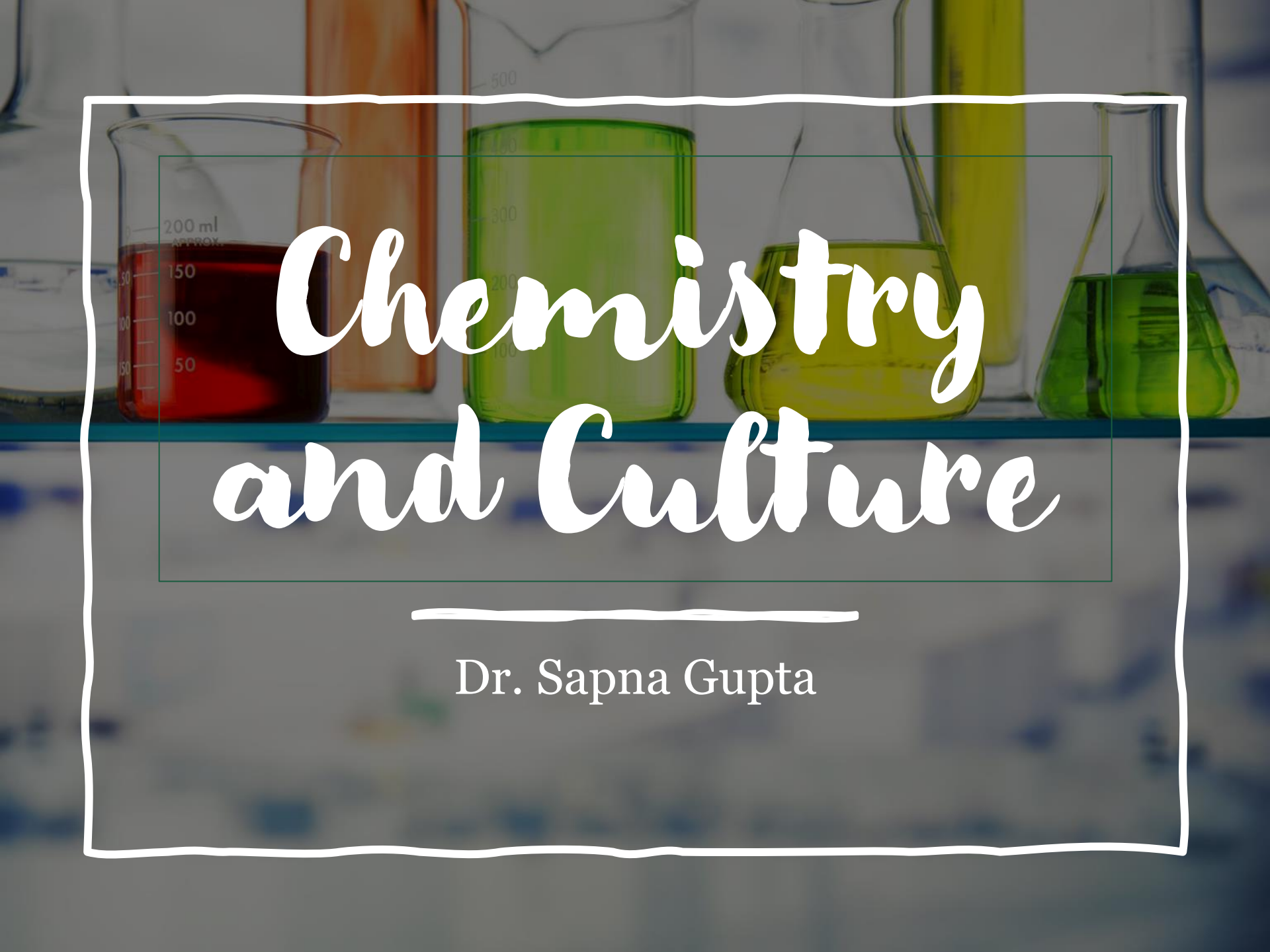


Chemistry and Culture

Dr. Sapna Gupta

History of Chemistry

- It is hard to pinpoint history of chemistry to one person or one region.
- Chemistry developed all over at various times.
- Historical times are named after chemistry – bronze age and iron age.
- Chemistry is prevalent in ALL aspects of our lives.
- Come on a journey with me….

