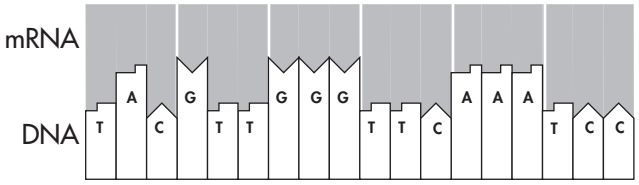


Figure 2

2. Working from left to right, find the mRNA pieces that match the DNA and line them up (fig. 2). What is the process in which an mRNA molecule that is complementary to a DNA molecule is produced?

_____

(Answer question 2 here)

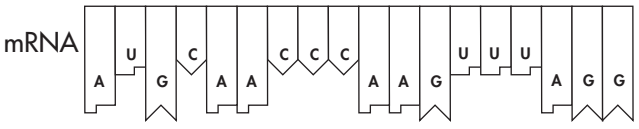


Figure 3

3. Separate the mRNA from the DNA to simulate the mRNA moving out of the nucleus to a ribosome in the cytoplasm of the cell. Leave the mRNA pieces lined up next to one another(fig. 3).

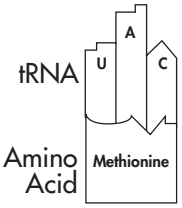


Figure 4

4. Match each of the tRNA pieces to the amino acid piece that fits with it (fig. 4). Lay them out so that all of them are visible.

Name _____

Date _____ Hour _____

5. Search for the tRNA that will base pair with the first codon of the mRNA (the one on the left-hand end). Move the tRNA with its attached amino acid into place in the mRNA (fig. 5). Continue with the second codon, and so forth. What is the name for this process in which a protein is produced that has an amino acid sequence specified by an mRNA molecule?

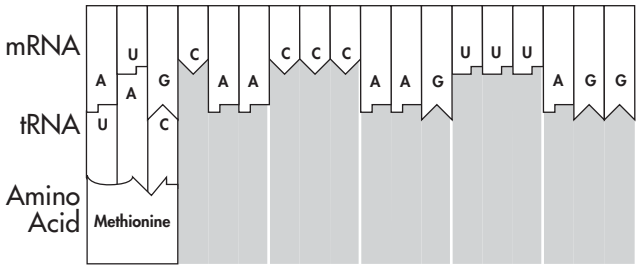


Figure 5

_____

(Answer question 5 here)

6. Now pull the string of six amino acids away from the tRNA (fig. 6). These six amino acids represent a new protein. (However, real proteins always contain many more amino acids than this, sometimes more than a thousand.)

Figure 6

After you have completed these steps, use the model pieces to explain the two component processes of gene expression to another student. Then write out the steps in your own words. You may refer to your notes or a book to check for scientific accuracy.

Name _____

Date _____ Hour _____

Using the Genetic Code to Translate an mRNA

AT THE HEART OF the regular and predictable relationship between the sequence of nucleotides in any gene and the sequence of amino acids present in the protein for which that gene is said to "code" is a fixed set of nucleotide-to-amino acid relationships that is known as **the genetic code.** Just as the Morse code can be printed in the form of a table indicating which letter of the English alphabet is specified by each combination of dots and dashes, the genetic code is usually printed in the form of a table indicating what kind of amino acid is specified by each possible mRNA codon.

To the right is a DNA coding sequence that codes for part of the hemoglobin molecule. Complete the mRNA strand following base-pairing rules. Then use the mRNA Genetic Code Table on the next page to determine the amino acid sequence for which this piece of a gene codes.

DNA	mRNA	Amino Acid
T		
A		
C		
C		
A		
G		
G		
T		
A		
A		
A		
C		
T		
G		
T		
G		
G		
G		
C		
T		
T		
C		
T		
C		
T		
T		
T		
A		
G		
T		
C		
G		
C		
C		
A		
T		

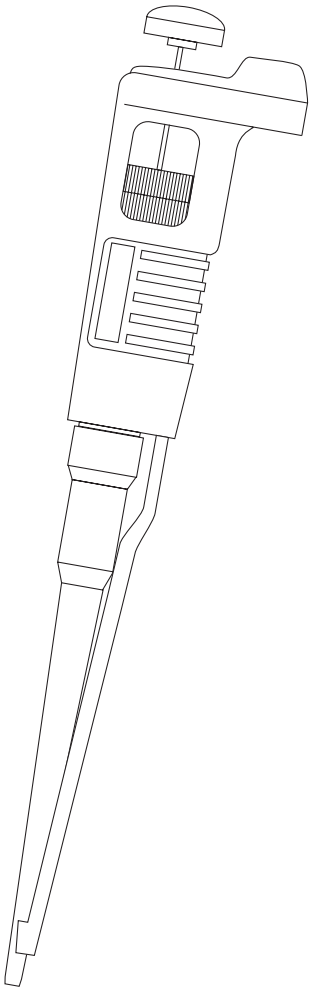
Congratulations! You have just "synthesized" the first part (12 amino acids) of the protein called ß-globin, which is part of the hemoglobin molecules that make your blood red and carry oxygen to cells throughout your body. (Each real ß-globin molecule actually consists of a string of 147 amino acids.)

Name _____

Date _____ Hour _____

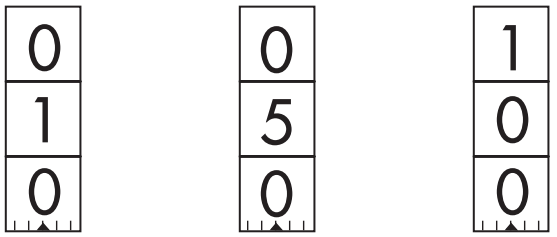
Shine On!

