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June 2022

LaSalle Labs Magazine

Volume 1, Issue 1

Cover art by Victoria Godinho, Grade 11

INTRODUCTION

The 2021-2022 Grade 11 Chemistry classes are pleased to present the inaugural issues of the first volume of LaSalle Labs. This magazine showcases articles from the students covering a wide variety of topics within the chemical industry. Topics from the chemical of personal care products, forensics, building materials and pharmaceuticals can be found in the two issues. You can also challenge yourself to some puzzles and crosswords for fun!

The students were tasked with seeking out topics of interest to them and doing some research to learn more about the chemical (or chemistry) behind the products. They then had to present the material in a manner suitable for a magazine targeted to high school students.

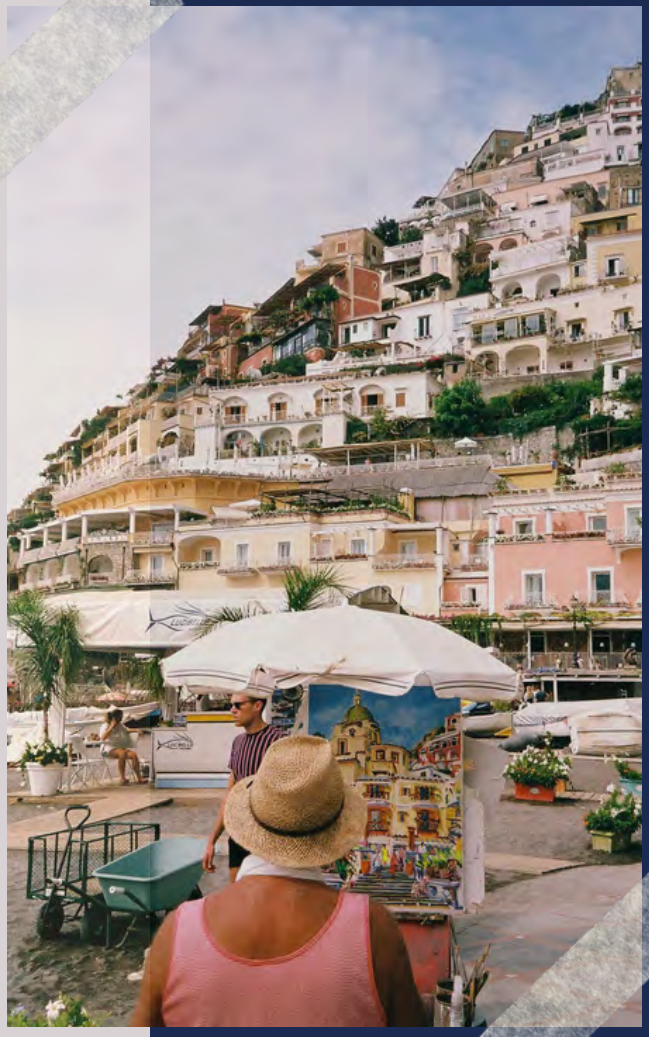
On behalf of Ms. Mohaghegh and myself, we are proud of their accomplishments this year and we hope you enjoy reading through the two issues appreciating that chemistry truly is everywhere.

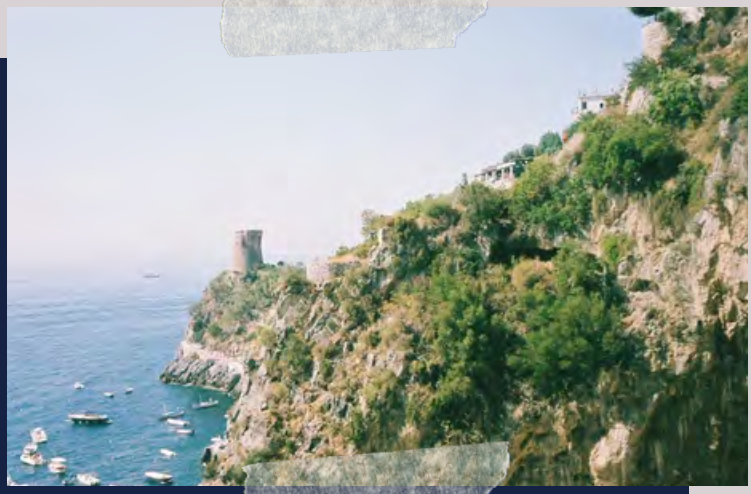
Sincerely,
Ms. Ceschia

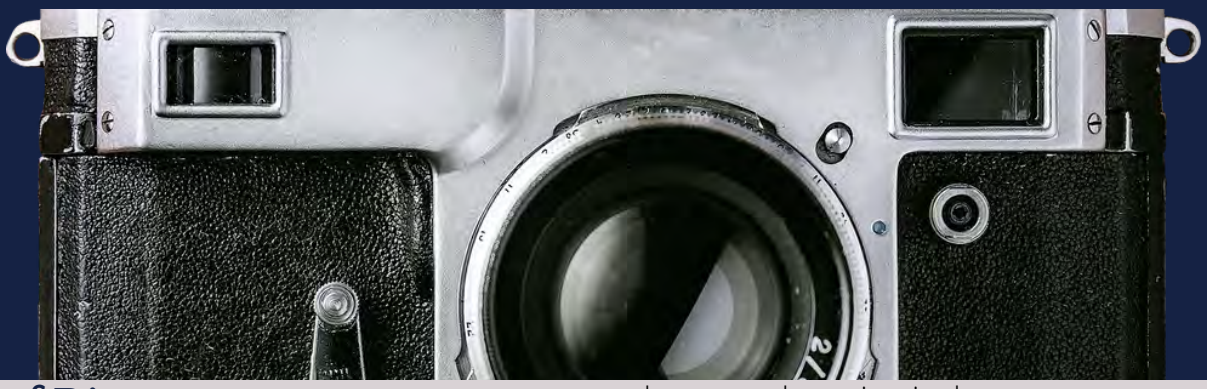
Picture Perfect

By: Emma Massaro & Avery Bailey

The pandemic has brought about the resurgence of numerous trends from the years past after a seemingly never-ending lockdown. Gen-z has single-handedly revived the early Y2K fashion trends, with teenagers around the world raiding their parents closet's for their low rise jeans, Juicy Couture tracksuits, and most importantly, their film cameras. Located in the hands of the young trendsetters of today, the disposable film camera gives teens the opportunity to experience what life was like before the digital age. However, many teens still do not know how disposable film cameras came to be and how they work?







History of Dispos

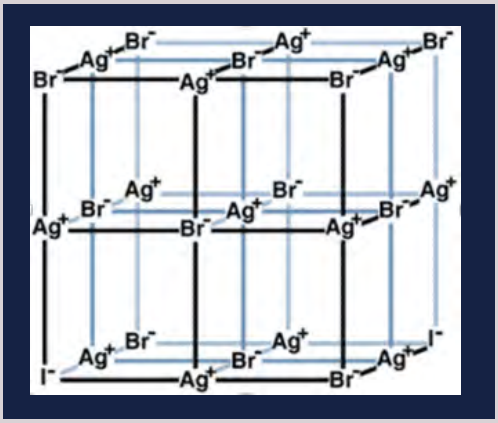
The disposable camera was first invented in 1986 by the company FujiFilm in Japan. Their Usturun - Desu ("It takes pictures") or "Quick Snap" line used 35mm film in order to snap a quick photo without the worry of how it appears. During the 80's in Japan, cameras were extremely expensive and only used on special occasions, typically by the men in each household. When disposable cameras were introduced, a cultural shift began in Japan which then flooded the rest of the world. The introduction of cheap, fun-sized, lightweight cameras brought families together and made memories a little easier to capture. Parents and children were able to take photos which created the "snap happy" stereotype that is still prominent in society today. Because of the overwhelming response that disposable film cameras had, major companies such as Nokia, Konica, and Canon produced their own versions of film cameras. FujiFilm then began to improve their disposable film cameras by adding features such as waterproofing, panorama photography, and flash photography which are now current models of all disposable film cameras used.

Over the pandemic, spending time with the people you love has become a source of core memories which changed Gen Z's view on photography. They have realized it is more important to have a photo that captures the moment rather than a photo that captures your best angle.

From Picture to Print

In film cameras, chemistry is involved through the actual film and photo paper, as well as its development. Photographic paper and film consist of a gelatin emulsion with silver halide grains layered onto either paper or film base. These halides that are most often used are chlorine, bromine and iodine; however, bromine is the most common one used out of all three elements. You may be wondering... what is silver halide?

The silver halide grains used in photographic paper and film are crystalline structures of silver and halide ions in a lattice structure. These grains are held together by chemical bonds that are extremely strong and stable; however, there is some movement allowed of important atoms and electrons throughout the structure which are crucial for the development of the film picture. (Witten, 2016)



When photons from light come into contact with a grain, an electron is ejected from the valence band of the halide into the conducting band of the crystal. This electron will then combine with a moving silver ion forming atomic silver. The place where this occurs is the latent image center. The latent image is invisible to the eye, but after further development, the atomic silver will create dark areas due to its color. The latent center serves as a catalyst for the development of the film picture. The most important compound in a developer is the developing agent, which is an organic compound that makes the latent image visible. Hydroquinone, an organic compound, is a popular developing agent often found in developing solutions.

In order to make the latent image visible, the developing agent acts upon the exposed light-sensitive silver-halide crystals. Each exposed silver halide crystal contains an invisible speck of metallic silver. A developing agent acts upon each crystal containing a speck of metallic silver and turns the entire crystal black. When all the exposed light sensitive crystals have turned black, the image is visible. Developing agents, however, are imperfect and other compounds must be added to help them do their jobs. (Houston, N/A)

Capturing Moments or Causing Pollution?

Although people around the world have re-discovered the classical art of film photography, many still prefer the digital use for photography. On the contrary, those who do use film cameras do not stop to question whether or not film photography is beneficial for the environment. In a way, film photography is sustainable for the environment as fewer cameras are being produced meaning that there is less plastic, chemicals, and other non-biodegradable things being exerted into the environment. Additionally, this means that less of these items are being manufactured to meet the demand for film cameras. Despite the partial sustainability that film cameras possess, they also suggest many detriments to the environment. As mentioned previously, film is not biodegradable due to the coating of silver halide crystals in both color and black and white film. This means that the film you throw away at some point in time will just sit in a landfill forever without bio-degradation. This problem is evident as the harmful aspects of film do not leave the earth in adequate conditions for future generations.

Additionally, the processing of film also requires many toxic chemicals that can cause great harm to the environment if not disposed of properly. The chemicals such as hydroquinone, phenidone, and dimezone, combined with either sodium carbonate or sodium hydroxide used to develop film are extremely harmful to oneself as well as the environment if not disposed of immediately. It is crucial that many film companies find the means to dispose of film cameras properly as it makes the use of these cameras more eco-friendly and sustainable. Over the last couple of years, FujiFilm has made efforts to make film photography more sustainable and accessible. The company has recently established an app that you can download on your smartphone (for free) which allows people to capture “film like” pictures digitally. This app does not only allow you to capture film-like pictures digitally, but also acts in the same way as a film camera as you are not allowed to see the pictures instantly. The app has a time frame of 24 hours in order to allow your photos to “develop”. This satisfies one's desires to have vintage looking photos that you get from a film camera in a more sustainable eco- friendly way. It is safe to say that film cameras have made a large impact on their users as its comeback has served as a platform for memory making amongst loved ones. Film photography has opened the eyes of Gen Z’s to the beauty of our world as we are now able to truly live in the moment while capturing the moment.

References

University of Houston College of Technology n. (n.d.). *Chemistry of Photographic Processing - University of Houston*. PhotoChem. Retrieved May 25, 2022, from https://web.tech.uh.edu/digitalmedia/materials/3351/PHOTCHEM.pdf

Witten, N. M. (2016, May 5). *The Chemistry of Photography - University of South Carolina*. The Chemistry of Photography. Retrieved May 25, 2022, from https://scholarcommons.sc.edu/cgi/viewcontent.cgi?article=1085&context=senior_theses

Europe, C. (2022, March 18). *Disposable camera*. Wikipedia. Retrieved May 24, 2022, from https://en.wikipedia.org/wiki/Disposable_camera

Lee. (2021, May 15). *Is film photography sustainable?* The Photography Professor. Retrieved May 24, 2022, from https://thephotographyprofessor.com/is-film-photography-sustainable/

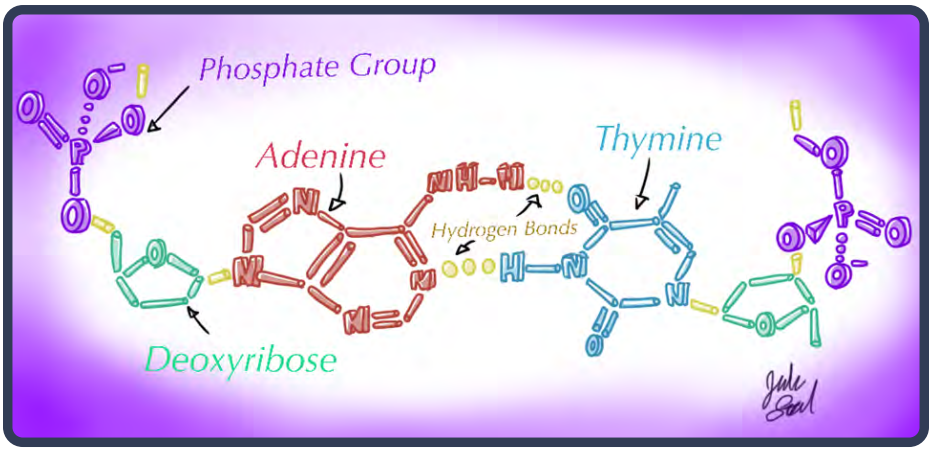
Shah, P. (2022, February 1). *9 reasons film photography is coming back*. Architecture Photographer | Film Photo Lab | Photography Classes. Retrieved May 24, 2022, from https://www.artbypino.com/blog/film-photography-revival

By: Jordan Sourial

COMPARATIVE GENOMICS

STRUCTURE OF DNA

In the early 1950s, James Watson, Francis Crick, and Maurice Wilkins were able to figure out the structure of DNA or "Deoxyribonucleic Acid". Their main method, X-Ray Crystallography, was used to identify patterns created by X-ray waves that signified the presence of certain monomers. The monomers that were discovered are called "Nucleotides", and when put in a specific sequence, they code for certain proteins that help create life. Nucleotides are composed of a nitrogenous base, a deoxyribose, and a phosphate group. The four nitrogenous bases are Adenine, Thymine, Guanine, and Cytosine, and each nucleotide is named based on which base it is bonded to. Adenine (A) and Guanine (G) are organic compounds with two rings called purines, and Thymine (T) and Cytosine (C) are single-ringed pyrimidines. One of these bases is then bonded to a deoxyribose which is a monosaccharide without a hydroxyl (OH) group on the 2' carbon. The bond between the base and the deoxyribose is called a "glycosidic bond", and it covalently forms between a nitrogen from the base and a carbon from the sugar. The deoxyribose is then bonded to a phosphate group. The entire DNA molecule is then formed by the repetition of this pattern; only, different bases are paired to each other through hydrogen bonds creating the differentiation in each of our genes. The hydrogen bonds between each base are formed as a result of the positively charged hydrogen being bonded to the negatively charged nitrogen; specifically, Adenine only pairs to Thymine, and Guanine only pairs to Cytosine. Eventually, the different combinations of bases in a double helix structure forms a gene, and many genes form a DNA molecule, and multiple DNA molecules form a genome.



The figure above shows the interactions between certain monomers in a DNA molecule. The bases Adenine and Thymine are shown; however, Guanine and Cytosine share very similar chemical bonds to each other and the deoxyribose with only slight variations in their chemical structures.

COMPARATIVE GNEMOMICS

"Comparative genomics is a field of biological research in which researchers use a variety of tools to compare the complete genome sequences of different species. By carefully comparing characteristics that define various organisms, researchers can pinpoint regions of similarity and difference." - **National Human Genome Research Institute**

Now that we know a little more about the chemical makeup of a DNA molecule, we can focus more on the bigger picture: researching the genomes of many different organisms to see when they developed new adaptations that allowed them to survive and reproduce more efficiently. To begin, a genome is the entire collection of DNA that contains many different sequences of the four base pairs which hold the information needed to build an organism. Inside the nucleus of a cell, the genome of the organism is held in tightly coiled, x – shaped strands of DNA called chromosomes. From here, we can discover how genomes may change over time.

GENETIC VARIATION

Genetic variation between species is caused by the formation of alleles and mutations. Firstly, alleles are different forms of the same gene. In only a few base pairs, an entire gene can be slightly altered creating a different form of the original. To better understand this, picture a gene used for coding hair colour. This gene will code for the colour of the organism's hair; however, the specific colour will be determined by slight variations in base pairs that produce slightly different hair pigmentation proteins. Moreover, mutations in the DNA may also occur as a result of exposure to radiation, carcinogens or during cell division when it isn't replicated or divided properly. Beneficial mutations and alleles are known as adaptations, and they are what cause organisms to genetically and physically change, and lineages to split.

GENE SEQUENCING

Further, the discoveries of mutations and alleles are only possible with DNA sequencing. The enzyme polymerase is able to replicate certain strands and add an additional fluorescent light that emits different signals depending on which bases are present. Once the specific bases are identified, researchers read only one half of the molecule to simplify things. They are able to do this because each strand of DNA exists in a double helix formation, and Adenine only pairs with Thymine while Guanine only pairs with Cytosine. This way, the other bases will always correspond to each other, and scientists can lay out information easier.

Putting it all Together

Scientists compare the genomes of different organisms to see at which genes and at which time periods linages separated. They search for differences and similarities in each gene, and they can determine how long-ago beneficial mutations and alleles may have surfaced for each of the organisms. For example, by looking at the genome of modern birds, we may be able to find when certain bird species developed powered flight, and when other species remained terrestrial.

Overall, genetic variation is vital to the survival of a species, and through comparative genomics, scientists can find those variations using different DNA sequencing technologies. Especially since these technologies are continuously being developed, it becomes easier and easier to shine light on how life evolved over the past 500 million years.

REFERANCES

- A brief guide to genomics. Genome.gov. (n.d.). Retrieved May 24, 2022, from https://www.genome.gov/about-genomics/fact-sheets/A-Brief-Guide-to-Genomics
- Comparative genomics fact sheet. Genome.gov. (n.d.). Retrieved May 24, 2022, from https://www.genome.gov/about-genomics/fact-sheets/Comparative-Genomics-Fact-Sheet
- What are the different types of DNA sequencing technologies? Thermo Fisher Scientific - US. (n.d.). Retrieved May 24, 2022, from https://www.thermofisher.com/us/en/home/life-science/sequencing/sequencing-learning-center/sequencing-basics/dna-sequencing-technologies.html
- Khan Academy. (n.d.). DNA function & structure (with diagram) (article). Khan Academy. Retrieved May 24, 2022, from https://www.khanacademy.org/test-prep/mcat/biomolecules/dna/a/dna-structure-and-function
- Fowler, S., Roush, R., & Wise, J. (2013, April 25). The structure of DNA. Concepts of Biology. Retrieved May 24, 2022, from https://opentextbc.ca/conceptsofbiologyopenstax/chapter/the-structure-of-dna/
- Ronit Dey - (B.S in Zoology). (2020, October 2). There are 3 types of bonds in DNA double helix structure. ONLY ZOOLOGY - (Know, Learn, Explore Zoology). Retrieved May 24, 2022, from https://onlyzoology.com/bonds-in-dna-double-helix-structure/

Wednesday
May 25th,
2022,

Cement

Issue #1

Adrian Battiston

Cement Through Time

The earliest records of cement usage date back to the time period of ancient Rome and Greece. However, the composition of cement back then was completely different than it is today. Back then cement was made of limestone and volcanic ashes and when mixed in water it hardened to form a solid mass that was stronger than any other material for its time or what we know today as concrete. The Romans utilized this new material to further develop their work in masonry to build foundations for new structures. One of the earliest buildings that that was made of cement was Opus Caementitium. Opus Ceaementitium was built by the Romans with a cement formula that was primarily comprised of lime and crushed rock. This ancient structure still stands today proving the strength and malleability of concrete even during its infant stages of use. Furthermore, it wasn't until the mid-18 hundreds when what is known as modern day cement was discovered. English Scientist Isaac Johnson discovered Portland cement by heating clay and chalk at temperatures of about 1400-1500 degrees Celsius. Through his research Johnson found that when chalk and clay reacted with higher temperatures more Clinkerization occurred. Clinkerization is the process when a solid state reacts with oxides of starting materials. Due to it being a solid-state reaction when more energy is needed to allow there to be diffusion of atoms and molecules of the crystals. It is through this chemical process that the components of cement become stronger and more reactive. Isaac Johnsons method of making cement is how it is still done to this day. Of course there may be some slight variations in temperature of the solids used in the making of the actual cement but the way that the cement is formed through Clinkerization is the same to this day.

Chemistry Behind Cement

Today Portland cement is the key ingredient in concrete which is the foundational building block of nearly all modern day structures. However, making Portland cement is not the easiest process. What needs to be done first is the harvesting of minerals such as limestone. The limestone is then shipped off to a factory. Within the limestone compounds such as calcium oxide CaO and silicon dioxide SiO_2 are primarily found because they make up about 80% of limestones composition. However, other minerals like clay and slate can also be used in the making of cement but what should be noted is that they contain different compounds. Such compounds include iron oxide Fe_2O_3 and hydrated aluminum $Al(OH)_3$. Once the minerals arrive at the plant they are put in a cement kiln where they undergo the process of Clinkerization. It is in this large kiln where the minerals are heated at temperatures of up to 1500 degrees Celsius. Additionally, kilns are positioned on an axis so that when the raw materials are placed inside of it the transfer of heat to the raw material is maximized. Furthermore, the axis position is purposely angled in order to reduce the amount of heat that is lost as a result of the waste gases. In addition to the heat and axis components of the kiln, there are many other chemical materials that play a large role in the formation of the actual cement that the kiln is responsible for. These materials include alite, belite, tricalcium aluminate, and tetracalcium alumino ferrite. The purpose of these materials is to give the cement its mineral properties so that the cement is able to react with liquid in order for it to make concrete. Once the material has gone through the kiln cement balls otherwise known as "clinker" are formed. The final step that the clinker balls must go through in order for it to become Portland cement is the clinker must go through a grinding process that breaks the clinker down into a sand like material. The clinker is first cooled down and then put in a ball mill that is filled with a material called gypsum ($CaSO_4 \cdot 2H_2O$). Gypsum breaks down the clinker and as a result, Portland cement is the product.

Image of Opus Caementitium today

Cementing a Legacy

Today, there are many ways that cement is used. However, it is most commonly used to make concrete. When cement (specifically Portland cement) is mixed with water it hardens creating concrete as the final product. Concrete is currently the foundational building block of nearly every structure that is built. In fact, you probably can't even leave your house without noticing concrete. For example, your sidewalks are made of concrete, and the foundation that your house is built upon is most likely made of concrete. What makes concrete so amazing is that it is able to withstand temperature related damage, it's fire resistant, and its strong enough to withstand large forces making it the ideal material for building foundations, dams, and bridges. Although it may seem there are no negative aspects to using concrete it is estimated that concrete production is responsible for 4-8% of global carbon emissions. Additionally, to get raw materials to make cement such materials must be harvested from the earth and transported distances to factories by large machines.

Sources

History of cement - meka concrete plants. MEKA Crushing & Screening and Concrete Batching Technologies. (n.d.). Retrieved May 24, 2022, from https://www.mekaglobal.com/en/blog/history-of-cement

Cement-Extraction and processing, (n.d). Encyclopedia Britannica. https://www.britannica.com/technology/cement-building-material/Extraction-and-processing

Word Count: 907

How Sunscreen Keeps you Safe

By Andrew Batelli

As summer is right around the corner it is time again for everyone to get out of the house and head to the beach. So then what better time to learn about sunscreen, it is one of the essential products you can use to protect your skin despite it usually going underappreciated. However, what really makes it so important is chemistry.

To fully comprehend how sunscreen provides protection, we must learn what it is we are trying to protect ourselves from. Now anyone can tell you that sunscreen is to protect from UV radiation but, what does that really mean. Well, UV radiation is energy emitted by the sun. There are three types of UV rays. First, there is UVC this is not very important as it does not reach the surface of the earth meaning it cannot reach us. The other two types UVA and UVB are able to cause damage to the skin UVB however only causes five percent of UV radiation to reach the earth. This means that the real problem and what we have to look at is UVA.

UVA is responsible for the largest amount of UV radiation from the sun that reaches the earth which is about 95 percent. UVA can penetrate very deep into your skin (all the way down to the connective tissue) this can cause things like faster aging of the skin. In more extreme cases UVA can cause indirect DNA damage by generating reactive species in the skin. It heavily adds to increased skin cancer risk.

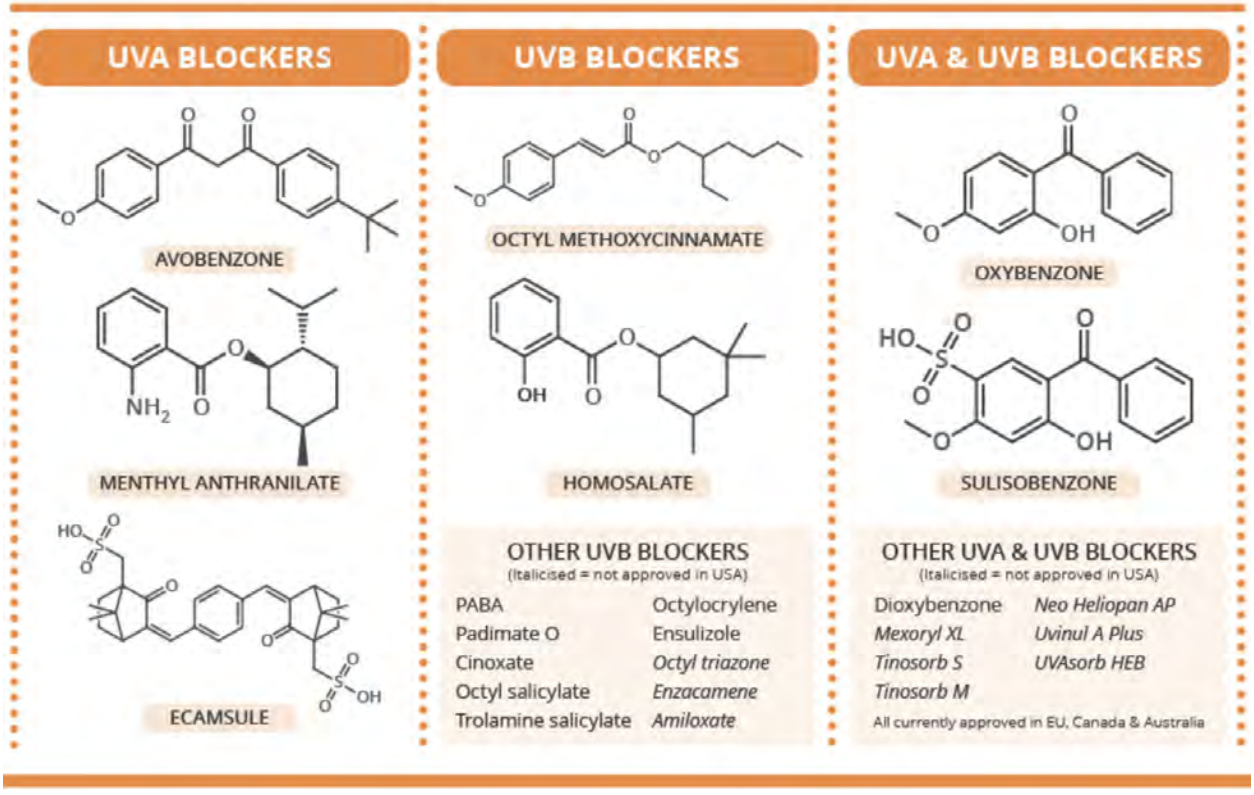


Diagram of some of the chemical UV blockers

Now how does sunscreen function chemically? Most sun protection products work by absorbing reflecting or scattering sunlight. There are two categories of sunscreen physical and chemical or organic (carbon-based) and inorganic chemicals used to provide protection. The active organic ingredients are titanium dioxide and zinc oxide these two compounds are used as a reflective barrier to light as well as absorbing the UVA and UVB radiation. They are the physical sunscreen ingredients. They can disperse UV rays leaving you harm-free however, these chemicals alone would leave a visible white layer atop your skin which is not very pleasing. In order to counteract this, there was a new kind of sunscreen developed that has a mixture of organic and inorganic chemicals. What this means is that there can be different chemical structures where different UV wavelengths get absorbed better than others. Organic chemicals used in this sunscreen are photostable which means they do not break down when exposed to UV light.

Moving on to inorganic chemicals in sunscreens. The most commonly used chemical is called avobenzone as opposed to organic chemicals this breaks down slowly over time which is why it is required to reapply your sunscreen often. This chemical has a very short time of protection when alone estimated to be between 30 minutes to an hour. In addition, it is not stable by itself. Meaning other chemicals need to be added in order to stabilize and increase the longevity of avobenzone. More additives also claim to make avobenzone-based sunscreen water-resistant however, this does not last very long and the time must be pasted on the bottle.

All this talk of chemicals organic and inorganic makes people wonder, how safe are these sunscreens products. Now as it tends to be organic chemicals are safer than inorganic which intern means that physical sunscreen is the safer of the two options. Physical sunscreen's active ingredients are mineral-based and are the only two active ingredients that the FDA calls “absolutely safe and effective.” It also requires less sunscreen to protect as it sits on top of your skin meaning there is no risk of space between molecules after application. This however does not mean better protection is provided.

Inorganic chemical sunscreen provides better protection however it is far less safe in comparison to organic chemical sunscreen. Avobenzone is made to absorb into your skin which means you need to apply a lot for it to be super effective. The problem is it does not go away once in your skin these chemicals can be found on your skin or in your blood weeks after no longer being used. This issue is even larger when discovered that too much avobenzone can be toxic which could happen from so much application. This chemical can also have negative reactions with chlorine which is used in pools turning it toxic. This is why physical organic chemical, mineral-based sunscreen is safer.

No matter what kind of sunscreen you use it is important to keep your skin safe at all times and if you are in the position to choose try and pick a physical sunscreen. In order to have the safest possible skin this summer.