Bronze Age

- Started in Greece and China around 3000BC.
- Based on the use of metals, copper mostly. Prior to that was “Stone Age”.
- Later copper and tin (bronze) were used for wheel, plow etc. Mostly domestic goods.
- After this came the …..

Iron Age

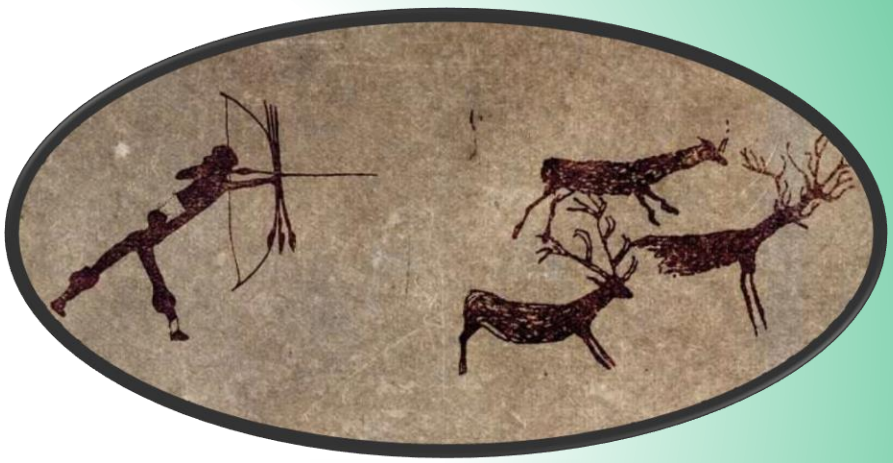
- Started around 1200 BC (Europe and India) and 600 BC (China).
- Now came tools and weapons from steel (iron and carbon).
- Iron was not considered durable prior to iron age because of rusting.
- Steel was first made in now Turkey region. (High heat is needed to make steel and it was not known how to generate high heat).
- After this came the ….

Dark Ages

- There was a general cultural decline.
- Historians and Archaeologists think a drought caused the decimation of a number of civilizations.

Chemistry and Art

- Art has been around since civilization.
- Paint was made from dirt, charcoal and spit/animal fat.



- Moss was used to cover large areas, twigs, fingertips and feathers were used to paint.

Art – Egypt

- Egypt has been using dyes for wall paintings since 6000 BC.
- Lots of reds, blues, black and golden colors. Most pigments were naturally occurring minerals that were bound by gum.

Art – Ethiopia

- Ethiopian art goes back 500 BC.
- Most paints used were mineral and naturally occurring chemicals e.g. red was cinnabar (HgS) and madder lake dye (an anthraquinone dye); white was gypsum (CaSO4); black was charcoal (carbon).; yellow was orpiment (As2S3); blue was made with indigo (C16H10N2O2) etc.

Chemistry and Art at Present

- Chemistry in art is used to study three things:
  - Forgery is one of the biggest problem in art world.
  - Conservation of artwork and
  - Degradation – ways on how paint degrades over time.
- Chemists can study all this by using analytical chemistry to study pigments.
- Common instruments are Infra Red spectrophotometer, optical emission spectroscopy, and now noninvasive techniques.
- Newer techniques are hyperspectral imaging and x-ray fluorescence mapping.

