



The Art of Forgery[©]

A Gel Electrophoresis Caper

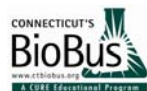
Student Guide

BioBus Educational Programs

Version 1

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Version 1



Art of Forgery v.1 • 2

STUDENT CASE BRIEF

TASK OVERVIEW

Last Friday night a burglary occurred at the **Louvre** Museum in Paris, France. **Leonardo da Vinci's** famous painting, the *Mona Lisa*, has been stolen! Interpol and local police are in a search to find the criminal. After a lot of investigation they identified a suspect.

When officials searched the suspect's home, they found several copies of the missing painting. Police think one of the paintings is the original *Mona Lisa*. It is now up to you to determine which painting is the real masterpiece.

Because the suspect may try to leave the country, results are needed quickly. The information below will provide you with some of the facts necessary to help you solve the crime. Before solving the crime, you will perform some pre-lab activities to prepare you for the experiment. Good Luck!

ART FORGERY

"As long as there is art there will be forgeries"--Vermeer

The art of forging (copying) works of art is almost as old as art itself. Throughout the course of history, there have been many famous forgers. In the 1930's, Henricus Antonius van Meegeren began studying and experimenting with **pigments**, media and old canvases. He forged many famous paintings by Vermeer. As a result, van Meegeren became very wealthy until he later admitted he had forged the paintings and went bankrupt.

Making a **forgery** is very hard work. Forgers must study the original artist carefully. What country were they from? What pigments did they use? What was their painting style? Forgers need to exactly match the **composition** of the paints (what was used to make the paint colors) to that of the original paint. They even have to use the same type of brushstrokes as the original artist. Now that takes a lot of studying! According to Thomas Hoving, a curator at the Metropolitan Museum of Art, 40% of all art given to the museum are forgeries!

In order to determine whether a painting is real, art collectors and museum curators rely on forensic scientists. Forensic scientists do many things. They may analyze the painting for fingerprints or palm prints left by the artist. Scientists may also X-ray the painting to find out how many layers there of paint there are (some artists layer their colors while others do not).

In order to analyze the color composition of the painting, scientists take a small chip of paint from the artwork and analyze it using gas



Mona Lisa
Leonardo da Vinci,
circa 1503-1507

Fact Files

Did you know, the *Mona Lisa*, which took over four years to complete, is about 500 years old and worth over 645 million dollars?

Go Online!

For: More about DaVinci
Visit: www.mos.org/leonardo/

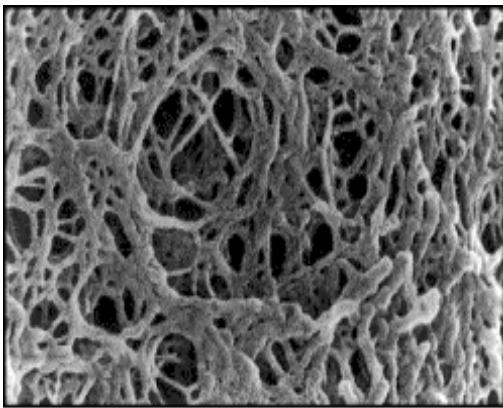
chromatography or **gel electrophoresis**. Gas chromatography takes a lot of time, and we need to get these paint samples analyzed as soon as possible, so we are going to use gel electrophoresis. In gel electrophoresis, colors separate by their size. Different sizes move or “run” differently on a gel. Because of this, all the colors in the paint sample will separate out, forming a unique pattern.

Correctly matching the composition of an artist’s paint is very difficult because the **formulas** used by famous artists are rarely written down or discovered. Additionally, each artist uses different color combinations based on the region of the world. For example, one artist may use the herb saffron for yellow color, while in a different region of the world, an artist may use yellow mustard seed. Black is almost always a combination of colors, so scientists frequently analyze what colors make up each artist’s black paint. Many painters used not only pigments, but other raw materials like glass, minerals and chemicals. These painters were not just talented artists, but experimental chemists too!

AGAROSE GEL ELECTROPHORESIS

Agarose gel electrophoresis is used in the laboratory to separate molecules by size. First, scientists make an agarose gel. Agarose is a sugar made from seaweed. When dissolved in hot water and cooled in a mold, the agarose hardens. Think of the gel as a square piece of Jell-O with pockets in it. However you cannot eat the agarose gel! The picture below is an agarose gel magnified under a powerful microscope. The agarose gel is like a maze for molecules to run through. Which size molecule, large or small, would be able to move through this maze faster?

To move molecules through an agarose gel, scientists use a technique known as electrophoresis. *Electro* refers to the use of electricity. The Greek verb *phoros* means “to carry across”. Molecules are loaded into pockets within the agarose gel and are *carried across* the gel using *electricity*. Gel electrophoresis uses electricity to separate molecules (like paint samples) based on their size or charge. Do you think the paint samples will separate based on size or charge?



This is an agarose gel magnified 50,000 times!
Source: www.amershambiosciences.com



Forgery

(fOrj-rE) – The act of falsely creating or altering a document or masterpiece.

Go Online!