Word count: 796

Sources:

Richey, Jason. March 16, 2018. How Does Sunscreen Work to protect your skin?
https://www.colorescience.com/blogs/learn/how-does-sunscreen-work-to-protect-your-skin
Accessed on May 18, 2022

American Chemistry Council. January 26, 2016. Sunscreen: Chemical Ingredients and summer-time safety.
https://www.chemicalsafetyfacts.org/chemistry-context/sunscreen-summertime-safety/
Accessed on May 20, 2022

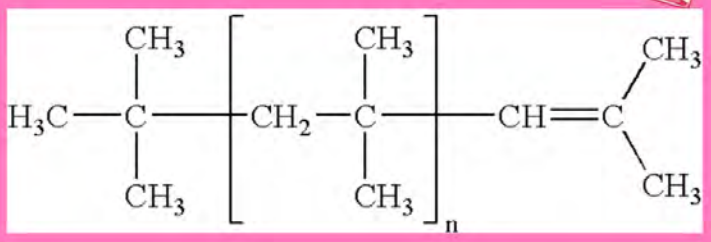
Compound Interest. July 5, 2014. The science behind sunscreen and how it protects your skin.
https://www.compoundchem.com/2014/06/05/sunscreenchemicals/
Accessed on May 20, 2022

THE POWER OF LIP-GLOSS

By: Aphrodite Mpampatsikos

The chemistry behind lip-gloss 101

Lip-gloss is a crucial part of a woman's daily routine. Feel like you're not looking your best? Lip-gloss. Need an extra glow? Lip-gloss. Going for a date? LIP-GLOSS!! Lip-gloss, as we know it, is a simple yet effective cosmetic that many woman all over the world rely on. But it isn't as simple as we all think. It's complexity is evident once you start to recognize the chemistry behind what makes lip-gloss actually glossy. The use of intramolecular forces and chemical compounds play a pivotal role in ensuring that lip-gloss can actually gloss!



What makes lip-gloss "glossy"

The ingredient which makes lip-gloss "glossy" is polybutene . Polybutene is a type of polymeric molecule composed of 1-butene, 22-butene, and isobutylene, which are all isomers of butene. It's molecular formula is C8H16 . Often it's transparent and colorless meaning it can reflect and refract light extremely well. This is the most important job because by doing this, it can accentuate one's lips to appear shiny when light is shone down on them. There are many ingredients in lip-gloss but polybutene is the one that acts as an adhesive which helps the lip gloss stay in place for a long period of time after being applied. The molecules of oils consist of many carbon-hydrogen molecular bonds. The two atoms share electrons equally within these molecular bonds because they are nonpolar. Since these molecules are nonpolar they can't dissolve in the polar molecules of water, which makes oil hydrophobic. Glosses are mostly made up of oils. Oils which are shinny and feel smooth once applied on the lips. The problem is, it tends to fade away after a certain amount of time.

A STICKY SITUATION!

Lipgloss is not just made up of polybutene. It is comprised of many ingredients which are pivotal in the role that the lipgloss has to play! Most lip-glosses are made of wax, oils, polybutene, petroleum jelly, color additives, and fragrances. Petroleum jelly is chemically inert, meaning it does little to nothing because it doesn't really react to other substances. It's a good base for lip gloss. Petroleum jelly is made from hydrocarbons and there aren't any dipoles. This means that the only force present is London dispersion force. The London dispersion occurs once the electrons are arranged so that the electron density is greater on one side of the atom than the other. Inevitably, a partial negative charge forms inside the atom of molecules where the electrons are clumped together. At this time, a small positive charge is formed on the other side. This dipole being formed allows attractions to occur between nonpolar molecules. The roles that the oils play in lip-gloss is it helps the gloss stay on your lips and helps keep your lips moisturized! Wax is also a huge part in making a solid lip-gloss that does the job! It helps build thickness and stickiness. Lip gloss is made up of hydrophobic and hydrophilic materials. The hydrophobic substances don't have the have ability to form I.M.F. attractions with H2O but the hydrophilic ones are polar and can mix with H2O substances. The multiple compounds that lipgloss comprises ensures the functions of it are perfect! To put it all together the wax thickens and the oils moisturize your lips. The emulsifier is what ties everything together.

THE CHEMISTRY BEHIND COLOUR-CHANGIG LIPGLOSS!

Colour changing lipsticks (or lip balm like PONI Lip Magic) goes on clear and gradually changes shade based on. Your pH of your skin as well as the true tone of your lips," stated by Evette Hess, the head of product design and development. A good comparison to understand this concept is how we have mood rings which change colour once you state something personal about yourself. Even though colour changing lip-gloss doesn't depict your moods it morphs your lips into a unique and different shade on different people's lips. Colour change has everything to do with acidity. The lip-glosses have dyes which act as litmus paper, an acidity indicator. The dyes are colourless and weak acids. But our lips have a higher pH than the lip-gloss that's colour changing. Therefore, this triggers a chemical reaction which converts the acids into a strongly coloured compound. There is a unique colour for each person's lips which use this gloss, but the exact lipstick colour will depend on the skin's pH. Our natural lip colour is what ultimately depicts the final lip-gloss shade that will be produced. This is determined by physiological factors. Ricinus Communis (Castor oil) is commonly used as an ingredient in terms of cosmetics. It is composed of monounsaturated fatty acid ricin oleic acid. This helps retain skin moisture. It does this by preventing water loss through the outer layer of your skin. It is in most lip-gloss colour changing products because it promotes hydration. It's molecular formula is C57H104O9. It is refreshing to learn about the actual complexity behind lip-gloss and how chemistry is the answer to most of the questions we stumble upon on a daily basis.

Citations

HOWE, S. O. P. H. I. E. (2018, March 11). Everything you need to know about colour-changing lipstick. beautyheaven. Retrieved May 24, 2022, from https://www.beautyheaven.com.au/makeup/everything-know-about-colour-changing-lipstick/

Davies, Dr Emma (2020, April 08). How does colour-change lipstick work? BBC Science Focus Magazine. Retrieved May 24, 2022, from https://www.sciencefocus.com/the-human-body/how-does-colour-change-lipstick-work/

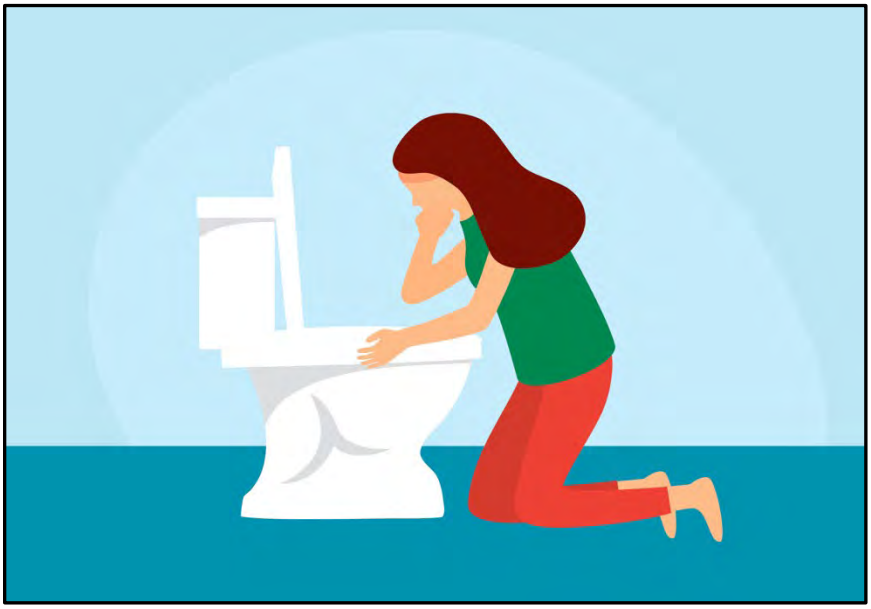
Author (2014, October 13). Chemical makeup of Lip Gloss. The chemical makeup of Lip Gloss Magazine. Retrieved May 24, 2022, from https://thechemivalmakeupofmakeup.wordpress.com/lip-gloss/chemical-makeup-of-lip-gloss/

Woodliffe, John (2019, July 23). The Chemistry of Lipstick. Let's Talk Science. Retrieved May 24, 2022, from https://letstalkscience.ca/educational-resources/stem-in-context/chemistry-lipstick

Anne, (2014, January 13). Lip Gloss: The Chemistry Behind A Substance In Every Woman's Pocketbook. Retrieved May 24, 2022, from https://bcachemistry.wordpress.com/2014/01/13/lip-gloss-the-chemistry-behind-a-substance-in-every-womans-pocketbook/

TREATING THE SYMPTOM: NAUSEA

By Jack Berkman



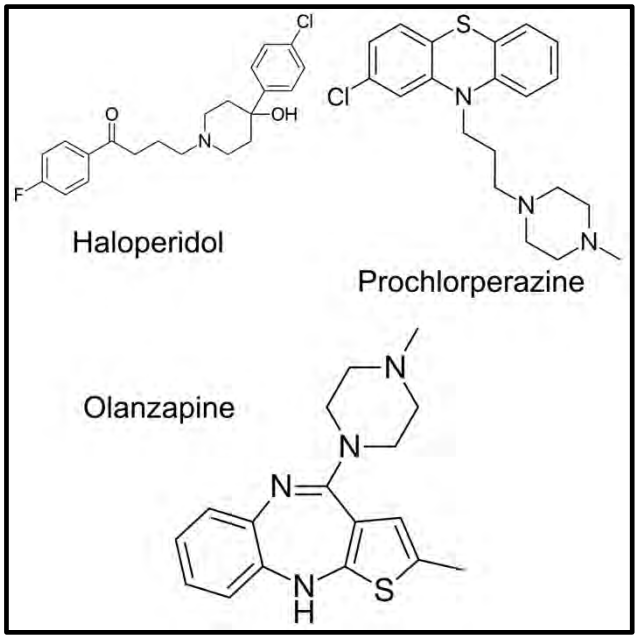
Cleveland Clinic

Nausea is a common symptom that is a common symptom that is frequently treated in my mother's line of work. She is a doctor of palliative care. I interviewed her to understand more about this symptom, one of the two symptoms that she encounters most often. There are 3 main drugs that she outlined for me, prochlorperazine, haloperidol, and olanzapine. There is some controversy surrounding the use of haloperidol, which will be discussed later. Olanzapine is a newer drug that has some amazing side effects and has been used regularly. for patients going through chemotherapy.

Firstly, I thought it would be best to introduce what palliative care is. Palliative care is a form of caregiving that optimizes the quality of life and mitigates suffering among people who have serious illnesses or are dying. Patients receive care symptoms, like nausea, as well as treatments to cure their illness. The reason that nausea is the topic of this article is because of the layers there are to treating it. Nausea is the feeling of uneasiness in the stomach and usually comes before vomiting. We've all felt it. It is a horrible feeling. In the kind of patients that my mother cares for, this is a serious symptom. She told me that at her medical school, she

and her fellow students were told to pick an anti-nausea medication and to learn how to dose it. Through her career though, she has realized that there is so much more to the treatment of nausea. You really must know how each medicine works and what is suppresses. What I mean by that is that you must know where the source of nausea is from. If the nausea is coming from irritation of the gastro-intestinal tract, then she would be using medications that would block the chemical, or neurotransmitter, that tells the brain that nausea needs to be felt in the body. Another common reason for nausea is comes from the chemical composition of the blood becoming unbalanced from what is usual. This then irritates a part of the brain called the Chemoreceptor Trigger Zone (CTZ). When the CTZ is irritated, the neurotransmitter, dopamine, is released, and therefore the medication that you want to you is a medication that blocks dopamine. This is where we get to two main medicines used and the controversy surrounding them.

The two medicines are prochlorperazine, $C_{20}H_{24}ClN_3S$, and haloperidol, $C_{21}H_{23}ClFNO_2$. They both are anti-nausea medications, and both have very similar chemical structures. Firstly prochlorperazine. Prochlorperazine's main action is to block dopamine. Dopamine is the neurotransmitter which is released when the CTZ is irritated, so you would use prochlorperazine to treat the instance where the CTZ has been irritated and nausea is a symptom. Haloperidol is also a dopamine blocker and can be used to treat nausea from CTZ irritation. There is an upside to one of them, haloperidol. Haloperidol has fewer side effects than prochlorperazine. There is less sedation and less confusion that follows taking haloperidol. There is also controversy with haloperidol though. Haloperidol is more known for treating schizophrenia and bipolar. There is stigma attached to haloperidol, and patients don't want to take it because of it. My mother says that when she has parents that are reluctant to use haloperidol, "I'll ask them if they are comfortable with prochlorperazine. They almost always say yes and then I tell them that haloperidol's chemical structure only differs by only a few molecules. They are usually very surprised to hear this." Because of the lessened side effects, my mother said that she uses haloperidol more than prochlorperazine by a long shot. Haloperidol has been around for decades now, and new drugs have come about, and this takes us to our next and final drug, olanzapine.

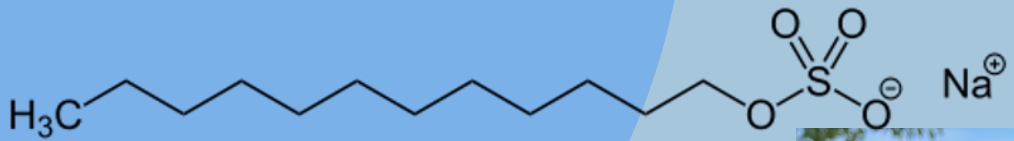


In recent years there have been a group of medicines developed that are considered to be the next generation of haloperidol, olanzapine, which has been using quite a lot to treat nausea. Olanzapine, like haloperidol, has also been used to treat schizophrenia and bipolar.

There are more added benefits of olanzapine that haloperidol doesn't have. Olanzapine stimulates appetite. Now this may not sound like much, or it may not sound helpful, but in the population that my mother treats, this is extremely helpful. Patients can have a reduced appetite from cancer, chemotherapy, or other diseases and the implored nutrition is helpful. A recent study from the Journal of the American Medical Association (JAMA), showed the effectiveness of olanzapine. For 7 days, patients with advanced cancer who had persistent nausea/vomiting without having had chemotherapy or radiotherapy in the prior 14 days, where either given a placebo or olanzapine. Baseline median nausea scores, in all patients, were 9 out of 10 (10 worst and 0 best). After 1 day and 1 week, the median nausea scores in the placebo arm were 9 out of 10 on both days, compared with the olanzapine arm scores of 2 out of 10 after day 1 and 1 out of 10 after 1 week. This study proved the effectiveness of olanzapine and olanzapine has become a standard for patients receiving chemotherapy. This positive outcome is amazing, as it provides a new and effective medicine for physicians, and it provides them backing if patients don't want to take the medicine because of the stigma attached.

Word Count: 883

Navari, R. M., Pywell, C. M., Le-Rademacher, J. G., White, P., Dodge, A. B., Albany, C., & Loprinzi, C. L. (2020). Olanzapine for the treatment of advanced cancer–related chronic nausea and/or vomiting. *JAMA Oncology*, *6*(6), 895. https://doi.org/10.1001/jamaoncol.2020.1052



Sodium Laurel Sulfate, commonly found in cleansers.
Sls Png. (2011). https://labmuffin.com/wp-content/uploads/2011/12/SLS.png. photograph. Retrieved May 24, 2022.

3 Steps to Skincare Success!

The chemistry behind effective products

By Ilaria Fazzolari

Photo : Ilaria Fazzolari

Every teenager can understand the dilemma of waking up with a monstrous zit on school Photo Day. Dealing with busy school days brings about stress acne, and spending all day sweating in a stuffy blazer creates problematically oily skin. We're all told that taking care of our skin will be the solution to these problems, but with such a large variety of skincare products out there, creating the perfect skincare routine can be incredibly daunting. A basic, effective skincare routine includes a cleanser, serum (to target specific skincare issues), and a moisturizer. Today we will go through the chemistry behind what makes a good skincare routine that actually works, and hopefully demystify some complicated skincare terms.

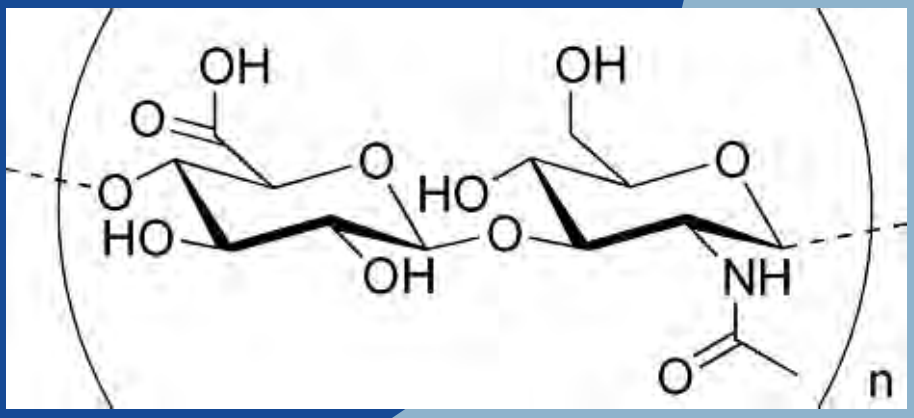
Let's start at the top: Wash. Your. Face.

Face wash is made up of "alkaline soaps or the less barrier-damaging synthetic detergents, known as syndets," (Draelos 2017). Syndets are better than the average soap because they have a flexible formulation process and can choose from a larger variety of potential ingredients. They also have less of a skin irritation or dryness risk, as they are not as susceptible to reactions with metal ions which would cause denaturing of important proteins.

We can connect washing our oily faces to polarity and the concept of like-dissolves-like. The best way to ensure your face is truly clean is to double cleanse, once with an oil-based cleanser and once with a regular foaming cleanser. The oil-based cleanser is non-polar. So given the like- -dissolving-like concept, it will emulsify and attract the excess oil and/or makeup on your face. Following with a soapy face wash, known as *surfactant*, removes the non-polar oil off your face, and any remaining dirt, into the polar water/soap solution.

Now that your face is totally clean and dry comes the most personalized part of the skincare routine: choosing a targeted serum!

Some of the most popular serums are acids such as hyaluronic acid (HA), a naturally occurring molecule found in the body with the important ability of retaining nearly 1000 times its weight in water. HA is a *glycosaminoglycan* or chemical with an extremely polar nature due to its efficient capacity to hold water. HA is applied onto the skin but "exists within the epidermis between cells and mainly within the dermis" (Ingraham, 2017) where it regulates water transport and content in the skin.



Hyaluronic Acid, commonly found in hydrating serums.
Hyaluornic Acid Png. (2016). https://labmuffin.com/wp-content/uploads/2016/08/hyaluronic-acid.png. photograph. Retrieved May 24, 2022.

Just like that, we're onto the last step of our three-step skincare journey: sealing all the good ingredients in, and bringing the moisture back into our skin with moisturizer.

01. There are three groups of chemical compounds that make up most moisturizers. First, we have *occlusive* agents that use *hydrophobic* ingredients to form a non-permeable barrier over the skin to prevent water loss. These include Vaseline or petroleum jelly which is composed of a mix of hydrocarbons containing 25 or more carbon atoms; however, they are generally greasier and shouldn't be used as a regular moisturizer.

02. The second group is called *humectants,* and their goal is to attract water to the skin. One example is *glycerin*. Humectants work better than occlusive agents, with irritation the only side effect, if they're present in too high of a concentrated moisturizer.

03. Finally, we have *emollients* that smooth the skin by filling spaces in between skin flakes with oil. Examples of emollients include long-chain saturated and medium-chain unsaturated fatty acids which benefit the skin barrier and its overall permeability. Emollients are not considered occlusive only if used in excess. If you have extremely dry skin, applying an emollient moisturizer followed by a thin layer of occlusive moisturizer, such as Vaseline, provides an extra physical moisture barrier sealing the beneficial ingredients into your skin.

HA cannot deeply penetrate the skin due to its molecular size. However, using HA regularly increases its content in the skin which is important, as HA is lost with age. The lifecycle of HA is very short "30-50% of it is broken down every 24 hours as part of the normal, natural turnover of the skin" (Ingraham, 2017). The enzyme *Hyaluronidase* breaks down the HA in our skin. HA levels decrease naturally over time, and sun damage also contributes to the overall loss of HA. Hyaluronidase levels stay the same all your life, therefore adding an HA serum into your skincare routine is a great way to ensure your deeper skin layers are adequately moisturized. HA serums can also help reduce redness and the visible appearance of acne without causing additional breakouts.

Photo: Ilaria Fazzolari

Photo: Ilaria Fazzolari

See, skincare isn't all that confusing, right?

To recap, all we need to remember is to find a gentle oil-based and soap syndet cleanser, use a specified serum like the universally loved hydrating, acne-minimizing hyaluronic acid, and seal all the goodness in with an emollient moisturizer. Understanding how these important ingredients work and the chemistry behind their composition provide you with the confidence to discover your own 3-step routine that works perfectly for you!

References:

Better Skin Care: Improve your skin with hyaluronic acid. North Pacific. (n.d.). Retrieved May 24, 2022, from https://www.npdermatology.com/blog/better-skin-care-improve-your-skin-with-hyaluronic-acid

Ingraham, S. (2017, April 6). The science behind Hyaluronic acid. Houston, TX Dermatologist. Retrieved May 24, 2022, from https://advanceddermatologymd.com/blog/the-science-behind-hyaluronic-acid#:~:text=Hyaluronidase%20is%20the%20enzyme%20that,hyaluronic%20acid%20by%20inhibiting%20hyaluronidase.

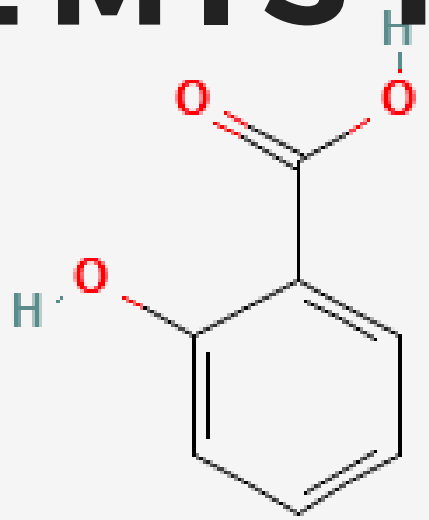
Lankerani, L. (2021, February 4). Skin cleansing 101: Why washing your face is important. Westlake Dermatology®. Retrieved May 24, 2022, from https://www.westlakedermatology.com/blog/skin-cleansing-101-why-washing-your-face-is-important/

Lynde, C. W. (2018, September 21). Moisturizers: What they are and how they work. Skin Therapy Letter. Retrieved May 24, 2022, from https://www.skintherapyletter.com/eczema/how-moisturizers-work/

What are syndets? DermLetter. (2021, March 11). Retrieved May 24, 2022, from https://dermletter.com/skin-care-beauty/what-are-syndets/

Wong, M. (2015, August 31). Fact-check: The science of face washing. Lab Muffin Beauty Science. Retrieved May 24, 2022, from https://labmuffin.com/lab-muffin-guide-the-science-of-face-washing/

YES, THERE IS CHEMISTRY



IN SKIN CARE PRODUCTS

By: Darius Matrakoukas

MAY 30, 2022

Before we go to sleep and first thing when we wake up, we should be keeping a routine skin/face care routine. The recommended amount of times to wash your face per day is twice, but don't take it from me, take it from Saya Obayah who is an M.D., a board-certified dermatologist located in Austin, Texas. She says "You should wash your face both morning and night because the skin creates sebum and oil throughout the day," People use these prevalent things such as shampoo, soap, lotion and deodorant, yet they rarely think about what goes into making them. Cosmetic chemists help develop most bathroom countertop products such as skin, face, and hair products. Obviously, there are many chemical principles involved with the making of these products. For example, oil-soluble ingredients in lotion prevent moisture from escaping through the skin. Hair conditioner uses positively-charged, water-soluble moisturizing agents, which then bind to damaged hair through electrostatic forces. The pH and viscosity are also very important factors to consider. Products that are too acidic or too basic will cause irritation to your skin or body (depending on where used), and a too-thick product will not be easy to spread across the skin.

My Usage and Experience with salicylic Acid

I never really took skin care and cleanliness too seriously. This is until I started to see acne break-outs on random parts of my body like underneath my arms and top portions of the back. I was recomended by a dermotologist to buy a salicylic acid cream. This was recomended to me because my skin wasn't too dry, some people cannot use this acid because of the side effects of over-usage it causes, such as irritation, redness, peeling, etc. This product should be slowly introduced to your body by using a salicylic based product every other day gradually untill you are able to use it every day based on your needs. I started with the recommended usage and quickly figured out it helps my skin clear up and it removes black and white heads. Bonus, it also helped with my dandruff.

What are some components in the making of Skin Care?

Salicylic Acid is very commonly used in the making of pharmaceutical products.

What is Salicylic Acid?
Salicylic acid is derived from willow bark, it belongs to a class of ingredients called salicylates. Salicylic Acid IUPAC 2-Hydroxybenzoic acid. It is an acid used in the medical field to help remove the outer layer of skin. Because of this function, it is used to heal warts, acne, skin tags, dandruff and many more outer layer skin diseases. Dermatologist and Chemist Randy Schueller says "When it comes to skin-care products, there are two classes of acids you'll see often: beta hydroxy acids (BHAs) and alpha hydroxy acids (AHAs). Salicylic acid is a beta hydroxy acid, this means the hydroxy part of the molecule is separated from the acid part by two carbon atoms, as opposed to an alpha hydroxy acid where they're separated by one carbon atom." The structure of this acid is important because it makes salicylic acid more oil-soluble so it can penetrate into the pores of the skin. Salicylic acid can get deep into your skin by breaking that first layer of skin to do its job. This quality is precisely what makes it such a great ingredient for targeting acne, especially for blackheads and whiteheads. Once the acid penetrates the skin, it can dissolve skin debris that clogs pores, it also acts as an anti-inflammatory, and also helps red, inflamed pimples go away faster. Salicylic acid can penetrate the skin so deeply that it actually breaks down the connections between skin cells. Once it has penetrated the skin, the acid part of the molecule can dissolve some of the intracellular glue that holds skin cells together.

ACIDS HELP WITH SKIN CARE PRODUCTS

There are multiple different acids that help with skincare and acne control. Glycolic Acid - 2-Hydroxyethanoic acid, is a well-known acid that helps to peel the skin with acne. When applied to the skin, glycolic acid works to break the bonds of the outermost skin layer including dead skin cells to create a peeling effect to make the skin appear more clear and more smooth. Glycolic acid can also affect the outer skin barrier, helping it retain moisture instead of drying your skin out. This is an advantage for acne-prone skin, because many other topical anti-acne agents, like salicylic acid and benzoyl peroxide, are drying. There are so many different acids and so much chemistry present in skincare products. There is one more final acid that is involved with chemistry in skincare products. It goes by the name of Lactic acid. 2-Hydroxypropanoic acid. Most of these acids involved with skin care do mostly the same thing to open up pores and clear dead skin cells. Lactic acid does just that, it increases cell turnover and helps eliminate accumulated dead skin cells on the outer layer of skin (epidermis). When using lactic acid in 12% concentrations, the skin gets firmer and thicker. Because of this result, there is an overall smoother appearance and fewer fine lines and deep wrinkles. There is basically chemistry in everything you can think of, fragrance, food colouring, salts, and obviously skincare products. Maybe now you can reap the benefits of the chemistry that works miracles on your face before big events or gatherings.

Wednesday,
May 25, 2022

Pesticides

The anchor of farming

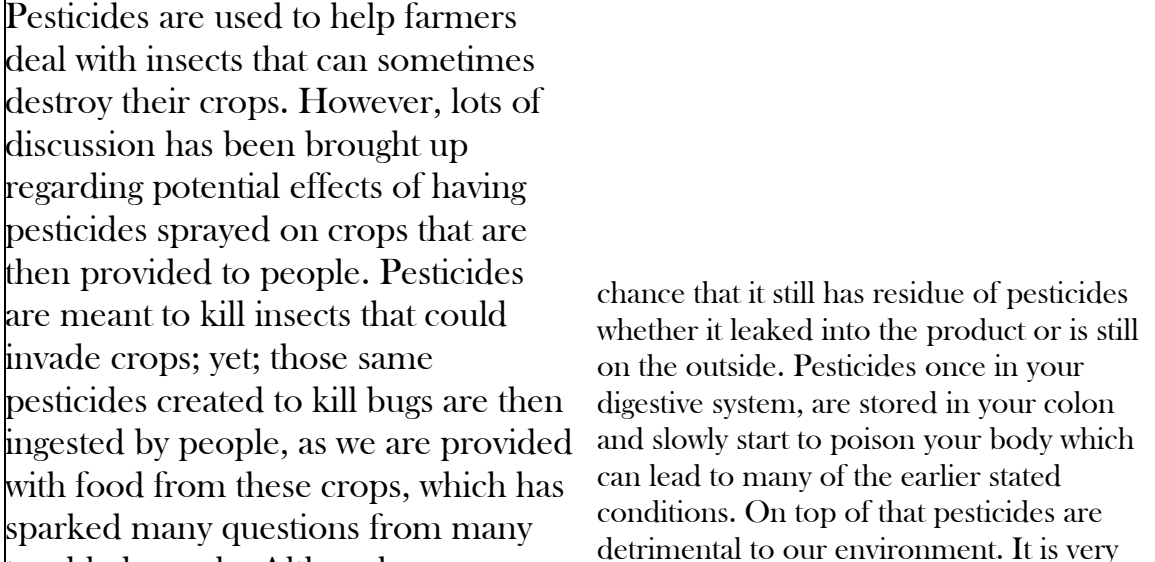
Issue
#10

Albert Abraham

History Time

Where'd it start?

Pesticides, which are commonly defined as any substance or organism that is prepared or used for controlling any pest, has been around for approximately 4,500 years. The Sumerians would use it to help control lots of insects and mites, which led to the Chinese using insecticides 3,200 years ago, and by 2,500 years ago had adapted to fully using pesticides to avoid attacks on their crops. The Greeks and Romans as well were able to take advantage of these discoveries, as they would use things such a mosquito nets, sticky bands on trees, and pesticidal spray. While the Chinese continued to develop their studies with pesticides, the Romans were starting to go back to relying on religious beliefs instead of new discoveries, especially after the fall of the Roman Empire. However, the renaissance sparked a light back into the new world for the people of Rome, many got re-involved with science and began experimenting and using natural pesticides once again which sparked an agricultural revolution in Europe, which although brought lots of prosperity led to some of the worst agricultural disasters in history. The potato blight in Ireland, England and Belgium, the outbreak of fungus leaf spot disease in coffee, and the grape phylloxera, which almost destroyed the wine industry in France. After these events it was clear that there was a necessary push needed to further advance pest control. In the 19th century they started making serious advancements and by the second world war pesticides had been fully revolutionized. This would lead to many new chemicals being screened for insecticidal properties, and many new breakthroughs in the modern age.



Pesticides have affected millions of farmers around the world

Albert Abraham

What's Wrong?

Why is there so much backlash?

