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Celebrating Chemistry

National Chemistry Week | American Chemical Society

Solving Mysteries Through Chemistry!

Fun with Che-mystery!

By Al Hazari

Do you enjoy doing crossword puzzles, solving problems, or exploring mysteries? If you answered yes to any of these questions, then you could also be a chemist!

From the moment babies are born, they use their senses to look for clues or hints to find out more about their surroundings. Chemists do the same thing — using not only their senses, but also technology to learn about the world around them. Many of the biggest scientific questions and some of the world's most urgent problems— involve chemistry, the science of atoms and molecules.

Many of the most famous scientists and chemists in history who have contributed to the most important discoveries were explorers. They used the **scientific method** in their work: They made careful observations, patiently gathered information, did experiments — and most of all, experienced the thrill of discovery!

For example, **Dimitri Mendeleev** was a Russian chemist best known for his work on how the elements are arranged in the periodic table. His first version of the periodic table was published in 1869. Many years later, **Rosalind Franklin** came up with an X-ray diffraction picture of an amazingly small piece of material that almost all living organisms have in their bodies, called DNA. Her picture of DNA was used by other scientists named Watson and Crick to create a model of the **DNA double helix**. British chemist **Sir William Henry Perkin** created the first synthetic dye called aniline purple used to dye fabric. **Alexander Fleming** was a doctor who studied bacteria and discovered penicillin, receiving the Nobel Prize in 1945. **John Dalton** was an English chemist best known for the atomic theory. Finally, **Marie and Pierre Curie** are best known for their pioneering work in the study of radioactivity, which led to their discovery in 1898 of the elements radium and polonium. In addition to many other benefits, the work of these discoverers made it possible for police detectives to use chemistry understanding and tools to solve crimes.

We hope that you'll enjoy reading this issue of *Celebrating Chemistry*, doing some hands-on chemistry activities, and pondering the puzzles! We also hope that you will be excited, inspired, and even more curious about the world around you. Last but not least, we hope you'll want to learn more about other topics in chemistry in this edition … and maybe someday you can contribute to solving one of the world's unsolved mysteries! Explore, investigate, analyze and enjoy!

Al Hazari, Ph.D., *is a retired Director of Labs and Lecturer in Chemistry at the University of Tennessee, Knoxville. He also teaches forensic chemistry as part of his science outreach programs for everyone.*

Milli's Safety Tips Safety First!

ALWAYS:

- Work with an adult.
- Read and follow all directions for the activity.
- Read all warning labels on all materials being used.
- Use all materials carefully, following the directions given.
- Follow safety warnings or precautions, such as wearing gloves or tying back long hair.
- Be sure to clean up and dispose of materials properly when you are finished with an activity.
- Wash your hands well after every activity.

NEVER eat or drink while conducting an experiment, and be careful to keep all of the materials away from your mouth, nose, and eyes!

NEVER experiment on your own!

Appearing and Disappearing Ink

By Marilyn Duerst

Would you like to write a “secret message” to someone? What if you could write the message in ink that is invisible … and then send it to someone who knows exactly how to make the message appear? Well, you can — if you know a little about science! In this experiment, you’ll learn how it can be done!

Q. If you want to write a secret message to your friend, you can either use a secret language or use this type of ink.

A. ______________________________________

Materials

- **Piece of yellow or dark yellow construction paper**
- **1/8 tsp. (about 0.6mL) powdered turmeric (available in the spice section of the supermarket)**
- **Small bowl**
- **1 tbsp. (15 mL) water**
- **1/2 tsp. (2.5 mL) rubbing alcohol**
- **Spray bottle of ammonia-based window cleaner**
- **Cotton swab or small paintbrush**

SAFETY SUGGESTIONS

- Safety goggles required
- Protective clothing suggested
- Do not eat or drink any of the materials used in this activity
- Thoroughly wash hands after this activity
- Cover your area with newspaper
- Work in an area with good ventilation

