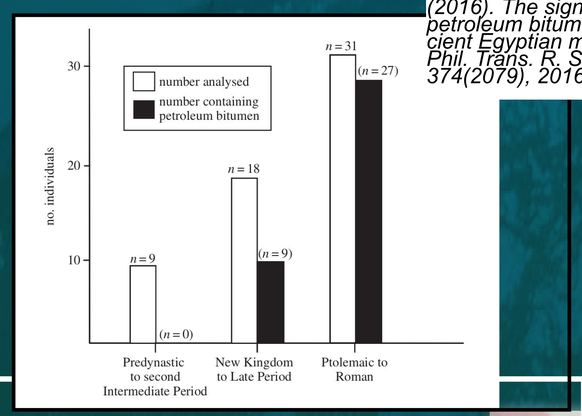
Topical Petrochemistry (Oil, Coal Tar, Vaseline)

TOPICAL PETROCHEMISTRY
Oil, Bitumen, Coal Tar, Tar, Asphalt, Pitch & Tarmac

"Topical Petrochemistry" describes how oil, gas, fossil fuels, coal and petroleum products have been applied to the exterior of bodies human and otherwise, to further health, sustenance and cosmetic goals.

"The relatively recent growth of the human population is connected to the story of fossil fuel, whether we look back on human history or anticipate our futures. After all, it was fossil fuel energy, 'and only fossil fuel energy, [that] made it possible to break with the old agrarian pattern and construct the industrial world,' writes the "peak oil theorist" John Michael Greer. The benefits (for humans) of plentiful and cheap energy derived from fossil fuel have been innumerable: food improved, both in quality and quantity, improvement in housing and clothing, more hygienic and healthier conditions in many places, public safety (better policing), and better illumination. The exponential growth of both human population and our average life span in the twentieth century—and here, of course, the poor are included in both figures—have generally had much to do with fossil fuels through the use of artificial fertilizers, pesticides, pumps for irrigation, and the use of petrochemicals in the manufacture of common pharmaceutical products such as antibiotic medicines."

— Dipesh Chakrabarty, "The Human Condition in the Anthropocene" - The Tanner Lectures in Human Values, Delivered at Yale University February 18–19, 2015

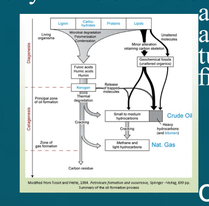


Histogram showing increasing abundance of bitumen in mummy balms from the Predynastic to Roman period. From Clark, K. A., Ikram, S., & Evershed, R. P. (2016). The significance of petroleum bitumen in ancient Egyptian mummies. Phil. Trans. R. Soc. A, 374(2079), 20160229.

HURT
Hydrocarbon Universal Running Tool

Diagenesis is a process of compaction under mild conditions of temperature and pressure. When organic aquatic sediments (proteins, lipids, carbohydrates) are deposited, they are very saturated with water and rich in minerals. Through chemical reaction, compaction, and microbial action during burial, water is forced out and proteins and carbohydrates break down to form new structures that comprise a waxy material known as "kerogen" and a black tar like substance called "bimen". All of this occurs within the first several hundred meters of burial.

— (US Geological Survey)



Bitumen is the product of deposition and maturation of organic matter, and the extractable organic material by organic solvents in petroleum source rocks and reservoir rocks is often defined as bitumen. Upon exposure to high regional temperatures over geological time, bitumen is converted to pyrobitumen as a result of the thermally activated reactions that drive off lighter oil and gas products and leave an insoluble, carbon-rich residue.

Pyrobitumen represents a significant fraction of the ultimate fate of petroleum liquids formed from kerogen during catagenesis. In the laboratory, experiments on organic-rich rocks (oil shale and petroleum source rocks), decomposition of the initially insoluble organic matter (defined as kerogen) produces gaseous and liquid products.The soluble fluid that remains in the heated rock is often defined (incorrectly) as bitumen. Upon further thermal exposure, this type of bitumen continues to evolve and reacts further to produce a harder pyrobitumen along with volatile products (liquid distillate and gas).

— (US Geological Survey)

Bitumen, tar and coal tars were substances that fascinated alchemists, calling up as it does the material-chemical, curative and aesthetic potencies of the nigredo, or the black nothing from which all potential difference, value and otherness is derived, and pictured in Robert Fludd's et sic in infinitum, 1624:

"The healthful balm, from Nature's secret spring,

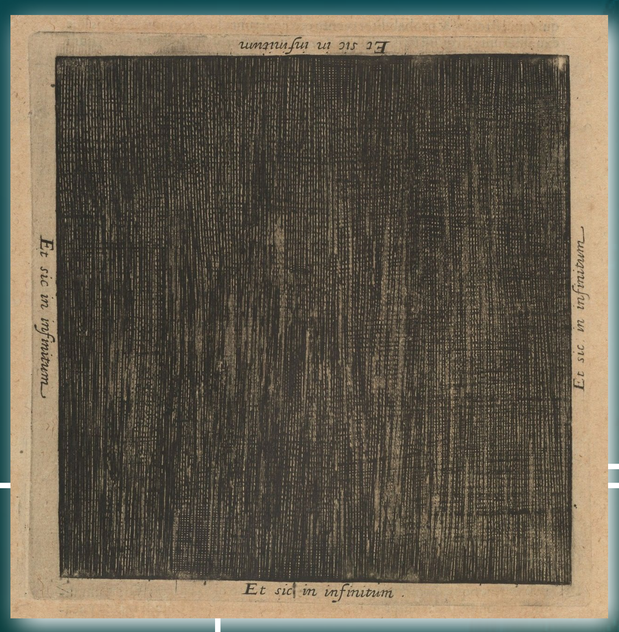
The bloom of health, and life, to man will bring;

As from her depths the magic liquid flows,

To calm our sufferings, and assuage our woes"

— Seneca Oil Advertisement c. 1850

HISTVISME
Historical Viscosity Measurement



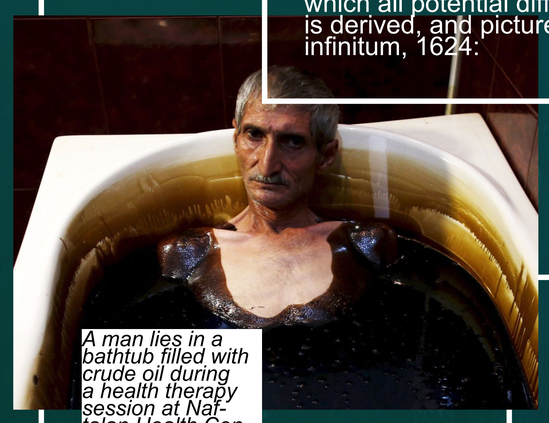
"Vacuum Residue is the bottom product from the vacuum distillation unit, used to process bitumen. It has several options for its use in meeting a refinery's product slate. In the case of the energy refineries it can upgraded to prime distillate products by a recycling thermal cracking process, co.king, deep oil fluid catalytic cracking or hydro-cracking or deed a combination of these processes."

oilngasseparator.info

The book of Genesis refers to bitumen as a main material used in the construction of the Tower of Babel, and the Epic of Gilgamesh 2500 BC) reports of bitumen use in the construction of Babylon.

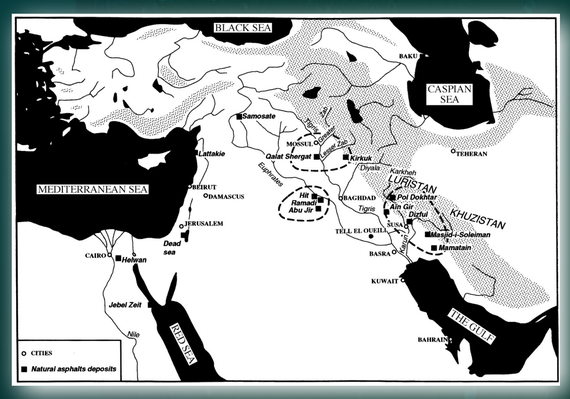
"The building of Babel in the land of Shinar by a people that had bricks stones and bitumen had they for mortar" (Genesis xi)

Bitumen, tar and coal tars were substances that fascinated alchemists, calling up as it does the material-chemical, curative and aesthetic potencies of the nigredo, or the black nothing from which all potential difference, value and otherness is derived, and pictured in Robert Fludd's et sic in infinitum, 1624:



A man lies in a bathtub filled with crude oil during a health therapy session at Naftalan Health Center in Baku, Azerbaijan June 27. (From Businessinsider.com)

Ancient Assyrian alchemists recommended asphalt for topical medicinal purposes, as well as for building purposes, and perhaps there is some merit in the fact that the Assyrian moral code recommended that asphalt, in the molten state, be poured onto the heads of delinquents. Pliny, the Roman author, also notes that bitumen could be used to stop bleeding, heal wounds, drive away snakes, treat cataracts as well as a wide variety of other diseases, and straighten out eyelashes which inconvenience the eyes. One can appreciate the use of bitumen to stop bleeding but its use to cure other ailments is questionable and one has to consider what other agents were being used concurrently with bitumen.



Map of the Near East showing the locations of the major natural asphalt deposits — Connan, J. (1999). Use and trade of bitumen in antiquity and prehistory: molecular archaeology reveals secrets of past civilizations. Philosophical Transactions of the Royal Society of London B: Biological Sciences, 354(1379), 33-50.

The embalm in cloth. was rare- tion, ex- pings the body. filled with spices, mersed dried, brief pe- asphalt corpse coat the mûmûia Byzan- bitumen. Empire and the Europe.

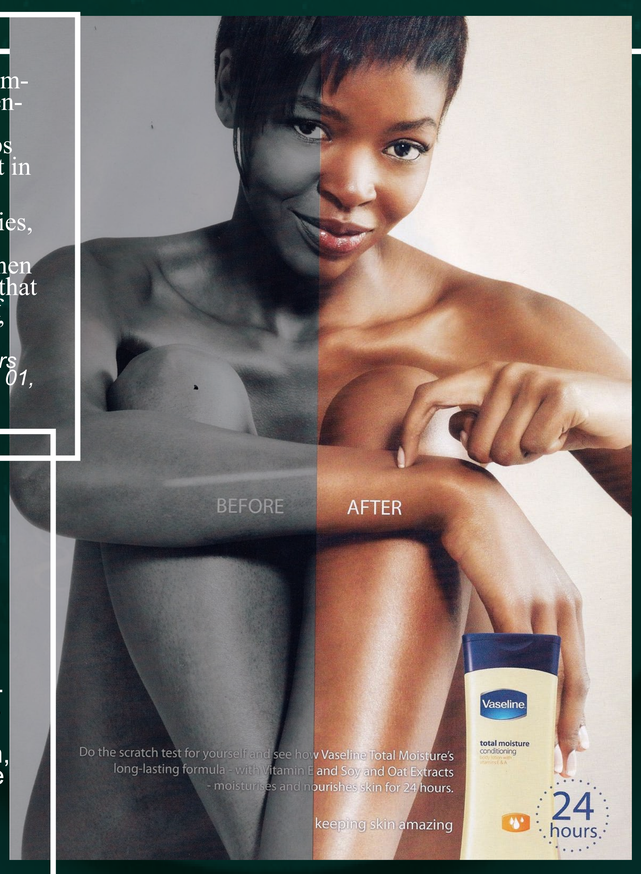
Egyptians were the first to their dead, wrapping bodies Before 1000 BC, asphalt ly used in this mummifica- cept to coat the cloth wrap- and thereby further protect Bodily cavities were first a mixture of resins and and then corpses were im- in a bath of potash or soda, and finally wrapped. For a riod (500 to about 40 BC) was used in cases to fill the cavities, as well as to cloth wrappings. The word first appears in Arabian and tine literature, signifying The spread of the Islamic brought Arabic science, use of bitumen, to western

In Persian, the term bitumen re- ferred to a paraffin wax that was symptomatic of some of the crude oils in the area and re- mained after the destructive distillation of bitumen — paraffins crystallized from the mixture over time. In Syriac, the term bitumen alluded predominantly to substances used for mummification. In Egypt, natural resins were used extensively for the purposes of embalming up to the Ptolemaic period 305 to 30 BC, when asphalts gradually came into use.

"Bitumen is the agent most closely associated with Egyptian embalming: The word "mummy" has long been thought to come from mumiyah, the Arabic word for bitumen. For centuries many people have believed that some mummies owe their black appearance to a thick coating of the material, which is found floating in blocks on the Dead Sea and seeps from the earth throughout the Middle East. Yet the Bristol team couldn't find a trace of it in their samples.

Small quantities of bitumen may have been used to waterproof some Roman-era mummies, Bristol concedes. But "the idea that bitumen was widely and generally used is just rubbish, quite frankly," Buckley says. "Some mummies are not black; they're only black when they're unwrapped by people," rather as a cut apple browns when exposed to air. Given that beeswax was a primary material used in mummification, Buckley says, the real origin of "mummy" may lie much closer to home: In Egyptian Coptic, the word for wax is mum."

— Glausiusz, J. The Chemistry of Mummies: The secret ingredients used by Egyptian embalmers are revealed at last. Discovery Magazine. Friday, March 01, 2002



What was once called mum, mummia or mumia is defined by at least three main mineralogical terms:

What was once called mum, mummia or mumia is defined by at least three main mineralogical terms:

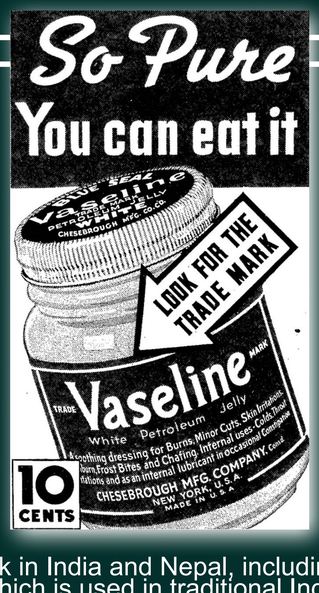
1. Bitumen (from Latin bitūmen) originally meant "a kind of mineral pitch found in Palestine and Babylon, used as mortar, etc. The same as asphalt, mineral pitch, Jew's pitch, Bitumen judaicum", and in modern scientific use means "the generic name of certain mineral inflammable substances, native hydrocarbons more or less oxygenated, liquid, semi-solid, and solid, including naphtha, petroleum, asphalt, etc."

2. Asphalt (from Ancient Greek ásphaltos "asphalt, bitumen") first meant "A bituminous substance, found in many parts of the world, a smooth, hard, brittle, black or brownish-black resinous mineral, consisting of a mixture of different hydrocarbons; called also mineral pitch, Jews' pitch, and in the [Old Testament] 'slime'", and presently means "A composition made by mixing bitumen, pitch, and sand, or manufactured from natural bituminous limestones, used to pave streets and walks, to line cisterns, etc.", used as an abbreviation for asphalt concrete. Until the 20th century, the Latinate term asphaltum was also used.