A. How to Read a Micropipettor (1000 µl size)



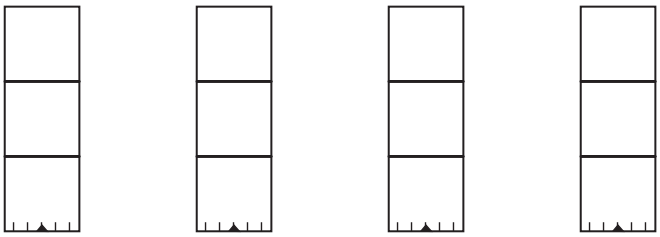
IN MODERN BIOLOGY LABS, it is often necessary to measure extremely small volumes of liquid. The measurements are usually in microliters (µl). One microliter is 1/1,000,000 of a liter. Scientists use instruments called micropipettors to measure these small volumes. The first step in learning to use a micropipettor is to learn how to set it for the exact volume you want to transfer. To do this, you need to look at the window on the micropipettor. The numbers in the window represent the volume of liquid, shown in µl (microliters), that will be measured. The window looks like the ones pictured below. Due to differences in models, your micropipettor may be different than the one pictured.

The numbers in the window will look like these when the micropipettor is set to measure the volumes shown in microliters.



100 µl 500 µl 1000 µl

In the windows below, write the numbers that would indicate that the micropipettor was set properly to measure the given volumes.



150 µl 980 µl 240 µl 556 µl

Now that you have filled in the windows, practice setting a micropipettor to the above volumes. Let your teacher check your work, especially when you set the volume of 556 µl. This is a little tricky.

Name _____

Date _____ Hour _____

5. To expel the volume of liquid onto a piece of filter paper (fig. 5).

   a. Hold the tip of micropipettor directly above the labeled filter paper.

   b. Slowly push the plunger button all the way down (past the first stop to the second stop). Look at the tip to make sure all of the liquid came out.

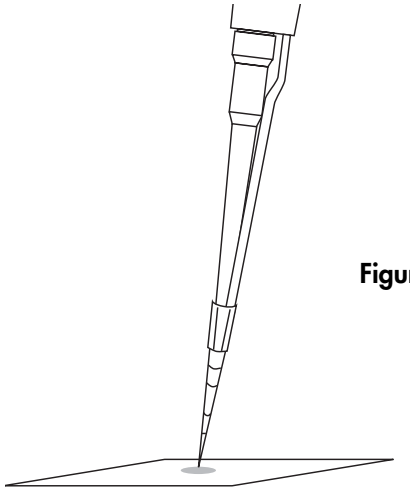


Figure 5

6. To eject the tip:

   a. Hold the tip over a waste disposal container.

   b. Push the eject button.

7. Reset the numbers in the window to read 020 (fig. 6). Write 020 and your name on another piece of filter paper. Follow steps 3-5 to transfer this volume of liquid to the filter paper. What volume in µl does 020 represent?

Figure 6

_____

(Answer question 7 here)

8. Now reset the numbers in the window to read 024 (fig. 7). Write 024 and your name on another piece of filter paper and follow steps 3-6. What volume in µl does 024 represent?

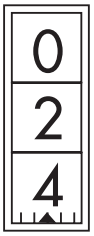


Figure 7

_____

(Answer question 8 here)

Name _____

Date _____ Hour _____

C. Part Three
Shine On! Viewing Plates

IT MAY TAKE SEVERAL days before the bacteria that you have genetically engineered begin to glow in the dark. Observe both of your agar plates each day and record what you see on the lines below. Be sure to record when bacterial colonies can first be seen on each plate. Meanwhile, begin filling out the Laboratory Write Up on the next two pages.

Once colonies have appeared on your "DNA" plate, observe both plates each day in a very dark room to see if they have begun to glow. Record the day that this happens. Continue observing the plates daily, and record whether the bacteria are still glowing. When your bacteria have stopped glowing in the dark, ask your teacher for instructions about how to dispose of your plates. Then complete your Laboratory Write Up.

Name _____

Date _____ Hour _____

LABORATORY WRITE UP

1 Purpose: Describe in your own words the reason for performing this experiment.

_____

_____

2. Background Information: Give information about the idea of adding genes to bacteria in order to change their traits.

_____

_____

3. Hypothesis: State the expected outcome of the experiment.

_____

_____

4. Independent Variable: State the independent variable.

_____

_____

5. Dependent Variable: State the dependent variable.

_____

_____

6. Controls: List the controls.

_____

_____

7. Procedure: Briefly describe in your own words the steps you took to perform the experiment.

_____

_____

Name _____

Date _____ Hour _____

8. Data/Observations: Organize your data and observations into a neat, meaningful chart.

9. Conclusions and Recommendations for Future Experiments: Tell what the data mean. Were the results what you expected? Was your hypothesis on target? In addition, write a paragraph telling your ideas for future experiments (how to improve, what other things to try, any mistakes to correct, etc.).

Name _____

Date _____ Hour _____

ALTERNATIVE ASSIGNMENT: NEWS ARTICLE

YOU ARE TO WRITE an article that is suitable to be printed in a newspaper and describes the Shine On experiment. Make your article interesting, informative, and scientifically accurate. Include the overall idea of the experiment as well as a brief description of the protocol and a conclusion. Your grammar and spelling need to be correct. The best articles may be submitted to the school newspaper.

NEWS ARTICLE GRADING SHEET

____ Scientific accuracy

____ Complete: Included introduction, brief procedure, description of the plates, conclusion

____ Creativity/Interest

____ Grammar/Spelling

____ Total