Procedure

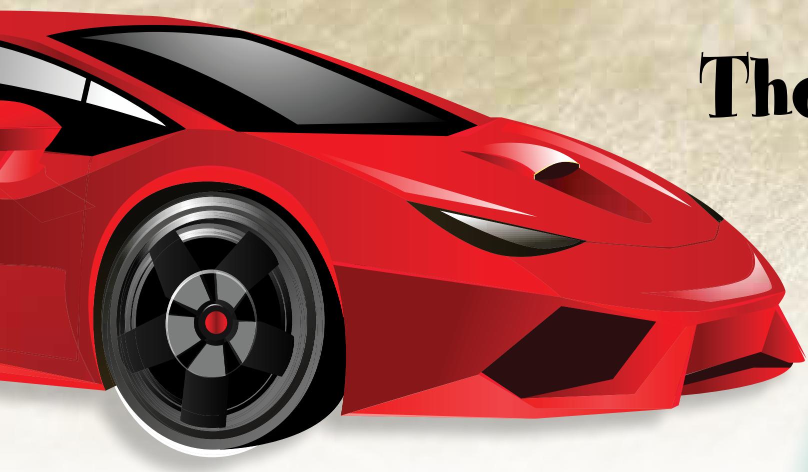
1. Lay your construction paper on a flat surface.
2. Prepare a yellow-colored solution by carefully stirring together the turmeric powder, water, and rubbing alcohol in the bowl.
3. Write a secret message on the yellow paper! To do this, dip the paintbrush or cotton swab into the turmeric solution, then brush it onto the paper.
4. Allow the writing to dry, and then spray the window cleaner on the paper where you wrote your message.
5. Wait a few minutes for the window cleaner to dry.

What did you see?

1. After the window cleaner dried, what happened to your message? Why do you think that happened?
2. Spray the paper with the window cleaner again and describe what happens.

Where’s the chemistry?

Turmeric is a powdered spice, made of the crushed roots of a plant. It contains a chemical called **curcumin** that stays yellow-gold in an **acid** (like lemon juice) or in **neutral** solutions like water. However, it changes to a red-orange color in a **base** like window cleaner, which contains a stinky gas called ammonia. When the ammonia evaporates into the air, the original yellow-gold color returns.



The Art of Color in

By Nelson R. Vinueza

Color surrounds you! Colors are in your clothing, in the artwork on your wall, and in your family's car. The colors we see are made up of tiny molecules called **colorants**, which can be dyes or pigments, and they are in almost every object you can imagine.

Although some of the colors that you can see are made by nature, many are man-made, or **synthetic**. You may wonder how all these colorants can help in solving mysteries or crimes. Well, each colorant molecule has a unique shape, like a tiny fingerprint. These "colorant fingerprints" tell scientists and investigators what object the colorant might have come from, and when. With these clues, they can solve mysteries!

Let's imagine you're a detective, and you've been asked to solve a crime. Someone crashed their car into the sign at your school in the middle of the night and drove away. You're looking for clues to figure out who did it. You don't see any tire marks on the ground, but you spot a patch of red paint that scratched off the car and got stuck to the broken sign. This is just the kind of color clue you were hoping to find! Believe it or not, this color will help you solve the mystery.

Why did we find paint on the sign? This is due to something called **Locard's exchange principle** which states, "when two objects come into contact, there will be a mutual exchange of matter between them." In this case, the red paint found on the sign must have come from the car that crashed into the sign. When you send a sample of the car paint to the lab, a color scientist looks at the colorant molecules and tells you that it is the color called "Ferrari Red." This is a pigment also known as "Red 254," and was patented in the early 1980s. That narrows it down! Now all you have to do is find any person in your area who drives a red Ferrari that has recently been in an accident — and you have found your suspect!

Q. Colors we see are made up of tiny molecules called what?

A. ______________________________

Cars are not the only things with special colorants to help in solving crimes. In 2005, some art collectors were trying to decide if the paintings they had just bought were real or fake. Supposedly, the paintings had been painted by Jackson Pollock, a very famous artist who painted during the 1940s and 1950s. However, when scientists looked closer at the colorants used in the paintings, they found one that looked suspicious: Red 254, the "Ferrari Red" color. The Red 254 colorant wasn't available until long after Pollock died, which means he definitely didn't paint those paintings! We just solved another mystery: the paintings were fake! Now, when someone talks about an old and unique painting from a famous artist, you know about some tools that could tell if it's real or a fake.