For: A fun electrophoresis animation

Visit:

<http://learn.genetics.utah.edu/units/biotech/gel/>



Gel Electrophoresis

(Gel i-LEK-tro-for-rE-ss) – The process of using electricity to separate molecules in a gel

GLOSSARY OF TERMS

Agarose – A sugar isolated from red algae or seaweed, commonly used as a thickening agent in food. Agarose is used to make gels in gel electrophoresis.

Bioscience – The study of life.

Buffer – A solution used to stabilize the pH of a liquid. The pH indicates how acidic or basic a liquid is.

Chromatography – The process by which a chemical mixture is separated into its component parts using a liquid or gas.

Composition – The product of mixing chemicals/molecules/elements; for example, water (H₂O) is a composition of hydrogen (H) and oxygen (O).

Digital balance – A scientific piece of equipment used to measure the mass of an object; how much the object weighs.

Forgery – The act of falsely creating or altering a document or masterpiece.

Formula – A recipe for making a molecule or solution.

Gel electrophoresis – The process of using electricity to separate molecules, for example paint or DNA samples, in a gel.

Graduated cylinder – A scientific piece of equipment used to measure liquids, usually in milliliters.

Hot Plate – A scientific piece of equipment used to heat chemicals.

Leonardo DaVinci - (1452-1519) A very famous artist, scientist, and inventor who painted the *Mona Lisa*.

Louvre Museum – The art museum in Paris, France where the *Mona Lisa* is housed.

Mass – A property of an object that describes how much matter it contains, typically thought of as how much an object weighs.

Masterpiece – An outstanding artistic achievement; a work of art created by a master craftsman.

Meniscus – The top, curved surface of a liquid that is formed when liquid is in a glass cylinder or column. In science when using a graduated cylinder a scientist reads measurement from the bottom of the meniscus.

Microliter – One one-millionth of a liter (10⁻⁶), designated μL.

Milliliter – One one-thousandth of a liter (10⁻³), designated mL.

Micropipette – A scientific piece of equipment used to measure microliters, small amounts of liquid.

Molecular fingerprint – The pattern of bands generated on an agarose gel which are specific to the object from which they were generated.

Mona Lisa – A masterpiece created by the artist Leonardo Da Vinci about 500 years ago.

Pigment – A substance that imparts color onto other materials or objects, for example, inks, minerals, and dyes.

Primary Colors – Red, yellow and blue, the colors from which all other colors are generated.

Secondary Colors – Any colors formed by mixing two or more primary colors.

TAE – Tris Acetic acid EDTA, a buffer used to make agarose gels and to conduct electricity in the gel electrophoresis chamber.

Vortex – A scientific piece of equipment used to mix chemicals.

FORTY FEET OF BIOSCIENCE FUN!

INSTRUCTIONS: Below is an article from the BioBus News. There are 12 errors in it. How many can you find? Circle them. Can you correct them? Write the answers on the next page.

By Erlyn Meier

THE BIOBUS NEWS

NEW HAVEN – Students at Weird Science Middle School were forensic scientists today, working to determine who stole the *Mona Lisa*. Wearing gloves and safety goggles, the students performed a scientific technique called Jell-O electrophoresis.

The scenario: The *Mona Lisa*, painted by Leonardo DiCaprio, was stolen from the Metropolitan Museum of Art in New York City. Police suspect a master thief, Ima Robber, stole the *Mona Lisa*. Police found four copies of the painting at Ima’s house. They think one of the paintings is the real *Mona Lisa*. The students’ jobs are to analyze the paint samples from each of the paintings to determine whether Ima is guilty of theft and forgery.

To start the two hour experiment, students measured 30 grams of agarose, a protein isolated from the octopus, into a test tube. Then they added 30 mililiters of 1xTAE, mixed them for 10 seconds and then placed them in the fridge. This mixture was then poured into a mold and allowed to cool.

The students placed the gel block in water. Then they painstakingly loaded samples of paint from the four forgeries and turned on

the electricity. This caused the paint samples to move through the bagorose gel separating by charge.

“It’s just fun! I have never done anything like this before!” said Milli Liter of New Haven. “I’m a scientist solving a crime.”

The Connecticut BioBus, which has been in operation since 2001, is a 40 foot-long custom designed mobile science laboratory with computers and bioscience equipment. The BioBus presents hands-on experiences in the life sciences above and beyond the normal classroom curriculum. The BioBus accommodates up to 75 students per teaching session.

“I thought at first it might be boring, but it’s not boring at all,” stated Molly Cule of Branford. When asked if she’d consider science as a career, Molly said “Definitely, I never realized science could be this fun!”

So how did it end? Ima Robber was found guilty of theft and forgery. Police were waiting outside. When asked why Ima Robber did it, Robber replied “I wanted the students to have a good time.”

Name: _____

FORTY FEET OF BIOSCIENCE FUN WORKSHEET

INSTRUCTIONS: After you have found all 12 errors in “Forty Feet of Bioscience Fun” go through the article and label the mistakes 1-12. Then see if you can correct the mistakes. Write your answers below.

Corrected answers:

- 1) _____
- 2) _____
- 3) _____
- 4) _____
- 5) _____
- 6) _____
- 7) _____
- 8) _____
- 9) _____
- 10) _____
- 11) _____
- 12) _____