Chemistry and Art Forgery Case

- In 2011 years ago and ring of 4 forgers were caught in Germany. They sold a total of 14 million pounds worth of fake art.
- White paint was the downfall – instead of just using zinc oxide, the forger used modern titanium oxide in the white paint.
- X-rays, optical microscopy, Infra Red spectroscopy were used to detect the forgery.
- Invasive procedures need to remove a microscopic fragment of paint and then analyzed using either electron microscopy or gas chromatography-mass spectrometry.
- Minerals/paint were made in certain time periods.
- Some pigments are associated with certain artists.

https://www.scienceabc.com/pure-sciences/what-is-the-science-behind-detecting-art-forgery.html

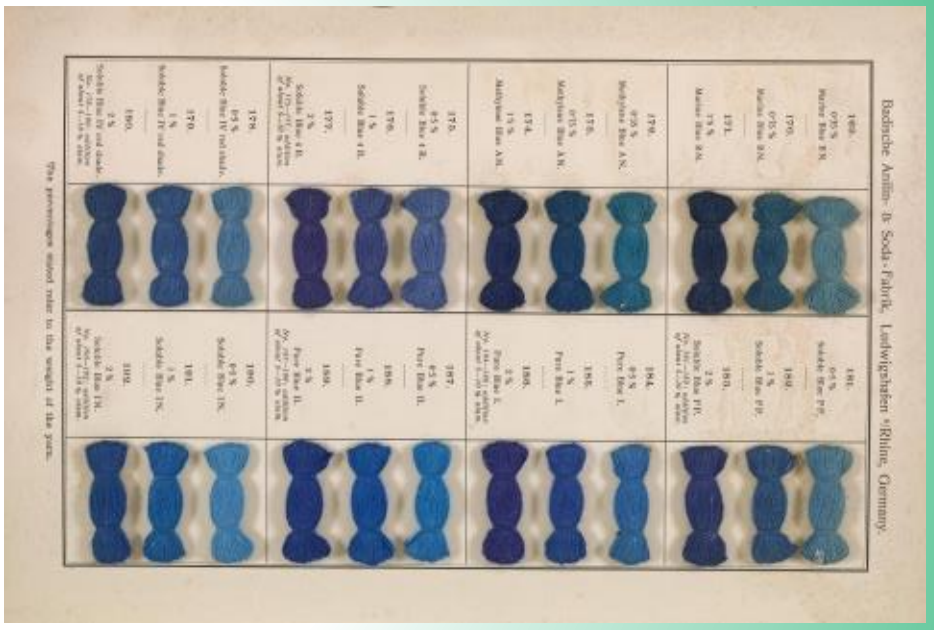
Dyes

- Natural dyes have been used in ancient China, Egypt, Rome and Greece, using natural dyes and pigments obtained from plant roots, animals or mineral sources.
- Some colors were more expensive than others e.g., royal purple was known as that because it was obtained from a sea snail, Bolinus brandaris, which was so rare that it was it's worth its weight in gold. To harvest the dye: the mollusk's shell is cracked open to extract a purple-producing mucus and exposed it to sunlight for a precise amount of time. It took more than 250,000 mollusks to yield just one ounce of usable dye, but the result was a vibrant and long-lasting shade of purple.
- No one was allowed to wear that purple color!

Dyes –The New Era

- In 1856 Sir William Henry Perkin produced the first synthetic organic dye, the so-called mauveine, using aniline as a starting compound. Mauveine proved to be a suitable dyestuff for various types of textiles predominantly silk, and mass production of the aniline purple (the original industrial name of Mauveine) commenced.
- Industrial revolution made the production of many more synthetic dyes feasible and helped the expansion of synthetic dyes industry.
- Dye industry is currently more than a $ 32.9 billion industry.

Dyes – Aniline for Cotton



Badische Anilin- & Soda-Fabrik

Aniline Colors on Cotton Yarn

New York: Badische Company, ca. 1900

https://library.si.edu/exhibition/color-in-a-new-light/making

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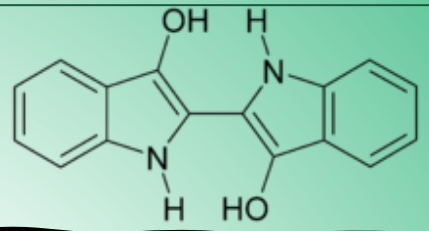
Dyes – Indigo



- It is a product of India.
- The Roman Empire had laws, which restricted the use of indigo (among purple and carmine colorants) to the top governing class, but after the decline of the empire, the colors also disappeared.
- Then Vasco da Gama established a route to India in 1498, Portuguese Estado da India reintroduced the color to Western countries.
- Later, provided by the British East India Company, the annual export of Bengal indigo reached its maximum in 1895: 9366 tons valued at 3,566,700 British pounds .
- In 1869, Adolf von Baeyer synthesized the molecule, and it came into market in 1897, which lead the export from India to immediately collapse.