It's not just colorants that can help us solve crimes. Textile materials (fibers) can help too. That's because colors and fibers have a unique relationship. The type of fiber (natural or man-made) will mean a specific type of dye was used. We can figure

Solving Mysteries and Crimes

out what dyes were used to color a piece of fabric found at a crime scene by using special microscopes and chemistry techniques, such as **mass spectrometry** and **infrared spectroscopy**. These are tests that are performed in a part of a crime laboratory known as "Trace Evidence," due to the very small size of the materials being tested.

Color-based detective work only succeeds if the investigators can match the colorant fingerprint they find with one they already know. For this reason, scientists at North Carolina State University are working to create a library of all the known colorant fingerprints to help during investigations. Hundreds of colorant fingerprints are being added to the library each year, and each new fingerprint may someday help solve another color mystery!

***Nelson R Vinueza Ph.D.**, is an Assistant Professor of Analytical, Organic and Forensic Chemistry at North Carolina State University College of Textiles.*

Word Search

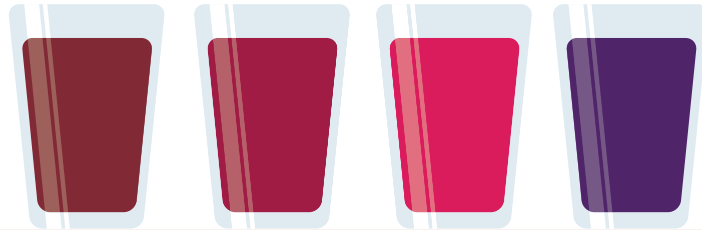
Try to find the words listed below — they can be horizontal, vertical or diagonal, and read forward or backward!

P	I	G	M	E	N	T	T	F	M	T
H	E	E	D	P	I	O	T	S	Y	D
S	Y	N	T	H	E	T	I	C	S	F
S	E	A	A	I	R	N	R	S	T	O
E	L	N	R	N	O	D	I	D	E	R
T	M	E	R	R	H	C	T	L	R	G
F	D	G	U	I	N	G	N	L	Y	E
T	G	S	E	T	D	N	A	N	C	R
H	A	H	R	P	H	O	N	C	M	Y
F	I	N	G	E	R	P	R	I	N	T
E	A	C	O	L	O	R	A	N	T	P

COLORANT	DNA	FINGERPRINT	FORGERY
PIGMENT	SLEUTH	SYNTHETIC	MYSTERY

Be a Fruit Juice Sleuth!

By Marilyn Duerst



Would you like to solve a mystery? Let's find out which beverage products actually contain fruit juice … and which ones are colored mainly with artificial food dyes.

Real fruit juices often change color if mixed with household acids and bases. Artificial food dyes usually do NOT change color when mixed with these same household solutions. Let's do some experiments with a variety of beverages to see if they contain real fruit juices or not!

Materials

- **Kids juice box (cherry flavor)**
- **Powdered mix drink (strawberry flavor)**
- **Cranberry or grape juice**
- **Powdered dishwasher detergent or white cleanser (used as the "base")**
- **3-5 small bowls or small clear glasses**

Procedure

1. Pour a small amount (about 1 tbsp. or 15 mL) of the different beverages into small bowls or glasses.
2. Add about 1 tsp. (2.5 mL) of powdered dishwasher detergent or any white cleanser to each bowl. Did any change color? If so, can you describe the change? Fill in your answers in the table below.
3. If you have other blue, red, or purple beverages on hand, try them and record your findings in the table.

Safety Suggestions

- Safety goggles required
- Wear a kitchen apron
- Do not eat or drink any of the materials used in this activity
- Thoroughly wash hands after this activity

Where is the Chemistry?