Pesticides are used to help farmers deal with insects that can sometimes destroy their crops. However, lots of discussion has been brought up regarding potential effects of having pesticides sprayed on crops that are then provided to people. Pesticides are meant to kill insects that could invade crops; yet; those same pesticides created to kill bugs are then ingested by people, as we are provided with food from these crops, which has sparked many questions from many troubled people. Although many organic foods do not use chemical pesticides (instead resorting to natural resources to use as a substitute to pesticides) many farmers who cannot afford different means other than pesticides. You might be wondering, "why is there so much fear towards pesticides." Through many studies it has been determined that pesticides have been linked to many serious conditions including cancer, Alzheimer's disease, ADHD, and even in some serious cases can lead to birth defects. Although many people might think washing their fruit or vegetables make it ok, if you are eating non-organic fruit or vegetable there is a very high chance that it still has residue of pesticides whether it leaked into the product or is still on the outside. Pesticides once in your digestive system, are stored in your colon and slowly start to poison your body which can lead to many of the earlier stated conditions. On top of that pesticides are detrimental to our environment. It is very common that pesticides that are sprayed will either contaminate the air by turning into vapor and travelling through the air affecting many animals, or much more seriously, when sprayed can make their way into a water source which many people and animals may rely on.

Pesticides have been revolutionzied so much so that they are used in every day life.

Background

Albert Abraham

What are Pesticides? Where did they come from? Why do we need them? Find out all of this and more on Page 1
Page 1 section 1

Issues

Mirjam Nilsson

Although you may think pesticides are good, there are many issues that the average person might not be aware of. Be sure to check it out on page 1
Page 1 section 2

Chemicides

Mirjam Nilsson

Interested in how chemistry plays a role in all of this. Be sure to check out the segment on page 2 regarding how chemistry is used to help create pesticides
Page 2

Wednesday May 25, 2022 **Chem News** Issue #10

Albert Abraham

Chemicides!

Where does chemistry come in?

Many pesticides can be grouped into 4 types, insecticides, herbicides, rodenticides, and fungicides. These can then be separated into chemical families, including organochlorines, organophosphates, and carbamates. The very first pesticides compounds were documented to be made up of elements such as sulfur, heavy metals, and salt. Through these compounds people were able to make the first known pesticides, some of the earliest examples being lime sulfur used to help destroy lice, sulfur dioxide was used to help inhibit the respiration of insects and small pests. Since then, the use of elements to aid in pesticides is still very common, including using sulfur as it has become the anchor to pest control. Metals were originally used to their high toxicity rate; Arsenic was one of the most common and is still commonly used today as a spray on wood to help avoid insects digging holes and inhabiting it. As well, natural Mercury was found to be helpful, as alike Arsenic it had a high affinity which allowed it to disrupt biological and enzymatic processes. Later, through history we can see many new organochloride compounds being used to create new pesticides, such as BHC (Benzene hexachloride) which was found in 1825 and DDT (Dichlorodiphenyltrichloroethane) found as well in 1825, however many properties of both of these compounds were not fully discovered or used till 1939 by Muller who actually ended up winning a noble prize for it. This sparked many new compounds being based around the original two, but through the 1980s-1990s, the introduction of neonicotinoids which are neuro-active insecticides started to takeover, and one of them, Imidacloprid, became the face of pesticides among the world. All these new, exciting, thrilling discoveries, started from simply using sulfur and heavy metals, all the way to genetically modified organisms.

Lethal Beauty

The ingredients used in the cosmetic industry aren't so pretty.

Written by Ruth McDonald

Source: TheHealthy.com

Despite the lack of regulations in the cosmetic industry, millions of people world wide include make-up in their daily routine.

Long and luscious lashes, red lips, darkened and thick eyebrows. All can be achieved with a few strokes of a brush and some powder. However, unbeknownst to the wearer, they have just plastered a toxic cocktail of poisonous chemicals onto their skin, and the result is more than just a pretty face.

Cruel Cosmetics

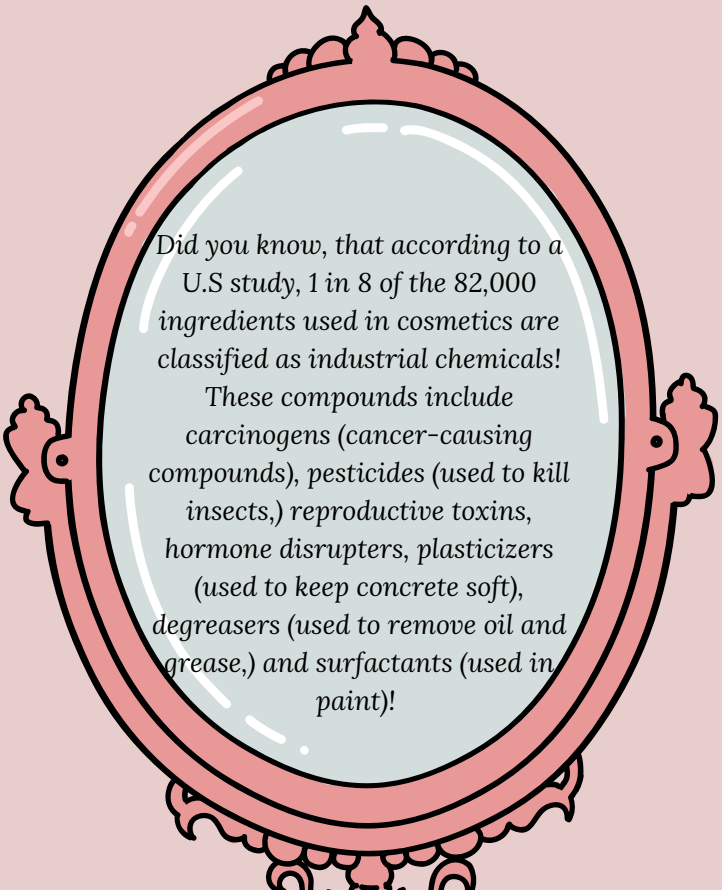
On average teenagers use approximately 17 skin care products a day. According to a 2016 study by the Environmental Working Group (EWG), women apply around 168 chemicals to their face daily (Brar, 2020). Recently, through research and experimental studies, scientists have determined that a significant portion of the chemicals that we apply to our skins daily, are actually harmful and even poisonous! Beauty and personal care products, from deodorant and lipstick to hair dye and nail polish and a variety of other cosmetic products from across the bathroom sink contain toxic chemical compounds in them. Brands such as L'Oréal, Covergirl, Chanel and more have all been flagged due to toxic ingredients.

Scientists have identified 12 toxic chemical compounds, colloquially named the "Dirty Dozen," (Suzuki Foundation, 2010), commonly found in cosmetic products. Some of the "Dirty Dozen" include the following, but are not limited to:

- **BHA; butylated hydroxyanisole, ($C_{11}H_{16}O_2$) and BHT; butylated hydroxytoluene ($C_{15}H_{24}O$)** which are oxidation-inhibiting (antioxidant) compounds, and they are often found in lipstick, moisturizers, and food preservatives.
- **Coal Tar Dyes; Phenylenediamine ($C_6H_8N_2$ or $C_6H_4(NH_2)_2$)** used predominately in dark hair dyes.
- **DEA; diethanolamine ($HN(CH_2CH_2OH)_2$)** which is a pH adjuster in soaps and shampoos. It is also favoured as it makes products creamy and soapy.
- **DBP; Dibutyl phthalate ($C_{16}H_{22}O_4$ or $C_6H_4(COOC_4H_9)$)**, a common ingredient in nail products.
- **Formaldehyde-releasing preservatives (CH_2O) and Parabens** are both preservatives used in cosmetics.
- **Triclosan ($C_{12}H_7Cl_3O_2$),** is a common anti-bacterial preservative used in personal care products such as deodorant, antiperspirant and hand sanitizer. It is also commonly found in laundry detergents and paints.

Beauty throughout the Ages

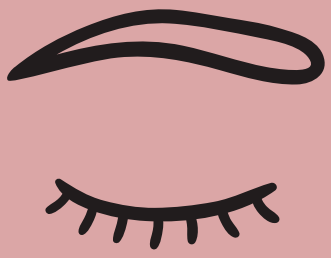
Dangerous makeup dates back to the roots of civilization. The ancient Egyptian's infamous winged eyeliner was achieved through a paste of heavy metal compounds such as malachite and lead. The Greco-Roman culture further developed make-up routines by introducing an arsenic-based white face paste to define the pallor of their skin. Today, harmful heavy metals ingredients in the make-up industry have been replaced by other lethal chemicals, such as carcinogens. Carcinogens are cancer-causing chemical substances. Substances commonly found in cosmetics, such as coal tar dyes, DEAs, and formaldehyde-releasing preservatives are all known human carcinogens. Furthermore, other common cosmetic ingredients, such as BHA and BHT have been known to negatively affect test animals, causing liver, kidney and lung damage as well interfere with blood clotting. Even still, ingredients like DPB, (found in almost all nail products) is classified as a mutagen, as it is known to cause genetic mutations. DBP, as well as synthetic parabens- both substances that are easily soluble and absorbable through the skin- are hormone disputers; chemical compounds which mimic, block, or interfere with the bodily production of hormones.



High concentrations of these chemical compounds can negatively affect the body's endocrine system and natural homeostasis. In the long run, hormone imbalances or disruptions can cause fertility issues in both men and women. Once absorbed through the skin and into the bloodstream, these harmful chemicals begin the process of bioaccumulation. As toxins build up and circulate in high concentrations within the body, some of the more serious side effects begin to display as degradation of the body's internal systems commences.

Rules and Regulations

One would think with all the dangerous- even lethal- chemical ingredients found in our cosmetics, regulations would be strict and rigid. However, reality is grimly contrary. Other countries and states, such as the European Union, have taken steps to band most of these harmful chemicals; however, Canada and the U.S. are sorely lacking. Despite having national agencies such as the *Food and Drug Administration* (FDA) which operates in the U.S. and governmental acts such as the *Food and Drugs Act* and *Cosmetic Regulations Act* (Health Canada, 2018), enacted in Canada, in the cases of most of the chemicals listed above, North America has placed little to no restrictions on them. Even still, the restrictions in place are not enough, as certain ingredients are frequently used, leading to a build-up on the wearers skin. According to the documentary, "Toxic Beauty," as of 2020, the United States had not enacted new personal care laws since the 1930s, leaving the cosmetic industry to regulate itself. Although some brands have put company policies in place, others resolve to misrepresenting their products and continuing to include harmful chemicals as ingredients.



For a women-targeted industry, the cosmetic field is lacking a motherly touch, as it is failing to protect the health and safety of its consumers. Instead, consumers must resort to protecting themselves. Reading labels, petitioning for more rigid ingredient regulations, lobbying harmful brands, and switching to cleaner, more natural based skin care products are all ways that you can raise awareness about this issue and help regulate the chemicals that will enter your body.

Sources:

1. *"The Dirty Dozen" Cosmetic Chemicals to Avoid.* (n.d.). David Suzuki Foundation. Retrieved May 25, 2022, from: https://davidsuzuki.org/living-green/dirty-dozen-cosmetic-chemicals-avoid/

Study referenced:

1.1 Faber, S. (2020, May 5). *The Toxic Twelve Chemicals and Contaminants in Cosmetics | Environmental Working Group*. Www.ewg.org. https://www.ewg.org/the-toxic-twelve-chemicals-and-contaminants-in-cosmetics\

2. *The Documentary "Toxic Beauty" Explores How Unregulated Beauty Products Can Make People Sick.* (n.d.). Shape. https://www.shape.com/lifestyle/mind-and-body/toxic-beauty-documentary-unregulated-cosmetics-dangers

3. *Suffering for beauty has ancient roots. (n.d.).* NBC. News. https://www.nbcnews.com/id/wbna22546056

4. Health Canada. (2018). *Regulatory information for cosmetics - Canada.ca*. Canada.ca. https://www.canada.ca/en/health-canada/services/consumer-product-safety/cosmetics/regulatory-information.html

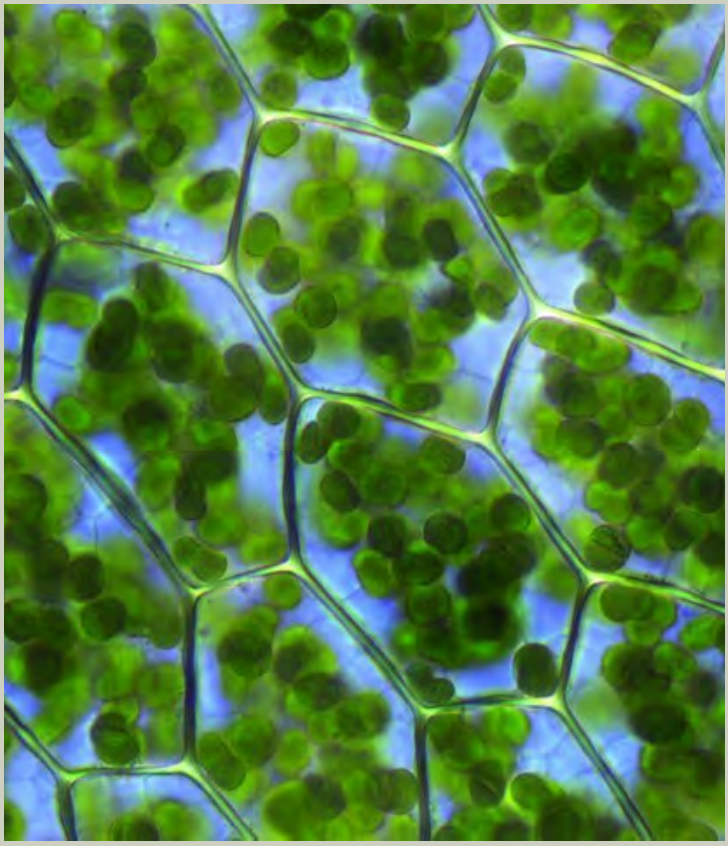
Source: missmalini.com

Switching to clean, natural based skin care products is one of the ways you can regulate the chemicals that enter your body.

Plants n' Pigments

Photosynthetic Pigments

Written by Hannah Bowman



Chlorophyll within chloroplasts in plant cells.

Chlorophyll. National Geographic Society. (n.d.). Retrieved May 24, 2022, from https://www.nationalgeographic.org/encyclopedia/chlorophyll/

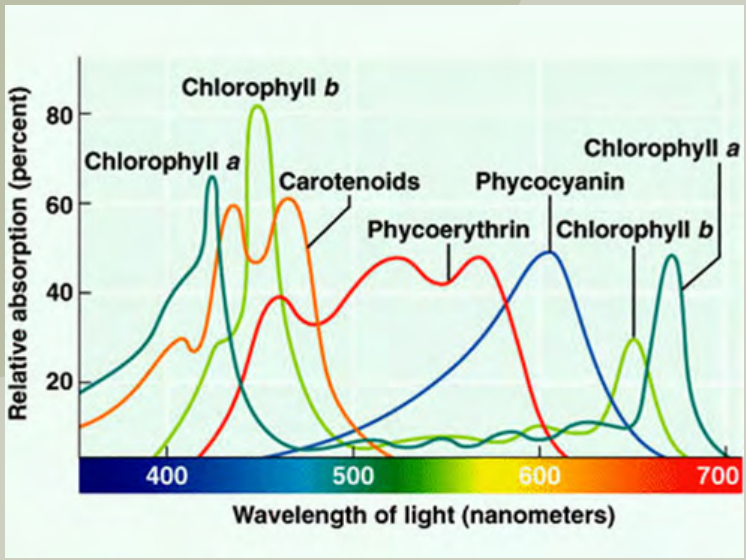
What are photosynthetic pigments?

Pigment is a general term used to describe a molecule that absorbs light and has a colour. Widely, pigments are used to provide lush colours to our everyday life. They can be used in foods, fabrics, cosmetics and paints – usually to appease the eye. However, pigments are also an essential part of life. Photosynthetic pigments are "the only pigments that have the ability to absorb energy from sunlight and make it available to the photosynthetic apparatus" (Plant & Soil Sciences eLibrary, 2022).

Essentially, these pigments are specially designed to capture light so that plants can perform photosynthesis and maintain their activities. Photosynthetic pigments can be split into three main categories; the most famous of these is chlorophyll, but there is also carotenoid and phycobilin.

How do they capture light?

When a pigment absorbs light, it becomes excited and is not in its normal state, or ground state. As the photon is absorbed into the molecule, it may cause an electron to jump up into the next energy level (or orbital). Only a photon with just the right amount of energy is able to make an electron jump between orbitals, exciting the pigment. However, pigments cannot absorb all wavelengths of light because of the different energy gaps between the orbitals. Each pigment has a different energy gap, meaning that only photons of a specific wavelength will match the energy gap, exciting the pigment. The set of wavelengths absorbed by a pigment is called its absorbance spectrum.



An absorbance spectrum for the photosynthetic pigments.

Photosynthetic pigments. (n.d.). Retrieved May 24, 2022, from https://www.simply.science/images/content/biology/cell_biology/photosynthesis/conceptmap/Photosynthetic_pigments.html

Moreover, this excitement and interaction of light with molecules occurs through conjugated double bonds, where double bonds are present between alternate pairs of carbon atoms. These bonds are able to absorb the energy from photons through the transfer of energy in the electrons in the conjugated double bonds. Chlorophylls, carotenoid and phycobilin all contain this structure in their molecules. Carotenoids have a linear system on the double bonds, chlorophyll have a zig-zag of bonds in the large ring structure, and there is a range of conjugated double bonds within phycobilin, where the greater number of double bonds results in increased absorption. The structure of these molecules allows electrons to move more freely, giving them the ability to gain or lose electrons easily.

What is a chlorophyll?

Chlorophyll is the primary structure through which light is captured for land plants; it is known for its green colour. When white sunlight falls upon chlorophyll, the green light, with a wavelength between 500-600 nm is not absorbed but reflected, making them appear green. Chlorophyll have the ability to absorb red and blue photons. On the light spectrum, this is photons with the energy from 640-700 nm (red) and from 430-475 nm (blue).

Additionally, there are also different forms of Chlorophyll which are able to absorb slightly different wavelengths of light. These include chlorophyll (chl) a and chl b, the two main types, as well as chl c, chl d, and bacteriochlorophyll. The colour of chl a "in reflected light [...] shows blood red color while in transmitted light, it shows blue green light," whereas chl b "appears dull brown in reflected light and yellowish green color in transmitted light" (Bioscience Notes, 2018). The difference in their structure allows chl a and chl b to absorb different colours. Chl a has a methyl group in the third position within the chlorine ring, whereas chl b contains an aldehyde attached to the chlorine ring in the third position.

Furthermore, chlorophyll a are considered to be the primary structure for light absorption because "all photosynthetic plants, algae, and cyanobacteria contain chlorophyll a, whereas only plants and green algae contain chlorophyll b," meaning that they are used most often for photosynthesis. Any pigments used in addition to chlorophyll a are known as accessory pigments, including other forms of chlorophyll, carotenoids and phycobilin.

What is a carotenoid?

Carotenoids are another common photosynthetic pigment composed of repeating, branched five-carbon units. They mostly absorb the blue area of the light spectrum (400-500 nm) and appear to be yellow or orange, colours not absorbed by chlorophyll. As an accessory pigment, carotenoids mainly function to get rid of excess light energy by absorbing the excess energy and dissipate it as heat. Carotenoids can be split into carotenes, which are orange in colour, and xanthophyll, which are yellow in colour.

What is a phycobilin?

Green algae and red algae uses phycobilin as their light-harvesting pigments since chlorophyll is fairly ineffective in their environment. Phycobilin are composed of a tetrapyrrole unit that forms an open chain. There are two forms of phycobilin: phycocyanin and phycoerythrin. Phycocyanin is a blueish pigment which give cyanobacteria their name. Phycoerythrin is a red pigment, giving Rhodophyta its common name, red algae. Moreover, phycobilin is unique because it is not found within the thylakoid of a chloroplast; instead, phycobilin is held in the cytoplasm or stroma of a chloroplast.

How else can photosynthetic pigments be used?

Phycobilin have been used as research tool due to their ability to fluoresce at particular wavelengths. It is "when they are exposed to strong light, they absorb the light energy, and release it by emitting light of a very narrow range of wavelengths" (UCMP Berkely, 2022). The light produced is so distinct and reliable that phycobilin can be used as a "chemical tag." The pigment can be chemically bonded to antibodies, put into a solution of cells, and then identified based on which cells have the "tag." This technique has found extensive use in cancer research, for "tagging" tumors.

References:

Anupbiochemist@gmail.com. (2018, November 1). *Photosynthetic pigments*. Bioscience Notes. Retrieved May 24, 2022, from https://www.biosciencenotes.com/photosynthetic-pigments/#:~:text=There%20are%20major%203%20types,Chlorophyll%2C%20Carotenoids%2C%20and%20Phycobilins.

Chlorophyll. National Geographic Society. (n.d.). Retrieved May 24, 2022, from https://www.nationalgeographic.org/encyclopedia/chlorophyll/

Khan Academy. (n.d.). *Wavelengths of light and photosynthetic pigments (article)*. Khan Academy. Retrieved May 24, 2022, from https://www.khanacademy.org/science/biology/photosynthesis-in-plants/the-light-dependent-reactions-of-photosynthesis/a/light-and-photosynthetic-pigments

Khan Academy. (n.d.). *Wavelengths of light and photosynthetic pigments (article)*. Khan Academy. Retrieved May 24, 2022, from https://www.khanacademy.org/science/biology/photosynthesis-in-plants/the-light-dependent-reactions-of-photosynthesis/a/light-and-photosynthetic-pigments

Markwell, J., & Namuth, D. (n.d.). *Plant pigments and photosynthesis*. passel. Retrieved May 24, 2022, from https://passel2.unl.edu/view/lesson/920a6340a995

Photosynthetic pigments. (n.d.). Retrieved May 24, 2022, from https://ucmp.berkeley.edu/glossary/gloss3/pigments.html

Photosynthetic pigments. (n.d.). Retrieved May 24, 2022, from https://www.simply.science/images/content/biology/cell_biology/photosynthesis/conceptmap/Photosynthetic_pigments.html

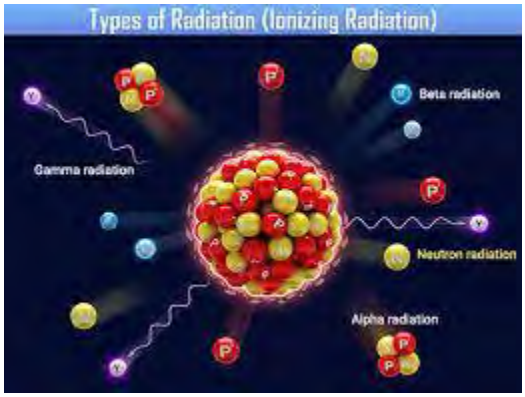
Radioactivity

Radiation accompanies man in everyday life. As a natural radiation, it occurs practically everywhere; in the air, water, soil and rocks. The discovery of natural radioactivity caused a real revolution in science and a breakthrough in the understanding of the universe. Due to its numerous applications, this discovery has had a great impact on the history and life of mankind.

The phenomenon of radioactivity is the spontaneous decay of nuclei combined with the emission of alpha and beta particles and gamma radiation. It is measured on the becquerel scale, after the French physicist H. A. Becquerel who discovered radioactivity in 1896.

Maria Curie-Skłodowska and Pierre Curie were the first researchers who studied radioactivity in more detail. They found that the transformation of the nucleus is not influenced by external factors such as temperature, magnetic field or the concentration of radioactive material. They also discovered the radioactivity of uranium and thorium, as well as the elements of polonium and radium. This discovery gave rise to natural radioactivity associated with about 60 radioactive isotopes naturally occurring in the Earth's environment.

Research on the so-called artificial radioactivity began on radioactive isotopes that appear on Earth only as a result of human activity. Due to the variety of properties, i.e., type of radiation, radiation energy, half-life time, mass of emitted particles etc., artificially obtained radioactive substances are used much more widely than natural radioactive substances. The discovery of artificial radioactivity makes possible the transformation of some chemical elements into another.



The wide possibilities of using radioactivity began its widespread use both in positive and harmful ways.

One of the most common applications of radioactivity are in medicine. The important achievement of the X-ray technique is in computed tomography. The computer takes a series of photos in different planes and places and at different angles, which allows to obtain a layered image showing very accurate even small lesions. Other application of radiation in medicine is in radiation therapy which is used in the treatment of cancers, especially melanoma. Radioactive isotopes have become extremely beneficial in nuclear medicine to diagnose and treat various ailments e.g., iodine 131 isotope is used to treat the thyroid gland. The diagnostic use of radioactive isotopes is based on the placement of radioactive material in the organs or tissues of our body and then monitoring the radiation with detectors, located next to the examined organs. Thanks to this method, lesions are detected earlier and completely eliminated.

Food irradiation is another well-known technique where radioactivity has been successfully utilized. It is used to prolong the food shelf life. The radiation-preserved food is not harmful or radioactive, but radiation causes some chemical changes in the food. The extent of the change depends on the dose of radiation, temperature, product content, and access to light and

oxygen during irradiation. As a result of ionizing radiation, free radicals are formed and the composition of vitamins A, B1, C and E is reduced by 20-60%. The same changes occur in food during thermal processing or its long-term accumulation.

Cobalt-60 irradiation facility

Radiation and nuclear techniques found their application in various branches of industry and in our everyday activities like microwave ovens to heat food. With tthe radioactive 1H hydrogen, called tritium, can track the migration of groundwater, which is important in mining. The 14C carbon isotope is used as an archaeological clock, to determine the age of the finds. This technique is used in mining, archeology and geology to accurately specify the age of analyzed rocks or minerals, or the age of the remains of living organisms. Radiation is used in the modification of polymers, materials and semiconductor devices, for dyeing fabrics, glass and even natural stones. It is applied in agriculture, in searching for water sources, discovering and eliminating environmental contamination. Ionizing radiation can change the chemical structure of substances, build very sensitive smoke detectors, analyze the pollution of lakes, water reservoirs and groundwater.

An important benefit of radioactivity is the possibility of generating energy from nuclear reactions. The energy is obtained from the fission of heavy element nuclei, mainly uranium 235, in nuclear power plants. The plants pollute the environment the least, and the costs of energy generation are low. This method of producing energy has become important in the energy-consuming economy.

Although radioactivity has many positive effects, it also has many negative effects. Radioactive elements have a negative effect on organisms, including humans. Leukemia, cataracts, and radiation sickness can occur when the body absorbs high doses of radiation. Accidents in nuclear power plants can cause disasters, e.g., the Chernobyl explosion in 1986 caused the death of thousands of people and tens of thousands suffered from radiation sickness. The wide possibilities of exploiting radioactivity started its widespread use.

It is worth mentioning that the worst misuse of radioactivity is in atomic bombs. During an explosion, a huge shock wave of great impact creates a great destruction and releases a lot of radiation killing thousands of people. Those who receive high doses of radiation suffer from radiation sickness for many years. The disposal of radioactive waste also carries the risk of environmental contamination.

There are many beneficial applications of radioactivity that save people's lives and make them easier, however, it also has many harmful side effects. It should also be said that radioactivity used rationally, for peaceful purposes and with the use of security measures, is something positive and it is only up to people whether they will experience moments of glory more often or leave a shadow on the history of mankind.

Resources

1. “Radiation in Everyday Life.” IAEA. IAEA, November 21, 2014. https://www.iaea.org/Publications/Factsheets/English/radlife.

2. “Radioactivity.” Encyclopædia Britannica. Encyclopædia Britannica, inc. Accessed June 5, 2022. https://www.britannica.com/science/radioactivity/Applications-of radioactivity.

3. “Uses of Radiation | Nrc.gov.” Accessed June 6, 2022. https://www.nrc.gov/about-nrc/radiation/around-us/uses-radiation.html.

4. “Radiation in Healthcare: Imaging Procedures.” Centers for Disease Control and Prevention. Centers for Disease Control and Prevention, October 20, 2021. https://www.cdc.gov/nceh/radiation/ionizing.htm.
5. “Food Irradiation and Food Safety Industry.” Nordion, March 6, 2019. https://www.nordion.com/industries/food-irradiation/.

THE MOST EFFECTIVE WAYS TO GET RID OF ACNE

Accutane. #1 Skincare Brands.

By: Joanna Katis

As summer approaches, outdoor gatherings begin, swimming pools open, face mask mandates are lifted, and the stress for facial and body acne begin.

More then 85% of teenagers struggle with acne. The increased stress of it begins at the start of the summer season. This follows with appointments to dermatologists beginning, Sephora runs to buy new skincare targeted to help with acne, and monthly facials beginning.

Knowing what chemicals are in these products and medications can make you aware of what you are are putting on your skin, and make you more educated on what these oral medications can do to your body.

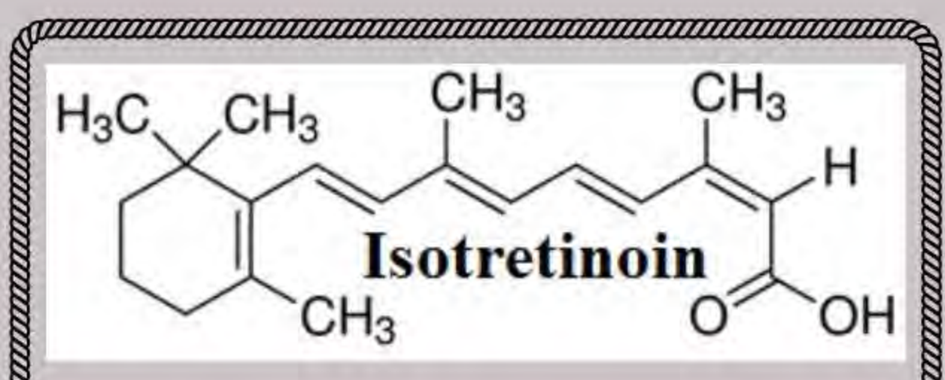
ACCUTANE:

Isotretinoin more commonly known as Accutane named as **3,7-Dimethyl-9-(2,6,6-trimethylcyclohex-1-enyl)nona-2,4,6,8-tetraenoic acid**, is a very powerful drug used for the treatment of acne. The typical amount of time someone is prescribed to be on Accutane is 4-5 months. This is usually prescribed to someone with moderate to severe acne. This is also prescribed to someone if other treatments such as antibiotic creams and pills have failed to clear acne. This medication has been prescribed for more then 200 million people, and around 1 million of them being teenagers. This medication leads to the goal of completely clearing one's skin.

