Flower Forensics

just add students™

The owner of a local flower store (Orchid World) has asked you to investigate a possible crime – the theft and illegal cloning of some of his prized black orchids. He has spent many years creating a new strain of rare black orchid that is resistant to insect predators. He recently noticed that three online flower companies are selling black orchids that seem similar to his. He is suspicious that these companies have stolen and are cloning some of his orchids.

Your Task: Analyze biological evidence to determine if the orchids sold by the online flower companies (orchid A, orchid B, and orchid C) are clones of (identical to) the Orchid World company's black orchid.

Part 1: Analysis of Flower Structure

You will compare the structure of the Orchid World orchid with the orchids sold by the online flower company.

1. Observe the color orchid flower diagrams in your kit. The diagram on the left shows the names for the parts of a typical orchid flower. The four diagrams on the right show the Orchid World company's black orchid and the orchids sold by the three online flower companies.

2. Compare the structure (shape, size, and organization of parts) of the four orchid flowers. Record your observations of the flower structure on the data table included with your kit. *(See data table on the last page. You may tear this data table off so that is easier to record your data as you work on this lab activity.)*

3. Based on your observation of orchid flower structure, hypothesize which orchids (A, B, and C) are clones of the Orchid World black orchid.

____

____

Part 2: Analysis of Flower Pigments

You will use paper chromatography to compare the pigments present in the four orchid flowers. Chromatography is a method used to separate the plant pigments into a distinct banding pattern of different colors.

Your kit contains droppers of the orchid flower extracts that were created by grinding up the orchid flowers. Follow the paper chromatography procedure below compare the pigments of your four orchid samples.

1. Draw a pencil (not pen) line 1 cm (approximately this distance ) from the bottom of a piece of chromatography paper as shown in Figure 1. Use a pencil to label the top edge of the chromatography paper OW, A, B, and C as shown in Figure 1.

2. Use the dropper labeled Orchid World to spot one small drop of the Orchid World flower extract just above the pencil line (see Figure 1).

Warning!
The pigments in the flower extracts will stain skin, clothing, and furniture.
- Cover your work area with waterproof material.
- Avoid contact with skin and clothing.

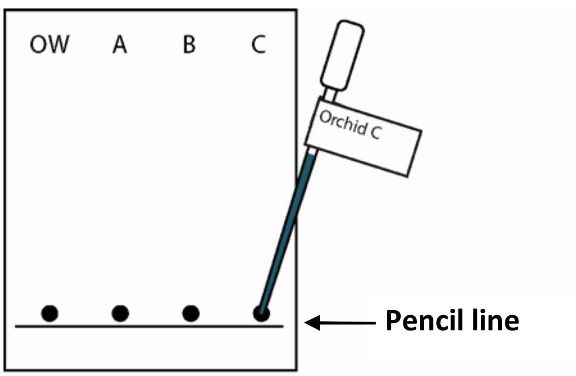

Figure 1

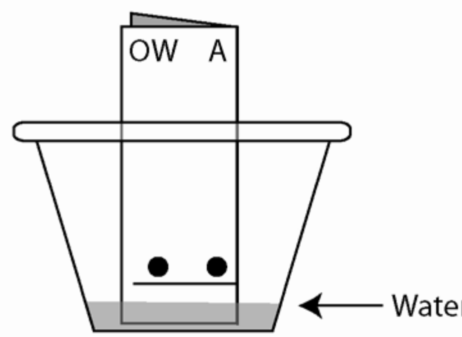

Figure 2

3. Repeat step 2 to spot the A, B and C orchid extracts in the appropriate locations. Make sure you use the correct dropper for each sample.

4. Add just enough water to cover the bottom of the cup approximately 0.5 cm deep. The water line should NOT be high enough to touch the spots of flower extract on the chromatography paper.

5. Fold and stand the chromatography paper in the cup as shown in Figure 2. Do not move the chromatography paper once you have set it in the cup.

6. Wait at least 5 minutes for the water to move up the chromatography paper and drag the flower extracts through the chromatography paper. Because the pigments in the extracts move at different rates, they will separate into colored bands of pigments.

