Name……………………………………….. Date……… Period…………

Student Laboratory Packet
Relationships and Biodiversity
A Laboratory Activity for the Living Environment

Introduction

Botana curus is a valuable plant because it produces Curol, a compound used for treating certain kinds of cancer. Curol cannot be produced in the laboratory. *Botana curus* grows very slowly and is on the endangered species list, so its ability to provide Curol in large quantities is limited. Species that are more closely related to *Botana curus* are more likely to produce the important substance Curol. Three similar plant species that are plentiful (X, Y, and Z) may be related to *Botana curus.*

You will work as a researcher to:

1. Gather structural and molecular evidence to determine which plant species is most closely related to the hypothetical species, *Botana curus*

2. Use this evidence to decide which plant species is most likely to serve as a source of the important substance Curol

Structural Evidence for Relationships

Procedure. Perform the following and record your observations in Table 1 on page 6.

Test 1. Structural Characteristics of Plants

Compare the structural characteristics of the plant samples. **Are the leaves oval shaped, spade shaped or irregular shaped? Do the lines run lengthwise or across ?**.Record your observations in Table 1 Column 1

Test 2.Structural Characteristics of Seeds

Compare the structural characteristics of the seed samples. **Are the seeds large, medium or small? Are they black, or gray?** Record your observations in Table 1 Column 2.

Test 3.Microscopic Internal Structure of Stems

a. Examine the microphotographs that show cross sections through stems of *Botana curus* and Species X, Y, and Z. Compare and choose the arrangement (**circular or scattered**) for the bundles of conducting tissue in each of the specimens. **Refer to Figure 1**.

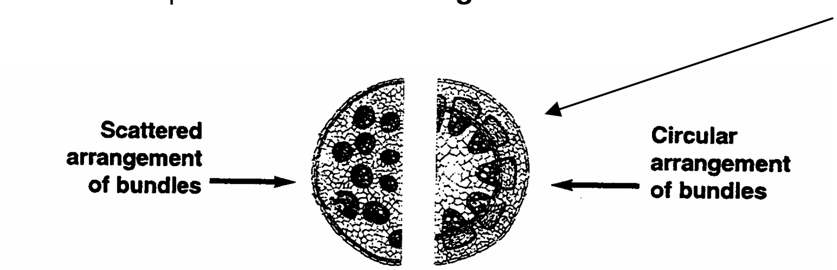


Figure 1

b. Record your observations of the conducting tissue arrangements in Table 1 Column 3.

Molecular Evidence for Relationships

Test 4. Paper Chromatography to Separate Plant Pigments

Record your observations of the colors in Table 1 Column 4.

Test 5-Indicator Tests for Enzyme M

A "fizzing" appearance indicates a positive test for enzyme M

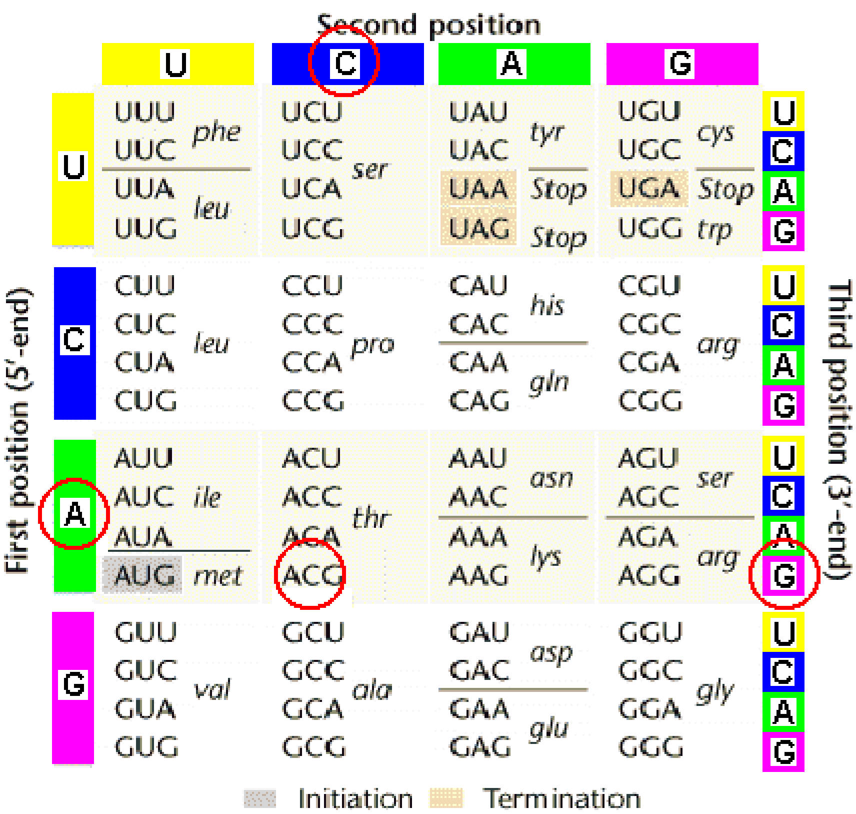
Record the results of your tests for enzyme M by putting a + marking for positive test and a - marking for negative test in Table 1 Column 5.