Oral isotretinoin **(13-cis-retinoic acid)** was first approved as a treatment for severe acne by the the US FDA in 1982. Accutane is a **retinoid** and **vitamin A derivative**. Vitamin A is apart of an enzyme that functions to assist a specific **enzyme to catalyze/increase the rate of a chemical reaction.** In 1982, Isotretinoin was used as a chemotherapy treatment for treating head and neck cancer. Now, in 2022 it is one of the most successful acne medications. It is a naturally occurring retinoid acid with **antineoplastic activity**. In other words, it was a medication used to treat cancer. Isotretinoin has little to no affinity for retinoid acid **nuclear receptors**, but, the little that it does have binds to and activates nuclear retinoid acid receptors (RAR's). **RARs** are a class of proteins that bind to retinoids. Activated RARs serve as transcription factors that promote cell differentiation which Isotretinoin produces. Isotretinoin is a retnoic acid that contains all trans retinoid acid. This means it double bonds (alpha and beta) to the **carboxy group**, and is changed from one **isomer** to another, to end in a Z configuration.

Accutane is very effective in treating severe acne because it targets clogged pores, bacteria, inflammation, and oil production. Isotretinoin works chemically by decreasing the size of **sebaceous glands** in the skin which are responsible for creating sebum, which is the oil in the skin. As a result, it alters the skin surface lipid composition. This is the part of your skin that can clog pores and cause acne. Once the **sebum** is controlled, breakouts stop. Also, a common dosage for accutane is 40mg.

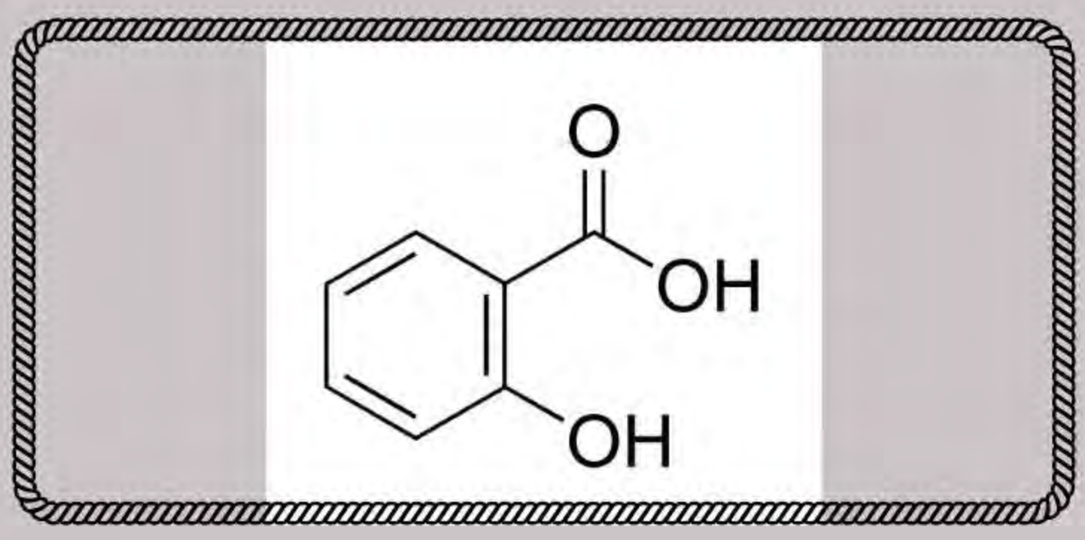
Common side affects that come along with Isotretinoin are chapped lips (90%) that Aquaphor is most proven to help with, dry skin (80%) which is helped by a hydrating moisturizer, dryness of nose/mild nosebleeds (80%), joint and muscle pains (15%), increased sensitivity to the sun (5%) and many more. Isotretinoin can also cause problems in your digestive and excretory system including bowel and stomach pain, heartburn, nausea etc. These symptoms could indicate damage to your liver, pancreas, intestines and esophagus which is why it is crucial to go for bloodwork once a month throughout the duration of taking Isotretinoin. Also, women that are pregnant cannot go on Accutane because there is an extremely high risk of birth defects including brain, heart, and face deformities. This happens because an intake of too much Vitamin A, retnoids, or isotretinoin can cause a baby to have a greater risk of birth defects. These defects happen in the **embryonic spinal cord** and central nervous system where retinoid acid synthesizes, and where **catabolic enzymes** are located.



SKINCARE

One of the most popular face washes used for acne is the Caudalie cleansing gel. It is one of the top selling face washes at Sephora to help with acne. It has a formula with 97% **natural origin ingredients** to visibly improve the texture of acne prone skin. One very important acid in this face wash that is most successful with helping acne is, **Salicylic Acid**. It's chemical formula is **C7H6O3**. Salicylic acid is a **beta hydroxy acid (BHA)** that is a natural compound in plants. Its purpose is that it has direct activity as an **anti-inflammatory agent**, and acts as a **topical antibacterial agent** due to its ability to promote exfoliation. It's an odourless white solid that mixes slowly with water that was separated from willow trees, which is how the molecule received its name. Salicylic acid can also be synthetically produced. This happens by **biosynthesis of the amino acid, or from phenol**. Salicylic acid was created with a process named Kolbe-Schmitt. This is when **phenol** and **sodium hydroxide** are reacted to make **sodium phenoxide**. Then, phenoxide came into contact with **CO2** to create sodium salicylate. Typically, the acid is **crystallized** from an aqueous solution to provide a 99.5% salicylic acid product.

Chemical Structure Of Salicylic Acid



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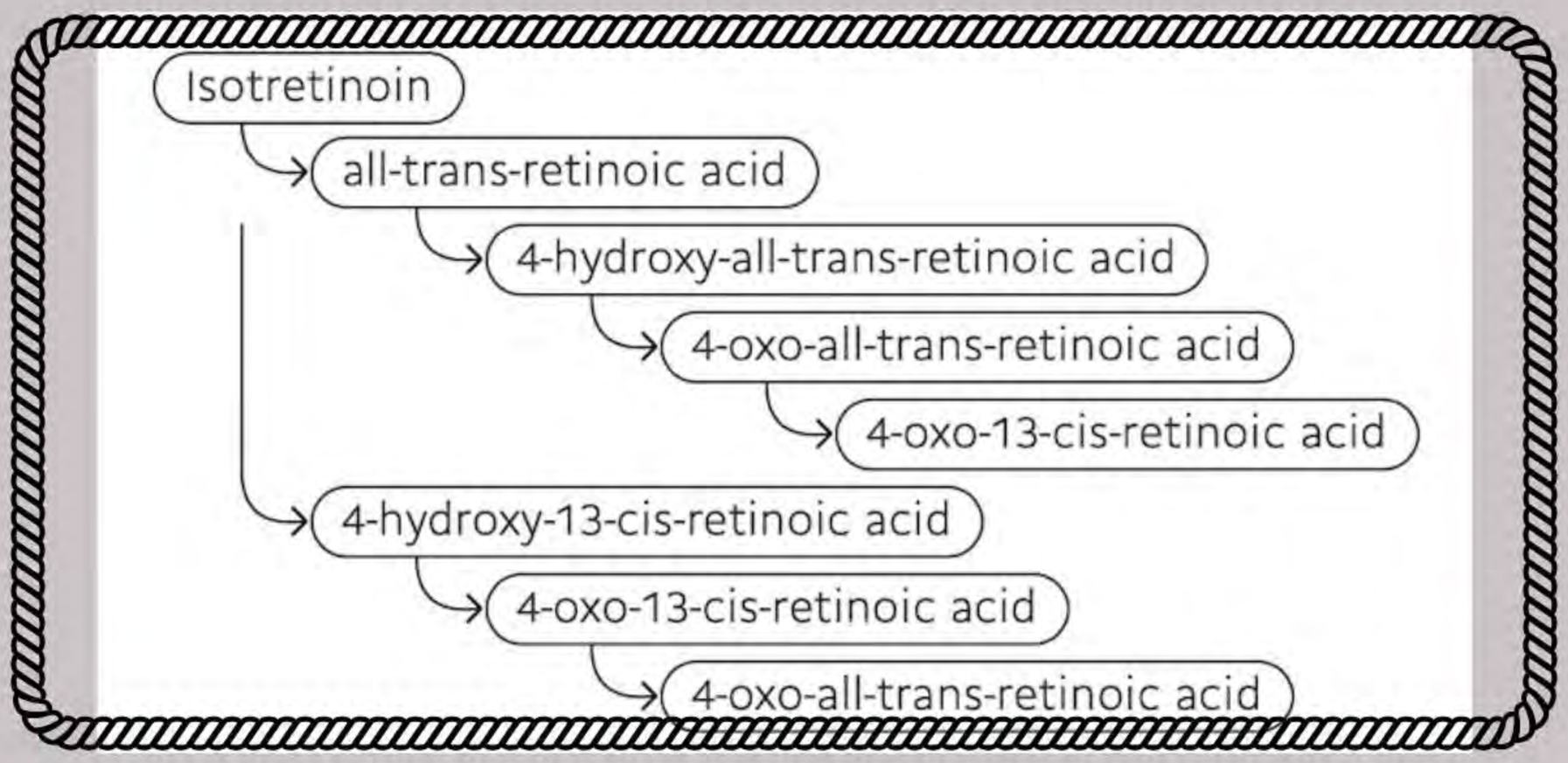


References:

The Embryo Project Encyclopedia. Isotretinoin (Accutane) as a Teratogen | The Embryo Project Encyclopedia. (n.d.). Retrieved May 25, 2022, from https://embryo.asu.edu/pages/isotretinoin-accutane-teratogen

Vinopure: The natural solution for acne-prone skin: Caudalie®. Caudalie. (n.d.). Retrieved May 25, 2022, from https://ca-en.caudalie.com/find-your-regimen/page/vinopure.html

The Embryo Project Encyclopedia. Isotretinoin (Accutane) as a Teratogen | The Embryo Project Encyclopedia. (n.d.). Retrieved May 25, 2022, from https://embryo.asu.edu/pages/isotretinoin-accutane-teratogen

Layton, A. (2009, May). The use of isotretinoin in acne. Dermato-endocrinology. Retrieved May 25, 2022, from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2835909/

Isotretinoin: 4759-48-2. ChemicalBook. (n.d.). Retrieved May 25, 2022, from https://www.chemicalbook.com/ChemicalProductProperty_EN_CB6222631.htm

Wikimedia Foundation. (2022, May 23). Salicylic acid. Wikipedia. Retrieved May 25, 2022, from https://en.wikipedia.org/wiki/Salicylic_acid

SYNTHETIC FOOD:

THE FUTURE OF CUISINE?

BY: JOHN ABAINZA AND JOHN MCFADDEN

The production of synthetic foods is a growing business. Do you believe that maybe one day "fake food" will one day change how we eat completely?

The future of food might be here. You might have heard of the immense hype around the Beyond Meat foods sold by many companies like A&W, Costco, McDonald's, and other participating food chains, from plant-based vegan chicken nuggets to "fishless sticks" making its way into food companies, it all sounds pretty ridiculous how we can now turn to plants and chemistry in order to help us create or replicate not only animal meat, but various other foods too.

It's so convincing that if you gave a person who doesn't know anything about these synthetic foods an "Impossible Burger", you could probably fool them if you told them that it was real meat. They most likely would not suspect a thing, as the plant-based synthetic foods that food scientists are making these days have perfected it to act, look, and taste exactly like your average ground beef patty and other foods.

Synthetic Foods: Tricking the Senses

One of the biggest, if not, the biggest companies to produce synthetic foods is the company called, "Beyond Meat" and according to their website, their ingredients use beans, potatoes, brown rice, and other minerals, all of which do not contain any GMOs (genetically modified organisms). This lack of GMOs stems from the fact that protein, fats, minerals, carbohydrates, and water are the five essential building blocks of meat. They use heating, cooling, and pressure for the texture and then they mix the fats, minerals, carbohydrates, fruits and vegetables colors and flavours to give it that realistic meat-

Synthetic foods are not natural, but they are made in a lab by scientists. Fundamentally, today's modern organic chemistry permits the synthesis of food substance from chemical elements. They are chemically synthesized and produced by new technological methods so that they can take on the appearance, odor and taste of the normal everyday foods that we eat, basically an imitation. It's kind of crazy that we humans are now able to manipulate the way we make food because there are actually tons of ingredients that can be used to make synthetic foods like carbohydrates, proteins, fats, minerals, vitamins, cells, minor/trace elements, all of which include soybeans, sunflower seeds, sesame, casein (slow-digesting dairy protein found in mammalian milk), and other aquatic sources. Micro-organisms like yeast (a fungal species) is one of the most promising and top candidates for making synthetic foods. It has so much potential and useability because of its rapid growth rate, versatile ability to grow on different mediums such as sugar and other non-food mediums, and it only needs few resources in order to survive. Yeast can be used for a fermentation process in order to create desired proteins for synthetic foods as one of the ingredients. Yeast basically works as a factory that mass-produces the certain protein. Other micro-organisms to produce the desired proteins could be cells from either insects or mammals, and even E-Coli can be used.

The Future of The Way We Will Eat

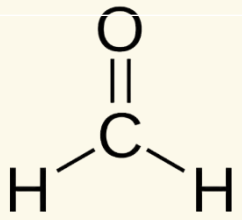
Steak Made from A Printer??

A big gamechanger that has been introduced to the synthesized foods category is the invention of 3D-printing meat. Who thought that there would be a time where we would be making a whole steak that's not even an actual steak using a 3D printer? Well, you better believe it, because an Israeli start-up called "Redefine Meat" definitely redefined what meat is to us now. The "meat" that they make is produced by using real muscle and fat cells taken from animals and chemically woven together, as well as plant-based ingredients like beetroot, chickpeas, pea protein, and coconut fat. The research and development team over at Redefine Meat even developed an artificial intelligence in order to replicate the appearance of actual meat.

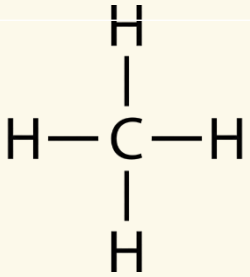
"We call it actually additive manufacturing, where you build the product layer by layer. That enables us to control the fibre structure to trap fat and moisture within the fibres and to create a food product that is man-made, the one that you're eating today, which is the closest thing to the biological meat that we're used to eat. And when you see it, it looks like meat, when you put it in your mouth, it feels like meat and your brain associates it with meat," says Eschar Ben-Shitrit, CEO of Redefine Meat.

Food From Thin Air: Magic?

Formaldehyde

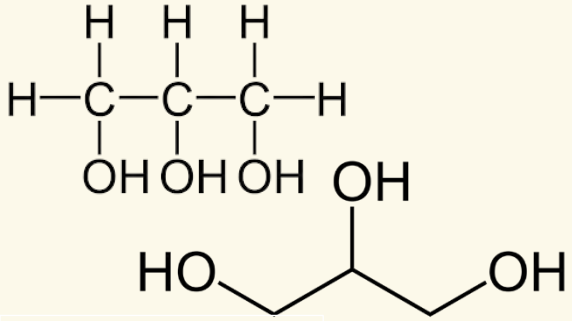


Methane



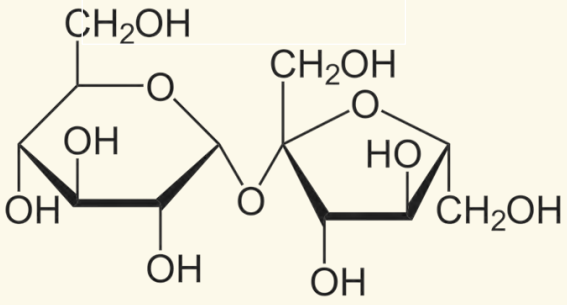
If you thought that 3D printing synthetic steak using plant-based ingredients was pretty cool, then how about making synthetic food out of thin air? Literally. This project is an initiative by a Finnish company collaborating with the European Space Agency (ESA) called, "Solar Foods". The main goal of their company is this one miracle protein called Solein. This protein was inspired by the work that NASA did between the 60s and 70's, where astronauts in space looked how to produce carbohydrates (sugar molecules) using different ways.

The process was that they used electrolysis (using electricity to split water and hydrogen and gain them individually) as well as using carbon dioxide exhaled by the crew to produce methane, which can be turned into formaldehyde by partial oxidation with oxygen that forms sugars and glycerol. The inspired protein Solein uses this similar process and can be super sustainable because it only requires air, water, electricity, and help from bacteria that can digest the hydrogen gas produced from the electrolysis and CO_2 captured which can transform it into edible synthetic food.



Glycerol: Lewis and Organic structure

Sugar Structure Example: Sucrose



The Impact, Ethics, and Health: Pros Vs. Cons

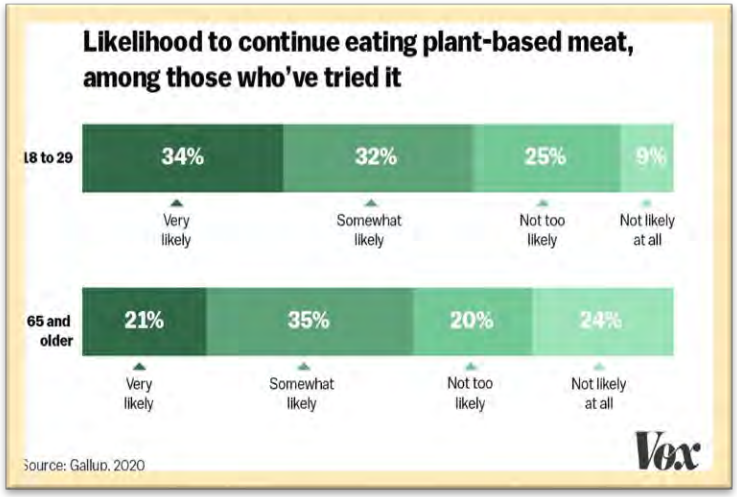
While some consumers are intrigued by the wow factor of synthetic or cellular foods, others are concerned about nutrition and safety. Some argue that these products are not "real" food; they worry about the addition of synthetic chemicals, food dyes and artificial preservatives. Food laws and regulations could influence the market of synthetic foods. There are no reports of health or environmental impacts from to date, but neither does it appear that anyone has researched the question. One of the main health concerns expressed about synthetic products is the addition of new proteins to foods, and these new proteins may be allergenic, according to Dana Perls, senior food and agriculture campaigner with Friends of the Earth. "We need to understand the short and long-term impacts before these ingredients and products enter the market or the environment," she cautions for products genetically engineered to replace animal products and stresses the need for stronger regulations for all genetic engineering.

Most consumers wouldn't know that the cheese they buy is produced using gene modification. Genetically Modified Organism (GMO) labeling laws in the U.S. don't apply to products made using synthetic biology, which makes it increasingly difficult for consumers to make informed choices. Cell-based meat, which is grown in a lab by multiplying entire stem cells taken from animal muscle, will be regulated by the Food and Drug

Administration in the U.S. and the Health Products and Food Branch (HPFB) in Canada, though it's not yet clear what that means in practice. Synthetic biology is advancing so quickly, regulatory plans are finding it very difficult to keep up. "The new wave of genetic engineering is slipping through very large loopholes," says Perls. "People who are trying to purchase food or clothing that reflects their values are in the dark."

Many consumer groups are active in their campaign against the production and distribution of artificial or synthetic foods. All arguments against this type of food are focused on one thing, the addition of synthetic chemicals like pesticides, heavy metals, food dyes and artificial preservatives to food affect its composition and nutritional value. Modern techniques that are being used in the production of this type of food, such as genetic engineering, hydrogenation or irradiation could also have the same effect. Some even speculate that this could ultimately lead to the development of new diseases, or serious impacts on our health.

Some experts believe that plant-based food manufacturers might not be as green as they position themselves; that they deliberately focus on specific metrics solely to make a marketing case. "They focus on the CO_2," says Frédéric Leroy, a professor at Vrije Universiteit Brussel in Brussels, "but that's a very limited view." Sustainability metrics like soil health and biodiversity should be part of the calculation, he says. "Monocultures will have



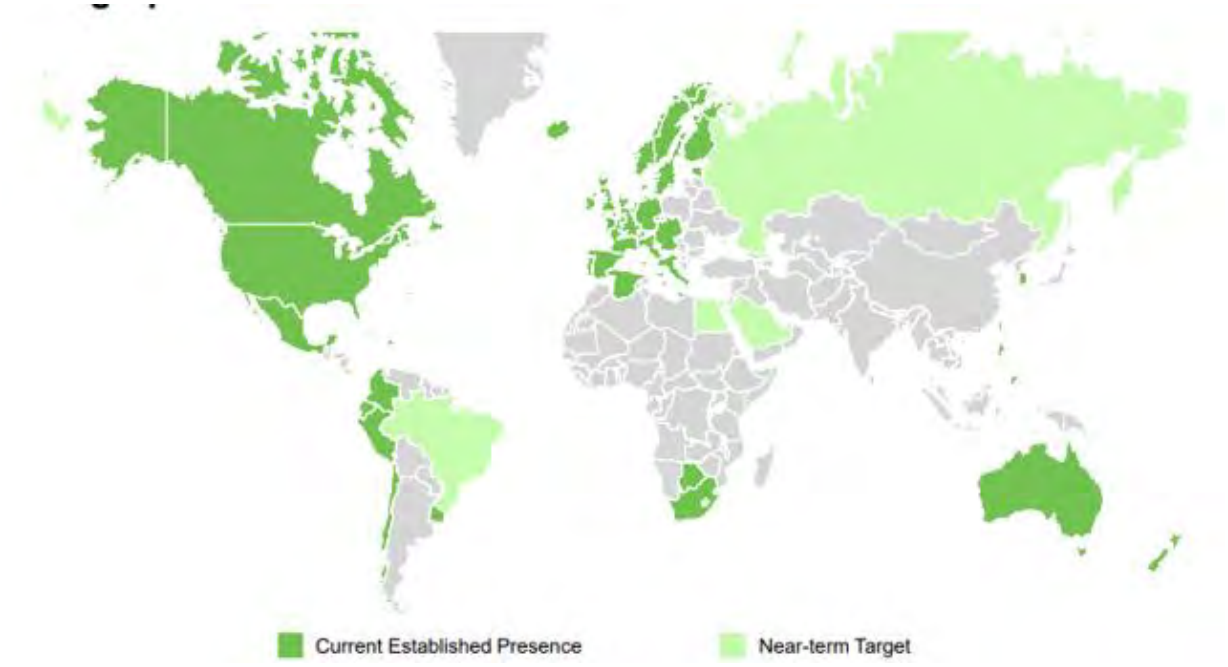
impacts on soil erosion, they depend heavily on fossil fuels because of the fertilizers, and they're a nightmare for biodiversity," says Leroy.

Amie Peck, stakeholder engagement manager for the Canadian Cattlemen's Association, thinks it's important to put the numbers into a Canadian context. "This country's beef industry is a global leader with one of the lowest carbon footprints, she says, What's more, the environmental benefits of beef production have been left out of the conversation, Peck says: Beef farmers and ranchers in Canada care for 35 million acres of native temperate grasslands, among the most endangered lands in the world, and which sequester 1.5 billion tonnes of carbon." She agrees with the need to reduce environmental impacts, but isn't convinced that eating less beef is the answer. If Canadians ate less beef, she argues, those grasslands would be plowed, releasing the sequestered carbon from the soil. You could actually see more emissions being released, you know, by not having cattle on the landscape than you ever would from reducing your meat consumption," Peck says. We want to be part of the solution," she continues. "We are very much committed to continuous improvement and that means a further reduction in emissions, Our target is a 33-per-cent reduction by 2030."

Obviously Beyond Meats website protests this saying "Beyond Meat is made from simple ingredients derived

from plants, without GMOs, synthetically produced ingredients, antibiotics or hormones. Beyond Meat products offer protein levels greater than or equal to their animal-based counterparts with no antibiotics and no hormones." In response to a reporter asking if it was healthier than Beef beyond meat said "Recently, the findings from a clinical study using Beyond Meat's plant-based products were published in the American Journal of Clinical Nutrition. In the study conducted at Stanford University, researchers evaluated the impact of replacing animal-based meat with plant-based meat over an 8-week period on cholesterol levels, heart disease risk factors including TMAO levels, and body weight, and found improvement in key health metrics when participants replaced animal-based meat with plant-based meat."

Beyond Meat Company Expansion Across the World



Source: https://seekingalpha.com/article/4292215-beyond-meats-valuation-is-beyond-belief-years-of-growth-already-incorporated-share-price.

Endless Possibilities

Hervé This, a French chemist and inventor of molecular gastronomy himself even follows the way for the future of synthetic foods. By using isolated compounds like proteins and fats and combining them, he opens the way to make an endless possibility of new dishes. "In the future, we won't cook with fruit, vegetables or meat. We will cook 'note by note' with the pure compounds responsible for taste and smell, " says Herve.

Citations

The Business Times. (2018, July 9). *Next Big Food Trend: "note-by-note" cuisine, pioneered by Herve this, father of molecular gastronomy*. The Peak Magazine. Retrieved May 22, 2022, from https://www.thepeakmagazine.com.sg/gourmet-travel/next-big-food-trend-note-by-note-cuisine-pioneered-by-herve-this-father-of-molecular-gastronomy/

Farlex. (n.d.). *Synthetic and artificial food products*. The Free Dictionary. Retrieved May 24, 2022, from https://encyclopedia2.thefreedictionary.com/Synthetic+and+Artificial+Food+Products

Farrant, T. (2022, February 8). *Would you eat this 3D printed plant-based steak?* euronews. Retrieved May 22, 2022, from https://www.euronews.com/culture/2022/02/02/would-you-eat-this-3d-printed-plant-based-steak

Harman, G. (2014, December 17). *Technology is ready for synthetic foods. are you?* The Guardian. Retrieved May 24, 2022, from https://www.theguardian.com/sustainable-business/2014/dec/17/synthetic-foods-technology-labeling-gmo

Le, B. (2018, December 20). *Three brilliant innovations in synthetic foods*. The Kolabtree Blog. Retrieved May 22, 2022, from https://www.kolabtree.com/blog/innovations-synthetic-foods/

McGee, M. (2022, January 23). *Those fake-meat hamburgers might not be a planet-saver after all*. thestar.com. Retrieved May 24, 2022, from https://www.thestar.com/news/insight/2022/01/23/those-fake-meat-hamburgers-might-not-be-a-planet-saver-after-all.html#:~:text=Sustainability%20research%20firm%20Sustainalytics%2C%20which,producing%20giants%2C%20Cargill%20and%20JBS.

The rise of cellular agriculture, synthetic meat and lab coat farming. C.O.nxt. (2022, January 12). Retrieved May 24, 2022, from https://co-nxt.com/blog/the-rise-of-cellular-agriculture-synthetic-meat-and-lab-coat-farming/#:~:text=Synthetic%20food%20is%20created%20from,to%20make%20food%20from%20it.

Synthetic Foods: A protein made from water, electricity, and Air. IMNOVATION. (n.d.). Retrieved May 24, 2022, from https://www.imnovation-hub.com/science-and-technology/synthetic-foods-protein-made-water-electricity-air/

Wilcox, M. (2019, May 14). *Why genetically engineered foods have some scientists nervous about the future*. Eater. Retrieved May 22, 2022, from https://www.eater.com/2019/5/14/18623258/impossible-foods-synthetic-lab-grown-meat-science

Williams, Z. (2021, November 16). *3D-printed steak, anyone? I taste test this 'gamechanging' meat mimic* . The Guardian. Retrieved May 24, 2022, from https://www.theguardian.com/food/2021/nov/16/3d-printed-steak-taste-test-meat-mimic

DAMAGED HAIR?
THE DYNAMIC DUOS GOT YOU

WRITTEN BY
LYNN CHUNG
GABRIELLA WAITE

STARTING OFF STRONG WITH SHAMPOO

How many times a week do you wash your hair? The average answer should be 2-3 times to maintain optimal hair growth. In fact, this is directly related to surfactants in a shampoo.

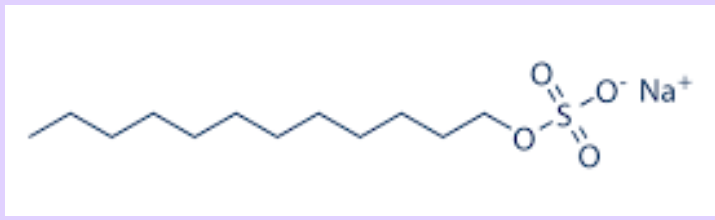
First off, shampoo contains detergent which works as its surfactant. They lower the surface tension of the water in order to separate hair and make it able to bind with oils. Surfactants are amphiphilic consisting of both lipophilic (oil-attracting) and hydrophilic (water-attracting). The lipophilic helps bind sebum while hydrophilic binds to water.

A surfactant's job is to dissolve the barrier between dirt, oil, and water which 'strips away' the oil and dirt particles. However, surfactants are sometimes 'too effective' because hair needs to retain its natural moisture and oils. Now, here comes the question: should I change to surfactant-free shampoo? Read the rest to find out!

TYPES OF SURFACTANTS

1. Anionics: good cleansing and lather, but leaves hair striped. Negatively charged
2. Cationics: poor cleansing and lather, but leaves hair soft. Positively charged
3. Nonionics: mild cleansing
4. Amphoterics: mild cleansing and non irritating. (often used in baby shampoo)
5. Natural Surfactant: poor cleansing but excellent lather.

CURIOUS CHLORIDE



This is the lewis structure of **sodium lauryl sulfate** (Anioncis), which is the most common sulfate. It has amphiphilic properties because of its hydrocarbon chain with a polar 'headgroup'; thus, the head is water soluble while the chain is water insoluble. Myths have linked it to cancer; however, science tells a different story: SLS is certified by FDA as a safe food additive.

CANVA DESIGN

YES- use surfactant-free

- sensitive skin (ex. eczema, psoriasis)
- dry, curly, or frizzy hair
- chemically altered or dyed hair

NO- use surfactant

- greasy hair
- hair with dandruff

PROS OF SURFACTANT-FREE

1. Non-stripping formula (positive for people with eczema and acne)
2. Preserves colour
3. Supports natural shine and reduce frizz
4. Reduce scalp irritation and allergies

CONS OF SURFACTANT-FREE

Because sodium lauryl sulfate is the most common ingredient in shampoos, the prices of surfactant-free shampoos are more expensive. These types of shampoo do not lather well, thus, it will be difficult to know if your hair is thoroughly washed since it does not help to alleviate dandruff. In addition, your hair may loose it's volume.

*If you use surfactant-free shampoo, make sure to wash more than once for a clean finish!

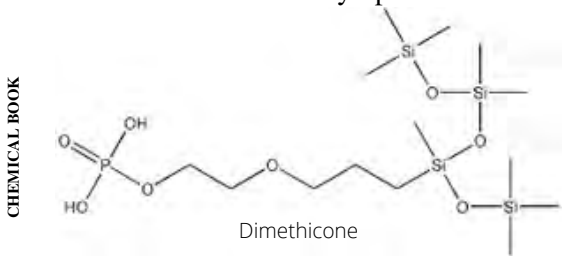
SURFACTANT-FREE OPTIONS TO BUY!