Chemistry and Tatoos

- Tattoos need ink that can be absorbed by the skin and be non toxic and stay the same color for life.
- Dyes do not have to be approved by FDA and are not regulated. Some people experience allergies, infections and other problems after tatt
- A good ink should be formulated to flow easily into skin, stay where it's injected, and maintain its color over time.
- Some needles leave chromium and nickel in the skin which can cause adverse effects.
- Some dyes can break down into smaller molecules causing cancer in cells.
- Some dyes cause allergic reactions – some red and yellow inks have caused more allergies in users.

Tattoos – Dyes and Process

- Tattoo color is a solid pigment which is suspended in a liquid carrier e.g. Listerine, water, vodka, and/or witch hazel.
- The pigment contains a range of ingredients, e.g., green pigment could contain malachite and chrome oxide; red pigment may have iron oxide or cadmium red.
- During a tattoo, the artist punctures their skin with a needle 50 to 3,000 times per minute.
- The carrier solution transports the ink into the epidermis or middle skin layer.
- The immune system thinks an invader is infiltrating the body and attempts to save the body from the wound and this is how the tattoo becomes permanent.
- As macrophage cells rush to the wound, the ink gets stuck in them. In turn, the ink sticks to the dermis and stays there permanently.

Tattoos – Removing Them

- Tattoos can be removed by lasers, but process may not be thorough.
- It may also cause ink molecules to be released into the skin causing more harm.

(https://www.healthline.com/health-news/whats-really-in-tattoo-ink-the-answer-may-surprise-you#A-primer-on-tattoos)

Chemistry and Movies

Environmentally Related

- Erin Brockovich – law case about pollution caused by Pacific Gas and Energy in the groundwater by Cr^{6+}
- A Civil Action - deals with trichloroethylene, an industrial solvent used by the local tanneries, Beatrice Food and WR Grace. Contamination in local aquifer, causing leukemia in the residents.

Nuclear Warhead

- The War Game
- On the Beach
- Terminator
- Sum of All Fears
- Planet of the Apes
- The Day After
- Crimson Tide
- Fail Safe

Chemistry and Movies

Avatar – all about “Unobtanium” - the best superconductor in the world

Chemistry and Movies

Avatar – the way of the water – all about “Amrita” the chemical to make one immortal and smart.