The colored chemicals in many juices are sensitive to the amount of acid or base in a solution. As we add an acid or base, the color changes as the chemicals combine with the acid or base. Acids have a sour taste and can dissolve many materials.

For example, lemons and cranberries are sour — so they are acidic. Bases have a bitter taste and tend to be slimy or slippery. Most soaps are considered bases.

If any of the beverages changed color with the addition of the "base," it likely had a significant amount of real fruit juice, because real fruits change color depending on the pH of the solution. Dishwasher detergent is a strong base, and most fruits change to blue or green in bases.

If it *did not* change color, it likely contains a red food dye (probably Red #40). Or it could have a mixture of dyes, such as Red #40 and Blue #1, or maybe Yellow #6. None of these dyes change color in a base.

Marilyn Duerst *is a retired Distinguished Lecturer in Chemistry at the University of Wisconsin-River Falls.*

What did you see?

Beverage	Original color	Color with a "base"	Did the color change?	Did it contain a real fruit juice?
Boxed juice cherry				
Strawberry powered drink mix				
Cranberry or grape juice				

Dusting for Fingerprints

By Jacqueline Erickson

Safety Suggestions
- Safety goggles required
- Protective clothing suggested
- Do not eat or drink any of the materials used in this activity
- Thoroughly wash hands after this activity

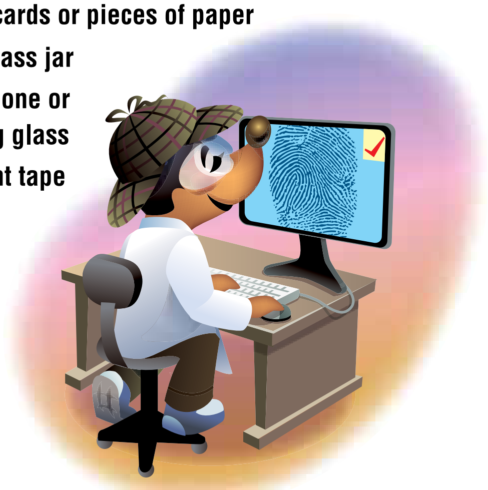
Do you want to act like a detective and solve mysteries? If so, you will need to learn how to look for clues such as fingerprints!

Fingerprints are one of the most common types of evidence or clues left behind at a mystery scene. Police have been using fingerprints to solve mysteries and identify people for over a hundred years. Why are fingerprints used so widely? Fingerprints are very common and useful because they are unique to you! Even identical twins have different fingerprints.

Have *you* left behind any fingerprints? Try the activity below to see if you can make your fingerprints visible.

Materials

- **Dark powder (either cocoa powder or black tempera paint powder works well)**
- **Fluffy brush (such as a make-up brush or round fine-art brush)**
- **4-5 white cards or pieces of paper**
- **Glass or glass jar**
- **Camera phone or magnifying glass**
- **Transparent tape**
- **Pencil**



Q. There's a kind of clue that is very personal, and unique only to you. It is also one of the most common types of evidence left behind at a mystery scene. What is it?

A. ______________________________

Procedure

1. Make sure your hands are clean.
2. Rub one of your fingers on the side of your nose and press down on the side of the jar.
3. Brush a small amount of the powder over the area where you pressed your finger and tap to shake off any loose powder.
4. Brush lightly to avoid smearing.
5. Once a mark is visible, carefully place a piece of tape over the mark, press down and rub lightly.
6. Lift the tape off and then press it onto the white card or piece of paper.
7. Use a camera phone or a magnifying glass to enlarge and look at your fingerprint.

Now Try This

1. Make sure your hands are clean.
2. On a new piece of paper, use a pencil and darken an area about 1 inch (25 mm) square.
3. Rub a finger over the darkened square, and then press that finger on a clean white card or sheet of paper.

What did you see?

- What did you see when you shook off the loose powder?
- What happens when you lifted the tape off of the jar?
- Use a camera phone or a magnifying glass and compare your fingerprint from the glass jar to the one with pencil. What do you see?

Where's the chemistry?