Test 6-Translating the DNA Code To Make a Protein

a. The sequences of DNA bases below represent parts of the genes responsible for the production of one type of protein, an enzyme, produced by *Botana curus* and Species X, Y, and Z.

b. **Under each DNA sequence, write the complementary messenger RNA base sequences that each of these gene fragments would produce. *Remember A goes with U, T goes with A, C goes with G, and G goes with C***

c. Use the universal genetic code table below to translate the messenger RNA base sequences on the following page into sequences of amino acids in the protein produced by each species. Write the sequences of amino acids under the messenger RNA sequences.



Botana curus	CAC	GTG	GAC	TGA	GGA	CTC	CTC
Sequence of bases in mRNA produced							
Sequence of amino acids in the protein							
Species X	CAC	GTG	GAC	AGA	GGA	CAC	CTC
Sequence of bases in mRNA produced							
Sequence of amino acids in the protein							
Species Y	CAC	GTG	GAC	AGA	GGA	CAC	CTC
Sequence of bases in mRNA produced							
Sequence of amino acids in the protein							
Species Z	CAC	GTA	GAC	TGA	GGA	CTT	CTC
Sequence of bases in mRNA produced							
Sequence of amino acids in the protein							

Test 7-Using Simulated Gel Electrophoresis To Compare DNA

For this test, you will use a series of letters (on page 8) representing portions of DNA molecules. These letters represent the sequence of bases in DNA molecules isolated from *Botana Gurus* and Species X, Y, and Z.

To compare DNA molecules, scientists use enzymes that bind to and cut specific base sequences within the DNA. Imagine that you are using an enzyme that binds to the base sequence CCGG and cuts between the C and G.

Scientists use *gel electrophoresis* to separate the DNA fragments resulting from this binding and cutting process. In an electrical field, the negatively charged DNA molecules migrate through a gel-like material toward the positively charged pole. The smaller molecules migrate more rapidly through the gel than the larger ones do.

Procedure

Simulate the electrophoresis process by writing the letter sequences of the DNA fragments from *Botana curus* in the appropriate well (column) on the Simulated Electrophoresis Gel (Table 2) page 7. Simulate the effect of electrical current on the DNA fragments by counting the number of letters (bases) in each of the fragments and writing them to the appropriate location on the electrophoresis gel (rows). Refer to the number of DNA letters indicated along the left side of the gel to determine the final position for each fragment '

Record the size on the fragments (number of bases in each) in Table 1. Column 6

Repeat this process for each of the other species (X, Y, and Z)

Laboratory Analysis Questions

1. Based on your data for structural relationships, which species (X, Y, or Z) would you hypothesize is most likely to produce Curol?

2. Explain how the evidence from your data table supports your hypothesis. You will test your hypothesis by completing additional tests in the second part of this laboratory activity.

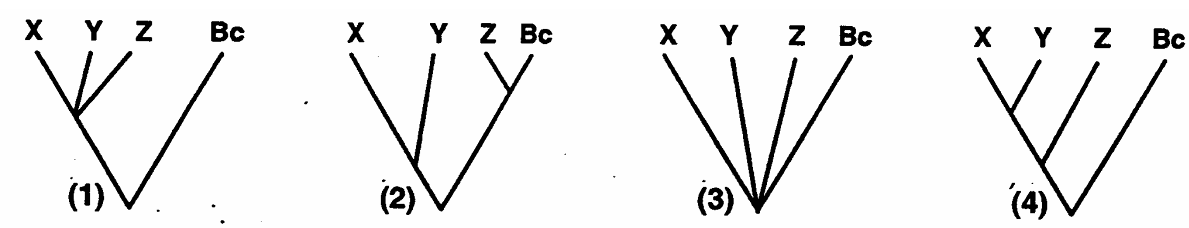
3. Did the addition of molecular evidence support or refute the hypothesis that you made earlier based on structural evidence only? Explain why or why not.