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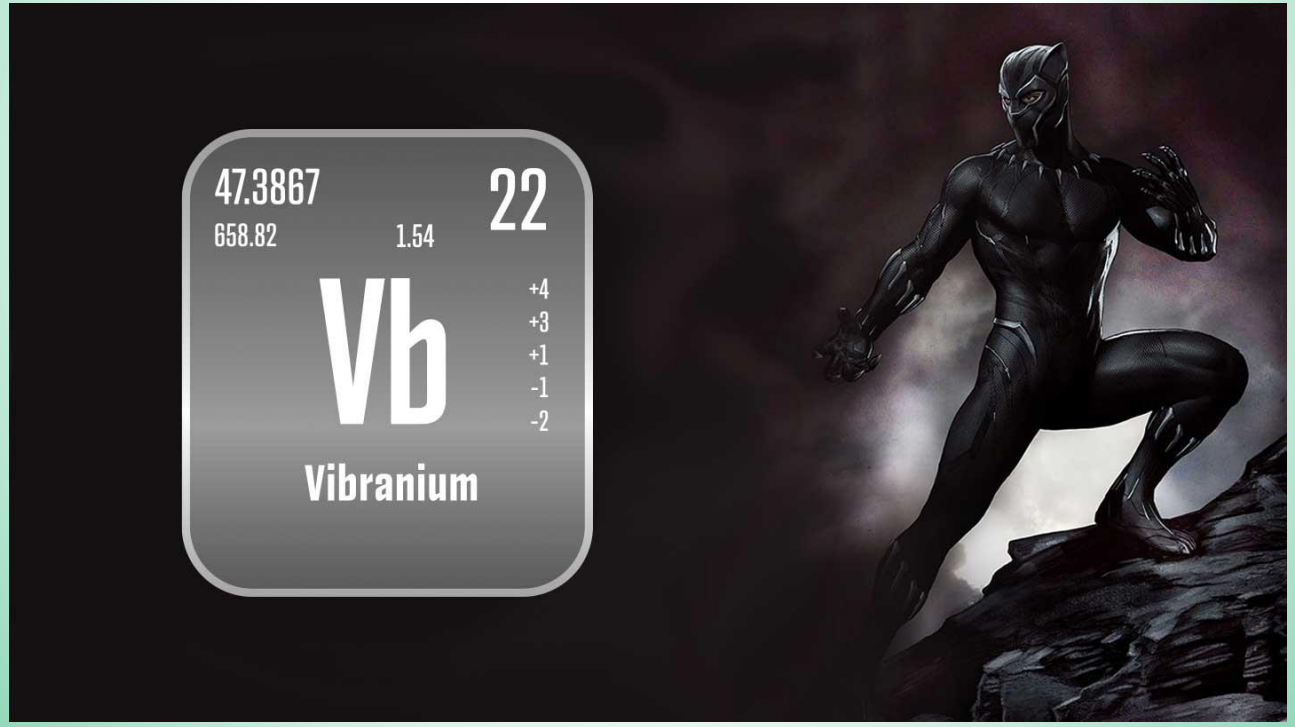
Chemistry and Movies

Black Panther – “Vibranium” – has the ability to store and release kinetic energy.

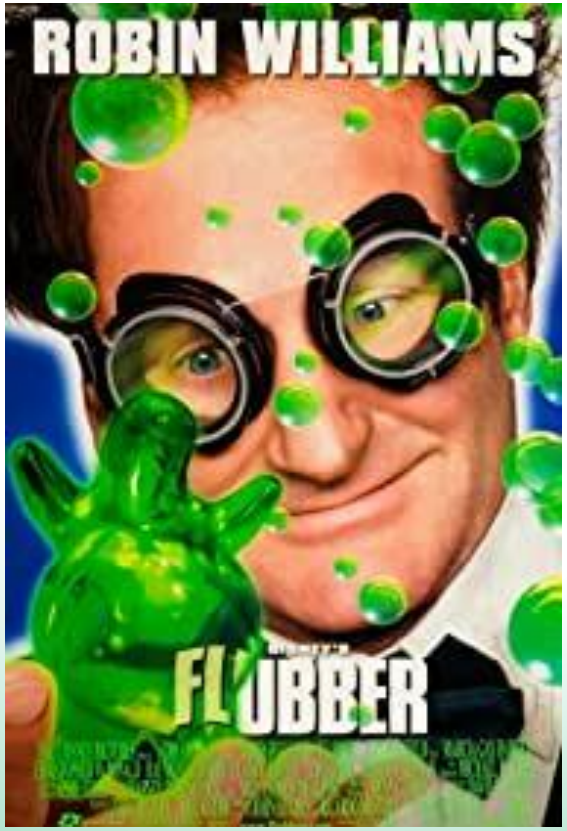


Chemistry and Movies

Adamantium – strongest metal in the world! Gave us Wolverine!

Chemistry and Movies

Flubber – a green slime that has elasticity and energy.



Chemistry and Cosmetics

- Lipstick
- Sunscreens
- Shampoos
- Face cleansers
- Body soaps
- Etc….

Going Shopping.....