3. Pissasphalt (from Greek pissasphaltus "pitch" and "asphalt") names "A semi-liquid variety of bitumen, mentioned by ancient writers".

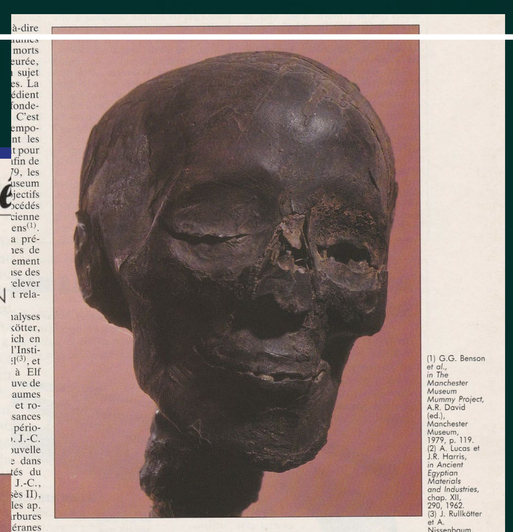
Likewise, creosote, pitch, coal tar and tar are terms that have described varying viscocities and types of ac- Mummia, inac- are curately and oils curately. All uid dark brown vari- and sol- ic id-liq- dis- composites, tilled from coal tar and used, broadly speaking, containing as preservatives. Pitch, creosote, coal tar and ous phenols bitumen have properties that make it essential other organ- for waterproofing and electrical insulation. It has compounds, found its way into hundreds of applications from road surfacing, to ship building, to roofing, to industrial anode and cathode production.

The black stuff is heavily prescribed in Greek and Roman medicine as a treatment for Pliny says everything from toothaches. ment of it should be used in the treat- John Rose "mammary excoriations" (Sir Chemical, Cormack. A Treatise on the Proper- Medicinal, and Physiological by Experi- ties of Creosote: Illustrated with Some ments on the Lower Animals: ment of Considerations on the Embal- veian Prize the Egyptians. Being the Har- millennia Dissertation for 1836). Many Muslim later, with the coming of Islam, it for skin physicians began to prescribe ailments and wounds.



The me- dicinal use of bituminous mummia has parallels in Ayurveda: various silajit (from Sanskrit shilajatu found on rock in India and Nepal, including a dark-brown odoriferous queror") or mumijo (from Per- substance which is used in traditional Indian medicine and probably con- iyā „wax") is a name given to sists principally of dried animal urine. solid or viscous substances

This geo-chemical-medicinal lineage short circuits toward petroleum jelly, lip-balm and petro-cosmetics. Vaseline, the Brooklyn-born balm, was American inventor and chemist Robert Chesebrough's brainchild. Chesebrough created the hydrocarbon mixture first in 1859, inspired by the resurgence of alchemical texts and practices in Europe. He distilling a raw slurry leftover from Pennsylvania oil fields called "rod wax". Chesebrough took to pouring acid on himself and burning himself with flames in public demonstrations in order to example the healing powers of his product. He also ate two spoonfuls of distilled rod wax a day. We now rub petroleum on ourselves; we smear our children with oil.



Published by Shift Register - www.shiftregister.info
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Critical Media Lab Basel
Institute of Experimental Design and Media Cultures

SHIFT REGISTER

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Topical Petro-chemistry (Oil, Coal Tar, Vaseline)

APETE
Artistic Petrophysical Evaluation

The practice or belief that it was used to preserve bodies forges a connection between tar, coal tar, asphalt and bitumen and bodily health, as well as aesthetic pleasures. Inaugurating two-millennia of profiteering derived from the ground up remains of dried, mummified body parts, used as tinctures and teas, pigments and powers. The ground up bodily remains of mummies constituted representations of the fleshy imagings of modern artists like Marcel Duchamp. The pigment “Mummy Brown,” a dark brooding greyish-brown, was popular amongst European artists well into the early twentieth-century. It was a colour created from the grinding up mummified corpses, available into the mid-1970s (McCouat, Philip. “The Life and Death of Mummy Brown,” Journal of Art In Society, 2013).

Nude Descending a Staircase. Painting by Marcel Duchamp, 1912.

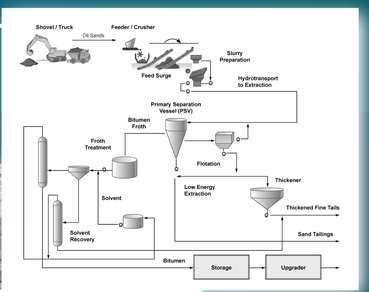
Mummia became a lengthy and unusual chapter in the history of both art and medicine, beginning with sasphalt a well known Persian mumiya black pisremedy for wounds and fractures, which was then confused with similarly appearing black bituminous materials used for Egyptian mummification, which then gave way to misinterpretations by Medieval Latin translators and alchemists to mean whole mummies. All of this was further complicated by greed for profitable fake mummy drugs, dust and paints.

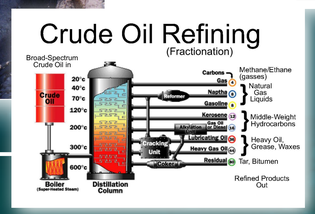
To cause the face to appear in a mass of flame make use of the following: mix together thoroughly petroleum, lard, mutton tallow and quick lime. Distill this over charcoal fire, and the liquid which results can be burned on the face without harm.

— Harry Houdini

Its character is of a solid at normal room temperatures, which can be shattered with a hard impact. It is always fluid, flowing imperceptibly over long durations — artist Rosemary Lee has highlight this through the slippage or spillage from ‘durée’ (as in length or period of time) to ‘dureté’ (as in durability or hardness). Unhindered in its movement, bitumen is an allegorical material, a substance that examples obdurate, slow violence—while fluid, it can effect great earthquakes and powerful ruptures—a cracking, liquid earth.

HOPS
Heavy Oil Production Systems





EUQ
EDIBLE UTILITY QUOTIENT

The French tradition of Gigot bitume involves a leg of lamb wrapped in kraft paper and cooked in a bath of molten bitumen. It is a traditional preparation for a ceremonial meal that celebrates the end of a construction project and takes place on the construction sites of buildings and public works.

HaFHD
Health and Fire Hazard Data

Routes of Entry:

Inhalation, Skin, Mucous Membranes, Eye Contact And Ingestion At Elevated Temperature Only

Effects of Exposure / Symptoms:
A Moderate Irritant.

Emergency Treatment:
Remove Victim To Fresh Air, Contacted Body Part To Be Immediately Plunged Under Cold Running Water For Ten Minutes.

Serious Eye Damage/Eye Irritation - Category 2A Skin Sensitization - Category 1
Causes serious eye irritation.
May cause an allergic skin reaction.

Germ Cell Mutagenicity - Category 2 Carcinogenicity - Category 1B
Suspected of causing genetic defects.
May cause cancer.

Reproductive Toxicity - Category 2
Suspected of damaging fertility or the unborn child.

Specific target organ toxicity - Single exposure - Category 1 (blood)
Causes damage to organs.

Specific target organ toxicity - Single exposure - Category 2 (eyes)
May cause damage to organs.

Specific Target Organ Toxicity - Repeated Exposure - Category 1 (blood , eyes , respiratory system)
Causes damage to organs through prolonged or repeated exposure.

Hazardous to the Aquatic Environment - Acute - Category 1
Very toxic to aquatic life with long lasting effects.

Hazardous to the Aquatic Environment - Chronic - Category 1
Very toxic to aquatic life with long lasting effects.

Suitable Extinguishing Media — regular dry chemical, carbon dioxide, regular foam, water spray

Unsuitable Extinguishing Media — high-pressure water streams

Hazardous Combustion Products — oxides of carbon

Advice for firefighters — Slight fire hazard. Contact with heat may generate toxic and/or flammable gases.
Containers may rupture or explode if exposed to heat.

Fire Fighting Measures — Avoid inhalation of material or combustion by-products. Move container from fire area if it can be done without risk. Stay upwind and keep out of low areas. Use extinguishing agents appropriate for surrounding fire. Flood with fine water spray. Directly spraying water or foam onto hot burning product may cause frothing. For fires in cargo or storage area: Cool containers with water from unmanned hose holder or monitor nozzles until well after fire is out. If this is impossible then take the following precautions: Keep unnecessary people away, isolate hazard area and deny entry. Withdraw immediately in case of rising sound from venting safety device or any discoloration of tanks due to fire.

HERPIS
Health and Environment Related Petrocultural Infrastructure Systems

The Naftalan resort is located 50 km from the ancient city of Ganja (Kirovabads), the second largest city in Azerbaijan, in a green area in a pine park on the shore of an artificial lake. In the shady alleys of the park created a great comfortable atmosphere for rest and treatment. The history of the Resort Naftalan has its origins in 1873, when the naphthalene

was extracted manually from shallow wells. “Thick blood of the earth” - the so-called naphthalene. It has been over 100 years since the beginning of the study and application of therapeutic properties naftalan. Its efficacy in various diseases confirmed by the results of more than 1,600 scientific papers and monographs. (naftalan-booking.com/)

HID
Health and Welfare Improvement Data

Coal tar topical (for the skin) is used to treat the skin symptoms of psoriasis, including dryness, redness, flaking, scaling, and itching. Tar can help slow the rapid growth of skin cells and restore the skin’s appearance. In addition, it can help reduce the inflammation, itching and scaling of psoriasis. Tar products can vary dramatically from brand to brand. Coal tar is not a cure for psoriasis, and it will provide only temporary relief of skin symptoms.

MG217 is 3% coal tar, as strong as you can get without a prescription. Coal tar is excellent on some psoriasis sufferers at reducing inflammation on their scalp while simultaneously slowing down cell regeneration. The anti-fungal properties of coal tar can also help alleviate mild cases of seborrheic dermatitis but there are better ingredients on the market.

After 40 years of suffering with psoriasis and trying different products, I finally got relief from this terrible condition when I found MG217 Medicated Coal Tar Ointment and MG217 Medicated Coal Tar Lotion. I only wish I knew about it earlier. It would have definitely changed my life. But better late than never!

— L.C. -Haddonfield, NJ (www.mg217.com/testimonials/letters/)

Warnings: For external use only. Ask a doctor before use if condition covers a large area of the body. When using this product avoid contact with the eyes. If contact occurs, rinse eyes thoroughly with water. Use caution in exposing skin to sunlight. It may increase your tendency to sunburn for up to 24 hours after application. Do not use with other forms of psoriasis therapy such as ultraviolet radiation or prescription drugs unless directed by a physician. Do not use for prolonged periods without consulting a physician. Stop use and ask a doctor if condition worsens or condition does not improve after regular use of this product as directed. Keep out of reach of children. If swallowed, get medical help or contact a Poison Control Center immediately. This product contains coal tar, a product known in the state of California to cause cancer. (amazon.com)

Coal Tar To Ease Psoriasis

The major chemical components of coal tar solutions are aromatics, and other components from partially hydrogenated aromatics and heterocycles. Non-exhaustively, chemical compounds contained in Coal Tar Topical solutions include:

1 ring aromatics

Benzene; 1,2-dimethylbenzene; Biphenyl; Phenol; toluene; xylene; cresol (3 isomers); p-cresol; o-cresol.

2 fused rings

Naphthalene; Phenanthrene; Indene; Indan.

3 fused rings

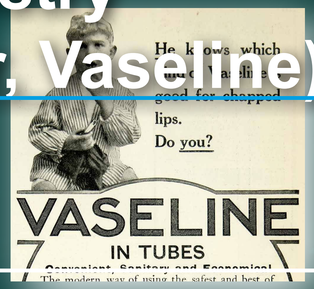
Anthracene; Anthraquinone; Dicyclopentadiene; Acenaphtene; Acenaphthylene; Fluorene;

4 fused rings

Pyrene; Chrysene; Fluranthrene; Benzo[k]fluoranthene;

Heterocycles (in which the ring contains one or many hetroatoms such as nitrogen, oxygen , sulfur)

Pyridine; Indole; Benzofurane; Carbazole; Quinoline; Quinaldine; Thiophene



Lip-balm, also known as “lip salve” is a petrochemical derivative, applied topically to the lips of the mouth to moisturize and relieve chapped or dry lips, angular cheilitis, stomatitis, or cold sores. Lip balm often contains beeswax or carnauba wax, camphor, cetyl alcohol, lanolin, paraffin, and petrolatum, among other ingredients. Some varieties contain dyes, flavor, fragrance, phenol, salicylic acid, and various chemicals which affect sunscreening.

The major petrochemical components of lip-balm are aromatics, and other components from partially hydrogenated aromatics and heterocycles. Non-exhaustively, chemical compounds contained in lip-balms include:

Parabens (methylparaben, butylparaben, etc.)

Parabens are known to interfere with hormone function, linked to increased risk of breast cancer and reproductive toxicity, and may also interfere with male reproductive functions. In a surprising recent study, methylparaben was found to block the breast cancer drug tamoxifen (more).

Synthetic Color and Dyes (FD&C Blue 1, Green 3, Yellow 5 & 6, Red 33)

Derived from coal tar, FD&C color pigments contain heavy metal salts that deposit toxins onto the skin, causing skin sensitivity and irritation. Animal studies have shown almost all FD&C colors to be carcinogenic.

BHT (butylated hydroxytoluene)

BHT has been show to mimic estrogen (endocrine disruptor). Is is linked to developmental and reproductive toxicity, and a possible carcinogen.

Fragrance and Flavor

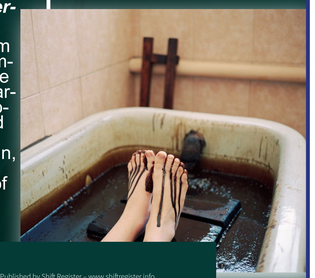
The U.S. Federal Drug Administration allows manufacturers to include a panapoly of ingredients in products under the term “fragrance”, without having to list the constituent chemical compounds. Many of these are composed of phthalates, which are are hormone disruptors linked to preterm births, reproductive birth defects in males, reduced fertility, and exacerbation of allergy and asthma symptoms.

Sunscreens (Oxybenzone, Octinoxate, Octisalate, Octocrylene, Avobenzone, Padimate)

The chemicals in sunscreen are disruptive to the body’s hormone system. The most common chemical sunscreen is oxybenzone can act like estrogen in the body, altering, amongst other things, sperm production.

Petrolatum (petroleum jelly, mineral oil):

Petrolatum is refined from petroleum (oil), processes which use toxic compounds. Petroleum jelly can become contaminated by PAHs (polycyclic aromatic hydrocarbons). PAHs are potentially carcinogenic and are linked to breast cancer. Petrolatum also creates an airtight barrier on the skin, causing it to act as a “penetration enhancer” aggravating the effects of other chemicals by increasing absorption into the bloodstream.