Brand	Benefits
Aveeno Pure Renewal Shampoo	Affordable, safe for chemically treated hair, doesn't strip
L'Oreal ever strong sulfate-free fortify system	Affordable, creates volume, thickens hair
Pureology hydrate sheer	Good for chemically treated hair, contains sunscreen, natural treatment
John Masters organics shampoo	Has 17 natural plant extracts, doesn't strip, organic,

WHY ARE SILICONES IN SHAMPOOS?

Silicones are polymers and they are large molecules formed by chemically connecting a series of building units together. Polymers are naturally derived; however, they are synthesized within a lab. In shampoo, silicone gives the hair a shine and makes the strands softer. Since silicone is hydrophobic, it 'sticks' to the hair surface and forms a protective barrier around hair shaft to make it heat-resistant.

Dimethicone is most commonly used but it is hard to wash off due to its polarity. This insolubility in water is explained through the non-polarity of Dimethicone, as like dissolves like and water is polar. It is a polyethylene glycol derivative of Dimethicone and contains 7 moles of ethylene oxide. However, its contamination concern is high because of ethylene oxide and 4-Dioxane. Human exposure to ethylene oxide increases the risk of lymphoid and breast cancer.



Dimethicone

CONTROVERSY BEHIND SILICONE

Since silicone is 'synthetic' it does not meet the requirements for a natural ingredient. Even though silicones are not toxic, people who prefer all natural products are against it. Scientists state that silicones may have the long term effect of leaving the hair looking dull, weak, and dehydrated. You may even see your hair becoming weaker and more prone to breakage. If you see "-cone" near the top of the ingredients list, there is a higher percentage of it in the product.

SO, SHOULD YOU USED SILICONE-FREE PRODUCTS?

Yes! Silicone can result in serious buildups and make your hair heavy and greasy. It can clog your hair follicles which leads to hair thinning and loss. You don't want that! An alternative is using jojoba oil, aloe vera, and shea butter.

In a blog by *prose*, people voted if they look for non-silicone products:

74.7% - look for non-silicone products

25.3% - does not look for non-silicone products

Ingredient label including Sodium lauryl sulfate and Dimethicone

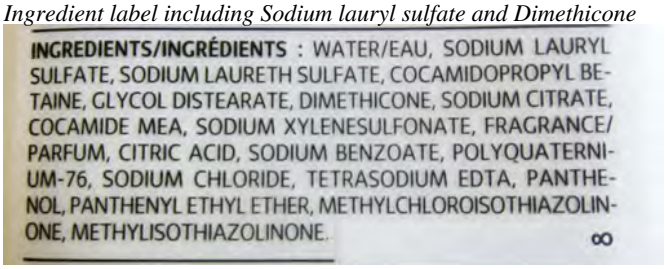


Photo taken by Lynn Chung

IS DRY SHAMPOO SAFE?

Dry shampoo absorbs oil from scalp giving it a matte look. Using dry shampoo occasionally is safe. When used for an extended period can seriously damage your scalp. It leads to hair breakage, clogged follicles, and hair loss. It is important to note that dry shampoo does not 'shampoo' your hair, it is only a sprinkled-on starch or alcohol that absorbs oil particles. Alcohol containing dry shampoo is drying for your hair and causes individual fibers to spilt. In fact, leaving dry shampoo in your hair for too long leads to a buildup of product on your scalp, which can lead to bacterial or fungal infection.

Some dry shampoos contain talc which is chemical that soaks up the oils. America has banned talc because they have asbestos in them. The American Cancer Society recommend people who are concerned with cancer to avoid the use of dry shampoos containing talc because there may be a link with ovarian cancer and talc in dry shampoo.

So if you use dry shampoo, make sure to not use it often!

WHAT IS PURPLE SHAMPOO?

Purple shampoo has crushed violet pigments which neutralize brassy and yellow tones. Simply put, purple is the opposite colour of yellow, so it cancels it out. But watch out! Using purple shampoo too often might make your hair too dry and brittle.

CONDITIONER CLOSING THE SHOW!

COMPONENTS OF CONDITIONER:

1. Cationic surfactants
2. Polymers
3. Emollients/oily compounds
4. Auxiliary emulsifiers

Hair goes through many rough trials throughout the day, starting with straightening or curling it in the morning with high intensity heat tools, or perhaps using hair gels or harsh shampoos that further dry out the hair. The one saving grace for this situation is using the right conditioner that can transform your frizzy dried up hair, into luscious silk.

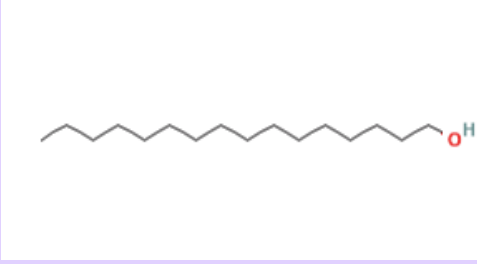
HOW DOES THIS WORK?

Hair has a strongly negative surface charge; while damaged hair has an extreme negative charge. It is so negative that the hair follicles physically repel from each other due to the basic law of like charges repel, this creates the frizz phenomenon. By reducing the friction between hair follicles, conditioner gives the hair a silky texture.

In a conditioner, the ingredient which gives hair this silky results is ***emollients*** (1), specifically fatty acids. This is why many conditioners contain coconut oil, as it is high in fatty acids. Additionally, ***polymers***, such as silicone, provide a backup plan as they deposit onto surface of hair, reducing friction, static charge, and all the while making the hair shiny in the process.

Shampoo, conditioners supposed best friend, also leaves hair with a negative charge, lifting up hair cuticles (2) by imparting a negative charge on them. The ***cationic surfactant*** in conditioner removes this negative charge, smoothing down the cuticle.

97% of hair contains keratin which has a surface comprised of negatively charged amino acids. The very positively charged cationic surfactants strongly bind to keratin, preventing the conditioner from washing out completely through water. Conditioners ability to leave a remnant of hydration in hair even after washed out, is a phenomenon that many don't understand, but don't worry because now you do!



PUB CHEM

Cetyl alcohol (most common cationic surfactant in conditioner), organic chemistry name is 1-hexadecanol. It is unable to react with water as the majority of it is nonpolar, meaning that it is insoluble in water. It has the ability to have hydrogen bonding due to its OH group which will enable it to retain water molecules and thus moisture in hair. Cetyl alcohol acts as an ***emulsifier*** as it prevents the ingredients in the conditioner from separating.

CONFLICTED MINIMALIST, WANTING *2 IN 1 SHAMPOO AND CONDITIONER* BUT NOT KNOWING IF IT ACTUALLY WORKS?

Using 2 in 1 shampoo and conditioner is extremely beneficial towards the environment because rather than using two bottles you only use one. Save the turtles! The two in one shampoo conditioner has a "Lochhead Effect". As we already know, shampoo works to break down oils and dirt, while the surfactants in conditioner are suspended in the soap suds. Washing out the shampoo causes the oil and dirt to wash away, and the presence of water triggers the surfactants to bind to the hair.

1- Emollient: has ability to soften skin and hair

2- Hair cuticle: protective outer layer of a hair strand composed of dead cells, protects hair from damage and imparts shine

Many people think that the conditioner will be washed away with the shampoo if applied at the same time. However, the chemistry still holds that the cationic surfactants bind to the hair, preventing conditioner from being completely washed out.

THE DILEMMA...

Even after determining that 2 in 1 works, the question still remains how to properly apply this environment saving hack? When applying shampoo you want to massage it into your scalp to stimulate circulation which aids in hair growth. You also avoid scrubbing the ends because that leads to split ends and other hair damages. We know this because shampoo leaves the hair with a negative charge and to put it on already dry parts of hair such as the ends will further split them. In contrast, conditioner is applied in a completely different method. You aim to apply it to the ends in order to further hydrate them through the hydrogen bonding from the cationic surfactants, and you need to avoid the scalp as you would risk making it too oily.

HOW TO PROPERLY APPLY 2 IN 1 SHAMPOO

Massage into scalp like you would shampoo? Lather on the ends like you would conditioner?

The best way to apply 2 in 1 shampoo and conditioner is to first wet all your hair, then apply the product from roots to ends and then completely rinse it out. This method will warrant the promised results that shampoo and conditioner achieve separately, however, it will also have negative side effects as the tips will have been shampooed and the roots conditioned which we know from the above paragraph is not a good thing.

Therefore, while 2 in 1 shampoo and conditioner is better for the environment, you run the risk of having a strange mix of oily roots and split ends, which is the worst of both worlds in the hair industry.

FIAGROLONDON

LEAVE-IN CONDITIONER

Leave-in conditioner contains similar, if not the same ingredients as normal conditioner, they just vary in concentration. Normal conditioner works to hydrate and replenish hair quickly so that it can be rinsed out within a few minutes. Whereas, leave-in conditioner achieves the same result but over a longer period of time. However, do not get mistaken, using them interchangeable is not a good idea. To leave in regular conditioner would be subjecting your hair to harsh chemicals that could have a reverse effect of stripping your hair from essential oils making scalp dry and irritable.

Photo taken by Gabriella Waite

References:

HARVARD T.H CHAN. (2021, July 6). Coconut oil. The Nutrition Source. Retrieved May 24, 2022, from https://www.hsph.harvard.edu/nutritionsource/food-features/coconut-oil/
Selecting the right surfactant for cosmetics. Surfactants in Hair Care Applications. (n.d.). Retrieved May 24, 2022, from https://cosmetics.specialchem.com/centers/selecting-the-right-surfactant-for-cosmetics/surfactants-in-hair-care-applications
Russick, J. (2021, July 7). Hair cuticle: Understanding this important part of your hair: F.Y.I. F.Y.I. | by Function of Beauty. Retrieved May 24, 2022, from https://www.functionofbeauty.com/blog/lightreads/hair-cuticle/
How long should you leave conditioner in? Viviscal Healthy Hair Tips. (n.d.). Retrieved May 24, 2022, from https://blog.viviscal.com/how-long-leave-hair-conditioner-in/
Joan. (2022, April 25). What is the difference between leave in conditioner and regular conditioner? Daily Dose. Retrieved May 24, 2022, from https://www.dailydoseme.com/blogs/faq/what-is-the-difference-between-leave-in-conditioner-and-regular-conditioner D'Souza, P., & Rathi, S. K. (2015, May). Shampoo and conditioners: What a dermatologist should know? Indian journal of dermatology. Retrieved May 24, 2022, from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4458934/
Anne Marie Helmenstine, P. D. (2019, September 8). How shampoo works and the chemistry behind it. ThoughtCo. Retrieved May 24, 2022, from https://www.thoughtco.com/how-shampoo-works-607853
Osbourne, V. (2016, January 14). 4 ingredients that make your conditioner the perfect Detangler. 4 Ingredients That Make the Perfect Detangler | NaturallyCurly.com. Retrieved May 24, 2022, from https://www.naturallycurly.com/curlreading/kinky-hair-type-4a/4-ingredients-that-make-your-conditioner-the-perfect-detangler
Shampoo and Conditioner. (n.d.). Retrieved May 24, 2022, from http://www.chm.bris.ac.uk/webprojects2002/hull/page3.htm
Norris, T. (2019, October 24). How to use conditioner on hair: Best practices by type and by hair. Healthline. Retrieved May 24, 2022, from https://www.healthline.com/health/how-to-use-hair-conditioner#2-in-1-product
What does purple shampoo actually do? how to use it & more. Redken. (n.d.). Retrieved May 24, 2022, from https://www.redken.com/blog/haircolor/everything-you-need-to-know-about-purple-shampoo-for-blonde-hair
Pictures and lewis structures:
U.S. National Library of Medicine. (n.d.). 1-hexadecanol. National Center for Biotechnology Information. PubChem Compound Database. Retrieved May 24, 2022, from https://pubchem.ncbi.nlm.nih.gov/compound/1-Hexadecanol
Alexia, & Figaro. (2022, January 13). The 2 golden rules of using hair conditioner correctly. Hair & Beauty Salon Near Old Street | Figaro London. Retrieved May 24, 2022, from https://www.figarolondon.uk/the-2-golden-rules-of-using-hair-conditioner-correctly/
Dimethicone PEG-7 phosphate. DIMETHICONE PEG-7 PHOSPHATE CAS#: 132207-31-9. (n.d.). Retrieved May 24, 2022, from https://www.chemicalbook.com/ProductChemicalPropertiesCB9960608_EN.htm
Avoid sodium lauryl sulfate: Curious chloride ingredient scanner. Curious Chloride. (2019, September 29). Retrieved May 24, 2022, from https://www.curiouschloride.com/substances/sodium-lauryl-sulfate/?utm_source=canva&utm_medium=iframely

Clothes so bad, it'll make you sick

Justin Kopman

Clothing is a basic, yet very important part of our everyday lives. No matter how much thought you put into your outfits every day, it usually is not a subject most would correlate with chemistry in the slightest amount. However, upon further research and investigation, one can find that it plays quite an important role in everyday clothes. Outside the obvious chemicals used in laundry detergents, we can also see its importance in stain resistance and removal, preventing wrinkles, dying in colors, and water resistance. These are just a few examples of how chemistry helps in the clothing industry, but what requires a bit more research, is how it negatively affects the industry. Oh yes, decades of research through various scientists and organizations has brought us to the shocking realization that the chemicals used in clothing are harmful not only to ourselves, but to the environment. Admittedly, this is not a new subject, as this has been researched and studied for many years now, but what is horrifying is how few people actually realize this. We all may be unknowingly at risk of very harmful diseases and illnesses simply by getting dressed in the morning. However, this is a lot to take in, so let's break it down step by step.

The Types of Harmful Chemicals

Before we go into the ways our clothing could be harming us, we're first going to be covering the types of chemicals to look out for in your clothing:

1. **Azo dyes**($C_{18}H_{18}BrN_5O_7$) are colorants used in clothing to provide a very vibrant and colorful texture which will not be removed when washed. These dyes can be found in 70-80%[1] of all colorants, and research shows that 5%[2] can lead to a harmful compound known as aromatic amines. These can be very dangerous for humans, and "they have been seen to cause bladder and liver cancers."[2]. Thankfully, these dyes are completely banned in Europe, but somehow are only banned in the State of California in The United States!

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2. **Formaldehyde** (CH_2O) is a chemical which is more recognizable, as it is used in textiles to help with water reflection, and wrinkling. However, unknowingly to most, formaldehyde can potentially be very dangerous. In 1987 the EPA determined "formaldehyde as a probable human carcinogen under conditions of unusually high or prolonged exposure. Since that time, some studies of humans have suggested that formaldehyde exposure is associated with certain types of cancer."[3] In other words, when used in large quantities, (over 75 ppm in clothing for

adults)[1] it can potentially cause rashes, asthma, cancer, respiratory illnesses, and much more. Thankfully, due to its dangerous qualities being found in the 80's, there is very little threat in it now.(For perspective, in the 1960s, formaldehyde levels could be up to 3000ppm, but that has drastically declined).

3. **Perfluorocarbon**(C_2F_6) is a chemical which is present in most water resistant and stain proof clothing, and also has been linked to infertility and cancer. Even small amounts of this chemical can have dangerous effects in clothing. It is quite terrifying that this was not discovered until a few years ago! In fact, a marketplace experiment determined that in a pile of children and maternity clothes, 1 in 5 contained concerning levels of this chemical.[5]

These are not the only toxic chemicals found in clothing, and unfortunately, they aren't even the most dangerous. The three chemicals just explained are merely a small sample of toxins in our clothes. A few others include heavy metal, chlorobenzene, chromium, VOCs, and Phalates. Once again, this barely even scratches the surface on the danger found in our clothes, but if I start going through all of them, we would be here all day. However, most of these chemicals cause similar issues in our bodies, the most common being cancer, skin irritation, rashes, digestive and respiratory diseases, and autism.

These chemicals not only harm our bodies, but our environment as well

Unfortunately, the bad news does not stop with the effect chemicals in clothing have on our bodies, as it is just as dangerous for the environment. Nearly every chemical I just listed as being harmful for us, has just as bad an effect on nature. Just to give you an example "Every time we wash a synthetic garment (polyester,nylon, etc), about 700.000 individual microfibers are released into the water, making their way into our oceans. Scientists have discovered that small aquatic organisms ingest those microfibers"[4]. The issue of some of these dangerous chemicals in our environment is a problem so vast, it is a discussion for another day. Although the chemicals discussed today are found in clothes, they are also found elsewhere. Meaning that it is unfortunately too large an issue to be covered in this article.

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What can be done to help?

Although it is very important to be informed on the dangers of chemicals in clothes, all of the information listed here would be completely useless without tips on how to protect yourself.

1. Do research. To be safe, either purchase from chemical free clothing brands , or those marked by GOTS (meaning it has been chemically tested.
2. When purchasing new clothes, be sure to always run it through a washing machine to hopefully filter out any possibly dangerous chemicals found in it.

3. In terms of helping the environment, aside from donations the main thing you can do is try to donate your clothing instead of throwing it out. Not only could it help out those in need, it could prevent a possibly dangerous chemical from being exposed to the environment.

In conclusion, I hope you learned something today that could possibly help in your future shopping decisions, as dangerous chemicals found in clothes are a topic I see being discussed far too little. So whenever you find yourself looking for a new outfit or clothing related chemical, be sure to put some research into it, as you never know what it could contain.

References

1. Yeomans, T. (2021, October 11). *Chemicals in textiles and the Health Implications*. Allergy Standards Ltd. Retrieved May 22, 2022, from https://www.allergystandards.com/news_events/chemicals-in-textiles-and-the-health-implications/

2. Schroecker, J. (2018, May 23). *Why we need to get rid of azo dyes*. Trusted Clothes. Retrieved May 23, 2022, from https://www.trustedclothes.com/blog/2018/05/08/why-we-need-to-get-rid-of-azo-dyes/

3. *Formaldehyde and cancer risk*. National Cancer Institute. (2011, June 10). Retrieved May 23, 2022, from https://www.cancer.gov/about-cancer/causes-prevention/risk/substances/formaldehyde/formaldehyde-fact-sheet#:~:text=In%201987%2C%20the%20U.S.%20Environmental,with%20certain%20types%20of%20cancer

4. Charpail, M. (2017). *Fashion & environment*. SustainYourStyle. Retrieved May 23, 2022, from https://www.sustainyourstyle.org/en/whats-wrong-with-the-fashion-industry#:~:text=Every%20time%20we%20wash%20a,aquatic%20organisms%20ingest%20those%20microfibers

5. McNeil, M. (2022, February 16). *Are there hidden chemicals in our clothing?* Remake. Retrieved May 22, 2022, from https://remake.world/stories/there-are-hidden-chemicals-in-our-clothing/

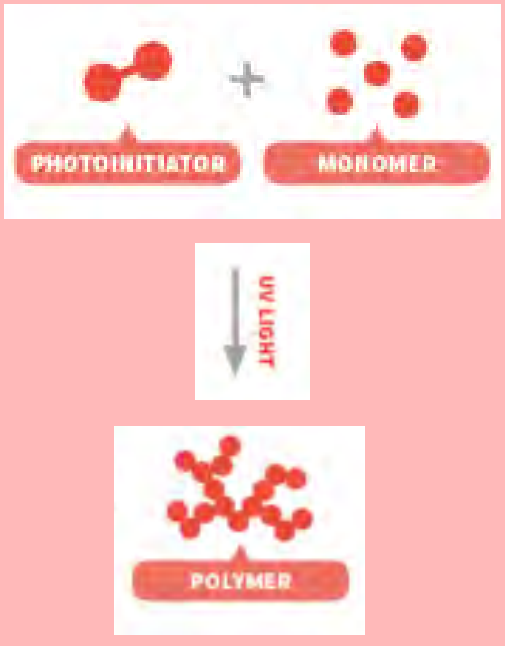
6. (2014, April 8). *News article: Toxic Chemicals found in clothing*. Shades of Fashion. Retrieved May 24, 2022, from https://shadesofashion.wordpress.com/2014/04/04/news-article-toxic-chemicals-found-in-clothing-2/

Maria Tassopoulos
Chem Matters

Chemistry at the tips of your fingers

The chemical composition behind nail products

Those part of the nail world know there is nothing more satisfying than a fresh manicure which carries art on your very hands, and is used as a form of self expression and beauty. However, behind all the sparkles, bright colours and precise detailing, chemistry is credited for the function of these products such as their durability, malleability, colours, and more. From acrylic to gel, to the reaction between nail polish and its remover, scientists are the true artists of the nail industry. This article will break down the fundamental chemical basis of nail products including the main elements which react with one another, and how they work together to create a beautiful masterpiece

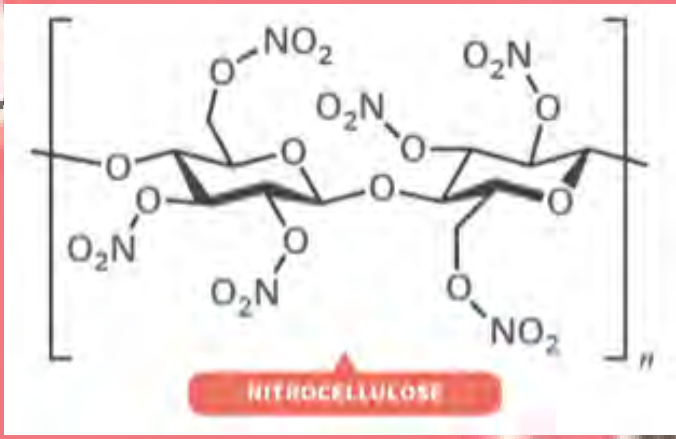


The Perfect Paint

Let's be honest, as much as doing your nails can be exciting and relaxing, the process of sitting in a chair for hours at times is very tedious and boring, but by understanding the chemical reactions happening right in front of you, you will appreciate your manicure as a lab experiment! Regular nail polish is normally made of solvents, film formers, resins, plasticizers, and pigments which mix together to create a uniform product. These polishes use a polymer, most commonly nitrocellulose which is dissolved in ethyl acetate or butyl acetate the solvent. When applied to your nail it starts drying and the solvent evaporates and the polymer is left on the nail which creates a film. The adhesive polymer helps the film stick to the nail and plasticizers like dibutyl phthalate, camphor and triphenyl phosphate are used in polish to prevent cracking and chipping. The plethora of colours which can overwhelm someone when doing their nails are a result of a multitude of pigments which are the compounds in polish which give them their colour. Pigments can be organic or inorganic meaning it does or does not contain hydrogen bonding. Inorganic pigments include chromium oxide for green, iron oxide for red and ferric ferrocyanide for blues. Organic compounds are like food colorings and come in a variety of colors. Sparkles are a must have for a unique manicure and this look in polish is achieved using titanium dioxide, mica or crushed natural pearls. Another popular nail product used for a longer lasting manicure is gel polish.

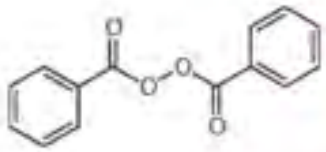
Unlike normal polished, gel polish will only dry if it is activated by a UV light. Unlike nitrocellulose polish, which will dry out gradually as the solvent evaporates, gel polish will never dry unless it is activated by ultraviolet light. Like a superhero gaining super strength after a dose of radiation, a "photo-initiator" molecule mixed into the polish can absorb the UV energy, break itself in half and make two super-charged molecules. These charged molecules are called free radicals-

-a type of chemical that gets an especially bad rap, because that extra energy can be used to break all sorts of chemical bonds where it's not supposed to. In the nail polish, the extra energy jump-starts a chain reaction that transforms the liquid polish into a hard layer of plastic within seconds. Gel polishes contain photoinitiators which initiate polymer chain growth that is very difficult to break. A common photoinitiator is benzoyl peroxide which is mixed into the polish and when in a plastic solution it's called methacrylate. The free radical from the benzoyl peroxide pushes electrons around in the liquid methacrylate monomers so they form bonds with each other and create a solid polymer.



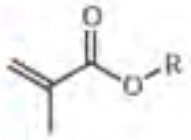
Fake it Till' You Make it!

Fake nails have had an impact on the fashion world and can be known as a staple asset to someone's look, so let's break down how they really work. In order for a nail to properly set and last a base/primer is a crucial step. The primer is able to bond the nail to the acrylic and is mainly acid based. Most primers contain methacrylic acid which has two arms on each side of the molecule. One of the arms creates the intermolecular force of H-bonding with the keratin on the surface of the nail, while the other creates a covalent bond and links the primer to the acrylic or gel applied on top. Primers also help to dehydrate the nail in order for proper molecular bonds to be made and trapped moisture should not interfere-

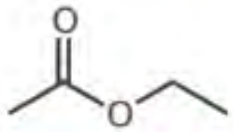


BENZOYL PEROXIDE

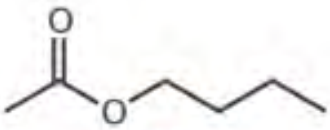
METHACRYLATE



-as Doug Schoon, president of Dana Point, California-based Schoon Scientific. “This moisture layer must be removed to ensure proper adhesion, especially for artificial enhancement products.” Not to mention, balancing the pH on the nail is a crucial step to make the surface of the nail less acidic since most acid groups in products are attracted to a more basic pH. The actual application of the fake nail itself works in three steps: monomer liquid, which gets activated by an initial molecule, and then the process is sped up by a catalyst. The powder is a mixture of polymers that carry the initiator molecule such as benzoyl peroxide and depending on the powder may include coloured pigments. A polymer itself is a long chain of monomers chemically linked together and the benzoyl peroxide breaks in half when exposed to our body heat from our fingers. Furthermore, the monomer liquid which is (EMA) ethyl methacrylate is a molecule which is the building block for polymer chains, since it only has one unit (“mono” meaning one). The catalyst, a molecule which speeds or initiates a reaction but does not change itself, speeds up the breakage of the polymer. Not to mention, these powders include inhibitors which prevent the monomers from joining to the polymers before mixing with the powder which can result in premature hardening.These molecules work in this process: the liquid on a brush gets dipped into the powder and the catalyst (in the liquid) breaks the initiator (in the powder) in half, creating two free radicals. Each of these combines with a monomer, and the reacted monomer attaches to another monomer creating a covalent bond. Each of these singular monomers link together and make long polymer chains. These chains then wrap around the polymer powder beads and encase them which fuses it to the nail!



ETHYL ACETATE



BUTYL ACETATE

ACETONE

Out with the Old In with the New

Nail Polish remover shows the physical breakdown of bonds on the nail by the use of an organic solvent. Knowing “like dissolves like”, we can understand that acetone molecules are attracted to polish molecules. Acetone is a colorless, flammable and liquid which is made up of carbon, hydrogen and oxygen and is found in the environment naturally. The remover causes the molecules to break down the polishe's hardened form back into liquid form which can be easily wiped off the nail and ready for a new colour! Now everytime you look down to admire those fabulous nails, think of the hard work scientists put into making these products safe and functional. Oh, and never forget, science IS in fact fabulous

References

Anne Marie Helmenstine, P. D. (2019, November 4). How nail Polish works and what it's made of. ThoughtCo. Retrieved May 26, 2022, from https://www.thoughtco.com/nail-polish-chemistry-603996

Chemistry of nail Polish. worldofchemicals.com. (2018, May 29). Retrieved May 26, 2022, from https://www.worldofchemicals.com/637/chemistry-articles/chemistry-of-nail-polish.html

The Chemistry of Nail Polish. www.ChemistryIsLife.com. (n.d.). Retrieved May 26, 2022, from https://www.chemistryislife.com/the-chemistry-of-nail-polish

How do fake nails work? Office for Science and Society. (2019, June 5). Retrieved May 26, 2022, from https://www.mcgill.ca/oss/article/technology/chemistry-fake-nails

Janelle Nassim, M. D., & Kristina Liu, M. D. (2019, November 21). A look at the effects of nail polish on Nail Health and Safety. Harvard Health. Retrieved May 26, 2022, from https://www.health.harvard.edu/blog/a-look-at-the-effects-of-nail-polish-on-nail-health-and-safety-2019112118231

Molecule Photos. Compound Interest. (2021, June 24). Retrieved May 26, 2022, from https://www.compoundchem.com/about/

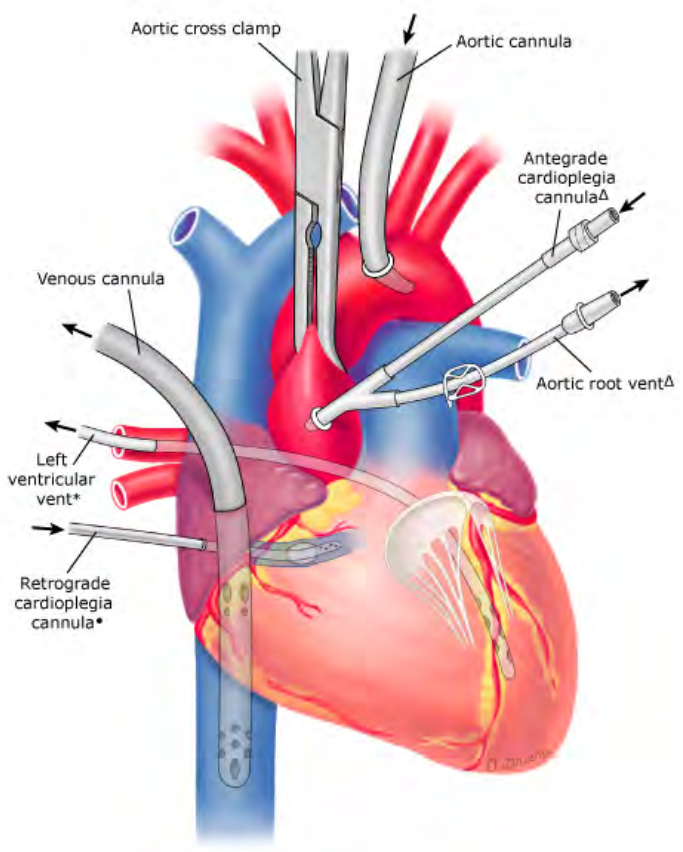
A REAL HEART STOPPER

By Michael Virdo

Every year over 500,000 open heart surgeries take place all of which wouldn't be possible without cardioplegia solution. Cardioplegia is a solution used in major surgeries with the use of bringing the heart to a state of asystole in which the heart stops all functions like beating and electronic signaling. The reason that the heart needs to be stopped for surgery is because the heart is constantly moving and unlike the rest of the body, will never stop which makes it difficult or in some cases impossible to operate on especially since every heartbeat is a quick rapid contraction. It would be like operating on someone who keeps opening and closing their hand over and over again. While the heart is stopped however patients are put onto a heart-lung bypass machine which works exactly like any other heart as it provides oxygen which is in the blood to the rest of the body. The machine also adds oxygen to the blood allowing it to be used by the body which means it also takes the role of the lungs but not entirely since the lungs still function like normal during this time. Now the heart is just like any other part of the body in which it needs blood and oxygen to support the cells, tissues and muscle that it's composed of and without this supply it would suffer major damage. This is where cardioplegia is used as its primary use. It reduces the demand heart cells have for oxygen and by doin this it prevents the cells from dying. The reason the demand has to be reduced is because during the heart is put into an ischemic state in which blood is restricted or reduced from the heart which is redirected into the heart-lung bypass machine so less blood is entering the heart and if the demand continues to occur the muscles can suffer damage. By reducing the demand the cells need less blood and oxygen flow to them allowing them to live with less oxygen and blood.