4. Which kind of evidence-structural or molecular-is most helpful in making decisions about relationships between species? Explain why.

5. Based on your observations, list three characteristics (structural or molecular) that all four species have in common.

6. Provide a biological explanation for the common characteristics that these species share.

7. Scientists frequently use branching tree diagrams to represent graphically the relationships between .species. Which branching tree, shown below, best represents the relationships among the four species?



8. Explain how you used the information on the data table to select this tree.

9. State two additional kinds of evidence you might use to further support your hypothesis about the relationship between *Botana curus* and species X, Y, and Z.

Base your answers to questions 8 through 10 on the reading passage below and on your understanding of biology.

The Biodiversity Crisis

Plant and animal species are being lost at a rate that is unprecedented in the history of life. Human activities are responsible for much of this biodiversity crisis. Some biologists estimate that within the next century, half of Earth's current species may become extinct.

Extinction and the loss of biodiversity occurs when species do not have adaptations that enable them to survive environmental changes. Human activities such as destruction of natural habitats and pollution are thought to be the major environmental factors causing the decline of species, but others are also important. Overhunting, introduction of foreign species that compete with native species, and removal of predators have also played a significant role in endangering some species.

Why should we worry about the loss of biodiversity? We depend on many species for food, clothing, shelter, oxygen, soil fertility-the list goes on and on. Large-scale extinctions of other species may be a waming to us that we are altering the biosphere so rapidly that our species is threatened too.

Biodiversity ensures the availability of a rich variety of genetic material that may lead to future agricultural or medical discoveries having significant value to humankind. Some species have been used as sources for medicines and other useful products. Scientists now use genetic engineering to transfer desirable genes from one species to another. As diversity is lost, potential sources of these genetic materials may be lost with it.

Biodiversity also increases the stability of the ecosystem. Every population is linked, directly or indirectly, with many others in an ecosystem. Disruptions in the numbers and types of one species can upset ecosystem stability. This means that extinction of one species can accelerate the rate of extinction for other species.

Endangered species hold medicinal, agricultural, ecological, commercial, and aesthetic value. They must be protected so that future generations can experience their presence and value.

Assume that the plant you identified as being closely related to *Botana curus* grows rapidly, survives in many environments, and produces Curol. News reports indicate that *Botana CllrllS* plants may become extinct unless expensive efforts are made to preserve the species. Members of your research team disagree as to whether or not *Botana curus* should be saved.

8. State three examples of human activities that could endanger *Botana curus.*

9. State three reasons why it might be important to preserve *Botana curus.*

10. State two arguments people might make for NOT preserving *Botana curus.*

Table 1: Comparison of *Botana curus* with Species X, Y, and Z

	Structural Evidence			Molecular Evidence			
Species	**Structural Characteristics of Plants**	**Structural Characteristics of Seeds**	**Microscopic Stem Structure**	**Paper Chromatography**	**Test for Enzyme M**	**Differences in Amino Acid Sequences**	**Gel Electrophoresis DNA Banding Pattern**
Botana curus							
Species X							
Species Y							
Species Z							

Table 2: Simulated Electrophoresis Gel

- Negative Pole -

Wells → / # of DNA bases	*Botana curus*	Species X	Species Y	Species Z
24				
23				
22				
21				
20				
19				
18				
17				
16				
15				
14				
13				
12				
11				
10				
9				
8				
7				
6				
5				
4				
3				
2				
1				

Botana curus	**ATTCC/GGATCGATCGCC/GGATATACTCC/GGTAATATC**
Species X	**ATTGTACC/GGGATCC/GGACGTCGCGACTAATATAGCA**
Species Y	**ACC/GGTCC/GGGATCGCACCC/GGTACTCCTGTAATATC**
Species Z	**ATTCC/GGATCGATCGCC/GGATATTCTCC/GGTAATATC**