ACKNOWLEDGEMENTS

Special thanks to Dr. E. Villemin of the Organometallic chemistry and Polymerization catalysis group, Institut de Recherche de Chimie Paris (Prof. C. Thomas) and Laboratory for Inorganic Chemical Biology (Dr. G. Gasser), Chimie ParisTech, PSL Research University. Thanks as well to

Professor Sylvie Michel of the Equipe Pharmacognosie, Chimie des substances Naturelles at Université Paris Descartes, Faculté de Pharmacie and for the wonderful visit to the museum there. Also, much appreciation for instructive exchanges with Christian Bonah, MD, PhD and Professor for History of Science as well as Nils Kessel, Maître de conférences à l’Université de Strasbourg, both of DHVS Département d’histoire des sciences de la vie et de la santé in Strasbourg. Gratitude and love to Nicolas Malivel, and family.

Critical Media Lab Basel
Institute of Experimental Design and Media Cultures

FNSNF
Swiss National Science Foundation

Published by Shift Register – www.shiftregister.info
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Enteral Petrochemistry (Pharmaceuticals)

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ENTERAL PETROCHEMISTRY

Precursors, Distillations, Reactants, Pharmaceuticals, Medicines, Preparations, Nutrition & Digestion

"Strange, strange are the dynamics of oil and the ways of oilmen."
— Thomas Pynchon, Gravity's Rainbow (1973)

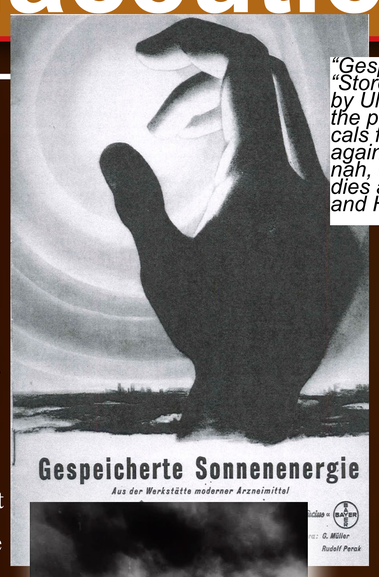
"Enteral Petrochemistry" describes those ways that petroleum serves as a precursor to the synthesis stages of internally administered pharmaceutical products. There is widespread understanding that the (American, long) Twentieth Century has (d)evolved into a petroculture, inescapably revolving, reacting and resulting from the petrochemical abundance of planet Earth: "In brief, while the 20th century was the century of oil, the 21st already is unfolding as the century of whatever follows oil, or the century of fighting over what's left of oil—or both." (Gerald F. Seib, "Oil Dependency Overshadows US Policy,"
Wall Street Journal, 22 August 2005)

Likewise and at the same time, internal cultures — microbiomes, gastric tissues, respiratory tracts and circulatory systems — are regularly, oftentimes knowingly and purposefully coated, soaked and contacted by the pure and applied, reactive and inert products of petrochemistry. This inner petro-fication results in and allows us to to preserve, manage, medicate and preservation, manage, tolerate and ignore endemic and intermittent disease, discomfort, disability and deregulations of the body. We are, all, oil women and oil men.

SSEUE
Solar Sourcing & Economies of Ultimate Expenditure

The green parts of the plants of land and sea endlessly implement the appropriation of an important part of the luminous energy of the sun. In this way light—sunlight— produces us, animates us and engenders our excess. This excess, this animation, is the effect of this light (we are essentially only an effect of the sun). In practice, from the point of view of wealth, the radiation of the sun distinguishes itself with its unilateral character: it loses itself without taking account, without compensation. The solar economy is founded on this principle. Usually, if one envisions our economy on the ground, one isolates it. But this is only a consequence of that which engenders and dominates it.

— Georges Bataille, The Economy Equal to the Universe: Brief Notes Preliminary to the Preparation of an Essay on "General Economy" Forthcoming Under the Title 'The Accursed Share'



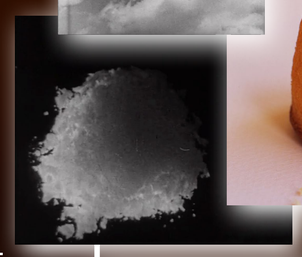
"Gespeicherte Sonnenenergie" / "Stored Sun Energy" a 1934 film by Ulrich Kayser for Bayer tracing the production of pharmaceuticals from sun to pill and back again (Thanks to Christian Bonah, Department for Social Studies and Humanities in Medicine and Health)

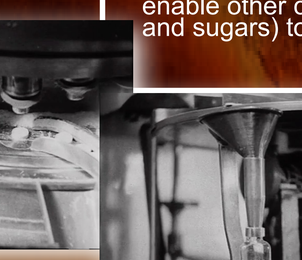
"What was I seeking when you arrived dyed by the sunrise
With the sea's age in your eyes
And with the sun's health in your body"
— Odysseas Elytis, Age of Glaucous Memory

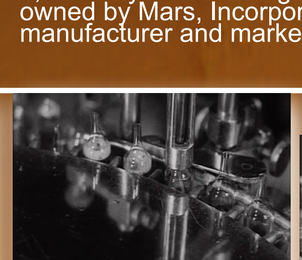
Histories and trajectories of solar geology can be told that link to synthetic opiates and birth control pills to universal labours; between the oil well and the pharmacy are the twined realities, imaginaries and projections of chemical engineering hopes and practices: on the one hand, "catalytic cracking" breaks down, aka "converts", petroleum in the refinery to isolate high-boiling, high-molecular weight hydrocarbon fractions of crude oils into more valuable gasoline, olefinic gases, and precursors like acetyls, alcohols, acetates, and others. On the other hand lies the dream of "total synthesis", the complete chemical synthesis of a complex molecule, often a natural product, from simple, commercially available, most often petrochemical, precursors. Synthetic drug production chemistry analyses and calculates petroleum hydrocarbons, opening and reconfiguring their structures. Often, a compound "synthesised by nature" and solar energies is felt to be all too rare, expensive or unruly, and the orientations and efforts of petrocultures becomes to replace these rogue creativities with understood and productive processes and delivery mechanisms. There is a conservationist argument to the use of petrochemical precursors for the synthesis of rarer hydrocarbons, in that the harvesting of difficult to find or un-farmed ecologies is lessened by the presence of.

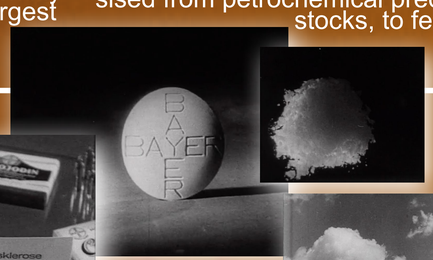
Petroleum is used in health care, as everywhere else, primarily as a transport fuel, but also significantly as feedstock for pharmaceuticals, plastics, and medical supplies. Few substitutes for these hydrocarbons, besides oil, are available. This dependence theoretically makes health care reliant on "Stored Sun Energy", and vulnerable to petroleum supply shifts, and it is a reliance that is particularly heavy in the United States, which consumes petroleum disproportionately on a per capita basis compared with other nations. There is increasing consensus that petroleum production has already declined or will soon begin to decline and that constrained supplies will adversely affect all sectors include health care. Health care's exposure to declines in petroleum production is a fact hiding in plain sight — the issue has received little attention from economists or policymakers, and little has been done to further assess and manage the potential risk. There are historical associations between petroleum supply shocks and health care prices. The In anticipation of future supply contractions lasting longer than previous shifts and potentially disrupting health care delivery, we propose an adaptive management approach and outline its application to the example of emergency medical services.

(American Journal of Public Health. 2011;101:1568–1579)









It is sunlight in modified form which turns all the windmills and waterwheels and the machinery which they drive. It is the energy derived from coal and petroleum (fossil sunlight) which propels our steam and gas engines, our locomotives and automobiles. ... Food is simply sunlight in cold storage.

— John Harvey Kellogg. New Dietetics: What to Eat and How (1921), 29

EIISC
Edible Inedible Indelible Snack Cakes

The Twinkie is an American snack cake, a "Golden Sponge Cake with Creamy Filling" made and distributed by Hostess Brands, Inc. which trades on National Association of Securities Dealers Automated Quotations (NASDAQ) securities exchange as "TWNK". Twinkie production was suspended on November 21, 2012, and resumed after an absence of at least ten months from American store shelves, becoming available again nationwide on July 15, 2013

There are 39 ingredients in a Twinkie, and all but one are processed. The list, which includes cellulose gum, calcium sulfate and polysorbate 60 are useful chemical additives for sheetrock building materials, shampoo, laundry detergent and jet fuel. Each of these processed ingredients — all vitamins, artificial flavors, colorings, and sorbic acid are made from natural gas and petroleum. To stay fresh on a grocery-store shelf, Twinkies can't contain anything that might spoil, like milk, cream, or butter. Each such perishable ingredient, systematically removed and reengineered as cellulose gum, lecithin, and sodium stearoyl lactylate give the cakes a maximum shelf life of approximately 45 days (1.5 months).

"Well, let's say this Twinkie represents the normal amount of psychokinetic energy in the New York area. According to this morning's sample it would be a Twinkie…thirty-five feet long weighing approximately six-hundred pounds.
—Egon Spengler, Ghostbusters (1984)

COHBOL
Chewing On the Humming Bird On the Left

Tlazolteotl is an Aztec goddess of purification, steam baths, midwives, filth, and a patroness of adulterers. Her dual her dual nature was as the goddess of dirt, but also of purification as she ate a person's sins to absolve them before death. Both the „Goddess of Dirt" (Tlazolteotl) and „Eater of Ordure" (Tlahelcuani), she was frequently portrayed with bitumen on her face and around her mouth to indicate divine excrement (holy shit).

The Gulf Coast of Mexico is an area of major oil drilling today and a region where Huitzilopochtli, the Aztec God of Sun and War once held dominion. Huitzilopochtli's name is a combination of two Aztec words: huitzilin, meaning "hummingbird", and opochtli, which means "left" — literally, "Hummingbird on the Left".

Chicle is a chewing gum substance made in part from bitumen, or chapapote, a black, natural petroleum tar that washes up onto the beaches of the Mexican interior, the Caspian sea, and the coasts of Norway and China. In addition to chewing chicle, ancient peoples used it for many practical purposes such as adhesives or sealants. Aztec women mixed bitumen together with axin, a yellowish oily substance that they obtained by cooking a small fly-like insect. Bitumen apparently had a refreshing taste. Spanish chronicler Fray Bernardino de Sahagun made note of the chewing of bitumen in his multi-volume treatise on Aztec culture known as The Florentine Codex (a twelve volume project he worked on from 1545 up until his death in 1590). Bernardino de Sahagún wrote that when it is chewed, bitumen "tires one's head; it gives one a headache." (from "The Florentine Codex : General History of the Things of New Spain" by Bernardino de Sahagún,). In Aztec society, the way in which you chewed this gum and where helped orient social, sexual and marital status. Aztec norms strongly disapproved of gum chewing among men, particularly in public.

Chapopote also had numerous domestic, religious, industrial and craft related applications, and Aztec priests used asphaltum for face and body painting. Sahagún write of its harvesting from the Gulf:

Bitumen [is] black, very black, black; [it is] that which flakes, crumbles, breaks up. It comes from the ocean, from the sea; it is produced within the ocean. When it comes forth, [it is] according to the time count. The waves cast it forth. It comes forth, it drops out according to the phase of the moon. When it comes forth [it is] like mat, wide, thich. Those of the seashore, those of the coast lands gather it there. They gather it, they pick it up from the sand."

– The Florentine Codex

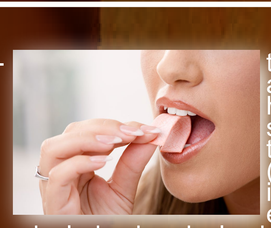
The nearby Chumash people, California's prehistoric peoples collected and chewed tar balls which seeped from the ground in places in that region (like the La Brea tar pits in Los Angeles). They also used tar to to waterproof woven baskets to make drinking vessels. More recent research reported in New Scientist in 2011 indicates that "Asphalt May Have Poisoned Ancient Americans". Bitumen is a source of polycyclic aromatic hydrocarbons (PAHs), which are pollutants that have been linked to a number of health problems.

"The chicle chewer" from The Florentine Codex, Book X. Axtecs created chewing gum by mixing bitumen (aromatic tar) with axin (a greasy oil made from crushed insects).

Of the over 100 polycyclic aromatic hydrocarbons (PAHs) found in oil, coal and tar, many are harmful to humans and life, causing infertility and stunting the growth of fetuses by damaging or altering DNA. (Note that psoriasis, often treated with coal tar, is characterized by an abnormally excessive and rapid growth of the epidermal layer of the skin due to excesses of DNA released from dying cells, which acts as an inflammatory stimulus in psoriasis). PAHs may also have been crucial for the first forms of life, as they contain most of the carbon found in space, and under the right conditions can be transformed into some of the complex molecules necessary for life.

Modern chewing gum is made from synthetic substitutes for natural rubbers, for the most part, butadiene-based synthetic rubbers. The material used as a base for chewing gum is High-Purity Iso-Butylene (HPIB). Isobutylene is an olefin petrochemical that is manufactured from feedstocks in the petroleum refinery, and is a four-carbon branched alkene (olefin) — one of the four isomers of butylene.

Other chemicals approved for use as a base in chewing gum include styrene-butadiene rubber (SBR), isobutylene-isoprene copolymer, paraffin wax, petroleum wax, polyethylene, poly-vinyl alcohol and synthetic terpene resin. Rubbers become softened when they absorb oils, and gum bases are similarly made softer when waxes are added; the waxes act as a kind of 'lubricant' between the strands of the hydrocarbon polymers in the rubber. Other petrochemically derived ingredients in chewing gum include emulsifiers such as glyveryl-monostearate, which are also softening agents and enable other components (including flavouring and sugars) to form a homogeneous mixture.



Humectants, a general term for substances that are added to keep things moist (the opposite of desiccant) are also used in the mix; these can include chemical substances like triacetin, the triester of glycerol (that is, glycol with three 'ester' groups) first prepared in 1854 by the French chemist Marcellin Berthelot who was born born in Rue du Mouton. Humectants are chemicals with an affinity to form hydrogen bonds with molecules of water, and are used in many products — food, cosmetics, medicines and pesticides — to decrease evaporation and increase shelf life.