Cardioplegia is composed of many different compounds which include calcium chloride, magnesium chloride, sodium chloride, sodium bicarbonate, potassium chloride and water. Firstly chlorine is present in all of these compounds simply because it helps to keep electroneutrality in the solution which means that there's an equal positive and negative charge in the solution. Water is simply used to inject the solution into the patient. Calcium is an important element in arresting the heart as well as protecting the cell membranes of the heart. When calcium levels are lowered it causes the force of the heart's contractions to decrease which helps to relax the heart and have it stop. It also protects the cell membranes and stops something called the calcium paradox where if the muscles are given calcium after a period of being given a solution without calcium the cells will become dysfunctional and die so it is important that there is a small constant stream of calcium being received by the cells so after the operation finishes the cells can functionally recover. Magnesium is important as it helps protect the heart muscles by protecting adenosine triphosphate reserves which is the energy source used by your whole body so they can be used for medicinal activity. This helps to keep the muscles safe and use the stored energy to recover after surgery. Sodium and sodium bicarbonate are important as they are essential for ionic integrity of the heart muscles as well as protecting energy sources after ischemic recovery but more importantly the heartbeat action needs sodium ions and without them the heart won't create the action to beat.

Finally the most important element in the solution is potassium as it is the main element which causes the heart muscles to stop mechanical function. The way potassium is able to do this is because the heart rate is powered by the sinoatrial node and atrioventricular node which generate rhythmic action potentials and the sinoatrial node specifically initials these actions which cause the atria and then the rest of the heart to contract. The impulse that is sent is an electrical impulse which is sent to the entire heart causing the atrioventricular node and then the bundle of his which is a branch of fibers all around the heart to cause the muscle to contract. When potassium is added it decreases the resting potential meaning it makes the voltage more positive across the membrane of the cells. Since electrons are negative and the voltage becomes more positive this causes depolarization to occur more quickly which causes the cells to relax since the charge is evened out more. Potassium also prevents repolarization where the charge of the membranes becomes more negative which if were to happen would cause the voltage to become more negative increasing the electron count and restarting the heartbeat. The temperature of the solution is also important as it is given at 4 degrees celsius so that way the heart can cool down to around 15 degrees. This slows down the metabolism or need for oxygen of the heart rate to protect the muscles from damage. This solution has been able to save the live of many people as it allows doctors to operate on the heart more effectively and who know how many it will save in the future?



Chem Magazine references

Wikimedia Foundation. (2022, April 7). *Cardioplegia*. Wikipedia. Retrieved May 24, 2022, from https://en.wikipedia.org/wiki/Cardioplegia#Overview

Wikimedia Foundation. (2021, December 28). *Resting potential*. Wikipedia. Retrieved May 24, 2022, from https://en.wikipedia.org/wiki/Resting_potential

National Institutes of Health. (n.d.). *Cardioplegic solution*. U.S. National Library of Medicine. Retrieved May 24, 2022, from https://dailymed.nlm.nih.gov/dailymed/fda/fdaDrugXsl.cfm?setid=1fd50ce5-2799-4c26-81da-02cf0578dd9e#:~:text=Each%20100%20mL%20of%20solution,or%20NaOH%20for%20pH%20adjustment.

U.S. National Library of Medicine. (n.d.). *Heart surgery*. MedlinePlus. Retrieved May 24, 2022, from https://medlineplus.gov/heartsurgery.html#:~:text=Open%2Dheart%20surgery%20(also%20called,the%20body%20during%20the%20surgery.

P;, C. C. G. A. T. (n.d.). *Cardioplegia*. National Center for Biotechnology Information. Retrieved May 24, 2022, from https://pubmed.ncbi.nlm.nih.gov/32119350/#:~:text=Cardioplegia%20is%20a%20pharmacological%20therapy,and%20temporarily%20arrest%20the%20heart.

Wikimedia Foundation. (2022, February 23). *Asystole*. Wikipedia. Retrieved May 24, 2022, from https://en.wikipedia.org/wiki/Asystole

Dobson, G. P., Faggian, G., Onorati, F., & Vinten-Johansen, J. (1AD, January 1). *Hyperkalemic cardioplegia for adult and pediatric surgery: End of an era?* Frontiers. Retrieved May 24, 2022, from https://www.frontiersin.org/articles/10.3389/fphys.2013.00228/full#:~:text=The%20term%20cardioplegia%20(cardio%2C%20heart,frog%20heart%20(Figure%202).

D;, J. M. R. L. R. A. M. (n.d.). *Asystole*. National Center for Biotechnology Information. Retrieved May 24, 2022, from https://pubmed.ncbi.nlm.nih.gov/28613616/#:~:text=Asystole%2C%20colloquially%20referred%20to%20as,tachycardia%20(V%2Dtach).

Jennifer Whitlock, R. N. (2020, January 9). *How a heart lung (cardiopulmonary) bypass works*. Verywell Health. Retrieved May 24, 2022, from https://www.verywellhealth.com/cardiopulmonary-bypass-machine-used-for-surgery-3157220

Electrophysiology and Heart Rhythm Disturbances Team, About the Author: Electrophysiology and Heart Rhythm Disturbances Team The Electrophysiology and Heart Rhythm Disturbances Team at the Lifespan Cardiovascular Institute is the most experienced and comprehensive center for arrhythmia services in , Author:, A. the, Aspry, K. E., Cioffi, W., & Tremont, G. (2018, June 13). *The evolution of heart surgery*. Lifespan. Retrieved May 24, 2022, from https://www.lifespan.org/lifespan-living/evolution-heart-surgery#:~:text=Open%20surgery%20versus%20minimally%20invasive&text=Today%2C%20there%20are%20about%20500%2C000,aorta%20or%20the%20heart%20itself.

Science Direct. (n.d.). *Calcium paradox*. Calcium Paradox - an overview | ScienceDirect Topics. Retrieved May 24, 2022, from https://www.sciencedirect.com/topics/medicine-and-dentistry/calcium-paradox#:~:text=Calcium%20paradox%20is%20the%20massive,period%20of%20calcium%2Dfree%20perfusion.

Food Chemistry

CREATINE MONOHYDRATE

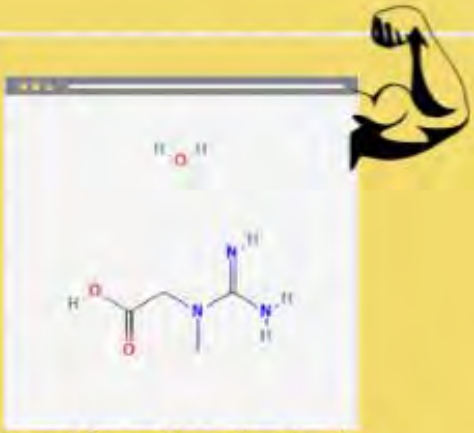
What Is It And What's The Hype?

What Is Creatine Monohydrate?

Creatine monohydrate, IUPAC name: 2-[carbamimidoyl(methyl)amino] acetic acid; hydrate, is an amino acid that is made in the liver, pancreas and kidneys of the body but can also be found in sources of protein like meat and fish or be supplemented with over-the-counter oral powders and pills. As a powdered supplement it is a white, fine, powder that is tasteless, scentless, and dissolves in liquid relatively easily. It is typically used to gain weight (most of which comes through water retention), gain muscle mass and improve strength training. It is most helpful in instances of short bursts of intense exercise such as the bench press or sprint cycling.

In the body, creatine is used to make phosphocreatine, a buffer which keeps up the production of triphosphate (ATP), which is used as energy in the body leaving a by-product known as ADP. In essence, creatine aids to turn ADP back into ATP, refiling the muscles' energy stores. In other words, "After intense effort, when ATP deposits are depleted, creatine phosphate donates phosphate groups toward the fast synthesis of ATP" (PubChem, 2022). As a result, creatine might be beneficial for athletes in high intensity sports such as weightlifting, sprinting, and other team sports such as hockey and football. Further, "while taking creatine might not help all athletes, evidence suggests that it generally won't hurt if taken as directed." (Mayo Clinic, 2022). However, because of a lack of research, creatine is not recommended for athletes under the age of 18 by the American College of Sports Medicine. Creatine is heavily advertised on social media with targeted advertisements towards young athletes and as a result impressionable high schoolers have become a main market for supplement companies selling creatine monohydrate.

There are several mild side effects that are common to creatine supplementation. They include bloating, diarrhea, and muscle cramping. However, these effects can be mitigated with proper water intake.



Creatine Monohydrate

$C_4H_{11}N_3O_3$

My Experience With Creatine:

Being a hockey player over the last two years has been difficult. The pandemic has interrupted my recent seasons and made me seek other ways to become a better player off the ice. As a result, I began to take my weight training in the gym seriously. And after having trained in a gym for over two years I decided to start taking creatine monohydrate. Many of my friends had taken the supplement for some time and I believed it would aid me as I continued to try to push myself in the gym. However, after having taken the supplement for about a week I decided to stop its supplementation. My quick change of heart came because of all the stomach issues I began to feel as soon as I began taking creatine. In my experience, creatine seemed to do more harm for me than good as I my stomach began to feel uneasy over the first couple days of its supplementation, which caused me to quickly stop taking the substance.

Other's Experiences With Creatine:

Tiago Rodrigues: "I found out about creatine through social media where there was a lot of advertising for it. I was initially very skeptical of taking creatine, but after more research I realized that I could take it but needed to make sure I got enough water in daily to effectively utilize the substance. I found creatine to be very beneficial for me. I have not experienced any side effects and would recommend it to others as long as they do their research."

James Dowd: "I discovered the supplement on social medias like YouTube and other sites online. It is a supplement that helps with strength, endurance and muscle size for athletes and bodybuilders. It really helps me out when working out as I find it gives me an extra edge. I would recommend creatine to other teens after they have done their research"

Mr. Calder: "It's used to generate the most power possible, so if you can store more creatine, you should be able to get those couple extra reps when you are exercising. They advise you to cycle it, six weeks, and two weeks off. As a teen I found out that if you don't cycle it your muscles cramp up. In fact, I had an experience where I was warming up on squats and my quads were cramping up worse than ever before. Though I don't think there's any harm in it. There is also no advantage if you take more than they recommend."

Should You Take Creatine?

A lot of research has been conducted on the effects of creatine in adults, and the results of these studies have been overwhelmingly positive. However, the effects of creatine on adolescents has not yet been properly analysed to give a clear picture on its effects. As a result, The American Academy of Pediatrics recommends against the use of creatine by adolescents, specifically warning of impurities within the lightly regulated substance, which has not yet been studied by the FDA.

My opinion on the matter is that teens should always question what they put into their bodies and do their research before taking any supplements, especially those that are heavily advertised online. Furthermore, if you wish to begin creatine supplementation you should talk to your family doctor or other medical professionals to make sure what you are doing is safe for you.

Sources
CANVA: Free Design Tool: Presentations, video, Social Media + more. (n.d.). Retrieved May 25, 2022, from https://www.canva.com/

Mayo Foundation for Medical Education and Research. (2021, February 9). Creatine. Mayo Clinic. Retrieved May 24, 2022, from https://www.mayoclinic.org/drugs-supplements-creatine/art-20347591

U.S. National Library of Medicine. (n.d.). Creatine monohydrate. National Center for Biotechnology Information. PubChem Compound Database. Retrieved May 24, 2022, from https://pubchem.ncbi.nlm.nih.gov/compound/Creatine-monohydrate

Encyclopedia Britannica, inc. (n.d.). Creatine. Encyclopedia Britannica. Retrieved May 24, 2022, from https://www.britannica.com/science/creatine

Neighmond, P. (2017, January 2). Is the warning that creatine's not for teens getting through? NPR. Retrieved May 24, 2022, from https://www.npr.org/sections/health-shots/2017/01/02/507478762/is-the-warning-that-creatines-not-for-teens-getting-through

Jagim, A. R., Stecker, R. A., Harty, P. S., Erickson, J. L., & Kerksick, C. M. (2018, November 28). Safety of creatine supplementation in active adolescents and youth: A brief review. Frontiers in nutrition. Retrieved May 24, 2022, from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6279854/

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Mayo Foundation for Medical Education and Research. (2021, February 9). *Creatine*. Mayo Clinic. Retrieved May 24, 2022, from https://www.mayoclinic.org/drugs-supplements-creatine/art-20347591

U.S. National Library of Medicine. (n.d.). *Creatine monohydrate*. National Center for Biotechnology Information. PubChem Compound Database. Retrieved May 24, 2022, from https://pubchem.ncbi.nlm.nih.gov/compound/Creatine-monohydrate

Encyclopedia Britannica, inc. (n.d.). *Creatine*. Encyclopedia Britannica. Retrieved May 24, 2022, from https://www.britannica.com/science/creatine

Neighmond, P. (2017, January 2). *Is the warning that creatine's not for teens getting through?* NPR. Retrieved May 24, 2022, from https://www.npr.org/sections/health-shots/2017/01/02/507478762/is-the-warning-that-creatines-not-for-teens-getting-through

Jagim, A. R., Stecker, R. A., Harty, P. S., Erickson, J. L., & Kerksick, C. M. (2018, November 28). *Safety of creatine supplementation in active adolescents and youth: A brief review*. Frontiers in nutrition. Retrieved May 24, 2022, from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6279854/

FRAG MAG

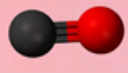
THE WORLDS FINEST CHEMISTRY FRAGRANCE MAGAZINE

WHAT DOES IT MEAN TO SMELL?

Firstly, before we explain the chemistry that creates scents, we must understand the chemical process of "smelling". Our sense of smell is derived from gaseous molecules, that either come directly from the air or from gaseous molecules released by other substances. These molecules are known as odorants. Odorants stimulate sensory nerve cells at the top of the nasal cavity, which respond by sending impulses back to the brain. This process is what allows us to recognize fragrances and our brain determines if the smell is "good" or "bad", which can be relatively different for everyone.

WHERE DOES CHEMISTRY COME INTO PLAY?

The role of chemistry in discovering scents is the materials used in fragrances and the reactions to create the materials. Materials used in fragrances are generally semi-volatile organic compounds and the molecular weight of these compounds barely exceeds 260 AMU. Some molecules do not have smell or does not have a smell potent enough to be perceived by the human nose, for instance Carbon Monoxide, so the processes involved to make the strong smelling molecules is necessary to produce any scented cosmetics. Now, the way a perfume orcologne smells is not based completely on what it comes from, but also on the chemical reactions in the brains of individuals who perceive the scents. This is why some people might perceive a scent as very soothing while others might not enjoy the scent, or why some people might smell something while others cannot pick up the scent. Another form of chemistry in this field comes with chemical reactions that can alter the fragrance's effectiveness and scent. For example, chemical reactions with light can change smells, where the energy present in light can break down the bonds present in the molecules creating the scent. Enough bright sunlight will certainly damage the perfume or cologne smell, and enough air will corrode the scent through oxidation. If you were ever wondering how to prevent your perfumes and colognes from slowly dying off, consider keeping them in dark places at room temperature, and be sure to keep the lid tightly sealed!



THE VIBRATION THEORY

Knowing that scents are made up of molecules (odorants) that are sensed by receptors in our nose, and these molecules have atoms bonded together by elastic bonds, we can dive into the vibration theory. This theory suggests that fragrances and scents are interpreted differently by our brains according to their specific frequencies of vibration. For the olfactory receptors in our noses to determine a specific scent, the vibrations of the molecules must be translated into electrical signals that can be sent to the brain. In essence, the specific vibration rates of different molecules are a necessary part of activating olfactory pathways that create what our brain interprets as different scents. This theory then begs the question, do molecules that vibrate at similar frequencies have the same scent? Biophysicist Luca Turin determined the accuracy of this theory by conducting a lab. By taking the specific smell of rotten eggs, created by the molecule vibration in Hydrogen Sulfide, he tried to determine if any other similarly vibrating molecules would have a very similar scent. He discovered a molecule with a similar vibration frequency, being borane (Hydrogen and Boron). Borane's scent was in fact that of rotten eggs, meaning the Turin's lab was successful, concluding that similarly vibrating molecules had virtually the same scent created.

NATURAL VS. SYNTHETIC SCENTS

NATURAL SCENTS

For thousands of years, people have tried to take the beautiful aromas of nature and capture them in bottle form. This can be done by extracting the natural oils produced in nature like flowers and fruits, and creating a delightfully fragrant scent that can be used in our colognes, perfumes, candles, etc. Jen Bayline, a chemist at Washington & Jefferson College in Pennsylvania claims, "The oils you extract from nature a complex mixture of maybe hundred of molecules", and "Together, they create a rich and complex fragrance". Essentially, these fragrant oils are naturally compiled with different molecules that create the scent. These oils are crucial in producing a compelling scent that can be used in creating effective fragrant cosmetics. A prime example of the chemistry in natural fragrance practices is in the rose fields of Pégomas, France. In these alluring fields of roses, workers will rise at dawn every day for two weeks and hand pick roses. By the end of their work, approximately 37 tons of flowers will be picked. Almost instantly after the flowers are picked they are taken to a nearby factory. Time is of the essence in this process as if any more time is wasted the molecules that are responsible for producing the graceful aroma of the roses will be disrupted and begin to break down. If the molecule was to break down the process would fail and the roses would no longer retain their scent. Petals of the roses are then tossed into a chemical bath and heated at high temperatures. The reaction that takes place has the liquid chemicals evaporate into a gas, and results in a wax with the same fragrance as the rose. A fragrant oil is extracted from the wax concentration and actively used in many renown colognes and perfumes around the world, such as Chanel No. 5. Chemistry is what allows the delightful fragrance to maintain and spread its lovely aroma!

SYNTHETIC SCENTS

While natural oils do effectively create the desired scent in many cosmetic fragrances, the natural process can often be costly and companies will resort to other forms of scent imitation. Lab made molecules are much easier and less-costly way to create a scent that almost copies the smell of its natural desire. The creation of synthetic scents requires the vast knowledge of chemists, first to identify the hundreds of molecules responsible in creating a particular smell. Of those hundreds, only a few of the molecules that smell the most like the desired scent are chosen. Then, the chemists will try to reproduce the molecule with the same structure as before, through the utilization of chemical reactions in the lab. The term "synthetic fragrances" is a very broad concept that can be broken down into three categories:

BY PAUL PRANGIKOS AND TIAGO RODRIGUES

1. Full synthetics: Nearly the entire fragrance is derived from petroleum by-products.

2. Semi-synthetics: As the name suggests, the fragrance is only semi-synthetic; it can be created from some synthetic, natural, or artificially modified notes. Sometimes, it's derived from all three

3. Natural isolates: A fragrance developed from synthetic and natural byproducts.

Overall, there are various synthetic scents created by molecules that are recognizable in day-to-day

MENTHOL

Menthol is a chemical found naturally in peppermint and other mint species, or made synthetically through hydrogenation of thymol. Hydrogenation is the chemical reaction between molecular hydrogen and an element or compound, in this case thymol. Menthol is also referred to as peppermint camphor, and is a terpene alcohol with a strong, minty, cooling fragrance and taste. Menthol has local anaesthetic and counterirritant qualities, so it is used widely to relieve throat pain. Menthol is a vital substance in many minty smelling colognes, such as: Prada Luna Rossa Eau de Toilette Spray for Men and Versace Eros Eau de Toilette Spray for Men.

VANILLIN

Vanillin is a chemical that is responsible for the famous "vanilla" scent in many shampoos, perfumes, and colognes alike. It contains oxygen atoms in three different functional groups: alcohol, aldehyde, and ether. Ever since the time of the Aztecs vanilla has been used in flavouring for chocolate, but it was not until French Biochemist Nicolas-Theodore Gobley crystallized vanillin from vanilla extract in 1858. In modern times, vanillin is used in multiple scents and fragrances to create that well-known smell evident in most shampoos across the showers of the world.

THE PERFECT COMBINATION

Synthetic and natural scents can be combined to achieve the well-known scents we see around the world today. Almost all fragrances use some sort of combination of natural and man-made scents to come up with the perfect mix that allows for the re-creation and distribution of scented cosmetics throughout the globe. While it would be ideal to only use natural aromas in fragrances to get that renown "clean" smell, its neither practical nor cost-efficient to do so. This is because synthetic scents and other chemicals are necessary in preserving the smell to leave the scent "long-lasting". Additionally, it is very labour extensive to produce solely natural scents, so the cost would be much greater than if synthetic scents are used. Natural and synthetic scents can be blended with Fixatives and Alcohol to make sure that the volatile perfumes do not rapidly evaporate. Fixatives are a chemical substance used to preserve or stabilize biological material prior to microscopy or other examination. If you want your scent to linger, fixatives should most certainly be a part of your fragrance. Most fixatives are comprised of resins, mosses, or animal substances, typically organic compounds that are effective in preserving scents. Alcohol is then used to strengthen the smell and allow the perfume or cologne to stick to clothing and skin, ensuring that you'll remain smelling good for longer! All in all, synthetic and natural odours are used in conjunction to create the fragrances you use in daily life, along with the help of fixatives and alcohols to craft the perfect combination of scent.

STUDENT INTERVIEW

We interviewed a fellow SCH3U classmate, Spencer Reece, and asked him some questions regarding fragrances.

Q: "What conditioner are you currently using to get those luscious curls?

A: "Shea Moisture hair conditioner"

The nutty shea smell in the conditioner comes mainly from the synthetic scent of stearic acid along with the natural scent of the raw shea butter extract.

Q2: "What scents do you find most appealing and satisfying?"

A2: "My personal favourite scents have got to be the smell of coconut and the smell of strawberries."

The renown coconut smell is derived from the chemical compound of gamma-nonalactone and coconut extract, while the strawberry smell is created from the chemical benzyl acetate and the natural extract of strawberries.

REFERENCES

- Anne Marie Helmenstine, P.D. (2019, February 7). What causes odors? ThoughtCo. Retrieved May 24, 2022, from https://www.thoughtco.com/aroma-compounds-4142268

- Encyclopædia Britannica, inc. (n.d.). Menthol. Encyclopædia Britannica. Retrieved May 24, 2022, from https://www.britannica.com/science/menthol

- How does perfume work? Science ABC. (2022, January 22). Retrieved May 24, 2022, from https://www.scienceabc.com/innovation/fascinating-theory-explaining-cience-scent.html

- Mon, 13 N. (2017, November 13). Appliance of Science: How are smells made? Irish Examiner. Retrieved May 24, 2022, from https://www.irishexaminer.com/lifestyle/appliance-of-science-how-are-smells-made_arid-20462710.html

- The Quick Guide to natural vs. Synthetic Fragrances. Private label perfume manufacturer - White Glove Perfumery. (n.d.). Retrieved May 24, 2022, from https://www.privatelabel.com/post/the-quick-guide-to-natural-vs-synthetic-fragrances

- Vanillin. American Chemical Society. (n.d.). Retrieved May 24, 2022, from https://www.acs.org/content/acs/en/molecule-of-the-week/archive/v/vanillin.html

- What's in a scent? chemistry article for Students: Scholastic Science World Magazine. Scholastic Science World. (n.d.). Retrieved May 24, 2022, from https://scienceworld.scholastic.com/issues/2018-19/021119/whats-in-a-scent.html#1020L

TODAY'S MENU

Pesticide Usage | How it Affects Us | What You Can Do

Appetizers

Pesticides are used in food production to control pests such as insects, rodents, weeds, bacteria, mold, and fungus. They safeguard or improve yields as well as the number of times a crop may be planted on the same piece of land each year. Pesticides are an important resource especially in nations where food is scarce.

Mains

Pesticides can help farmers avoid major crop losses, thus they will continue to be used in agriculture. However, the impacts of pesticide exposure on people and the environment are still a source of worry. Pesticides are conceivably toxic to humans and can affect humans' health in the short term and long term. Acute OP (organophosphate) poisonings lead to symptoms such as nausea, abdominal cramps, diarrhea, dizziness, anxiety and confusion. Long term effects include respiratory problems, memory disorders, skin conditions, depression, miscarriages, birth defects, cancer and neurological conditions such as Parkinson's disease.

Deserts

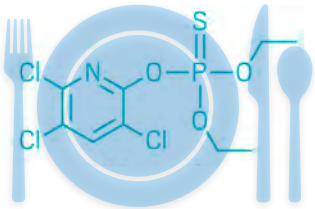
Pesticides are one of the most common causes of self-poisoning, especially in low and middle income nations. Pesticides must be produced, distributed, and used under stringent oversight and control since they are innately hazardous and intentionally disseminated in the environment. Residues of pesticides in food or the environment must be monitored on a regular basis. Pesticides should be used to produce food, both for local use and for export, in accordance with sound agricultural practises, regardless of a country's economic situation. Farmers should only apply as much pesticide as is absolutely required to safeguard their crops. The World Health Organization is hoping to ban the most dangerous pesticides for humans as well as the pesticides that last the longest in the environment, to safeguard public health by establishing maximum pesticide residue limits in food and water.

The Recipe

Food is a necessity in our lives. It provides us with nutrients and energy, therefore, food helps the entire body function. We often have those cravings for a nice corn on the cob, or a sweet strawberry, or a juicy, crunchy apple. Well, what if I told you those are several foods that include potentially toxic pesticides? Scientists have learned that even modest doses of pesticides and other synthetic chemicals can damage primarily young children. Exposure to chemical combinations, particularly during essential windows of neurodevelopment, can carry substantial health hazards that take years to manifest. This is of great importance to us as pesticides are so prevalent in our environment.

Chemical Ingredients

Some older, inexpensive, pesticides can prevail in soil and water for many years. Absorption of pesticides is a key component in determining where pesticides end up in the environment and how they degrade. The majority of pesticides are non-polar and hydrophobic which means they are not soluble in water. They are pushed out of the water onto non-polar organic matter containing soils. Oxidation of pesticides is a reaction process whereby the dissolved oxygen in the environment reacts with pesticides that bring about chemical oxidation of pesticides in water or the atmosphere. Pesticide reduction is a chemical process in which the oxidation state of the substrate is reduced. In most cases, the reducing agents in the environment are H+. Pesticides react with water in a pH-dependent process called hydrolysis. Most pesticides in the environment undergo hydrolysis. Due to the greater polar nature, a pesticide will not build in soil, it will instead disintegrate by hydrolysis, which is the preferred process in water. The breakdown or modification of pesticides by sunlight, which results in the breakage of chemical bonds is known as photolysis. The organic molecule absorbed photons and becomes stimulated, releasing an electron, causing the molecule to change. Organic molecules are degraded by photolysis processes in the upper atmosphere, shallow aquatic environments, on vegetation and on soil surfaces. A pesticide's entire break down in in the air can take several steps. Pesticides are generally broken down or transformed by microbiological organisms in water and soil. The amount and nature of pesticides present in the soil, the microbial population in the soil, and soil conditions that favour microbial activities, such as warm temperature and desirable pH, adequate soil moisture, aeration and high organic matter content, all influence the rate of microbial degradation.



Physical Ingredients

———— $C_9H_{11}C_{l3}NO_3PS$ ————

Chlorpyrifo (an OP pesticide) is the most extensively used pesticide on agriculture. It has a very unpleasant odour, usually referred to smelling somewhat like rotten eggs, and is used to control pests such as termites, mosquitoes, and roundworms.

This chemical is either colourless or white, and it is a crystalline solid. Its molecular weight is 350.6g/mol. It is not soluble in water, so it is usually mixed with oily liquids prior to being applied to crops. It is also known as Dursban or Lorsban. As well, it is completely synthetic, meaning it is fully artificially made. Chlorpyrifos by itself is not toxic, however when the body tries to break it down with food, it produces a toxic form. Chlorpyrifos act by inhibiting an enzyme that regulates the transmission of signals between nerve cells. The nervous system is then unable to deliver regular signals between nerve cells. This causes the neurological system to misfire, which leads to the pest's death. It is very easy to be exposed to this pesticide. Most commonly it is done by eating them, inhaling them, or getting them on the skin or in the eyes. Signs and symptoms can appear within minutes to hours, but can last as short as a day and as long as multiple weeks. Children are more likely to experience effects of pesticides than adults. A common effect on children under three years were developmental delays and disorders.

REFERENCES

Centre for Ecogenetics and Enviornmental Health. (2018, January 13). *Fast facts about health risks of pesticides in food*. Health Risks of Pesticides in Food. Retrieved May 25, 2022, from https://depts.washington.edu/ceeh/downloads/FF_Pesticides.pdf

Christensen, K.; Harper, B.; Luukinen, B.; Buhl, K.; Stone, D. 2009. *Chlorpyrifos General Fact Sheet*; National Pesticide Information Center, Oregon State University Extension Services. http://npic.orst.edu/factsheets/chlorpgen.html.

De Bellefonds, C. (2020, February 6). *Yes, organic food has pesticides-but that shouldn't scare you off of Veggies*. Yes, Organic Food Has Pesticides—but That Shouldn't Scare You Off of Veggies. Retrieved May 24, 2022, from https://www.wellandgood.com/pesticides-in-organic-food/

Gross, L. (2019, March 22). *More than 90 percent of Americans have pesticides or their byproducts in their bodies*. The Nation. Retrieved May 24, 2022, from https://www.thenation.com/article/archive/pesticides-farmworkers-agriculture/

World Health Organization. (n.d.). *Pesticide residues in food*. World Health Organization. Retrieved May 24, 2022, from https://www.who.int/news-room/fact-sheets/detail/pesticide-residues-in-food

Zacharia, James Tano (2011). Identity, Physical and Chemical Properties of Pesticides, Pesticides in the Modern World - Trends in Pesticides Analysis, Dr. Margarita Stoytcheva (Ed.), ISBN: 978-953-307-437-5, InTech, Available from: http://www.intechopen.com/books/pesticides-in-the-modern-world-trends-in-pesticidesanalysis/identity-physical-and-chemical-properties-of-pesticides

The Final Dish

People tend to think the solution to not injecting pesticides is switching to all organic foods. However, organic foods are not completely pesticide free. Organic foods contain pesticides derived from all natural substances, meaning they are produced or extracted from a natural source such as plants or varying living organisms. This differs from conventional foods because they use synthetic pesticides. When comparing natural pesticides to synthetic ones, natural come from naturally occurring processes like composting, fermentation, heating or enzymatic digestion. In organic produce, weeds are controlled naturally through processes such as crop rotation, hand weeding, etc., whereas for conventionally grown produce weeds are controlled through chemical herbicides. Organic produce pests are controlled through natural methods using animals like birds, and in conventionally grown produce pests are managed using synthetic pesticides. Regarding organic meat, dairy and eggs, all livestock are given hormone free and non GMO feed, rather than with conventional, livestock are provided with growth hormones for quicker growth, and non-organic and GMO based feed. Concerning disease, food that is organically produced from livestock uses disease preventatives that are natural, such as rotational grazing, and ensuring living spaces are always cleaned. For conventionally raised meat, dairy and eggs, diseased livestock are given antibiotics and medications.