Sunscreen

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Sunscreen: What They Do

- Sunscreens will generally prevent sunburns, reduce skin cancer and decrease early aging. Because of these medical effects, FDA regulates these as OTC drugs.
- Should be broad spectrum (protects from UVA and UVB radiations); has SPF 30 (Sun Protection Factor) or higher.
- SPF is given in 30 mins increments. So SPF 15 means 30x15 = 450 mins - about 7.5 hrs. This is not accurate.
- SPF 100 means only 1% of UV-rays can get through. Lower SPF means more UV-rays can get through.
- Best if it is water resistant.
- Can be spray or lotion.

Suncreens – Types

There are different kinds of sunscreens

- **Absorbs the radiation** – chemicals: oxybenzone, avobenzone, octisalate, octocrylene, homosalate, or octinoxate and parabens. These sunscreens tend to be easier to rub into your skin without leaving a white residue.
- **Deflect the rays** – physical sunscreens – chemicals: titanium dioxide, zinc oxide. This is good for sensitive skin.
- **Non-Chemical** – Cover your skin with cloth or be in shade. Hot and cold weather have nothing to do sunscreen – if there is sun, there is radiation.
- High SPF can be misleading. Always reapply 2-3 hrs and limit time in the sun. Just applying sunscreen does not mean no skin cancer. Sometimes Vitamin A additive can accelerate skin damage. Some of the chemicals in sunscreen can damage coral reefs in the ocean.
- If you avoid sun then get your vitamin D checked.

Sunscreen: Making Your Own

- 1 cup Oil (coconut or almond oil) + 2 tbsp zinc oxide + 1 tsp raspberry seed oil or carrot seed oil (for higher SPF value) + any other essential oils for good odor. Heat all the oils to melt them before adding the zinc oxide.

Cautions: 1) Should store in the fridge for longer shelf life;

2) Don't inhale zinc oxide

3) Add beeswax to make a thicker sunscreen.

- SPF 2-5: Use 5% zinc oxide
- SPF 6-11: Use 10% zinc oxide
- SPF 12-19: Use 15% zinc oxide
- SPF 20+: Use 20% zinc oxide

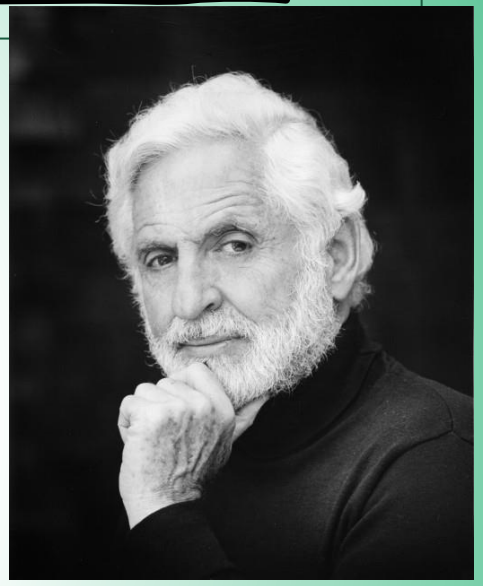
- OR even easier is to take your favorite lotion and add the zinc oxide.

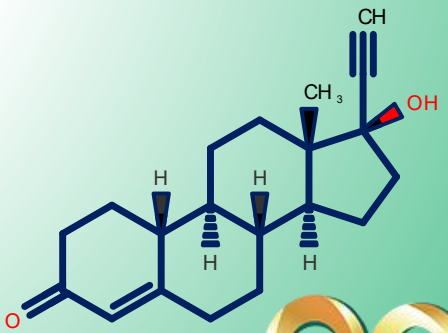
Forensic Chemistry

- Chemistry can be used determine
  - Arson
  - Forged wills
  - Identity of metals
  - Drugs in the body (medical and narcotics)
  - Blood deposits/patterns
  - Firearm – matching bullets to guns
  - Determining fingerprints – using glue, dyes and now instruments can be used to reveal fingerprints.
- DEA is all about analyzing and identifying unknown powders.

Chemistry and Women's Freedom

- The "pill" gave freedom to women.
- Carl Djerassi is the father of pill.
- Norethisterone was developed in 1951 and patented by 1952.
- The game changer was the oral delivery.
- By 1966 more than 5 million women were using birth control
- The pills in market now are a variable of progesterone (*structure on the right*).