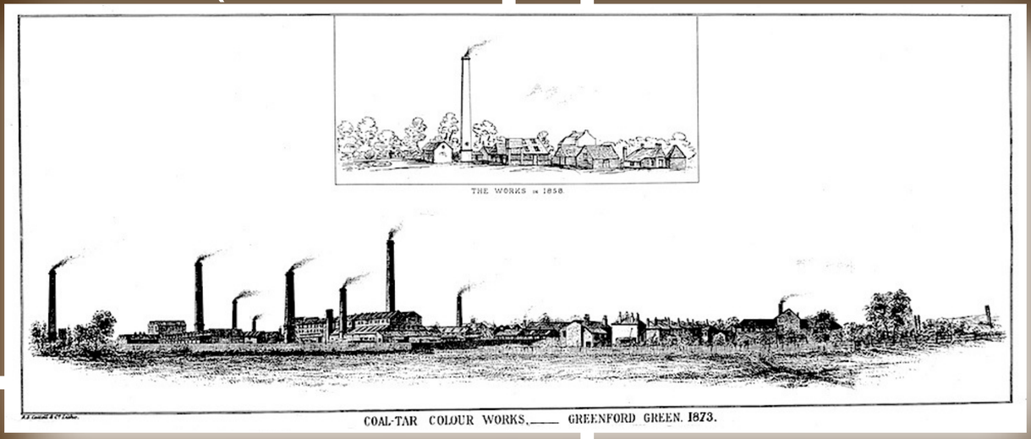
There are Internet forums rife with stories and anxious questioning about people chewing tar on the job or as children, mostly in poor areas in the U.S. and the Soviet Union in the late 19th and early 20th centuries, but also right up until today. "Wrigley's" is an American chewing gum company that was founded on April 1, 1891 by William Wrigley Jr. and now wholly owned by Mars, Incorporated. It is the largest manufacturer and marketer of chewing gum in the world. In the year 2000, this maker of Juicy Fruit, Big Red and Doublemint gums signaled the expansion of its offerings in being granted a U.S. patent to develop a gum that contains a dose of the generic chemical in Viagra (patent No. 6531114). The active ingredient of Viagra is sildenafil citrate, itself a drug synthesised from petrochemical sources and patented by the chemical company Pfizer Corp. Chewing gum is used and promoted as a delivery agent for numerous pharmaceutical, medicinal and therapeutic products and treatments. Examples include the addition of fluoride for strengthening tooth enamel and Nicorette, the brand name for gums and a number of other products that effect nicotine replacement therapy (NRT), against addiction to that chemical. Nicotine is itself now synthesised from petrochemical precursors and feedstocks, to feed the growing

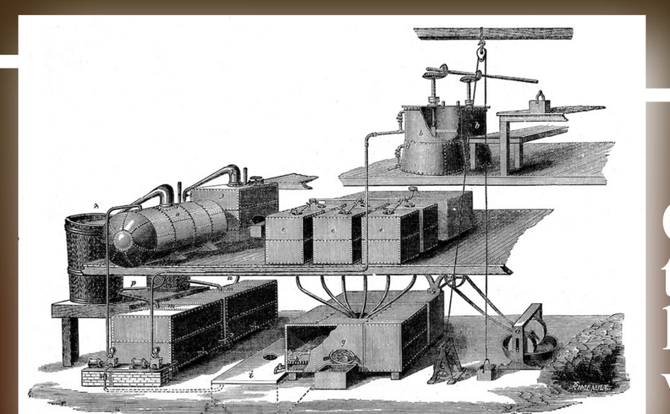
Critical Media Lab Basel
Institute of Experimental Design and Media Cultures
FNSNF Swiss National Science Foundation
Published by Shift Register – www.shiftregister.info
For the workshop The Eye Altering (cur. Garance Malivel)
Within the event We Are Not the Number We Think We Are
February 2–3, 2018, Cité Internationale des Arts, Paris
Edited by Jamie Allen, Martin Howse, Jonathan Kemp
Designed by Merle Ibach

Enteral Petrochemistry (Pharmaceuticals)

FEEDSARR
Coloration Cookbooks and Contrasting

Anne Ewbanks writes in a January 23, 2018 post at Atlas Obscura of a time "When Food Dye Was Made From Coal Tar" from the factories of one (later, Sir) Henry Perkins. "It was considered almost magical…" Petroleum now





In 1856, an 18-year-old British chemist made a mistake in one of his experiments. That mistake marked the beginning of synthetic food dye. William Henry Perkin wasn't trying to make Red #40 in his lab that day. As a research assistant for a famed chemist, he was trying to whip up synthetic quinine, a treatment for malaria. Perkin was interested in the properties of coal tar, an abundant byproduct of coke fuel, which comes from heating coal. But instead, he ended up with a dark powder. Washing out his flask with alcohol, Perkin was struck by the residue's bright purple color. He tried using it to dye silk, and it was a success. Perkin had found the world's first synthetic dye.

Dozens of illnesses caused by brightly colored Halloween candy in 1950 led the FDA to strike coal tar colors Orange #1,

Orange #2, and Red #32 from the list. Any potential renewal of their status was squelched when testing of all three colors made lab animals seriously ill. Twenty years later, another scare involved Red #2. Some tests showed that female rats develop tum- the color made ors. The backlash was so intense that some companies stopped selling red-dyed food for the next decade. The red M&M disappeared until 1987.

The 1906 Pure Food and Drugs Act empowered American regulators to decide which colors could be used for food, and they only approved seven colors. A writer for the The New York Times described with awe the difference: As manufacturers adjusted to the new rules, the "masquerade" was temporarily stripped away. Some formerly red, jarred cherries, for example, were naturally yellow. The coal tar dye used to brighten them had been banned.

Perkin also visited New York in 1906. Fifty years after his mauve discovery, hundreds of chemists celebrated the "magician of coal tar" at a dinner at Delmonico's, the country's most famous restaurant. The Americans all wore mauve bow ties in his honor.

— Ewbanks

FEEDSARR
Front End Engineering Design Actants, and Reagents

There are established naming conventions and product matrixes that travel from the petrochemical cracking and refining factory to the floor of pharmaceutical manufacturing plants. As with any raw material based on extraction, testing for quality and purity are paramount, and various 'grades' are set for uses. Higher grade materials are used and produced variably for customers in pharmaceutical and food industries, and monitored by quality control offices at the shipping and receiving end. The specific petrochemical reagents used in the arsenal of offerings by big pharmaceutical development, delivery, marketing and manufacturing companies would be impossible to list exaustively for all drugs on the market. A partial listing of pharmaceutically relevant precursors derived from oil and gas refineries is included here (all from Burdick & Leffler, "Petrochemicals in Nontechnical Language" (2010)

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The C16 AND C18 ALCOHOLS are used extensively in the cosmetics and pharmaceutical industries as emollient additives (the heaviest of the higher alcohols are actually wax-like), intermediates for perfume and avor components, and as a basis for creams, ointments, and suppositories.

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Until 1959, all the PHTHALIC ANHYDRIDE was made from coal tar NAPHTHALENE... which was easily oxidized directly to phthalic acid. But with phthalic anhydride being only a small share of coal oil, and with the demand for phthalic anhydride escalating rapidly, coal tar became an inadequate source. The frantic search for an alternative route led to the development of the recovery process for ORTHOXYLENE from re nery aromatics streams… and the conversion of ORTHOXYLENE to phthalic acid and anhydride. With the continued growth in the need for

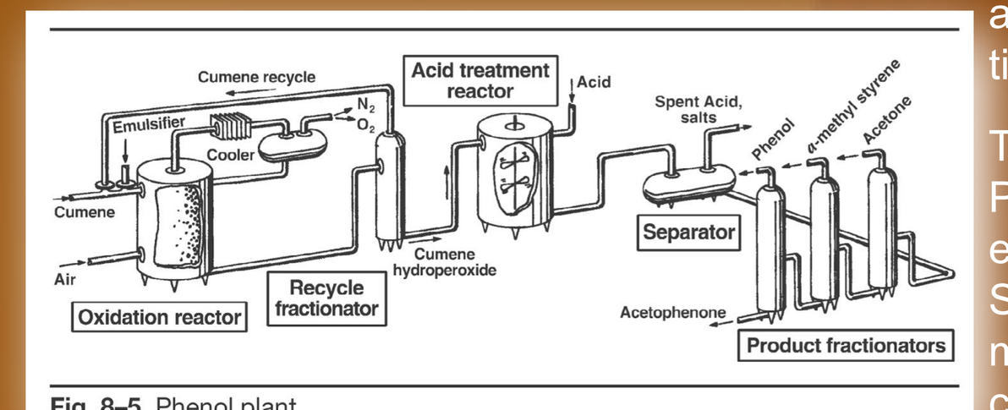

Fig. 8–5. Phenol plant

plasticizers and the inelasticity of naphthalene supply, orthoxylene now accounts for 90% of the phthalic anhydride supply in the United States.

PHTHALIC ANHYDRIDE is used largely to make plasticizer for polyvinyl chloride. It is also a feed for alkyd resins and for unsaturated polyesters that are widely used in construction, marine, and synthetic marble applications. Other minor applications are dyes, esters, drying oil modi ers, and pharmaceutical intermediates.

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PHENOL has been used for decades in the medical eld as an antiseptic under its alias, carbolic acid, and at one time as a preservative of human organs under the name creosote (from the Greek kreos, " esh," and sogein, "to preserve"). The name creosote eventually became associated with the wood preservative, but phenol remains the principal ingredient in this product.

The early sources of phenol were the destructive distillation of coal and the manufacture of methyl alcohol from wood. In both cases, phenol was a by-product. Recovered volumes were limited by whatever was made accidentally in the process. Initial commercial routes to on-purpose phenol involved the reaction of benzene with sulfuric acid (1920), chlorine (1928), or hydrochloric acid (1939). All these were followed by a subsequent hydrolysis step (reaction with water to get the –OH group) to get phenol. These processes required high temperatures and pressures to make the reactions go. They are multistep processes requiring special metallurgy to handle the corrosive mixtures involved. None of these processes is in commercial use today.

In 1952, a technological breakthrough was found: the cumene oxidation route. It was much cheaper, and it quickly proliferated. It is now the primary route, accounting for almost all of U.S. production.

The powder form of PHENOL is usually traded either as a United States Pure (USP) (98% minimum) grade or a chemically pure (CP) or synthetic grade (95% minimum), using nomenclature from the pharmaceutical industry. The first indicates a grade suitable for human consumption or for manufacture of a consumable. In the liquid form, the commercial grades are 90%–92% purity and 82%–84% purity.

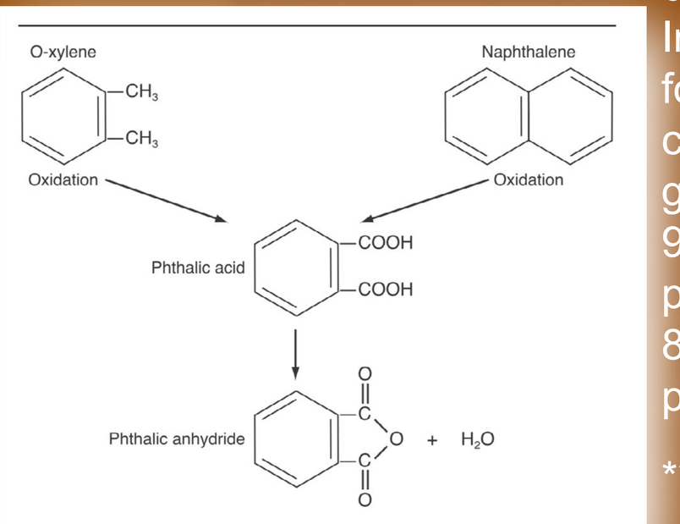

Fig. 20–3. Phthalic anhydride processes

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PHOSGENE was one of the rst poisonous gases used in the ghastly chemical warfare during World War I. It was later replaced by (and should not be confused with) the more vicious mustard gas (dichlorodiethyl sul de). Phosgene is also notorious for being one of the deadly gases created from the disastrous leak at a Bhopal, India, chemical plant in 1984, which resulted in more than 10,000 deaths. Clearly this is nasty stuff that calls for those extraordinary safety procedures.

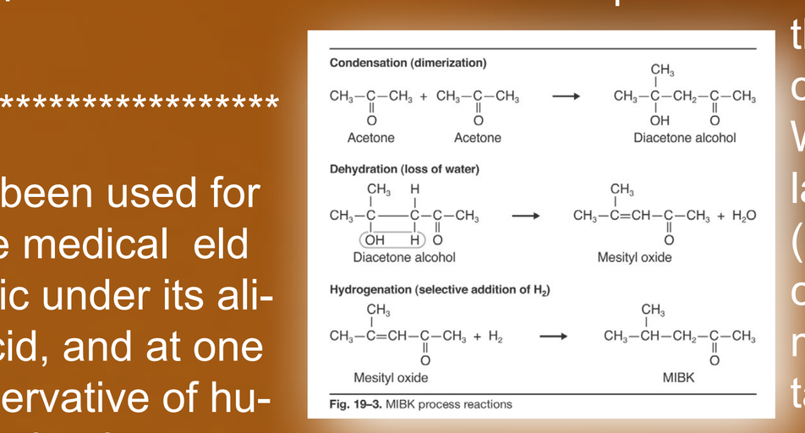

Fig. 19–3. MIBK process reactions

The rapid industrial growth of PHOSGENE is related to the manufacture of isocyanates for producing polyurethanes and bisphenol A for polycarbonates. After these two applications, about 10% of the phosgene finds its way into chemical intermediates for pharmaceuticals, pesticides, and agricultural chemicals.

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METHYL ISOBUTYL KETONE (MIBK) is more complicated than the one-step conversion process for acetone and MEK. Manufacture of MIBK takes the three-step process shown in gure 19–3, starting with acetone.

Some unique applications for MIBK include metallurgical extrac- tion (particularly plutonium from uranium), coating solvent for resins, a reaction solvent in pharmaceuticals, and as an adhesive. It is also used in the manufacture of methyl isobutyl carbinol.

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The fermentation of sugar in the presence of yeast to produce ETHYL ALCOHOL in the form of wine goes back beyond written history. The sugar came from grapes. Later, starch from grain, potatoes, or "corn squeezins" was used also. The yeast came from living matter in the form of mold or fungus. Yeast contains the enzyme zymase. It is this enzyme that catalyzes the fermentation of sugar. Mix sugar (in grape juice) with yeast, and they will react slowly over weeks, months, or maybe years to form ETHYL ALCOHOL and carbon dioxide, as well as minor amounts of some aldehydes. Depending on preferences, some of the nonalcoholic contents can be separated by distillation.