In conventional farming (using synthetic pesticides) some pesticides are non-toxic, however, some lead to very serious consequences. Glyphosate is a herbicide that attacks weeds and there is a debate regarding it being cancer causing. This pesticide has already been banned in two countries, France and Germany. These are the risks that come with synthetic, conventionally produced, agriculture. But how much better are organic foods? Eating organic exposes you to less pesticides, and those include naturally occurring pesticides. A paper summarizing 343 studies on organic versus conventional foods concluded that organic foods had four times less pesticide residue than conventional produce. However, it is vital to remember that the logic behind purchasing organic is more than just for the food you are putting in our bodies,

"It's a way of agriculture that supports a more biodiverse, sustainable ecosystem," says Sharan Palmer, the Plant Powered Dietitian.

There are a number of things that can reduce the amount of pesticides that you eat:

- It is necessary to wash fruits and vegetables under running water before eating.
- Throw away the outer leaves of leafy vegetables.
- To lessen the amount of residue that can remain on the food when it's chopped, thoroughly scrub the inedible skin of fruits.
- Finally, due to various crops requiring different pesticides, indulging in a diverse selection of healthy foods reduces the exposure one has to pesticides, while also providing greater nutritional advantages.

Overall, the way the food you eat is grown and produced has a tremendous impact on not only your physical health and the way your body functions, but also your mental health, and the growth of the environment. A key benefit of organic foods is that they have a significantly higher amount of a very valuable nutrient in them, called antioxidants, which greatly reduce the risks of contracting many diseases, and they keep your body generally healthier. To conclude, organic foods container fewer pesticides and less harmful pesticides, they are usually more fresh because they don't contain preservatives that extend their shelf life, they are better for the environment because they greatly decrease pollution, preserve water, etc., organically raised animals are not provided with antibiotics, or fed animal byproducts, organic meat and milk are proven to have 50% greater levels of certain nutrients than conventionally produced foods, and finally, organic food is not produced with GMO's.

So next time you're grocery shopping, spend a few extra dollars on those organic strawberries, because it might be worth your while!

Human Essentials: Water (H_2O)

By: TJ Lee | De La Salle Chemistry

Dihydrogen Monoxide, also known as H_2O or in its most common form, WATER, is an essential resource for the human race. It is so crucial to us that we will not be able to survive after three days without. But with the ongoing climate, and pollution issues, our water is becoming unclean more and more, and fresh water is limited to only the more developed countries.

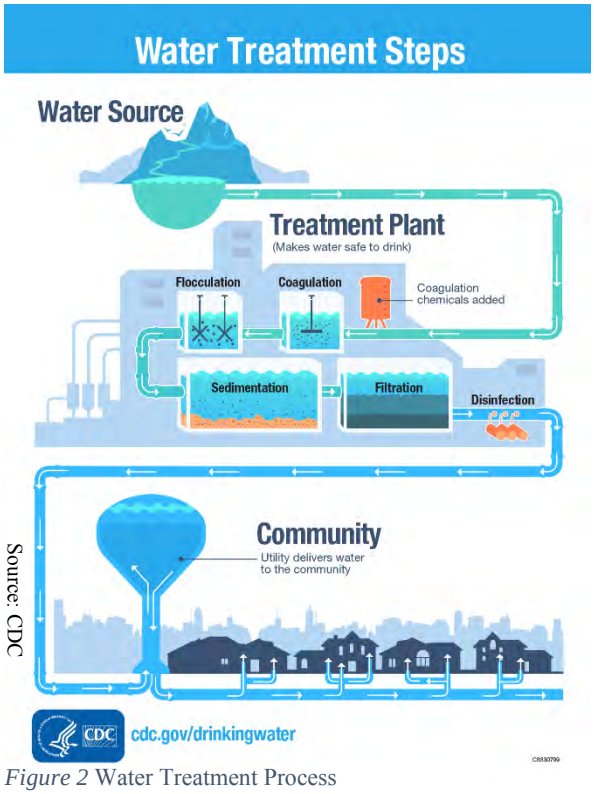
Source: Pexels

Figure 1 Water

Background to the Crisis:

To start off, we must ask, how do we get clean drinking water. According to the Centers for Disease Control and Prevention (CDC)[1], water goes through treatment plants that coagulation (filtration of large particles and dirt), flocculation (gentle mixing of water to form larger and heavier particles), sedimentation (separation of solids from the water), filtration (filtration to separate additional solids from the water), and disinfection (addition of chemicals to kill any remaining parasites, bacteria, or viruses from the water) so that we get clean drinking water in our communities (see *figure 2*). However, in less fortunate and developing countries in the world, they do not have full access and freedom to clean drinking water.

In an article published by the United Nations (UN) 'Water for Life' research[4], one of the main continents that is currently dealing with an endemic of poverty, food insecurity, and massive underdevelopment would be the continent of Africa. With access to sanitation, according to the WHO, only 59% of the world's population has access to adequate sanitation systems for clean water with North Africa having 90% coverage, but however, a shocking and startling 30% coverage lies in the Sub-Saharan Africa[2]. This would be considered a terrible concern as there is a massive health burden because people are becoming ill due to lack of basic sanitation of clean water (through resources), and unsanitary actions. Furthermore, a driving force to this massive issue would be the massive population growth found, and rural-urban migration. Many who live in the Sub-Saharan live in urban slums, with the population surpassing 200 million in counting. This is totally unproportionate to the benefits we are having living in a well-developed country.



Source: CDC

Figure 2 Water Treatment Process

What Resources are Available?

In developing countries, they have to resort to different alternative methods to get clean water[3]. These methods include Membrane Separation Technology (MST) by which they use high pressure to push water through a porous barrier to separate pollutants from water; chlorination, where sodium hypochlorite solution is added to a contaminated water to destroy bacteria and viruses; and Solar Water Disinfection (SODIS) where they use the sun's ultraviolet radiation to improve the water quality to prevent diarrheal infection. This is an easy and inexpensive method; however, they are limited to the amount of water that can be treated a one time, and does not fill out chemical pollutants. No matter how many alternative resources used to provide clean water, they still are limited and cannot get the adequate resource of getting fresh water.

Humanitarian Aid to help Developing Countries:

Source: The Water Project

Figure 3 The Water Project Logo

One of the major humanitarian charities that can provide adequate and clean water to these less developed countries is *The Water Project*. This organization provides reliable water projects to communities who suffer needlessly from a lack of access to clean water and proper sanitation. This organization takes the donations of patrons, and build new wells, rehab neglected wells, construct rain catchment tanks, where when it rains, it would connect to a tank to store for the community in case if there is a drought, or lack of fresh water, protect springs, and build sand dams to retain the water in the community.

In addition, the UN General Assembly of human right to water and sanitation had made a important recognition in July 2010, as they recognized that every human being has the right to have access to enough water for personal and domestic uses, meaning 50-100 L of water per person per day. The water pledged must be safe, acceptable, and affordable by not exceeding three percent of household income, and that collection of fresh water should not exceed thirty minutes. Moreover, the UN has been addressing this global crisis through many conferences like the United Nations Water Conference of 1977, the International Conference on Water and the Environment (1992), the Earth Summit (1992), and global initiatives. One major global initiative was through the 'Water for Life' International Decade for Action 2005-2015 initiative, by which this helped close to 1.3 billion people in developing countries to gain access to safe, and clean drinking water and drilled the progression on sanitation as part of an effort to meet the standard[4]. Therefore, this will provide equity to those families and communities in need of clean and fresh water.

Source: The United Nations

Figure 4 UN 'Water for Life'

Conclusion:

To conclude, there has been ongoing efforts to provide developing countries with clean and fresh water. However, there is still more work that needs to be done, and a way to help is to donate and contribute to a organization of you choice that will help reduce the risk of fatalities due to unsanitary water. It is also in our hands to help others have access to clean water, so whatever one can do to help and support this initiative should do so. This is one way that we can make the world a better place, as the whole world is in our hands.

Source: Pexels

Sources:

1. Disease Control and Prevention, C. for. (2022, May 16). *Water treatment*. Centers for Disease Control and Prevention. Retrieved May 23, 2022, from https://www.cdc.gov/healthywater/drinking/public/water_treatment.html
2. Lewis, L. (2006). *Water in crisis - spotlight Africa: Rural and urban issues*. RURAL AND URBAN WATER ISSUES IN AFRICA. Retrieved May 23, 2022, from https://thewaterproject.org/water-crisis/water-in-crisis-rural-urban-africa#:~:text=Groundwater%20is%20the%20best%20resource,a%20reliable%20source%20during%20droughts.
3. Media, H. W. (2021, May 18). *How developing countries get clean water: Healing waters international*. How Do Developing Countries Get Clean Water? Retrieved May 24, 2022, from https://healingwaters.org/how-do-developing-countries-get-clean-water/
4. Nations, U. (2014, May 16). *Africa, decade, Water For Life, 2015, UN-Water, United Nations, MDG, water, sanitation, financing, gender, IWRM, human right, transboundary, cities, quality, food security*. United Nations. Retrieved May 23, 2022, from https://www.un.org/waterforlifedecade/africa.shtml

Image References:

- Photo by Pixabay from Pexels: https://www.pexels.com/photo/water-bubbles-under-the-sea-62307/
- Photo by Yassin Doukhane: https://www.pexels.com/photo/person-holding-water-in-cupped-hands-2570439/
- Centers for Disease Control and Prevention
- The Water Project
- UN 'Water for Life'

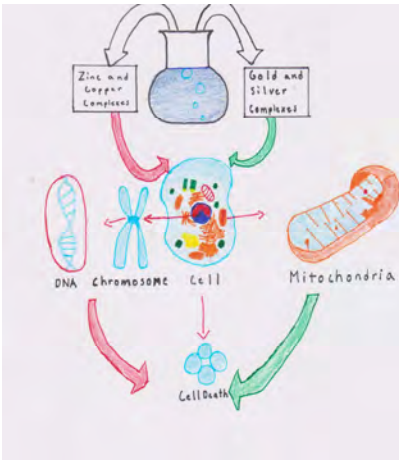
MEDICINAL INORGANIC CHEMISTRY
METALLODRUGS THE FUTURE OF TREATMENTS?

BY SIMON WHITTAKER

Healthcare globally has been forced to deal with the COVID 19 pandemic; nonetheless, progression of ways to improve healthcare has persisted. One area is medicinal inorganic chemistry (MIC) and the uses of metals in drugs (metallodrugs).

Metals creation in inorganic chemistry have proved applicable to improving global sustainability. Therefore, suggesting the progression of this science is something requiring study due to the nature of the materials it uses.

So, why endeavor in advancing medicinal inorganic chemistry? Researchers believe, "new materials could reduce dramatically the loss of raw resources" (Salviulo et al., 2021, p. 6691). The production of inorganic metals especially affects our everyday items such as our personal devices where raw metals used are said to have very low end-of-life recycling rates (Salviulo et al., 2021, p. 6691). In this regard, pursuit of creating new materials not only allow for sustainability through the production of less metallic waste. The additional application is the availability of metals to be used in drugs for serious health conditions such as cancer.



Metallodrug complexes and their effect on tumors.

Source:

Zaki, M., Arjmand, F., & Tabassum, S. (2016). Current and future potential of metallo drugs: Revisiting DNA-binding of metal containing molecules and their diverse mechanism of action. *Inorganica Chimica Acta*, *444*, 1-22.

So, what are the methods? Treating diseases are a prime use of metallodrugs. According to Victor Miranda, in an article for *Reviews in Inorganic Chemistry* testing of metals in drugs as treatment has been occurring as early as the late 1800's and the uses of metallodrugs can be in both therapy and imaging (Miranda, 2022, p. 30). A key example proving the effectiveness of metallodrugs is Muhammad Ajmal for the *Journal of Coordination Chemistry* stating, "Metal-based anti-cancer agents are more effective and selective for chemotherapy as compared to other anti-cancer therapeutics currently available in the market" (Ajmal, 2017, p. 2582). Suggesting in combatting cancer metallodrugs are one of the best solutions to further develop.

ANALYSING TREATMENTS

Metallodrugs Miranda mentions within therapy act through as examples, "direct bonding between the metallic center and the biological target, release of a biologically active ligand" (Miranda, 2022, p. 30). So where direct bonding has resulted in studies of many drugs one example being auranofin the only gold-based drug still being employed in clinics (Miranda, 2022, p. 31). The support behind studying MIC is helping understand that to treat rheumatoid

arthritis, “Five Au [gold] complexes have been approved for clinical use” (Miranda, 2022, p. 31). In this way, metallodrugs application due to the similarities of different structures provides options for treatment of arthritis so whether a person trusts the treatment is up to them, but they do have a choice. Furthermore, the biological release of ligand (a molecule or atom reversibly bound to a protein (Biology Dictionary, 2018)) intends to want high stability and kinetic inertness out of metallodrug candidates (Miranda, 2022, p. 33). As such, metallodrugs depending on if they are meant to be therapeutic or not will release or hold the ligand to activate for the needed treatment (Miranda, 2022, p. 33). Therefore, pursuing MIC as something that is taught may aid health care in understanding ways in which metallodrugs activation could be controlled per when the ligand is released.

However, with other types of therapy consisting of Radiotherapy and Photodynamic therapy. Where Radiotherapy has the edge in its use of metallodrugs for cancer primarily. Radiotherapy Miranda believes is limited, “production and distribution of the radioactive metallic isotope is a limiting factor in new radio metallodrug candidates” (Miranda, 2022, p. 37). This is further limited by metals being a raw material which are running out as time runs on. As such, the argument for radiotherapy as a means of study in MIC is arguable especially if results are limited by materials to create a solution. Comparatively, photodynamic therapy since it activates due to light as Miranda mentions, “the incorporation of a metal into the structure of an organic molecule offers a great advantage over non-metallic photosensitizers” (Miranda, 2022, p. 40). What this suggests is that since it is said, “new excited states are available,” (Miranda, 2022, p. 40). Then the possibility of photodynamic therapy is that new treatments can be tested so long as light allows for the metallodrugs to work to the best of their abilities.

Nonetheless, although not a sure proof solution to disease treatments medicinal inorganic chemistry and the production of metallodrugs allows for identification of health conditions as well. This in fact may be a better application of metallodrugs as it has been estimated for MRI scans worldwide, “40% employ gadolinium (III)- based contrast agents” (Miranda, 2022, p. 41). In this way, MIC which can utilize every element in order to synthesize new potential treatments is only in its development period. Whilst implications of treatments still pose risks as elements can be both radioactive along with compounds that can be inorganic an unknown in nature. It is still imperative the research is furthered into this field and is taught because although difficult any opportunity to save more lives is valuable one.

References

Ajmal, M. (2017). Review: electrochemical studies on some metal complexes having anti-cancer activities. Journal of Coordination Chemistry, 70(15), 2551–2588. https://doi.org/10.1080/00958972.2017.1362559

Editors, B. D. (2018, April 22). *Ligand: Definition, examples, and how it works*. Biology Dictionary. Retrieved May 24, 2022, from https://biologydictionary.net/ligand/

Miranda, V. M. (2022). Medicinal inorganic chemistry: an updated review on the status of metallodrugs and prominent metallodrug candidates. *Reviews in Inorganic Chemistry*, *42*(1), 29–52. https://doi.org/10.1515/revic-2020-0030

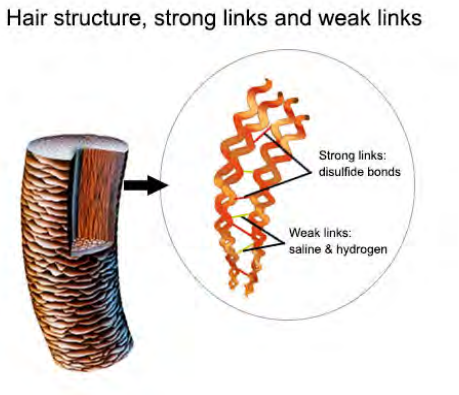
Salviulo, G., Lavagnolo, M. C., Dabalà, M., Bernardo, E., Polimeno, A., Sambi, M., Bonollo, F., & Gross, S. (2021). Enabling Circular Economy: The Overlooked Role of Inorganic Materials Chemistry. *Chemistry - A European Journal*, *27*(22), 6676–6695. https://doi.org/10.1002/chem.202002844

DEL Matters

Keratin Hair Bonds: What *really* happens when we apply heat?

Written by Sophia Bucciarelli

How often do you blowdry or straighten your hair? A common statistic is that most women report using heat on their hair a few times a week! This may seem to be the norm for most; however, heat styling even once begins to break down bonds in your hair leading to damaged and dry, brittle hair over time.



First, let's start with the basics. What **exactly** is hair made up of? 95% of it is made up of a protein called keratin which is synthesized by minuscule cells called keratinocytes located in the hair bulb, where new growth is formed. Keratinocytes are insoluble in water and protect our hair. The root of our hair is anchored in the hair follicle, which punctures the outer layer of the skin. We have millions of these hair follicles all over our bodies. As our hair grows, the hair shaft is primarily made up of protein molecules. The formation in which these keratin bonds construct will then determine whether you have curly or straight hair, with the more keratin bonds you have equalling the more curly your hair gets (this portion is purely dependent on genetics).

Certain specific bonds are present in our hair that allow for its continuous growth. Keratin forms a helix bond which consists of hydrogen bonds. Cysteine, another amino acid that makes up the majority of keratin (almost 18%), is what coils these helixes. This amino acid is formed by sulphur-sulphur (disulfide) bonds responsible for rigidity and strength. Typically, disulfide bonds are strong and provide an excellent structure for thin hair strands. On the other hand, the hydrogen bonds present in hair strands are weaker and more prone to breakage.

Blowdrying wet hair or applying a straightening iron does not have visible consequences until split ends eventually show up. Split ends are formed by the continuous weakening of the hair shaft. When heat is applied to your hair, chemical bonds are broken and reformed, specifically hydrogen bonds. They are

susceptible to breakage from heat styling, which causes a temporary change in appearance, i.e. curly hair that becomes straight. Moisture becomes evaporated from the hair strands, drying them out and reverting back to their original state in the presence of humidity. This also explains how you can curl your straight hair. Certain styling products prolong the outcome of heat styling because they temporarily coat the hair shaft in a film that prevents water absorption. Regular styling does not damage keratin bonds but can begin to weaken their rigidity over time

In recent years, the trend of permanently altering your hair through straightening or perming has taken the beauty world by storm. Knowing what we do about hair bonds and how heat styling impacts them, how does permanently altering your hair work? Often, it starts with applying a chemical solution and heating it on the hair. Keratin bonds are then denatured and uncoiled. However, there are downsides to this treatment.

Although you may be achieving straight, shiny hair, you are also exposed to a highly toxic chemical. In most cases, the chemical solution applied to hair contains high levels of formaldehyde, a known carcinogen. This sums up the intensity needed to break keratin bonds in our hair.

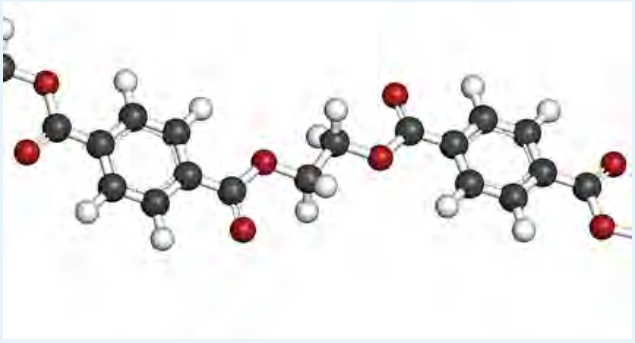
Knowing what we do about the importance of keratin in our hair, products have hit the shelves claiming to repair broken keratin bonds. How can we know if these work? Olaplex is a popular brand that claims to repair broken disulfide bonds. It is recommended for highly overtreated hair, whether from heat styling or colouring. It uses a chemical compound known as Bis-Aminopropyl Diglycol Dimaleate. Their explanation shows that a sulfur hydrogen molecule can pair with an oxygen atom when a hydrogen bond is broken. The second scenario is that the sulfur hydrogen pairs with three oxygen molecules to create a sulfate, which then, over time, breaks down the helpful protein we rely on in our hair. Their patented compound pairs with the sulfur hydrogen atom before the oxygens to create a healthy bond.

Hair bonding is a complicated process that not many people realize. However, breakage is highly preventable. In order to keep your keratin bonds healthy and intact, the best advice is to avoid heat styling as a whole and, if necessary, to be sure to follow up with a bond-building treatment afterwards.

THE REALITY OF PLASTIC

WHAT IS PLASTIC?

Plastics are defined as either synthetic or natural materials that can be shaped when soft and then hardened to retain the given shape. Plastics are **polymers,** which are chains of molecules linked together, where each molecule is a monomer, or single unit that is linked together with other monomers. Some examples of natural polymers include tar, tortoiseshell, animal horn, and amber, while examples of some synthetic polymers include polyethylene (used in plastic bags), polystyrene (used in plastic cups), and polypropylene (used in fibers and bottles).



Basic Polymer Strucutre

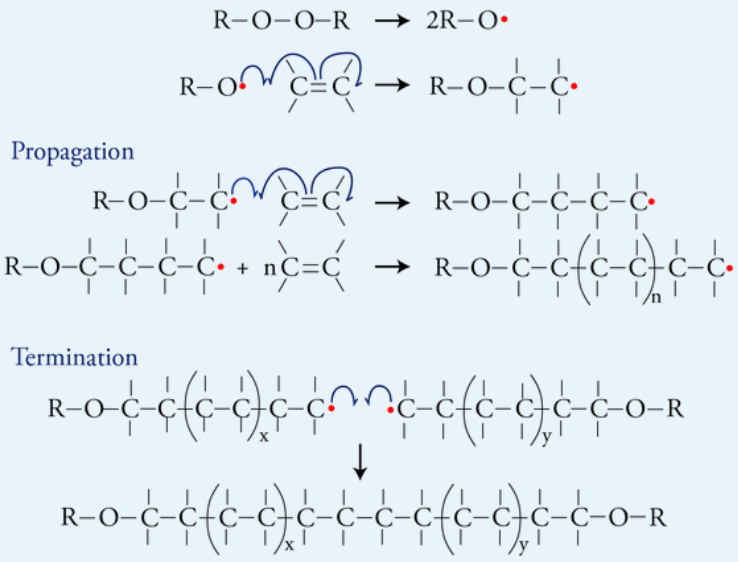
HOW DID WE GET HERE?

Although polymers existed in nature a long, long time before the first ever synthetic polymers made, the first ever synthetic polymer, Parkesine, was introduced in 1862 when Alexander Parkes was trying to find a substitute to shellac for waterproofing, and he marketed his invention as a substitute for horns and ivory. This was not a commercial hit but it was a big step in the development of synthetic polymers. In 1907, the first ever fully synthetic plastic was invented, containing all man-made molecules. This polymer is Bakelite, and it was discovered by Leo Baekeland when he was trying to find a substitute for shellac as well. Bakelite was a commercial success and remains one to this day. The next big step in synthetic polymers was during WWII when demand for war supplies was very high, which resulted in plastic production in the United States increasing by 3 times as much as pre-war levels. Plastic was a great substitute for metal which led to the invention of polyethylene, polystyrene, nylon and plexiglass, all during the war. Following the war, plastic production at these high output levels continued, and the economic boom of the 1950s led to increased spending on many plastic products, and the introduction of polyester. Nowadays, plastic remains extremely popular due to its many purposes and uses, as well as simplicity in production. Unfortunately, plastics can take hundreds or even thousands of years to decompose in nature, so to dispose of it, we as humans dump it into places such as the oceans which harms the animals that live there and contributes to climate change.

CHEMICAL COMPOSITION

To make plastics, chemists begin with various elements derived from natural resources, such as atoms of carbon, hydrogen, oxygen, etc. They then make chemical bonds between these various atoms to make molecules, and in the context of making plastics/polymers, these molecules are referred to as monomers. Monomers then must be chemically joined together in order to make polymers, and this can be done through two different processes: addition polymerization or condensation polymerization. In addition to polymerization, monomers are added on to each last monomer in the chain via chemical reactions with each other through double or triple bonds, as if the chemists were building a paper clip chain. Additional polymerization has three steps: initiation, propagation, and termination. In initiation, an initiator such as a radical, cation, or anion is used to start the polymerization process. In propagation, a monomer is added onto the chain and each new one creates space for the next. Finally, in termination, the radical, cation, or anion that was used to initiate the polymerization is neutralized in order to stop the process. In condensation polymerization, monomers react with each other to form larger structures (polymers), at the same time releasing byproducts, such as water or methanol, hence condensation. The main difference between the two is that addition polymerization does not release a byproduct while condensation polymerization does.

The monomers in a polymer can have many different molecular structures, such as a linear arrangement, but they may also have arrangements such as a crosslinked configuration, resembling a mesh-like structure, or even be amorphous, which means it has no shape, similar to the arrangement of a plate of spaghetti. These plastics are usually transparent so they are used rightfully as materials such as food wrap, headlights and contact lenses. Finally, polymers have a seemingly infinite range of characteristics and properties that contribute to their popularity in being used as a material for many goods, as the ability to create polymers to fit different uses makes them so abundant. Many different polymers have many different characteristics, but the ones found in most of them include “resistance to chemicals, being insulators of both heat and electricity, being light in weight and having different degrees of strength, and the ability to be processed in different ways to produce fibers, sheets, foams, or intricate molded parts.”



Addition Polymerization, per Prepatory Chemistry

WHY IS IT HARMFUL?

Plastic is present in our everyday lives. We use it multiple times throughout the day and hardly think about any environmental and personal health effects it has. However, the chemicals found and released a variety of substances pose serious health threats to humans. PVC plastic is the 3rd most synthetic plastic that is produced across the globe. It surrounds us, but what you did not know is that it has extreme negative effects on one's health. When said plastic is produced, harmful chemicals including dioxins, phthalates, ethylene dichloride, and lead are exposed to us and can get into our system via attaching to food and water. These chlorine based solutions have contaminated the air. Since organochlorines have a certain chemical structure that makes humans unable to expel them, humans are at risk of developing immune disorders, hormone disruption, and cancer. Aside from humans, the environment faces detrimental loss due to the presence of plastic that is not properly disposed of which ends up polluting our air. When plastic is burned, the number of toxins and fumes released is immense, including mercury, dioxins, and polychlorinated. Dioxins settle on crops, fields, rivers, and bodies of water. In water, dioxins become strongly attached and eventually make their way to the sediment where they remain for numerous years. Next time you use a plastic bag or drink from a plastic water bottle, understand the chemicals that are and will be released along with the severe effects it can have on your body and the ecosystem around you.

THE PROBLEM IS PLASTIC! THE SOLUTION TO A DISASTER?

“Plastic pollution is killing sea turtles” I’m sure everyone has seen a variant regarding this issue in the last few years. The earth is all we have, meaning it is in our best favor to fix the environmental problems that are destroying wildlife and ecosystems globally. One of the main solutions to these problems is to correct it from the start, known as recycling. Recycling is defined as collecting and organizing waste that would otherwise be thrown away into landfills, oceans, and the air. Currently, the recycling of plastic globally is a disaster with it being the least recycled common material in the US at only 9%. Plastic producers are emphasizing a shift to chemical recycling in order to achieve the original raw materials. Recycling has mostly been completed through mechanical processes but recently scientific breakthroughs have allowed waste management teams to use innovative technology to chemically recycle plastic that otherwise would have been extremely costly and difficult to do. The new technology is just emerging from the experimental stage but holds much potential to significantly increase inversion from landfills and keep plastics in the cycle of reusing.

Although chemical processes vary on products and companies, they follow the general template: The plastic is first dismembered or broken down to a reasonable size followed by a treatment in a combination of water, enzymes, and catalysis. They are now in small polymer chains, a chain molecule made up of the same monomers. At this point, the monomers can be separated and reattached to create new polymers that can be used later for manufacturing products or packaging. This process is a loop, showcasing its potential to be extremely environmentally friendly compared to the majority of plastic that poses as a one time use.

Over 30 countries across the world have already approved the various chemical processes, with multiple companies already well underway in small scale processing using the methods. Coming out of Oregon, USA, Agilyx is a main established company of chemical plastic recycling. Agilyx takes the unique role of taking mixed plastic from refineries and transforming them into jet fuel and gasoline. Recently, they have refurbished their buildings to fit the needs of recycling polystyrene. It follows a near identical process with the only substitute being once into small enough chains, it is heated up in the absence of oxygen. This in return allows the company to mix and create new polymers and plastics. In addition, polyethylene terephthalate is the most common thermoplastic resin. Its resilience and durability make it an excellent choice in a variety of industries. Loop Industries located out of Quebec, Canada uses depolymerization as a method to break polyethylene terephthalate (PET) into its two simplest mono Ethylene Glycol. During its past mechanical decomposition, PET would only last on average about six cycles, while this new innovation allows for infinite reuse. It is then polymerized, a chemical reaction in which monomer molecules form polymer chains. This reaction creates polyethylene which is used to produce terephthalate. When these materials are combined, numerous forms of PET are achieved.

Chemical recycling of plastic is looking into a bright and greener future. Canada is currently investing heavily on chemical recycling in forms of PET and PS. Overall, chemical plastic recycling has great potential if all goes to plan and can help be the solution to eliminate world-wide problems that have been detrimental to our planet.

BY: BRANDON CALALANG AND ANTHONY FORLETTA

SOURCES:

PLASTICS, P. (2018, OCTOBER 30). PLASTICS CHEMISTRY: THE SCIENCE OF PLASTICS. PLASTICS MAKE IT POSSIBLE. RETRIEVED MAY 24, 2022, FROM HTTPS://WWW.PLASTICSMAKEITPOSSIBLE.COM/ABOUT-PLASTICS/FAQS/PROFESSOR-PLASTICS-INTRO-TO-THE-CHEMISTRY-OF-PLASTICS/

SCIENCE OF PLASTICS. SCIENCE HISTORY INSTITUTE. (2019, NOVEMBER 20). RETRIEVED MAY 24, 2022, FROM HTTPS://WWW.SCIENCEHISTORY.ORG/SCIENCE-OF-PLASTICS#:~:TEXT=PLASTICS%20ARE%20A%20GROUP%20OF,MADE%20OF%20MANY%20REPEATING%20UNITS.