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Chemistry and Environment

- Global warming (old term) – now it's climate change.
- Water shortage and clean water.
- Clean air.
- Recycling – plastics, aluminum cans, glass etc.

Chemistry – Global Warming

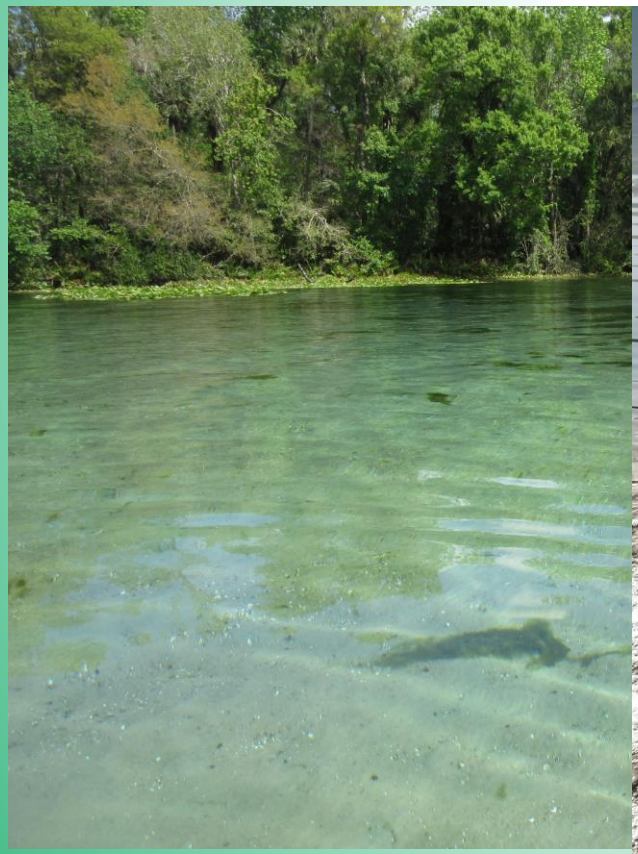
- Changes in atmospheric temperature can change weather patterns.
- So…what causes atmospheric temperature change? Molecules released into the atmosphere that absorb energy and retain it because of the nature of their bonding.
- Carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O).
- CO_2 comes from burning fossil fuels (cars, industries etc)
- CH_4 comes from volcanoes, cattle and fuels.
- N_2O comes from fertilizers and fuel consumption.

Chemistry – Water

- Earth is about 70% water, 97% is undrinkable ocean water.
- About 3% is fresh water for drinking/human consumption.
- Average American uses 82 gallons per day. It can be lowered by using water efficient fixtures/appliances; fix leaky faucets and toilets; turn off tap when brushing or shaving etc. Watering lawns can waste water.
- Half the globe lives in some water distress, either lack of water or polluted water (with arsenic, fluorides, feces, nitrates, microbes etc.)

Water…2

- About half of America's water is too polluted to drink.



Chemistry – Air Quality

- Air affects our general health. Cancer, asthma and other lung diseases.
- Major pollutants are ground level ozone (usually on hot days), particulate matter (dust), carbon monoxide, sulfur dioxide and nitrogen dioxide.
- Most of these come from fuel exhaust from vehicles and industry.
- Most cities will release an air quality index so citizens can plan activities accordingly.

Air Quality – 2

- Living in Los Angeles…

Chemistry – Recycling

- Recycling can save a lot of energy and raw material e.g. up to 90% for aluminum cans; plastics degrades over 400 years, however reusing it can save one third energy. Similar stats for glass, steel and paper.
- Industries can do a lot more e.g. coke or beer companies, glass producing companies, energy producing companies. These can recycle more by providing incentives to their customers.
- Rubber tires can be recycled as road fillers.
- Lead batteries MUST be recycled to prevent lead pollution.
- Oil – from frying or cars can be used as energy sources.

Chemistry – Cell Phones

Thank you for attending and listening.....

Sapna Gupta

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