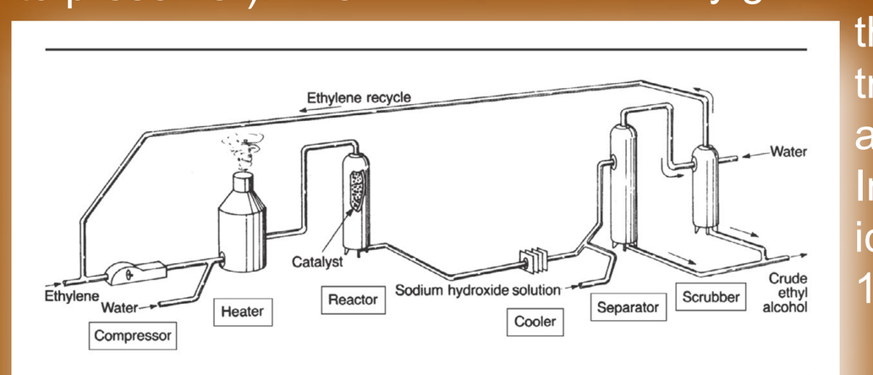

Fig. 16–2. Ethyl alcohol plant

Alcoholic beverages in the United States are made exclusively by the fermentation process, not the petrochemical process. It has nothing to do with the chemistry. It is due to a law enacted to protect the grain growers, not the consumers.

Until World War I, fermentation accounted for all the ETHYL ALCOHOL produced in the United States. In 1919, a petrochemical route based on ethylene, sulfuric acid, and water was developed commercially and called indirect hydration. By 1935, only 10% of the ETHYL ALCOHOL was produced this way, primarily because of the expense of the ethylene at that early stage of the industry. With the rapid improvements in ethylene technology, the share quickly grew to 90% by the 1960s. At that time, an alternate route, direct hydration, was developed, eliminating the use of sulfuric acid and one step in the process. Direct hydration replaced the indirect hydration process by the 1970s. Advantages were higher yields, less pollution, and lower plant maintenance due to less corrosion—all leading to better economics.

Currently, almost all synthetic ETHYL ALCOHOL is produced via the direct catalytic hydration of ethylene. That volume is totally overwhelmed by the fermentation-produced alcohol for the motor fuels market.

The balance of the industrial ETHYL ALCOHOL is in demand as a solvent in personal care products (aftershave lotion, mouthwash), inks, cosmetics, detergents, household cleaners, pharmaceuticals, industrial coatings, and as a processing solvent.

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BASF introduced high-pressure technology way back in 1960 to make ACETIC ACID out of METHANOL and carbon monoxide instead of ethylene. Monsanto subsequently improved the process by catalysis, using an iodide-promoted rhodium catalyst. This permits operations at much lower pressures and temperatures. The methanol and carbon monoxide, of course, come from a synthesis gas plant.

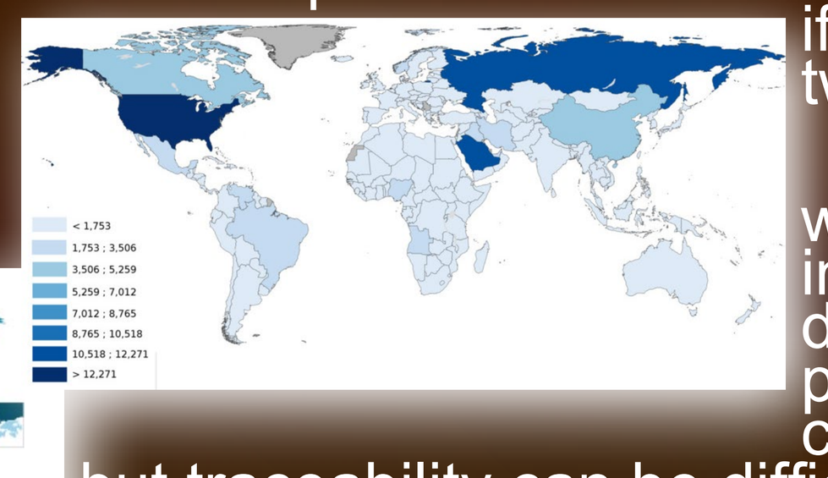
More than 65% of the ACETIC ACID produced in the United States goes into vinyl acetate. Nearly all the vinyl acetate ends up as polyvinyl acetate, used to make plastics, latex paints, and adhesives. About 12% of acetic acid is converted to acetic anhydride that is mostly used to make cellulose acetate, the white stuff in cigarette liters. It is also used in the manufacture of plastic sheeting and film and in formulating lacquers.

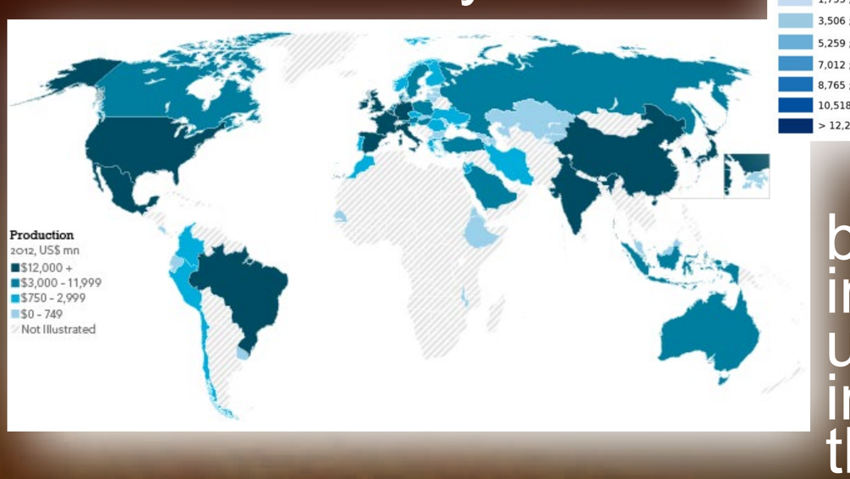
ACETIC ACID also finds use as a chemical intermediate in the production of acetate esters for paint solvents and as a reaction solvent for the manufacture of terephthalic acid. Also, acetic acid is the source of the acetyl group in the manufacture of ACETYL SALICYLIC ACID (ASPIRIN)

PPP
Planetary Petrochemical Pharmaceutics

Pharmaceuticals, generally speaking are now vital to modern, bodily health. This chemical category represents a relatively small but increasing proportion of total petroleum usage. More than half of most adult Western citizens take prescription medications at some point in their lives. Approximately 2.3 billion medication orders or prescriptions were written in 2006 in the U.S. alone. Analgesics, antidepressants, antihyperlipidemics, antidiabetic agents, antiemetics, and antihistamines are the leading medications prescribed. Approximately 3% of petroleum production is used for pharmaceutical manufacture, but just under 99% of pharmaceutical feedstocks and reagents are derived from petrochemicals (Joyce Easter, PhD, Virginia Wesleyan College, December 2010).

Pharma- and petro-chemistry two highly interlinked industries, yet they are so in a highly asymmetrically interdependent way. If "big pharma" matters little to big oil, big oil matters a great deal to big pharma. (One is reminded of Canadian Prime Minister Pierre Trudeau's comment that living next to America "is in some ways like sleeping with an elephant. No matter how friendly and even-tempered is the beast, if I can call it that, one is affected by every twitch and grunt.").





Drug manufacturers may ask where the starting materials for the drugs they purchase come from, but traceability can be difficult. Asking "where do you get your butyllithium from?" is somewhat akin to asking the name of the farmer who raised the specific chicken for a chicken sandwich bought at a McDonalds. The lines of flight, mixing and transport are many and complex, and those commissioning a drug to be manufactured to specification will be dealing with pharmaceutical engineering firms in India, and China. The suppliers of these Chinese and Indian industries come from other smaller industries which make the petrol cracking and small chemical conversions of these cracking products. Problems of supply and temporal latency in material pipelines such as "using up the world's supply of magnesium bromide" for a short time, to conduct a single synthetic step, can arise in what is a surprisingly disparate and wild industrial landscape.

AOPS
Aspirin Offloading, Production and Storage

Aspirin is an anti-inflammatory and one of the first drugs to come into common usage. It remains the mostly widely used drug in the world. Approximately 35,000 metric tonnes of the pharmaceutical are produced and consumed annually, or approximately 100 billion standard aspirin tablets each year. Aspirin is acetylsalicylic acid (ASA) which, typically for medicinal chemistry, comes originally from a natural source, although today is difficult to find as a commercial nonsynthetic. It was redeveloped in the laboratory and developed into pill form to be sold at mass market. Natural aspirin can be derived from the herbs meadowsweet and willow bark, but as a chemical and process was patented by Bayer in Britain (filed 22 December 1898) and the United States (US Patent 644,077 issued 27 February 1900). The word Aspirin was Bayer's brand name, a drug who's popularity grew over the first half of the twentieth century but declined after the development of acetaminophen and paracetamol in 1956, and then ibuprofen in 1962. Bayer's profits were eaten into after its brand name and rights to the trademark were lost or sold in many countries, and generic products by other manufacturers proliferated.

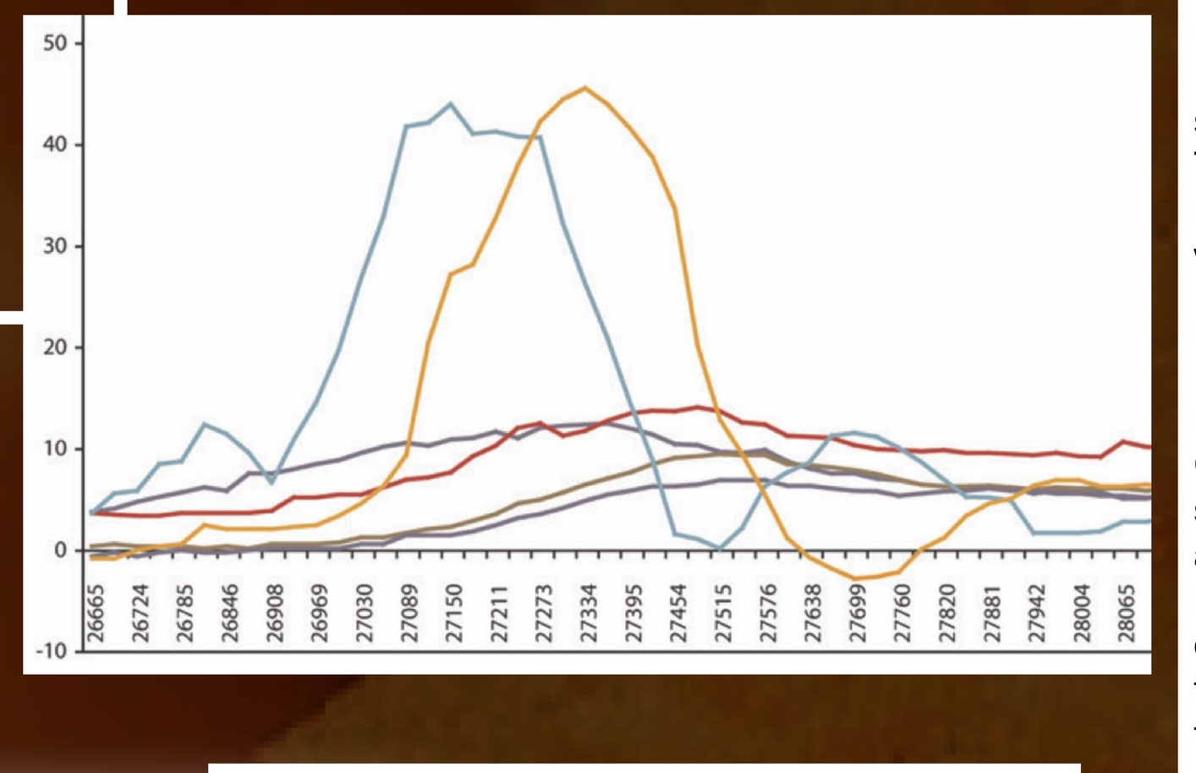
When SALICYLIC ACID (100.0 parts) is heated with acetic anhydride (150.0 parts) for 3 hours under reflux, the salicylic acid is quantitatively acetylated. After distilling off the acetic acid one obtains the above in the form of needles, which, when crystallized from benzene, melt at 136 degrees (value in the literature is 118 degrees). In contrast [with] the literature reports, my acetyl product no longer gives a reaction with ferric chloride, which readily distinguished it from salicylic acid. By its physical properties, e.g. its sour taste without being corrosive, the acetylsalicylic acid differs favourably from salicylic acid, and is now being tested in this respect for its usefulness.

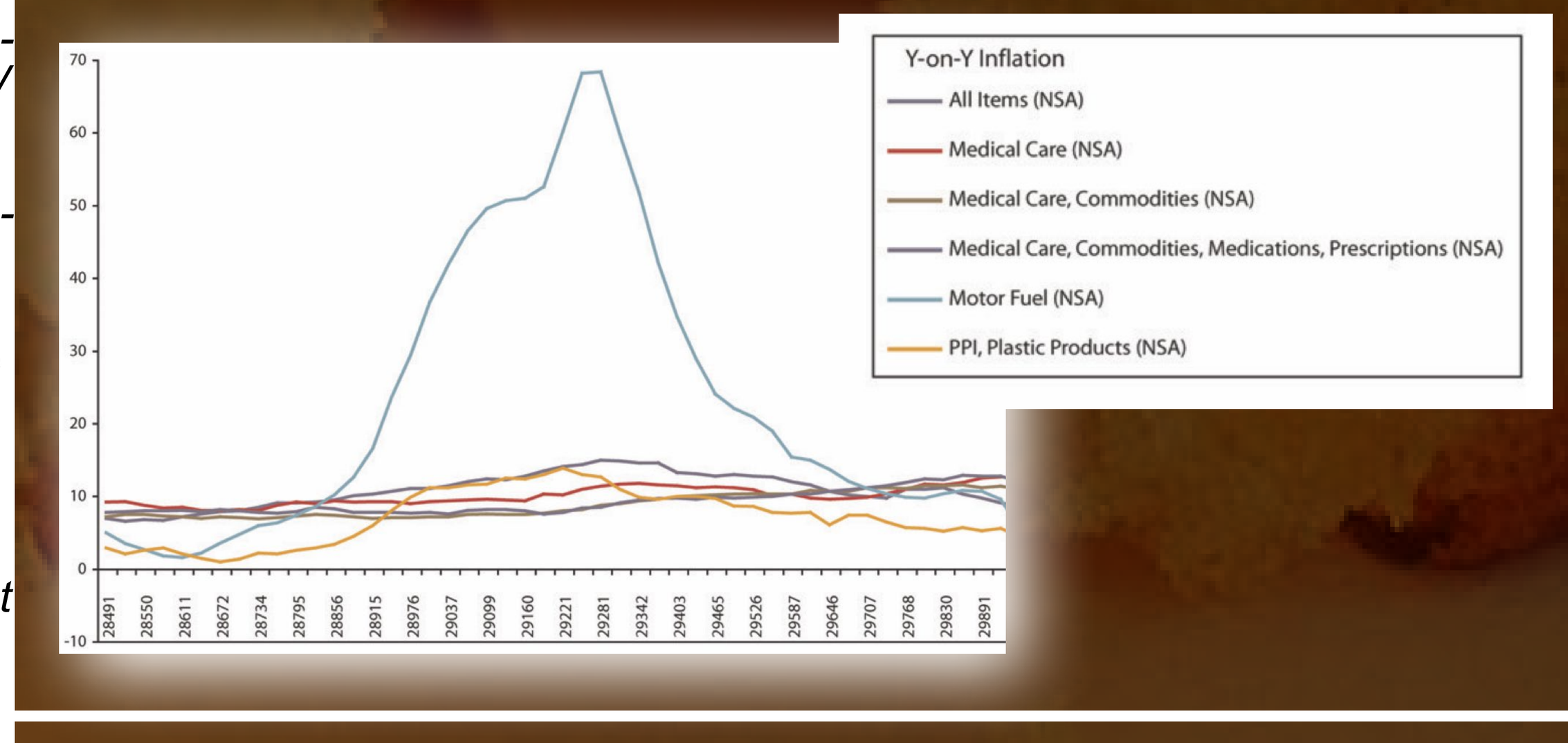
— From the laboratory journal of Felix Hoffman, 10 August 1897 (from Diarmuid Jeffreys' 2010 book "Aspirin.")