SHAH, K. (2020, SEPTEMBER 19). A BRIEF HISTORY OF PLASTIC. MEDIUM. RETRIEVED MAY 24, 2022, FROM HTTPS://HISTORYOFYESTERDAY.COM/A-BRIEF-HISTORY-OF-PLASTIC-2336F7BBDB96

ADDITION POLYMERIZATION. ADDITION POLYMERIZATION - AN OVERVIEW | SCIENCEDIRECT TOPICS. (N.D.). RETRIEVED MAY 24, 2022, FROM HTTPS://WWW.SCIENCEDIRECT.COM/TOPICS/ENGINEERING/ADDITION-POLYMERIZATION

CONDENSATION POLYMERIZATION. (N.D.). RETRIEVED MAY 24, 2022, FROM HTTPS://POLYMERDATABASE.COM/POLYMER%20CHEMISTRY/CONDENSATION%20POLYMERIZATION.HTML

ENVIRONMENTAL PROTECTION AGENCY. (N.D.). EPA. RETRIEVED MAY 24, 2022, FROM HTTPS://WWW.EPA.GOV/RECYCLE/RECYCLING-BASICS

MAY 16, 2022 N. G. (2022, MAY 16). GREENWASHING ALERT: "CHEMICAL RECYCLING" ISN'T ACTUALLY RECYCLING. IT'S PLASTIC INCINERATION. NRDC. RETRIEVED MAY 24, 2022, FROM HTTPS://WWW.NRDC.ORG/STORIES/GREENWASHING-ALERT-CHEMICAL-RECYCLING-ISNT-ACTUALLY-RECYCLING-ITS-PLASTIC-INCINERATION

CEN.ACS.ORG. (N.D.). RETRIEVED MAY 24, 2022, FROM HTTPS://CEN.ACS.ORG/ENVIRONMENT/RECYCLING/PLASTIC-PROBLEM-CHEMICAL-RECYCLING-SOLUTION/97/I39

HOW TO AVOID TOXIC CHEMICALS IN PLASTICS. MADE SAFE. (2017, MAY 5). RETRIEVED MAY 24, 2022, FROM HTTPS://WWW.MADESAFE.ORG/AVOID-TOXIC-CHEMICALS-PLASTICS/

PVC: THE POISON PLASTIC. (N.D.). RETRIEVED MAY 24, 2022, FROM HTTPS://WWW.GREENPEACE.ORG/USA/WP-CONTENT/UPLOADS/LEGACY/GLOBAL/USA/REPORT/2009/4/PVC-THE-POISON-PLASTIC.HTML

PERKINS, S. (2020, APRIL 22). EXPLAINER: WHAT ARE POLYMERS? SCIENCE NEWS FOR STUDENTS. RETRIEVED MAY 24, 2022, FROM HTTPS://WWW.SCIENCENEWSFORSTUDENTS.ORG/ARTICLE/EXPLAINER-WHAT-ARE-POLYMERS

BISHOP, M. (N.D.). ADDITION POLYMERS. RETRIEVED MAY 24, 2022, FROM HTTPS://PREPARATORYCHEMISTRY.COM/BISHOP_ADDITION_POLYMERS.HTM

I Don't Feel Anything!

An Article On Pharmaceutical Chemistry

Created by Victoria Godinho

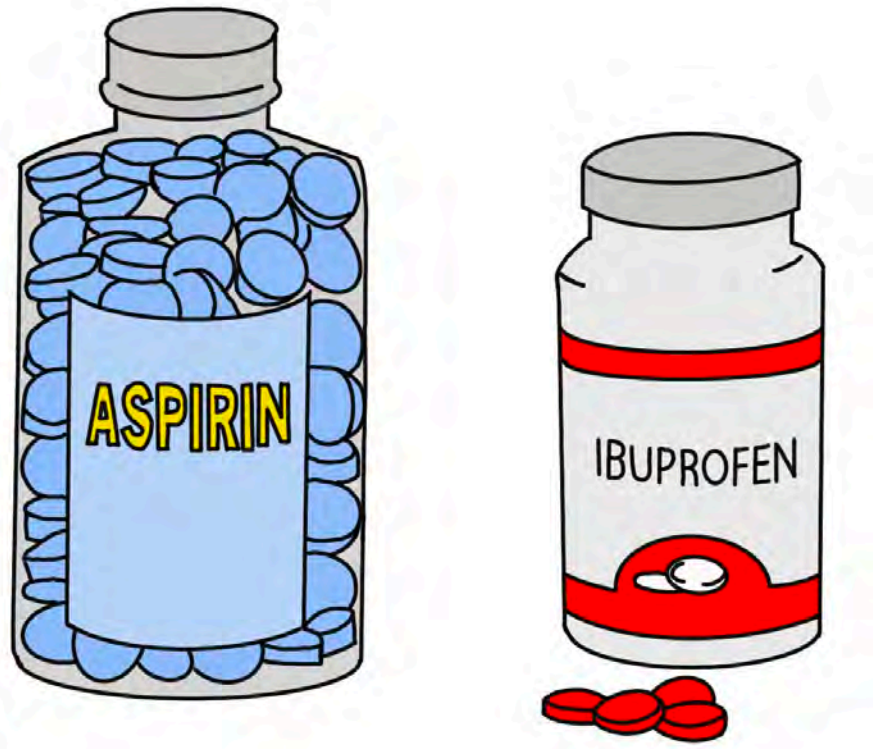
HOW DO PAIN RELIEVERS WORK?

Pain relievers work with your cells, your body's nerve endings, the nervous system, and the brain to keep the pain away. When these cells in our body become injured or damaged, they release a certain chemical called prostaglandin. Prostaglandins ($C_{20}H_{32}O_5$) are a group of lipids made at sites of tissue damage or infection. They control processes such as inflammation, blood flow, and the formation of blood clots. The nerve endings in our body are extremely sensitive to prostaglandin. When they sense a release of prostaglandin, the nerve endings transmit a message to the brain through the nervous system, telling it where the pain is and how much it hurts. The pain relievers work by preventing the cells from releasing prostaglandin. When we stop releasing it, the nervous system will stop sending pain messages to the brain which means we won't feel any more pain. This process doesn't just happen instantly. After you have consumed the pain reliever, it goes to the stomach to be digested, and then it will be absorbed into the bloodstream. When it's in the bloodstream, it can travel throughout the body.

OUCH!

You fell and hit your head against something. Or, maybe you have a monstrous headache that just doesn't seem to go away. In painful situations like these, taking a pain reliever is the best course of action.

The two most common types of pain relievers are NSAIDs and acetaminophen. They are available in various forms (e.g. pills, liquids, creams) and dosages (e.g. children's, regular, extra strength). Once taken, pain soon diminishes or even goes away entirely.

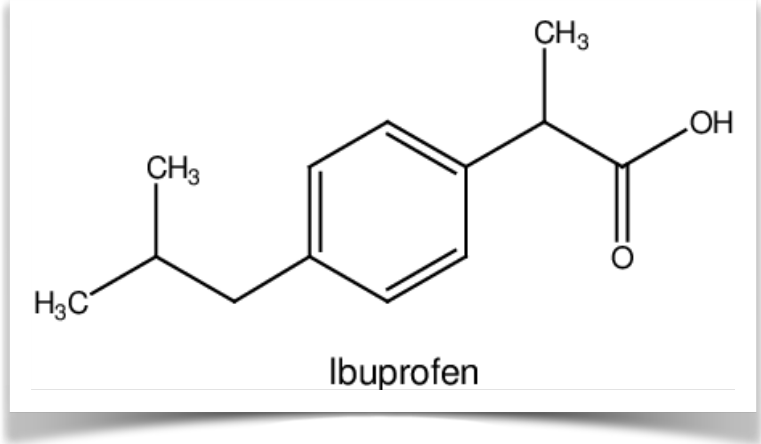


Picture Created By Victoria Godinho

TYPES OF PAIN RELIEVERS OVER THE COUNTER

NSAIDS:

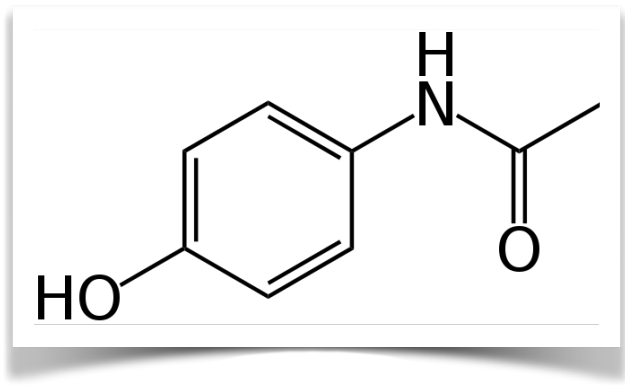
Non-steroidal anti-inflammatory drugs (NSAIDs) are medicines that are used to relieve pain, reduce edema, and bring down high temperatures. The main types of NSAIDs are ibuprofen, naproxen, and aspirin. NSAIDs work by blocking a specific type of enzyme called cyclooxygenase (COX) used by the body to make prostaglandins that contribute widely to our pain. Although NSAIDs are good for relieving pain, they can cause many unwanted side effects. These side effects include indigestion, stomach ulcers, headaches, drowsiness, dizziness, allergy reactions, and in rare cases serious issues with the liver, heart, or kidneys.



Ibuprofen

Acetaminophen:

Acetaminophen is a pain reliever and a fever reducer. Researchers are not sure of the exact mechanism of acetaminophen's action. They believe it may reduce the production of prostaglandins in the brain. Acetaminophen reduces pain by elevating the pain threshold, and by elevating the amount of pain to develops before a person feels it. Acetaminophen reduces fever by acting on the hypothalamus region of the brain where body temperature is regulated. Some side effects include nausea, headache, fatigue, etc.



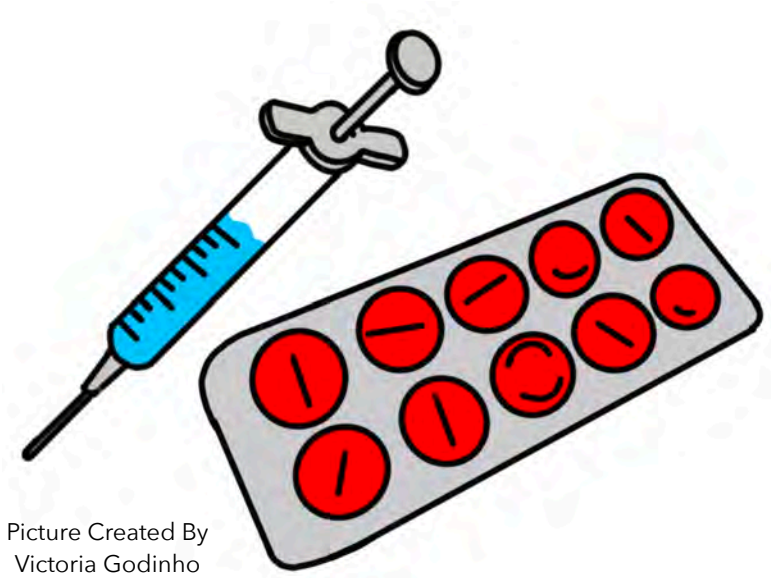
TYPES OF PAIN RELIEVERS PRESCRIBED

Opioids:

Opioids are a class of drugs naturally found in the opium poppy plant that have various effects on the human body. Opioids work differently compared to other pain medications. They work by activating opioid receptors on nerve cells. These receptors belong to the G protein-coupled receptors. When the opioid attaches to the receptor, it blocks pain messages sent from the body through the spinal cord to the brain. Although opioids are highly effective in reducing pain, they are highly addictive. Taking opioids should only be under the discretion of your doctor.

Anti-Depressants:

Anti-depressants are a type of medicine used to treat clinical depression. They can also be used to treat disorders like obsessive-compulsive disorder (OCD), anxiety disorders, and post-traumatic stress disorders (PTSD). Anti-depressants work by increasing the activity of chemicals called neurotransmitters in the brain. Increasing the activity of the neurotransmitter's serotonin, norepinephrine and dopamine lessens the symptoms of depression and anxiety. Increasing the activity will balance the chemicals in the brain which can overall improve your mood, concentration, sleep and increase your appetite. The side effects of this medication include feeling shaky or anxious, feeling sick, indigestion, etc.



Picture Created By Victoria Godinho

Pain is something all of us don't like to feel. From headaches to stomach aches, no one enjoys feeling pain. These medications are amazing discoveries that help us feel better and allow us to have a better quality of life. Without medications, the world would have more suffering and the quality of life would be poor. All these medications would not be possible if it weren't for chemistry! Chemistry serves as a backbone for discovery and growth in the pharmaceutical industry. Advances in chemistry will help create more medications to help save the lives of many people and treat a variety of illnesses.

REFERENCES

American Society of Anesthesiologists. (N.D.). *What Are Opioids?* Retrieved May 22, 2022, from https://www.asahq.org/madeforthismoment/pain-management/opioid-treatment/what-are-opioids/

MedicineNet. (2018 July 19). *Acetaminophen (Tylenol) Side Effects (Liver Toxicity) and Dosage.* Retrieved May 22, 2022, from https://www.medicinenet.com/acetaminophen/article.htm#what_are_the_side_effects_of_acetaminophen

NHS Choice. (N.D.). *NSAIDs.* Retrieved May 22, 2022, from https://www.nhs.uk/conditions/nsaids/

RxList. (2021, June 9). *Types of Pain Relief Medications: Uses, Side Effects, Comparison.* Retrieved May 22, 2022, from https://www.rxlist.com/pain_medications/drugs-condition.htm

WebMD. (N.D.). *How Antidepressants Work: SSRIs, MAOIs, Tricyclics, and More.* Retrieved May 22, 2022, from, https://www.webmd.com/depression/how-different-antidepressants-work

Wonderopolis. (N.D.). *How Does Medicine Know Where You Hurt?* Retrieved May 22, 2022, from https://wonderopolis.org/wonder/how-does-medicine-know-where-you-hurt

CHEM MATTERS

By: Marcos Galnares
2022-05-25

What is Forensic Serology?

Forensic serology is a significant part of modern forensic research. The primary activity of a forensic serologist is the identification of bodily fluids. It focuses on determining whether a questioned sample contains blood, sperm, saliva, or other bodily fluids. The presence of bodily fluid stains is frequently linked to violent criminal cases. Proving the presence of bodily fluids can help investigators confirm alleged violent crimes. For instance, the identification of blood evidence is often required in cases involving aggravated assault, homicide, sexual assault, and burglary. Forensic serology is the process of evaluating and identifying biological evidence prior to its individualization. Individualization of biological evidence is used to ascertain if a bodily fluid sample is from a specific person. Individualization can now be performed by forensic DNA analysis. However, the identification of bodily fluid cannot be omitted or replaced by forensic DNA analysis. The identification of bodily fluid can be carried out by using confirmatory and presumptive assays to ensure that the sample is the bodily fluid in question. Assays are investigative procedures that determine the composition or quality of a substance. This article will mainly focus on the identification of blood through the use of presumptive and confirmatory assays, and the most commonly used examinations of each method.

HOW IS BLOOD IDENTIFIED?

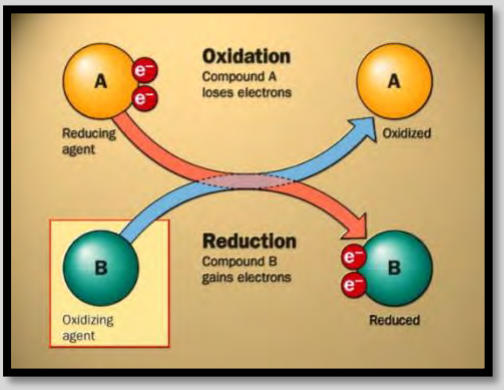
As previously mentioned, blood can be identified using both presumptive and confirmative assays. Oxidation-reduction assays are the most used presumptive evaluations in forensic laboratories. Moreover, the most common confirmatory assays are microcrystal examinations. For instance, a red stain identified through visual examination is typically analysed using presumptive assays. If the assay of the questioned blood stain is positive, the stain is subjected to further evaluation by forensic DNA analysis. This method can only conclude that the results indicate the presence of blood. Therefore, if appropriate quantities of biological materials are available, confirmatory assays should be carried out if possible. As a result, if the confirmatory assay is positive, it can be concluded that blood was identified from the evidence. A normal human's blood volume is around 8% of their body weight. The fluid portion of the blood is called plasma. Erythrocytes (commonly known as red blood cells), leucocytes (also known as white blood cells), and thrombocytes (more commonly known as platelets), make up the cellular fraction of the blood which is suspended in the plasma. Most presumptive and confirmatory assays of blood identification are based on the detection of hemoglobin. Hemoglobin is a protein found in erythrocytes that is responsible for the transportation of oxygen. Each hemoglobin

component contains a heme molecule. The heme molecule is comprised of a protoporphyrin IX (which is an organic compound). and a ferrous (Fe2+) iron atom.

PRESUMPTIVE ASSAYS:

OXIDATION-REDUCTION REACTIONS

This type of presumptive assay is centered on the biochemical properties of the heme molecule, which can catalyze an oxidation-

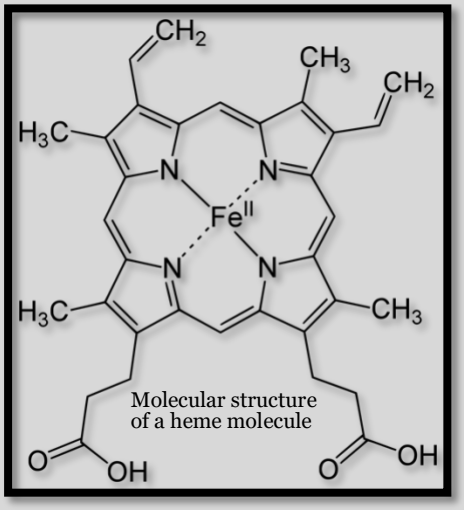


reduction reaction. As we have studied this year, a redox reaction changes the oxidation state of chemicals. In presumptive testing for blood identification, oxidation is frequently associated with hydrogen loss, while reduction is frequently associated with hydrogen gain. In redox reactions for blood identification assays, hydrogen peroxide is often used as an oxidant. Furthermore, the most common reductants that are used in the redox reaction are phenolphthalein, tetramethyl-benzine, leucomalachite green, and luminol. A colourless reductant is oxidized in the presence of a heme, resulting in a product with colour or chemiluminescence. Subsequently, a positive reaction suggests the presence of blood.

CONFIRMATORY ASSAYS:

MICROCRYSTALS

In microcrystal examinations, blood crusts coming from a bloodstain are processed chemically to convert native heme to heme



Molecular structure of a heme molecule

derivatives. These heme derivatives can crystallise in a variety of shapes. Moreover, microscopic observation can be used to evaluate the crystal morphology of heme derivatives. What this means is that the presence of heme derivative crystals indicates the presence of blood. There are two commonly used microcrystal assays, and those are the Takayama and Teichmann crystal assays. A key difference between microcrystal assays and the types of presumptive assays, is that microcrystal evaluations are much less sensitive than the presumptive assays. Going back to the protein of hemoglobin, the ferrous ion of the heme can create six bonds under normal physiological conditions. Of those six bonds, four are formed with the nitrogen of protoporphyrin IX, one with oxygen, and one with a hemoglobin component. How are blood crusts treated in the two microcrystal assays? Well, in the Takayama crystal assay, blood crusts are treated with pyridine (organic compound) and a reducing sugar capable of reducing other compounds in an alkaline environment. And in the Teichmann crystal assay blood crusts are treated with heated salts and glacial acetic acid.

Overall, forensic serology is a very interesting yet difficult topic to understand. However, as this article has proved, this branch of forensic science is crucial as it often is the key factor in many investigations of violent criminal cases.

References:

Image sources:

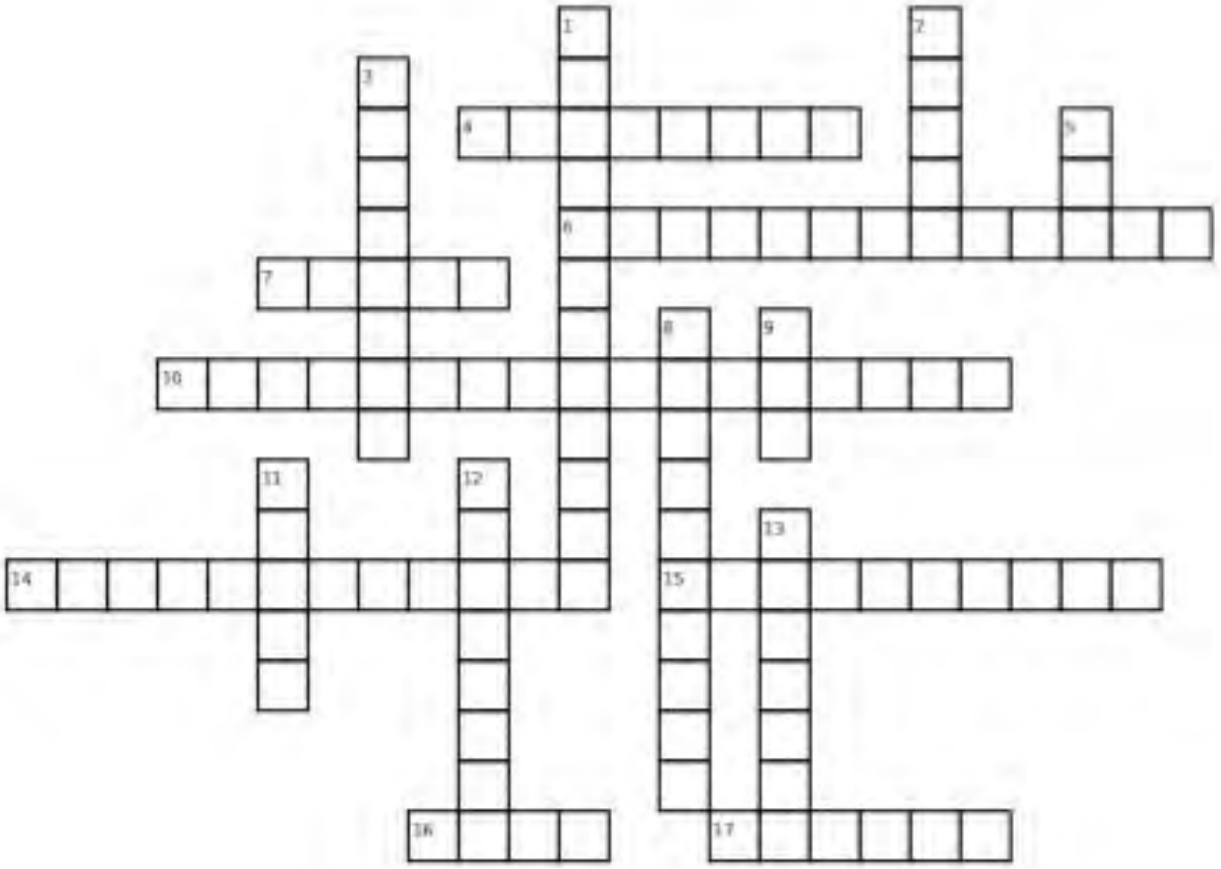
- Emily. (2012, November 19). *As chemistry - redox reactions and Group 2 elements*. Owlcation. Retrieved May 25, 2022, from https://owlcation.com/stem/AS-Chemistry-Group-2-and-7-Elements
- *File:heme b.svg*. Wikimedia Commons. (n.d.). Retrieved May 24, 2022, from https://commons.wikimedia.org/wiki/File:Heme_b.svg
- Limited, A. (n.d.). *Forensic investigator at the crime scene investigating woman Mur Stock Photo*. Alamy. Retrieved May 25, 2022, from https://www.alamy.com/forensic-investigator-at-the-crime-scene-investigating-woman-mur-image217482378.html

Research sources:

- *Blood & Bodily Fluids*. Forensic Resources. (2019, May 29). Retrieved May 25, 2022, from https://forensicresources.org/forensic-disciplines/blood-bodily-fluids/
- *Bloodstain pattern analysis: Forensic types and classification*. Forensic Reader. (2022, January 24). Retrieved May 25, 2022, from https://forensicreader.com/bloodstain-pattern-analysis/
- *Forensic chemistry handbook - ffh.bg.ac.rs*. (n.d.). Retrieved May 25, 2022, from https://www.ffh.bg.ac.rs/wp-content/uploads/2021/01/Forensic-Chemistry-Handbook-by-Lawrence-Kobilinsky.pdf
- *Forensic serology*. Forensic Serology - an overview | ScienceDirect Topics. (n.d.). Retrieved May 25, 2022, from https://www.sciencedirect.com/topics/medicine-and-dentistry/forensic-serology
- *Presumptive test for blood: 11 important forensic test + reactions*. Forensic Reader. (2021, December 22). Retrieved May 25, 2022, from https://forensicreader.com/presumptive-test-for-blood/

By: William Wietfeldt

Forensic Serology Crossword Puzzle



Down:

1. synonym for "platelets"
2. the process of testing a substance, to identify how pure it is
3. organic compound mentioned in the article, with formula C5H5N
5. cell that carries genetic information
8. substance in the blood that carries oxygen
9. the number of bonds that the ferrous ion of the heme molecule create
11. the fluid and body component of blood
12. the process of causing a reaction
13. one of the more common reductants used in redox, as mentioned in the article

Across:

4. the scientific study of bodily fluids
6. a type of confirmatory assay
7. a reaction between oxidizing and reducing substances
10. term which describes the use of chemistry in a legal setting, specifically at a crime scene
14. another name for "red blood cells"
15. sometimes called "white blood cells"
16. used in blood to connect oxygen
17. makes up around 55% of human blood

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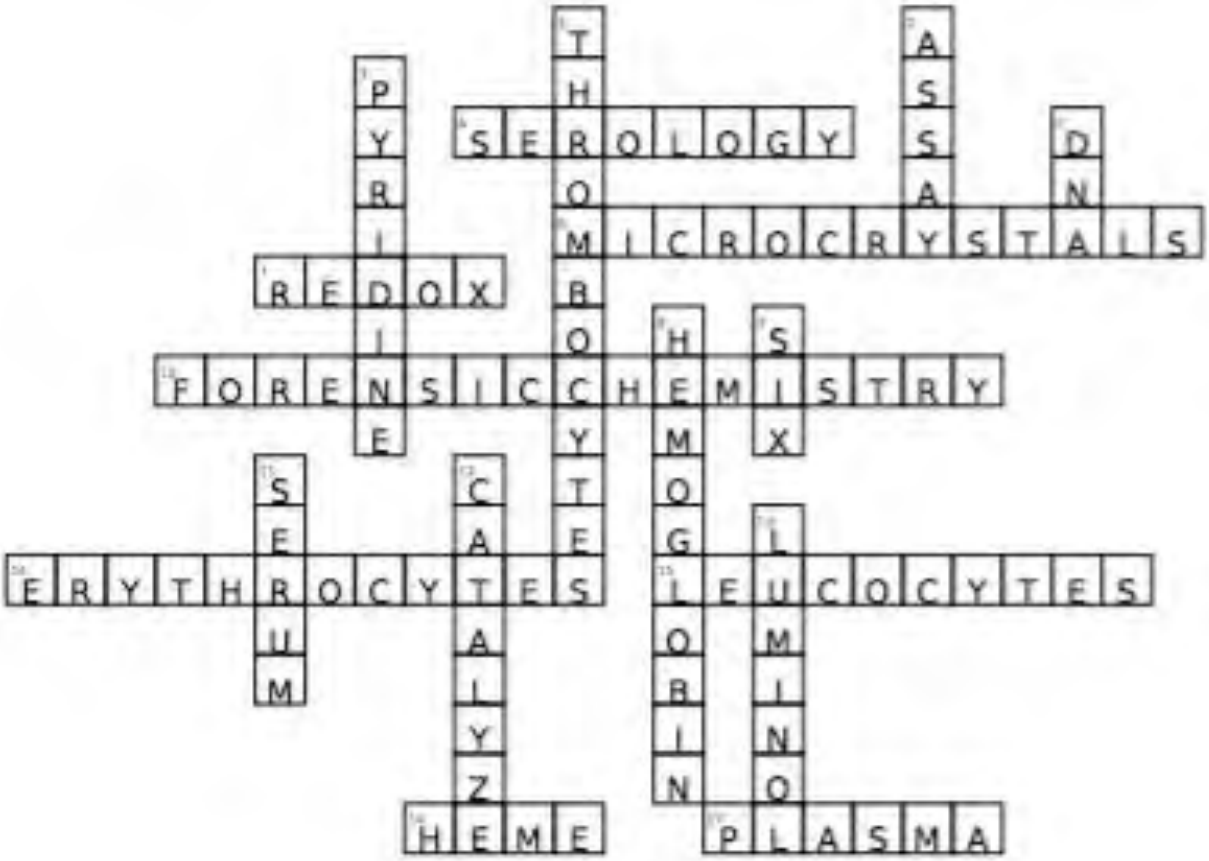

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Periodic Puzzle

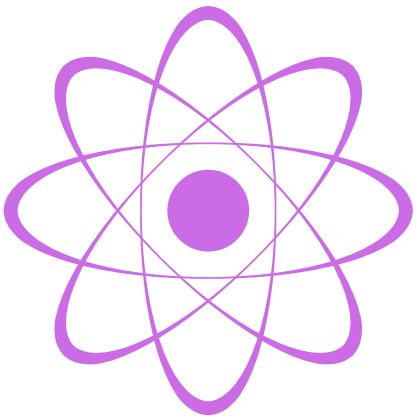
Decode the message below just as geneticists decode genomes! Use the hints provided to figure out which elements correspond to each number, and from there you can input the elements' symbols into each space to spell out the message.

1 8 3 2

1 9 7 5 6 2 4

1. This element is number 32 on the periodic table
2. This element is found in group 16 and period 3
3. After this element undergoes alpha decay, it becomes $^{234}_{90}Th$
4. This element was discovered in Tennessee by adding Ca (20 protons) to Bk (97 protons)
5. This element is a main component in organic molecules when bonded with Hydrogen
6. This element's electron configuration is [Kr] 5s2 4d10 5p5
7. This element is named after the Titans of Greek Mythology, and contains 22 electrons
8. The average atomic mass of this element is 58.69
9. This element is a noble gas in period 2

Now that you know which elements corresponds to each number, you can input their symbols into the spaces below!



Answer:

GENIUS GENETICISTS