Fingerprints are a sticky residue made up of oil and sweat on your fingertips, and they contain fat molecules and proteins. The powder sticks to the residue and makes the fingerprint visible. If someone's hands are dirty, they may leave visible fingerprints. However, most of the time, the prints are invisible, and must be made visible with physical or chemical techniques, based on reactions with the fat and protein molecules. Forensic scientists use many techniques for detecting fingerprints, including the one in this activity using fine powder.

Jacqueline Erickson *is a Senior Development Scientist at GlaxoSmithKline Consumer Healthcare, R&D, Warren, NJ.*

The Adventures of Meg A. Mole, Future Chemist

Dr. Bill Bass

Forensic Anthropologist

For National Chemistry Week 2016, I decided to travel to the world's only outdoor forensic anthropology laboratory, known as "The Body Farm" in Knoxville, TN. I was so excited to spend the day with Dr. Bill Bass, a retired professor from the Department of Anthropology at the University of Tennessee.

At the Body Farm, scientists perform experiments on bodies donated for research and education. Dr. Bass explained that here they "examine the effects of various conditions" on the bodies. The observations and results can help them learn the effects on a body from being buried in the ground, left in the trunk of a vehicle, underwater, or even exposed outside to the weather elements. This helps them learn how to determine the length of time since death when bodies are found at crime scenes.

Dr. Bass greeted me while holding a skull in his hand! I could not wait to learn more about his work. He explained that "as a Forensic Anthropologist, my job is to identify human skeletal (bone) remains for federal, state, and local law enforcement agencies." He told me how important safety is in his job, saying, "While working, I always wear a protective overall, gloves, and safety glasses."

I was very curious about where Dr. Bass did his work. He told me, "I do most of my work in the field (the crime scene) locating the skeleton and recovering as many of the bones as possible (in an adult human, there are 206). The bones are often scattered by animals. Later I do indoor lab work that involves detailed testing (chemical, anatomical, DNA, etc.). I also do special tests to determine the length of time since death." Dr. Bass shared that "solving problems" is what he enjoys the most.

I wanted to know more! I asked him to walk me through how he solves problems in his daily work. He explained it like this: "When I find a skeleton, I start by asking whether it belongs to an animal or to a human. If an animal, what kind? If a human, can I determine how long the person has been dead, their age at death, and their sex, race (ancestry), and height? Sometimes I can even tell whether they were left- or right-handed."

I will never, ever forget my trip to the Body Farm!

Personal Profile

FAVORITE COLOR?
Orange

ACCOMPLISHMENT YOU ARE PROUD OF:
I have written several books, including both non-fiction (factual) and novels (made-up stories) about my work and my career.

VERY INTERESTING PROJECT YOU WERE A PART OF?
Establishing "The Body Farm" at the University of Tennessee, Knoxville in 1970.

Art Forgeries Revealed through Chemistry

By Jeffrey E. Fieberg and Gregory D. Smith

Q. Analyzing the kind of pigment (what gives paint its color) can be a clue to solving what mystery in the art world?

A. ______________________________

Have you ever visited an art museum and been interested in a painting by a famous artist, or in an object from ancient Egypt? Artworks like these are highly valued, both for their beauty and their cost. It is common for artwork to sell at auctions for thousands or even millions of dollars.

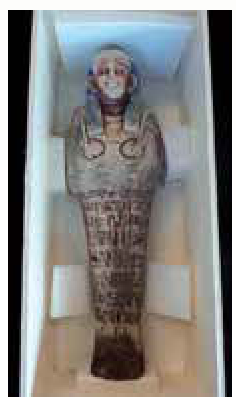
Because people pay so much money for certain artwork, many criminals produce **art forgeries** that they try to sell. Forgeries are objects that are made to look like real, or authentic, works of art in order to fool people into buying them. How can chemists tell if a work of art is a forgery? One method is to analyze the **pigments** (or **colorants**) that were used in the artwork.