On the 10th of August, 1897, Felix Hoffmann synthesized acetylsalicylic acid while working at Bayer under Arthur Eichengrün. By acetylating salicylic acid with acetic acid, he succeeded in creating acetylsalicylic acid in a chemically pure and stable form. The pharmacologist responsible for verifying these results was skeptical at first, yet once several large-scale studies to investigate the substance's efficacy and tolerability had been completed, it was found to be a pain-relieving, fever-lowering and anti-inflammatory substance. The company then worked to develop a cost-effective production process that would facilitate the promising active ingredient to be supplied as a pharmaceutical product. In 1899 it was marketed for the first time under the trade name Aspirin, initially as a powder supplied in

A number of synthetic steps which are changed in scaling up from laboratory to manufacturing scales have to do with (chemically relatively simple, but costly) manufacturing limitations. Not every company, region or industrial plant can do, for example, cryo-reactions which require large, one thousand litre liquid nitrogen cooled vessels. Not every company, region or industrial plant has a large enough palladium catalyst contraptions to do relatively dangerous hydrogenation reactions that require large vessels of highly explosive hydrogen gas under high pressure. Less a matter of money, than time, plants and manufacturers are less likely to buy into processes that can take many months to commission, startup and test. Validation batches are high-loss, lengthy steps for new production manufacturers to bring online.

Glenmark Pharmaceuticals is a pharmaceutical company headquartered in Mumbai, India that was founded in 1977 by Gracias Saldanha as a generic drug and active pharmaceutical ingredient manufacturer; he named the company after his two sons. Glenmark's first manufacturing facility in Nashik, India, which commenced operations in 1983. The facility is equipped to manufacture products across various dosage forms: Oral solids, Liquid orals, External creams and Powders, and was ISO 14001 (environmental responsibilities and management) approved in 2004 and has regulatory approvals with ANVISA Brazil, MOH Ukraine, INVIMA Columbia, NDA Uganda, MOH Nigeria, TFDA Tanzania, MOH Ethiopia, MCC South Africa, MOH Congo, MOH Oman, WHO – GMP. Products made at Nashik are exported to Glenmark's emerging markets including Asia, India, Africa, Russia, the Commonwealth of Independent States and Russia, and Latin America.





The trajectories of year-on-year inflation several non-seasonally adjusted price variables including motor fuel, health care, health care services, health care commodities, prescription medications, plastics, and the consumer price index for the years 1973—1977 and 1978—1982 show declining associations between oil and health care prices. (Hess, J., Bednarz, D., Bae, J., & Pierce, J. (2011). Petroleum and health care: evaluating and managing health care's vulnerability to petroleum supply shifts. American journal of public health, 101(9), 1568-1579.) There often appears to be an association between decreased petroleum supply (indicated by a rise in inflation in motor fuel prices, which covary closely with petroleum supply), a rise in the price of plastics, and, lagged by several months, the prices of healthcare commodities such as pharmaceuticals and health care as a whole.

ACKNOWLEDGEMENTS

Special thanks to Dr. E. Villemin of the Organometallic chemistry and Polymerization catalysis group, Institut de Recherche de Chimie Paris (Prof. C. Thomas) and Laboratory for Inorganic Chemical Biology (Dr. G. Gasser), Chimie ParisTech, PSL Research University. Thanks as well to

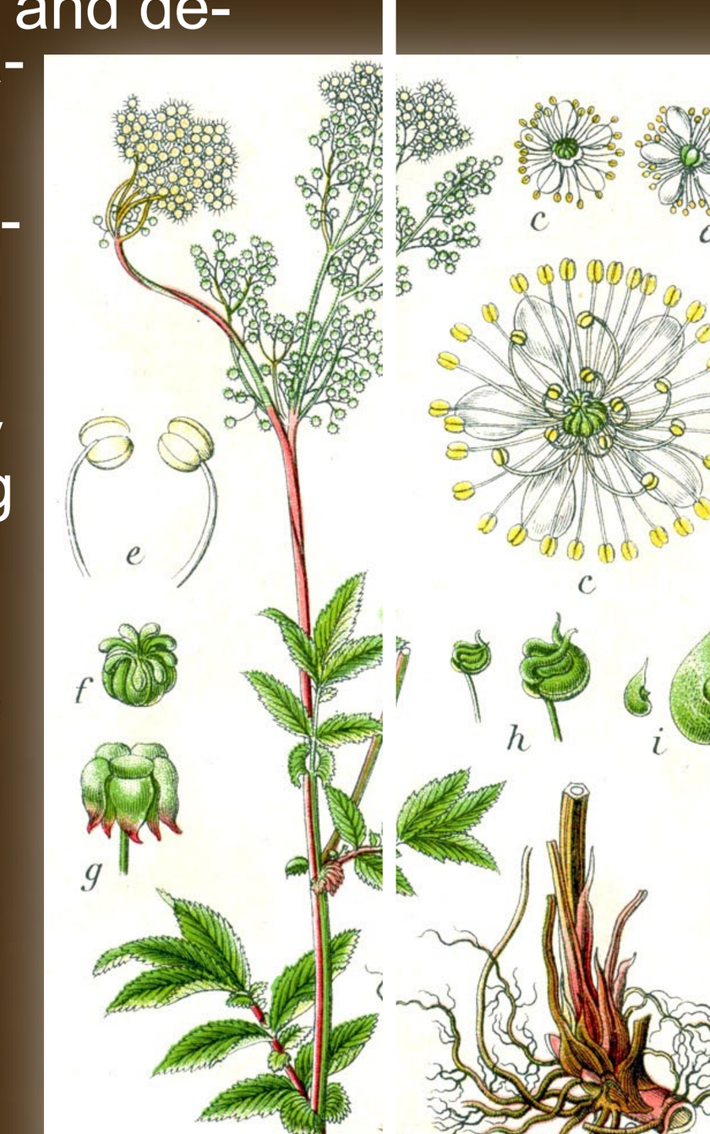
Professor Sylvie Michel of the Equipe Pharmacognosie, Chimie des substances Naturelles at Université Paris Descartes, Faculté de Pharmacie and for the wonderful visit to the museum there. Also, much appreciation for instructive exchanges with Christian Bonah, MD, PhD and Professor for History of Science as well as Nils Kessel, Maître de conférences à l'Université de Strasbourg, both of DHVS Département d'histoire des sciences de la vie et de la santé in Strasbourg. Gratitude and love to Nicolas Malivel, and family, and Darren Begley, and family.

As expected, the increase in health care inflation is small compared with the rise in the price of plastics. These patterns are most evident in the first oil price shock in the 1970s, diminishing over time. There is increasing volatility in oil price inflation that makes it difficult to discern a clear pattern in later shocks.

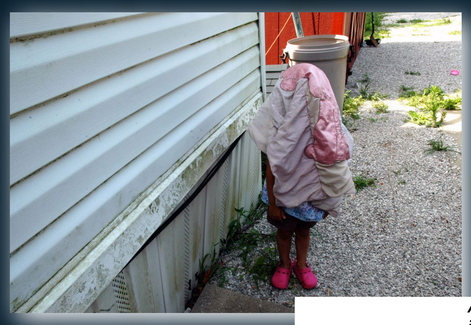
There is little likelihood that reverse causation is driving these observations because health care delivery consumes a relatively small proportion of total petroleum output and does not set demand for petroleum-based products. Oil supply shifts are presumed to not be related to health care delivery, so there is little likelihood that this association is significantly confounded by an unexamined factor.

The most likely reasons for the observed association are that health care delivery is petroleum dependent and that its cost is sensitive to shifts in petroleum supply. The apparent decline in the magnitude of effect over the two periods, 1973—1977 and 1978—1982, is important to note, however. This is likely because of the decreasing contribution of both transport and supply costs to overall health care costs. Health care is a service industry, and labor costs are increasingly dominant in its price structure. Overall, the analysis suggests an association between petroleum supply and health care prices that is inconstant over time because the costs of other health care components have risen disproportionately.

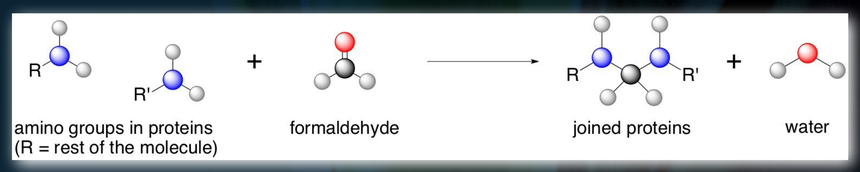
Oil price inflation has a modest impact on health care price inflation, with some time lags. Petrochemical feedstock costs are likely a relatively small share of total pharmaceutical costs, however, which are dominated by marketing, research, and development (largely labour and distribution costs). Also, the impact on medical commodity prices started later than did the impact on other medical care prices, likely due to manufacturing times, lengthy testing and delivery lags and transport and shelf life factors. The health care system exhibits high exposure, moderate susceptibility, and high resilience to short-term supply shocks; long-term shocks likely pose a more difficult challenge. (Hess, J., et. al 2011)

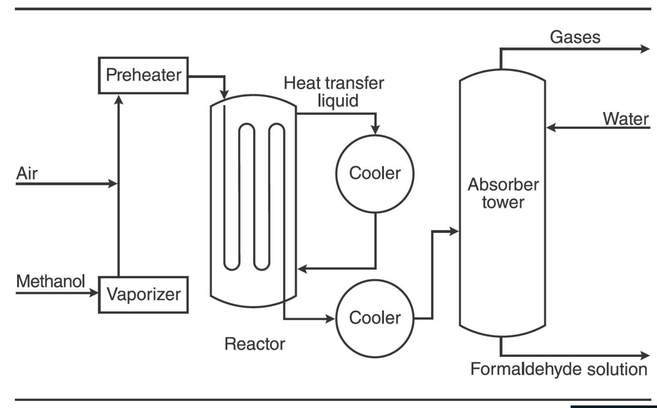


Formaldehyde



A five-year-old waits outside of her formaldehyde-laiden home, Indiana 2011.





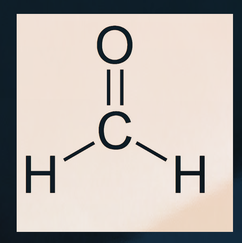
Formaldehyde process — air oxidation of methanol. Petrochemicals in Nontechnical Language, D. L. Burdick and W. L. Leffler, 2010

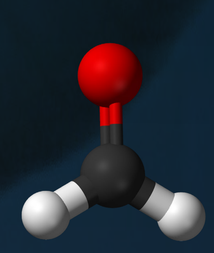
When Shelter Becomes Exposure

Indoor air is routinely more polluted than the air of corresponding outdoor environments. This is partly because polluted outdoor air seeps inside, but the major contributors to poor indoor air quality are often the construction materials of the built environment itself, which slowly off-gas a host of volatile organic compounds.

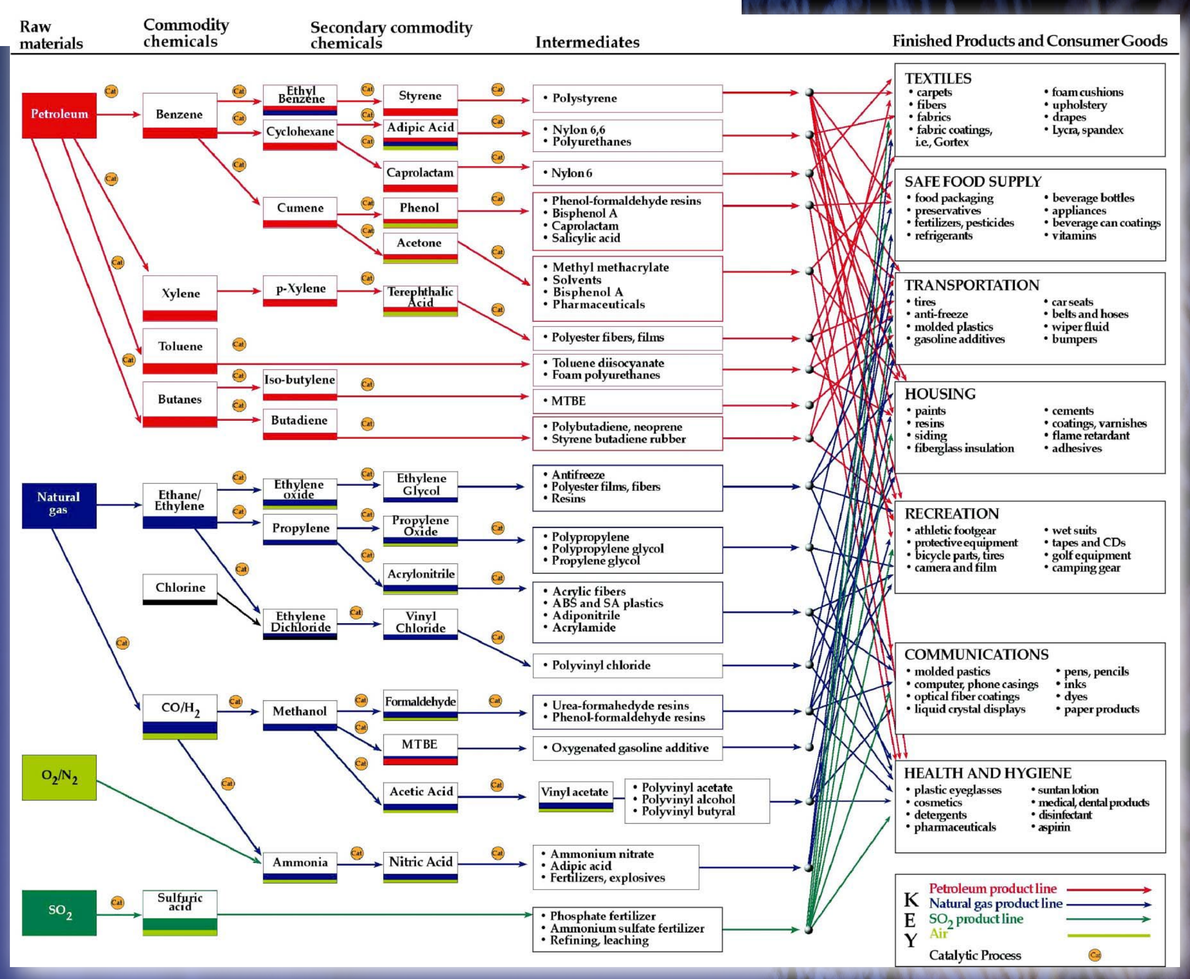
Domestic chemical ecologies have both many toxicant sources and many toxicant sinks. We are focusing on formaldehyde because it is the most common and also most toxicologically understood indoor air pollutant. Formaldehyde slowly and silently off gasses from engineered woods, carpets, and permanent press clothing.