7. The chromatography paper must be removed from the cup before the wetness reaches the pencil labels at the top of the chromatography paper.

8. While you are waiting for the water to move up the chromatography paper, go on to Part 3.

9. Record your observations of the types of colors and relative darkness of the colors on the data table. <u>Save the droppers</u> for use in Part 3.

10. Based ONLY on the information from Parts 1 and 2, which of the online orchids (A, B, and C) is <u>NOT</u> a clone of the Orchid World black orchid? Support your answer with specific information from your data table.

____

____

____

Part 3: Test for Chemical X

Orchid World's black orchids produce a special chemical (Chemical X) that protects the flowers from being eaten by insect predators. You will test the orchid flower extracts for the presence of Chemical X by mixing a small amount of the extracts with Chemical X Indicator Powder. A fizzing reaction will occur if Chemical X is present in the orchid extracts.

Follow this procedure to test for Chemical X:

1. Add one small scoop of Chemical X Indicator Powder to the circle on the plastic test strip labeled Orchid World. Add 3 drops of Orchid World (OW) extract on top of the Chemical X Indicator Powder on the **plastic test strip**. Immediately observe and record the results on the data table.

2. Repeat the indicator test for Chemical X using the other orchid extracts (Orchid A, Orchid B, and Orchid C) and the appropriate circles on the test strip. Make sure you use the correct dropper for each sample.

3. Record the results (fizzes **or** no reaction) of your tests for Chemical X on the data table.

4. Discard the droppers of orchid extracts, the test strip and the tube of Chemical X Indicator Powder by placing them in the small bag labeled "Part 3."

5. Based ONLY on the information from Part 3, which of the online orchids (A, B, and C) is NOT a clone of the Orchid World black orchid? Support your answer with specific information from your data table.

____

____

____

Make sure you go back to complete steps 9-10 in Part 2

Part 4: Compare the DNA from the Orchid Plants

Cloned plants are produced by asexual reproduction. If the online orchids were cloned from the Orchid World black orchid, they should be genetically identical to the original plant. This means that the coded information in DNA molecules of cloned plants should be identical To the Orchid World orchid.

You can use DNA samples from the four plants (OW, A, B, and C) to make "DNA fingerprints" for the plants. You kit contains colored DNA strips that represent one section of bases in the gene for flower color isolated from the Orchid World orchid and from Online Orchids A, B and C. You use these DNA strips to simulate the process of "DNA fingerprinting."

To make "DNA fingerprints" for the four plants, you will simulate the use of special enzymes called restriction enzymes to cut the plant DNA into small pieces. Restriction enzymes bind to and cut specific base sequences on the DNA. Then you will simulate the use of gel electrophoresis to separate the small pieces of DNA into a specific pattern of bands which can be compared.

1. Obtain the page with the colored DNA strips from your lab kit. Cut along the dotted lines to cut out the green colored DNA strip labeled Orchid World.

CCGGAATTCAGGACAATTCGTACGCGCTATAATTACAGCT

2. The restriction enzyme you will use in this simulation binds to the base sequence, AATT, and cuts between the A and the T. Use a pencil to circle <u>all</u> the AATT nucleotide sequences on the Orchid World orchid's DNA.

CCGGAATTCAGGACAATTCGTACGCGCTATAATTACAGCA

3. Use scissors to cut the strip between the A and T in each of these AATT sequences. This will create smaller fragments of the Orchid World orchid's DNA.

CCGGAA | **TTCAGGACAA** | **TTCGTACGCGCTATAA** | **TTACAGCA**

4. The fragments from the Orchid World's DNA are then placed at one end of a gel (which is made of a substance that looks like Jell-O). Instead of a real gel, you will use the paper Simulated Electrophoresis Gel in your kit.

5. You will use the Simulated Electrophoresis Gel to separate the DNA fragments based on their size. When an electrical current is applied to the gel, the smaller DNA fragments will move more quickly though the electrical field than the larger DNA fragments.