Egyptian Blue

Some pigments used in works of art are found in nature. But other artistic materials are man-made, or synthesized, so they can only appear in pieces of art created after their date of invention. The blue mineral **azurite** was crushed and used in paint since ancient times. Egyptian blue, thought to be the first man-made pigment, has been found in objects dating back to 3000 B.C. Even so, we still don't know exactly when it was first created. For modern synthetic pigments, the dates of invention are well-known, because they were announced in a chemistry journal or as a legal patent.

The first modern synthetic pigment, **Prussian blue** was discovered by accident around 1705. Another blue pigment is called **ultramarine**. Natural ultramarine comes from the stone called **lapis lazuli** The rareness of this stone — first found only in the mines of present-day Afghanistan — once made ultramarine more expensive than gold! Because of its high cost, in 1824 the *Societé pour l'Encouragement d'Industrie* in France offered a large sum of money to anyone who could **synthesize** ultramarine and produce it at a low cost.

In 1828, Jean-Baptiste Guimet of Toulouse, France, figured out how to make it and won the prize, so the synthetic version is called French ultramarine. Knowledge of these dates of discovery is extremely important when a chemist investigates a possible forgery. If pigments are found in the objects that were not yet available at the time when it was supposedly created, it's strong evidence that the object was created more recently, and is a forgery.



Egyptian Ushabti

As an example, the Indianapolis Museum of Art was given an Egyptian ***ushabti***. Ushabti are figurines that were placed in tombs in ancient Egypt to be servants for the dead. Some people thought the museum's ushabti might be a fake because of its odd style and inaccurate hieroglyphics (ancient Egyptian writing). To find the truth, scientists investigated the blue pigment from the headdress (a decorative covering for the head). If the ushabti was really as old as its owner said, the pigment should be Egyptian blue. But the chemical and microscopic analysis showed that the blue pigment was really French ultramarine. That meant the ushabti was a forgery, created sometime after the invention of French ultramarine in 1828. By using similar tests, chemists have helped to bring many art forgers to justice.

Jeffrey E. Fieberg, Ph.D., *is an Associate Professor of Chemistry at Centre College, in Danville, KY.* ***Gregory D. Smith, Ph.D.***, *is the Otto N. Frenzel III Senior Conservation Scientist at the Indianapolis Museum of Art.*

The Mystery of DNA

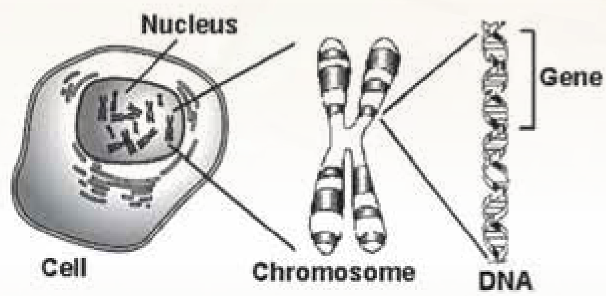
By Al Hazari

Are you curious about your physical appearance — like why your hair or eyes look the way they do? To find answers, you have only to look to your biological parents. Before you were born, cells from your mother and father united to form an organism. Within each of those cells were thin threads called **chromosomes**, which are made up of even smaller material called DNA. DNA stands for deoxyribonucleic acid, and it holds a "code" for every cell in your body!

Parts of these cells are **genes** (*not* your blue jeans!). Genes which tell a person's body how to develop, and carry coded information about the characteristics of the person's parents, like the size and shape of their nose, whether they're short or tall, and other qualities.

In the 1950s, James Watson and Francis Crick built a model of the DNA molecule based on X-ray data collected by Rosalind Franklin and Maurice Wilkins. Rosalind helped in a very important way, by making an X-ray diffraction picture of a DNA that Watson and Crick used to create their **DNA double helix model**.

Each molecule consists of millions of atoms arranged in a double helix — a spiral shape that some people say looks like a twisted ladder, held together by cross pieces (see picture below). The order in which the atoms are arranged is the "genetic code" — the information that parents pass on to the next generation. Today, scientists do *genetic fingerprinting* to track criminals and to study diseases.



In the activity on the next page, you can build your own model for a DNA molecule. Models are used by scientists for many purposes, but especially to visualize what is far too small to see. Enjoy!