Formaldehyde is an irritant, an allergen, a neurotoxin and a known human carcinogen. Its presence in mammalian bodies can destroy enzymes that maintain bronchial tone, strip axons of their sheathing, dysregulate gene expression, break chromosomes, mis-fold proteins and create deficits in behavior, cognition, and learning. Neurochemists are increasingly suspecting this nearly omnipresent chemical to have a role in neurodegenerative diseases such as Alzheimer's disease and multiple-sclerosis.





Flow-Chart for Products from Petroleum-based Feedstocks, 2004. National Renewable Energy Laboratory, U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy. (Natural gas → CO/H2 → methanol → formaldehyde)



Binding Functions

A man in a suit demonstrates the flexibility of a plywood veneer in the 1950s.

Even the most serene home is bustling with molecular labour. Before we begin to fill our homes with the airborne residues of myriad commodities, the adhesives that hold together the plywood walls, particleboard subfloors, hardboard cabinetry and carpet backings of conventional western homes slowly exhale chemical vapors into interior breathing space. In the home, no compound does as much immobilizing, adhering, hardening, painting, lacquering, disinfecting, laminating or reinforcing as formaldehyde.

Formaldehyde is not only essential to the building techniques propagated by industrial capitalism but also to life itself. In the human body, the chemical is an indispensable metabolic intermediary in the biosynthesis of two of the four building blocks of DNA, some amino acids, and molecules that plays a role in blood pressure control and hormone signaling. The chemical is both ***essential*** and ***routinely*** destructive to biotic functioning.

The material paradoxes of formaldehyde abound. The chemical defends home construction materials from insect, bacteria and fungal decay while also hastening the decay of human inhabitants. Ironically, this chemical not only decomposes human bodies, but an average of 3.5 gallons of formaldehyde is injected into the veins of the dead to fend off post-mortem decomposition. The compound chemically tugs Americans towards death, and then ultimately defends their inanimate bodies from biological disintegration. The removal of biotic life to maintain an immaculate form.

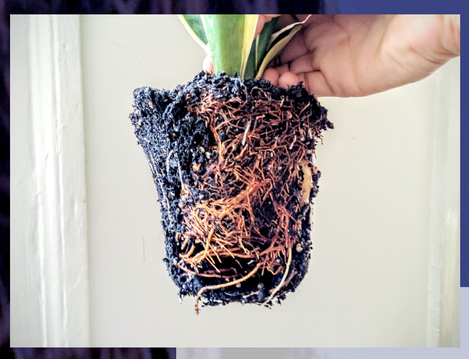
Extractive Histories

Formaldehyde was originally produced as a by-product of the destructive distillation of hardwoods, as were most chemical feedstocks at the turn of the 20th century. As the petroleum industry burgeoned into the petrochemical industry in the 1920s and 30s, formaldehyde became exclusively sourced from cracked methane. Formaldehyde's cheapness, and thus its ubiquity of use as a binding agent, is predicated on the economies and infrastructures of oil extraction and is implicated not only in stories of toxicant exposure, be they in downstream products or along the fence line of extraction, but also in contributions to climate change as methane is a hyper-potent greenhouse gas.

Chemical Freshness

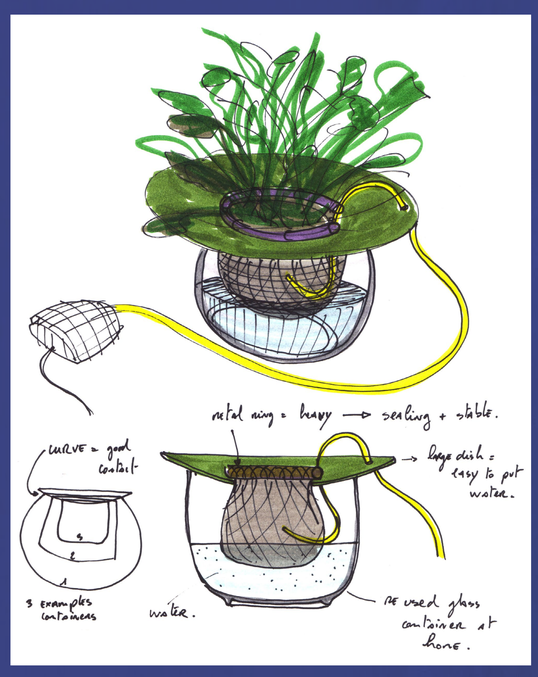
"I love the new car smell—why, everybody does that has air fresheners, they smell like that ya know. And that's what it smelled like to me. And I was like, 'YAY!! They brought us a brand spanking new one!!' I thought they would bring us an old ratty one, ya know?" recalled a Mississippi woman who was given a rapidly built emergency home after she was displaced by Hurricane Katrina in 2005. The trailer's appearance of newness, and therefore its quality, was first observed visually but authenticated by its scent.

For many inhabitants of these homes, which were later found to harbour elevated formaldehyde levels, the social currency of the smell overrode the raw nature of its sensory experience. The chemical brew known as 'the new car smell' imbues formaldehyde exposures with pleasure, fashioning the aroma as a selling point. Borne out of the mid 20th century auto industry, the positivity of the 'new smell' is now drawn upon by consumers when purchasing a broad range of products and serves to occlude perception of potentially hazardous chemical exposures.



Various Uses of Formaldehyde

- Adhesive/Binding agent
- Solvent
- Disinfectant
- Fixative
- Lubricant
- Printing ink
- Color film development
- Bleaching agents
- Textile-sizing agent
- Plastics
- Electronic products
- Fertilizer
- Biocide
- Antiparasitic for animals
- Pharmaceuticals
- Embalming fluid
- Food preservative



Rhizospheric Alliances

Some of the silent formaldehyde emissions emanating from construction materials waft out open windows. Others are absorbed by human bodies or the bodies of companion species. Others still are metabolized by decorative indoor plants and the microbes that inhabit their roots, known as the rhizosphere. In this project we seek to accentuate the remediation capacity of this final chemical sink by pulling air down across the plant and the rhizospheric bacteria with an inexpensive aquarium pump. Without accentuating the air diffusion across these micro-ecosystems, one would need 680 potted plants to adequately scrub the air of toxicants in a 140 sq meter home.

Critical Media Lab Basel
Institute of Experimental Design and Media Cultures
FNSNF Swiss National Science Foundation
SHIFT REGISTER
Published by Shift Register – www.shiftregister.info
For the workshop The Eye Altering (cur. Garance Malivel)
Within the event We Are Not the Number We Think We Are
February 2–3, 2018, Cité Internationale des Arts, Paris
Edited by Nicholas Shapiro and Christophe Guérin
Designed by Merle Ibach

Repair - Adhere - Heal

Understanding biological materials such as proteins, fats and polysaccharides is important for many reasons. Not least of all they are the materials of which we are made, which heal, protect and make use grow; but they are also molecules that make it possible to trace how residues, toxins and chemicals travel through an ecosystem, even to offspring and organisms on the other side of the planet.

Rachel Carson's 1962 publication Silent Spring illuminated for the first time to the general public the impact of certain toxins and residues in the ecosystem. Rachel Carson's research examined how one type of toxin could be ingested by an insect, which was eaten by a bird. Carson's study lead her to learn that chemicals traveling from prey to predator would interrupt normal biological processes. The name ***Silent Spring*** come from the 1961 event that she witnessed, where the impact of pesticides damaged reproductive biological functions in birds, leaving a generation of birds unable to produce offspring.

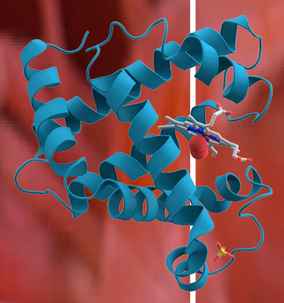
"Sprays, dusts and aerosols are now applied almost universally to farms, gardens, forests and homes – non-selective chemicals that have the power to kill every insect, the 'good' and the 'bad', to still the song of the birds and the leaping of fish in the streams, to coat the leaves with a deadly film and to linger on in the soil – all this though the intended target may be only a few weeds or insects," she wrote.

Her book spurred a reversal in national pesticide policy, leading to a nationwide ban on DDT for agricultural uses.

We can trace toxins such as DDT through an ecosystems as they bind within different types of animal and plant tissue and how they bind to water, travel across the world via rising up to the stratosphere and infest the soil and water table for generation.

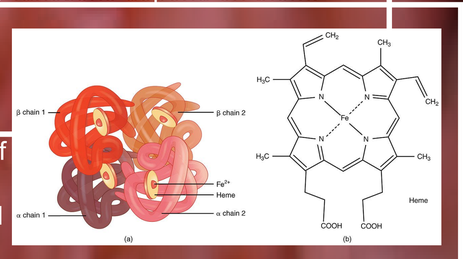
Biomaterials

polysaccarides proteins and THE CENTRAL DOGMA OF MOLECULAR BIOLOGY

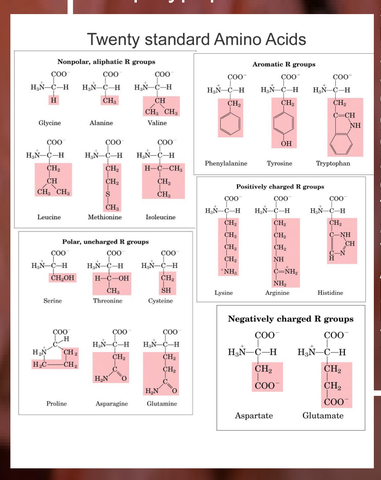


Proteins

Life depends on polysaccharides and sugars, but it also depends on proteins - large organic molecules composed of tens, hundreds or even thousands of amino acids bound together and folded into specifically shaped structures. Enzymatic, structural, and respiratory functions depend on them. Proteins are behind the workings of every biological function in your body and the body of every animal, bird, fish and plant on the planet. They are tiny molecular machines that make everything from respiration and the absorption of oxygen to the very mechanics of cell replication. Without proteins there is no DNA!



Proteins consist of one or more polypeptide chains, each of which is a linear polymer of amino acid residues. Twenty types of amino acid occur naturally in proteins. A polypeptide can be defined simply by its sequence of amino acids. These 20 alpha-amino acids each consist of a primary amino group, a carboxyl group, a hydrogen atom and an R group (side chain that gives each amino acid its individual properties). Amino acids are linked by peptide bonds to form polypeptide chains.



DDT molecule

DDT is a persistent organic pollutant that is readily adsorbed to soils and sediments, which can act both as sinks and as long-term sources of exposure affecting organisms. DDT is lipophilic meaning that it will bond to fat and oil molecules in living creatures. It has been traced in the breast milk of mammals (including humans) and has been found in the fat depot of humans across the planet. DDT bioaccumulates in predatory birds and is toxic to marine animals too. Crayfish, daphnids, sea shrimp and many species of fish, will absorb it and thus it enters the food chain by this route. Despite being banned, DDT was detected in almost all human blood samples tested by the Centres for Disease Control in the USA 2005. While their levels have sharply declined since most uses were banned food tests commonly detect it.

How DDT travels through the food chain

Atrazine is the common name for an herbicide that is widely used to kill weeds. It is used mostly on farms. Pure atrazine –an odourless, white powder –is not very volatile, reactive, or flammable. It will dissolve in water. Atrazine is made in the laboratory and does not occur naturally.

Atrazine

Human exposure to atrazine is linked to a number of serious health effects. A potent endocrine disruptor, atrazine interferes with hormonal activity of animals and humans at extremely low doses.

· Endocrine Disruption: The science on atrazine's effects on the hormone system continues to grow. It hormones in rats and can delay puberty. In male frogs, exposure to atrazine causes a kind of "chemical castration," causing them to develop female sex characteristics. Researchers hypothesize that atrazine signals the conversion of testosterone to oestrogen, demasculinizing the frogs.

· Reproductive Effects: Because atrazine disrupts hormones, it is not surprising that epidemiological studies find associations between exposure to the herbicide and reproductive effects including increased risk of miscarriage, fertility, weight, and higher incidence of abdominal defects;

· Cancer: Evidence for the carcinogenic potential of atrazine is growing — exposure has been linked to elevated risk of breast and prostate cancer. The recent President's Cancer Panel Report notes that atrazine has possible carcinogenic properties. In response to concerns, U.S. EPA is currently re-evaluating atrazine's carcinogenic potential.

Timing of exposure may be more important than exposure levels. Research shows that low levels of exposure during key periods of pregnancy may interfere with healthy foetal development. The third trimester of pregnancy appears to be most critical, says a recent epidemiological study. Synergistic effects between atrazine and other pesticides may also render health harms more severe.

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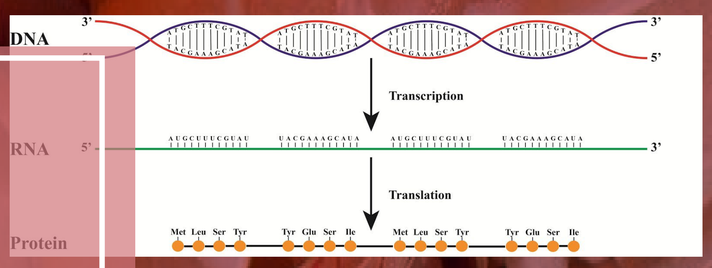
Nuclear testing research carried out by the U.S. Department of Energy under the Atomic Energy Commission from 1946 onwards reveals the horrendous impact of nuclear tests carried out by the USA in great detail. In documents declassified under the Clinton administration we can learn about how radioactive nuclei passed into the food supply,how military personnel were harmed by experiments, the destruction of the Marshall Islands and devastation to its exiled inhabitants. From the Fukushima Daiichi nuclear disaster to Chernobyl and the bombing of Hiroshima and Nagasaki on August 6, 1945, we can trace radioactive isotopes binding to human, animal and vegetable tissue for decades following these events.