6. Simulate the movement of the DNA fragments in the gel.
   - Count the number of DNA base letters (A, T, C, G's) in each of the DNA fragments.
   - Refer to the number of bases indicated along the left side of the gel to determine the position for each DNA fragment on the gel. Place each DNA fragment in its appropriate location on the electrophoresis gel. *Dotted line boxes are shown to indicate the position of the Orchid World DNA fragments so that you can check your work.*
   - Tape each Orchid World DNA fragment in the proper location on the electrophoresis gel.

7. Repeat steps 1-6 to make a "DNA fingerprint" for the DNA molecules from orchids A, B and C.
   - Simulate using a restriction enzyme to cut between the A and T in each of the AATT sequences on the DNA strips.
   - Simulate using gel electrophoresis to separate the DNA fragments.

8. The banding pattern of DNA from the plant samples can be compared. On the data table, record the positions of the DNA bands (use the corresponding numbers on the left side of the electrophoresis gel) for each orchid).

9. Based ONLY on the information from Part 4, which of the online orchids (A, B, and C) is NOT a clone of the Orchid World black orchid? Support your answer with specific information from your data table.

____

____

____

Part 5: Comparing the Protein Amino Acid Sequences from the Orchids

The genetic information stored in DNA is used to assemble amino acids into protein chains. Cloned plants should produce identical proteins. The final test that you will do is to compare the sequence of amino acids in the proteins produced by the flower color gene in the four orchids.

The sequences of DNA bases below represent part of the gene for one protein involved in flower color. Follow these instructions to transcribe the DNA into messenger RNA (mRNA) and then to translate the mRNA into a sequence of amino acids in a protein.

1. DNA is transcribed to make a complementary (opposite) mRNA molecule. Use the information in the chart on the right to write the letter sequence for the messenger RNA. Under each DNA sequence, write the complementary messenger RNA (mRNA) base sequences that each of these genes would produce. *The first six mRNA bases for the Orchid World flower color protein are provided as a sample.*

Base Letter on DNA	Complementary Base Letter on RNA
A	U
T	A
G	C
C	G

Orchid World DNA	**CCG**	**GAA**	**TTC**	**AGG**	**ACA**
mRNA Produced	GGC	CUU			
Sequence of amino acids in the protein	Gly	Leu			

Orchid A DNA	**CCG**	**GGA**	**TTC**	**AGG**	**ACA**
mRNA Produced					
Sequence of amino acids in the protein					

Orchid B DNA	**CCG**	**GAA**	**TTC**	**AGG**	**ACA**
mRNA Produced					
Sequence of amino acids in the protein					

Orchid C DNA	**CCG**	**TAA**	**TTC**	**AGG**	**ACA**
mRNA Produced					
Sequence of amino acids in the protein					

2. Translate the mRNA code to make the amino acid sequence of a protein. Use the Universal Genetic Code Chart provided in your kit to translate the mRNA base sequences into sequences of amino acids in the protein produced by each species. Write the sequences of amino acids under the messenger RNA sequences. *The first two amino acids for the Orchid World flower color protein are provided as a sample.*

3. Circle the differences in the protein amino acid sequences that you can find when you compare Orchids A, B and C to the Orchid World orchid. On the data table, record your observations of the number of differences in the amino acid sequences.

6. Based ONLY on the information from Part 5, which of the online orchids (A, B, and C) is NOT a clone of the Orchid World black orchid? Support your answer with specific information from your data table.

____

____

____

Part 6: Data Analysis

You will now analyze ALL of the data that you have recorded on the data table. You may find it helpful to highlight or circle the characteristics that that orchids A, B and C have in common with the Orchid World orchid.

1. Which of the orchids (Orchid A, B or C) are likely to be clones of the Orchid World orchid? Why or who not? Support your answer by citing specific evidence from your data analysis.

2. Which data was the most helpful in making your decision? Explain why.

3. Describe two additional kinds of data that you might collect to provide additional evidence that the orchid you selected is a clone of the Orchid World black orchid.

Data Table:

Orchid	**Part 1** Flower Structure	**Part 2** Paper Chromatography	**Part 3** Test for Chemical X (fizzes **<u>or</u>** no reaction)	**Part 4** Gel Electrophoresis DNA Banding Pattern	**Part 5** Protein Amino Acid Sequences
Orchid World					
Online Orchid A					
Online Orchid B					
Online Orchid C					