Q. What is the material that carries all the information about how a living thing will look and function?

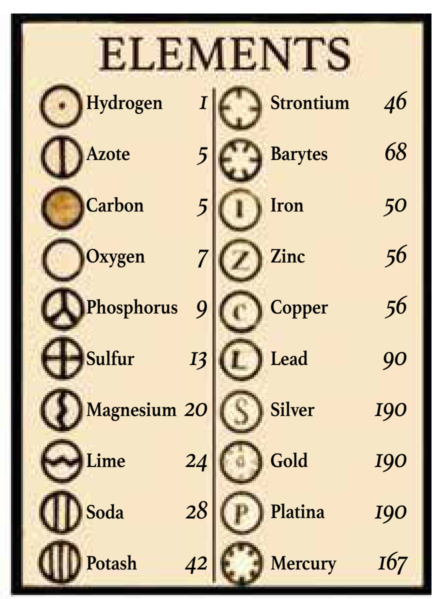
A. ______________________________

You Are *not* Clueless!

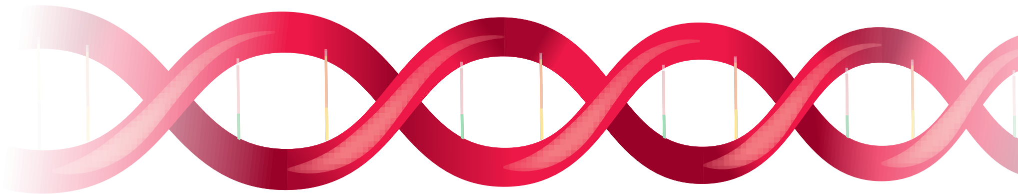
We've made a secret code using alchemists' symbols of the "elements." See if you can use the code to find the last name of a famous chemist mentioned in this publication.

Here's the tricky part. For the first symbol, use the *first letter* of the element's name. For the rest, use the *second letter*. After solving the puzzle, go to the web to learn more about this person's contributions to chemistry.

___ ___ ___ ___ ___



Sweet Science of DNA



By Al Hazari

Introduction

What do you think a single strand of DNA looks like? When DNA is taken out of the cell and stretched out, it looks like a twisted ladder — a shape called a double helix.

The sides of the DNA ladder are called the **backbone**, and the steps are pairs of small chemicals called **bases**. There are four types of bases in DNA: Adenine (A), Cytosine (C), Guanine (G) and Thymine (T). DNA bases follow certain rules when they form. Adenine (A) always pairs with Thymine (T), and Guanine (G) always pairs with Cytosine (C).

Using colored mini-marshmallows, licorice strips, and toothpicks, you can construct your own DNA double helix. Two licorice pieces will be the backbones and the marshmallows and toothpicks will be the bases.

Safety Suggestions

- Be careful not to poke yourself or others with the toothpicks.
- Do not eat any of the materials used in this activity.

Materials

- **2 licorice strips**
- **16 colored mini-marshmallows (4 each of 4 different colors)**
- **8 toothpicks**

Procedure

Use the following color coding for marshmallows:
A = **green**; T = **pink**; C = **yellow**; G = **orange**.

1. Place both pieces of licorice on a flat surface (a table or the floor).
2. Put together one side of your DNA double helix using this sequence (from top to bottom): T A G A C T C G. To do this, place one marshmallow that matches the correct base (using the color codes above) on the end of toothpick.
3. Push them in about ½ inch from the end.
4. Then, stick the toothpick into the left licorice.
5. Repeat this for the next several toothpicks, following the order above. Space the toothpicks about ¾ inch apart from each other.
6. Match the chemical base pairs by placing the colored marshmallow for the chemical base on the other end of each toothpick. Remember, A (**green**) always pairs with T (**pink**) and C (**yellow**) always pairs with G (**orange**). For example, place a green marshmallow on the other end of a toothpick with a pink marshmallow, and a yellow marshmallow on the other end of a toothpick with an orange marshmallow.
7. Complete your DNA double helix by attaching the other backbone (right licorice).
8. Carefully twist your DNA until it looks like the picture above.

What did you see?

- When you attach both backbones, what does it look like?
- What is the shape of DNA called when you twist it?

Where's the chemistry?

DNA is what makes living things look, and sometimes behave, the way they do — from birth, through growth and death. When chemists discovered DNA, it changed science and medicine forever. It has also affected many other parts of our lives. For example, it helps to explain why people look the way they do, gives police tools for finding criminals, and much more.

DNA is also important in our own lives. First, it carries hereditary information from generation to generation. Second, it controls the production of proteins and the structures of cells. That means DNA can determine whether a cell will become part of a nerve, a muscle, or even an eyeball.

When it comes to forensic science and its uses, DNA is also important. Because each person's DNA is one-of-a-kind, even a small sample of it can be used to positively identify an unknown person.

Celebrating Chemistry

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What is the American Chemical Society?

The American Chemical Society (ACS) is the largest scientific organization in the world. ACS members are mostly chemists, chemical engineers, and other professionals who work in chemistry or chemistry-related jobs. The ACS has more than 156,000 members. ACS members live in the United States and different countries around the world. Members of the ACS share ideas with each other and learn about important discoveries in chemistry during scientific meetings held around the United States several times a year, through the use of the ACS website, and through the many peer-reviewed scientific journals the ACS publishes. The members of the ACS carry out many programs that help the public learn about chemistry. One of these programs is Chemists Celebrate Earth Day, held annually on April 22. Another of these programs is National Chemistry Week, held annually the fourth week of October. ACS members celebrate by holding events in schools, shopping malls, science museums, libraries, and even train stations! Activities at these events include carrying out chemistry investigations and participating in contests and games. If you'd like more information about these programs, please contact us at **outreach@acs.org**.

ACS Chemistry for Life®

Words to Know

Acid – a corrosive or a sour-tasting substance such as lemon juice or vinegar.

Base – tend to taste bitter and feel slippery such as baking soda or soap.

Colorant – molecules used to give color to something, such as a pigment or dye.

Disappearing ink – ink that is colorless and invisible until treated by a chemical, heat, or ultraviolet light.

DNA – short for deoxyribonucleic acid, the material that carries all the information about how a living thing or organism will look and function.

Double helix – the spiral structure of DNA that gives it a "twisted ladder" shape.

Fingerprint – a mark or pattern that is made by pressing the tip of a finger on a surface.

Forgery – a copy of something (such as a document or work of art) made falsely in order to mislead someone.

Mystery – anything that is kept secret or remains unexplained.

pH – a numeric scale (0-14) used to tell the acidity or basicity of a substance.

Pigment – a natural coloring matter in animals and plants.

Sleuth – a detective or investigator who looks for information to solve mysteries.

Synthetic – not of natural origin; prepared or made artificially.

PRODUCTION TEAM

Alvin Collins III, *Editor*
Rhonda Saunders, RS Graphx, Inc., *Layout and Design*
Jim Starr, *Illustration*
Eric Stewart, *Copy Editing*
Lynn Hogue, *Consultant, Committee on Community Activities*
Sumera Razaq, *Puzzle Design*

TECHNICAL AND SAFETY REVIEW TEAM

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Michael McGinnis, Chair, *Committee on Community Activities*
David Katz and Betty Ann Howson, *Safety Reviews*

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George Fisher
Avrom Litin
Ressano Machado
Verrill Norwood
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Denise Creech, *Director*
John Katz, *Director, Member Communities*
Alvin Collins III, *Program Manager, Volunteer Support, Member Communities*

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The activities described in this publication are intended for elementary school children under the direct supervision of adults. The American Chemical Society cannot be responsible for accidents or injuries that may result from conducting the activities without proper supervision, from not specifically following the directions, or from ignoring the safety precautions contained in the text.

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Member Communities/Volunteer Support
Membership and Scientific Advancement
1155 Sixteenth Street NW • Washington, DC 20036
800-227-5558 • outreach@acs.org