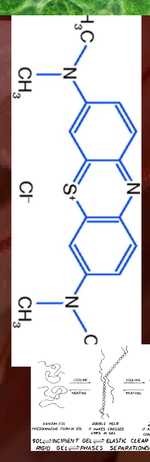
One of the impacts of strontium 90 is that it competes with calcium and is absorbed in the bones of young children.

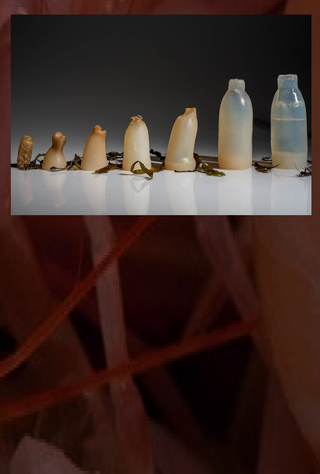
Let us turn now to biology, and focus on the nature of biological materials. Their role in our bodies and those of other living creatures and their potential applications in industry. This not only helps us to understand the diverse, overlapping roles of the biomaterials that constitute the different tissues in our bodies, but helps us to gain insight into the bioaccumulation of toxins and their extent.



The Central Dogma of Molecular Biology "DNA makes RNA makes Protein...".

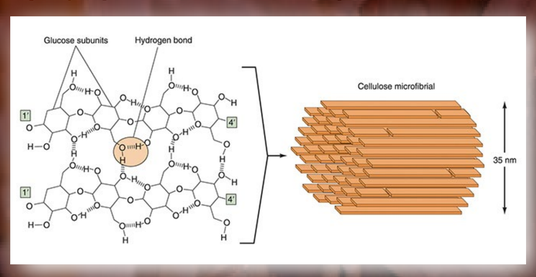
A wide range of important industrial molecules that we use in pharmaceuticals, the food industry and construction only exist because they originate from living creatures. A collection of these molecules, which only exist because they are coded for by the DNA of living creatures are explored briefly below:





Cellulose and polysaccharides

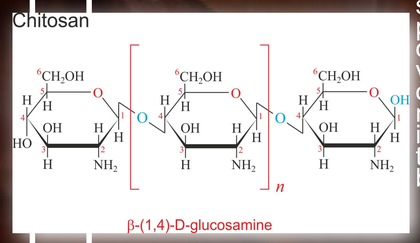
Cellulose contains only glucose and is the major polysaccharide in woody and fibrous plants. It is the most abundant single polymer in the biosphere.



Polysaccharides more broadly referred to as carbohydrates. These are produced by plant seeds, tubers, fruits and vegetables as an energy source as well as for structural purposes. They come in many forms, including starch that can be found in corn, potatoes, rice and grain - bread, cereal and pasta also contain starch. Polysaccharides such as pectin, agar and chitosan can broaden our view of this wonderful natural group of molecules.

The diverse naturally obtained polysaccharide chitosan can supply a broad range of resources applicable in the biomedical field. It can be found in marine creatures such as crabs and shrimp.

Chitosan



As well as having potential to support development in the biomedical field it can be used to create biodegradable plastics (bioplastics) and with over 400 millions tonnes of waste from the food and fishing industry, it seems a shame to waste this wonderous material.

Chitosan is also used in the cosmetics and pharmaceutical industry and extracted from the shells of marine creatures by crushing them and dissolving the calcium carbonate and bicarbonate that also constitutes these shelly structures in hydrochloric acid.

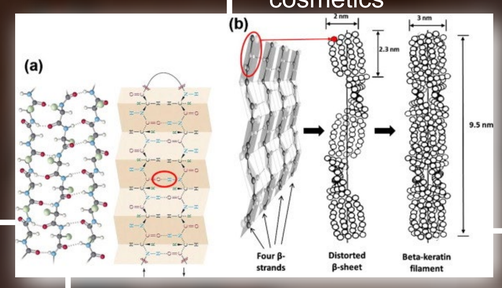
Blueberries, pears, apples, guavas, quince, plums, gooseberries, orange peel and other citrus fruits contain a lot of pectin, while softer cherries, grapes, and strawberries contain small amounts.

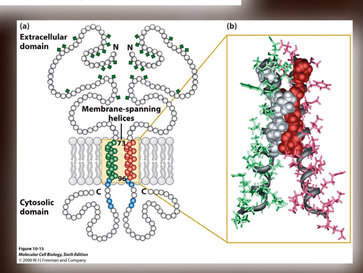
Pectin

This has jellifying properties, as does agar which is found in seaweed and algae. Making bioplastics from agar and algae more generally hold much promise for sustainability… and of course, other biomolecules also include gelatin, collagen and other proteins.

Keratin

Keratin is a fibrous structural protein found in hair, nails, horn, hoofs, wool, feathers, and of the epithelial cells in the outermost layers of the skin. Keratin serves important structural and protective functions, particularly in the epithelium. Much like collagen and chitosan, keratin is also used in cosmetics





Published by Shift Register – www.shiftregister.info
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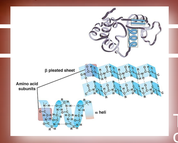
Institute of Experimental Design and Media Cultures
Critical Media Lab Basel
FNSNF Swiss National Science Foundation

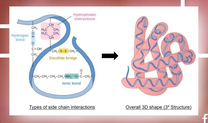
Biomaterials

polysaccarides proteins and THE CENTRAL DOGMA OF MOLECULAR BIOLOGY

Tertiary structures

Tertiary structures are the level of structure created when further hydrogen bond interactions cause the secondary structures to folds and twist upon themselves resulting in complex three-dimensional forms.





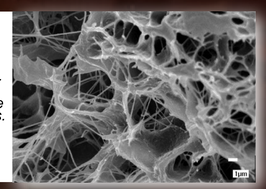
The form of a tertiary structure depends on 'distant group interaction' between the R-groups of the amino acids in the primary structure. Again the hydrogen bonds are responsible for stabilising the tertiary structure although other bonds such as hydrophobic packing, Van Der Waals forces and disulphide bridges also play a role in the resulting shape of a protein's tertiary structure. A tertiary structure's form will be partially dependant on the environment in which it usually forms, for example in water (which is polar) all the polar molecules of the protein will interact with the polar H2O molecules, creating a non-polar internal space, this is what hydrophobic packing entails. Disulphide bridges happen only between cysteines – amino acids with a thiol side chain that contains sulphur – and are essentially covalent bonds between the sulphur groups resulting from oxidation. Because of the oxidizing environment necessary for the formation of disulphide bridges they tend to form in extracellular space.

The quaternary structure

The quaternary structure of a protein describes the bonding between multiple polypeptides.

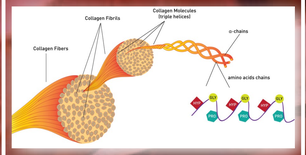
The same interactions of hydrogen, Van Der Waals, hydrophobic packing and disulphide bridges are involved in the formation of the quaternary structure. Within the resolved protein, each individual polypeptide is called a subunit. If there are two subunits interacting then you have a quaternary structure called a dimer. For three subunits the term 'trimer' is used, for you tetramer and more that four produces a multimer. The term for a completely, properly folded protein is the proper confirmation of a protein. Triose phosphate isomerase, is a dimer – or dimeric enzyme. The word dimer refers to the two subunits present in the enzyme. Haemoglobin on the other hand is a quaternary structure.

Research team from Purdue University-based startup GeniPhys led by Associate Professor Sherry Harbin is commercialising a synthetic collagen polymer known as Collymers. It exhibits uncommon self-assembly properties not seen in conventional collagen. These collagens work in a similar way as those in the body's tissues – they polymerise to form fibrils. As such, they can be used to customise 3D collagen-fibril matrices and materials for cell and tissue research, in vitro drug discovery and toxicity testing as well as 3D bioprinting.

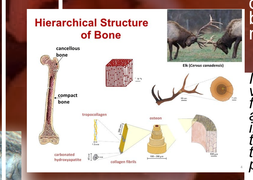


Collagen

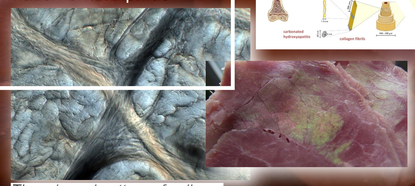
Collagen is a ubiquitous protein. It is an important component of connective tissue, skin, bone, cartilage, and tendons and is the single most abundant protein in the animal kingdom.



Its biological function is to provide support, structure and flexibility to living creatures, organs, bone and muscles.

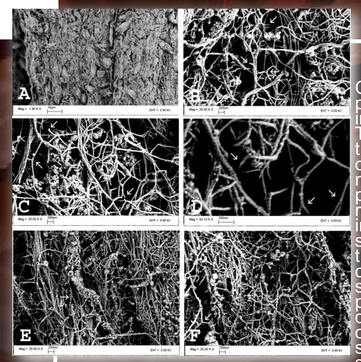


It is also very reflective and has interesting optical properties

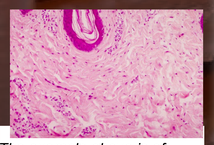


The crimped pattern of collagen fibrils, showing their reflective optical properties

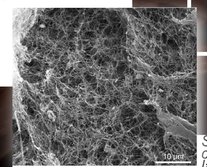
The crimped pattern of collagen fibrils results in interesting optical properties.



Collagen is produced in our cells. The skin is the largest organ of the human body and plays a major role in maintaining homeostasis and protection. As the main component of skin, animal cells produce many different kinds of collagen, resulting in larger scale structures that resemble long rope-like structures and tough sheets. These are used for structural support.



The example above is of dense irregular collagenous connective tissue in skin from a pig. The dark purple U-shaped band at the top of the field is the epithelium of the skin, and the rest is the connective tissue. Connective tissues as a group of tissues categorically have protective or supportive functions.



Scanning Electron Microscopy (SEM) of a fibrin-collagen blend hydrogel. The aqueous part of the hydrogel is evaporated after critical point drying and fibrillar structures of fibrin and collagen is left behind. The random architecture of the hydrogel is clearly visible.

PROTEIN STRUCTURE BACKGROUND

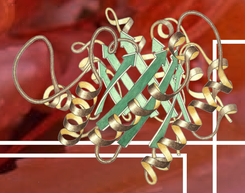
There are four levels of protein structure: the primary, secondary, tertiary and quaternary structure. A polypeptide is a polymer of amino acids linked together by peptide bonds. Each amino acid is termed a residue and all amino acids have the same basic structure. Amino acids are individual molecules consisting of carbon atoms bonded with carboxyl (COOH) and amino functional groups (NH2), as well as a hydrogen atom bonded to one of the carbon atoms in the molecule. Amino acids also contain a variable group that is termed the R group. The R group provides each amino acid its characteristic chemical properties. A protein is one or more polypeptides, and a

primary structure

is simply the linear sequence of amino acids. There are just twenty amino acids but by varying the number and order of these amino acids, has the possibility to generate a vast number of different polypeptides and resulting proteins.

Proteins fulfil a number of functions in the cell including: catalysis; defence; transport (i.e. haemoglobin transporting oxygen; support (actin fibres; motion; regulation (hormones) and energy storage. The R-groups in their amino acids must be sequenced properly in order for them to fold in the correct final structure, as it is the proteins structure that makes it function properly and carry out its role without damaging the organism.

Triose phosphate isomerase is a protein found in both prokaryotic and eukaryotic cells. According to UNIPROT, it is an enzyme that is 'involved in the pathway gluconeogenesis, which is part of Carbohydrate biosynthesis'. This subpathway is part of the pathway glycolysis, which is itself part of Carbohydrate degradation. Its primary structure will influence how its secondary and subsequent structures are folded.



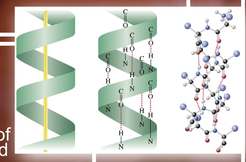
Process of Translation

DNA Polymerase is also an important protein in the process as it unzips the DNA molecule in order for the mRNA to copy the appropriate sequence of nucleotides in the first place. This enables the process of transcription to occur. DNA Polymerase is a DNA-binding protein with helix-turn-helix motifs, containing both alpha-helices and beta sheets.

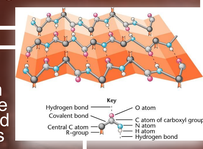
Proteins with a similar structure resulting from a common ancestor are called homologous. The human cyclophilin family is one example of such a family group of proteins. The structure of this family contains both alpha helices and beta pleats.

Secondary structure

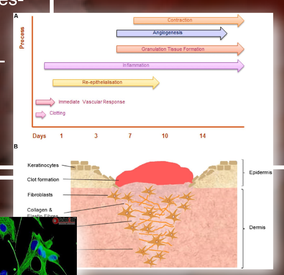
Secondary structure refers to the way in which primary structures fold over themselves. The form that the secondary structure of a linear polypeptide sequence will take is primarily dependant on hydrogen bonds although other intramolecular interactions also play a role. Secondary structures can be understood as being determined by 'backbone interactions' and may result in any number of folded forms or motifs. In an alpha helix for instance the polypeptide will twist into a coil that is stabilised by hydrogen bonds acting between each coil – the resulting from is that of a spiral staircase.



Another secondary structure motif is a beta pleated sheet that looks much like a zig-zag whereby the point of each zigzag is stabilised by a hydrogen bond.



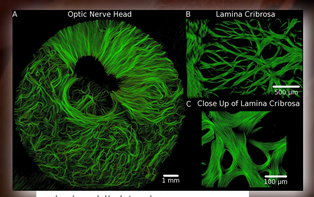
If the resulting motif is such that the amino ends and the carboxyl ends of the pleated sheet are lined up, then it is described as parallel pleated sheets. An alternative manifestation of a beta sheet is an anti-parallel beta sheet where by the zigzagging pattern of linear amino acids folds over itself, resulting in amides lining up with carboxyls, and alternating in how the carboxyls and amines line up as illustrated in the image below



The Central Dogma of Molecular Biology

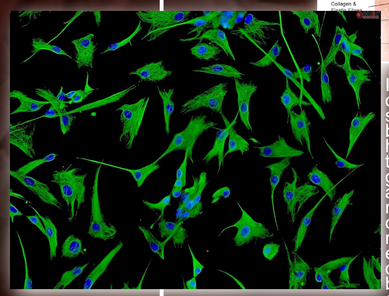
The Central Dogma of Molecular Biology is "DNA makes RNA makes Protein...". RNA is short for Ribonucleic acid. RNA is a polymeric molecule essential in various biological roles in coding, decoding, regulation, and expression of genes. RNA has a ribose sugar in its chain of molecules while in DNA a deoxyribose sugar exists in the polymer. RNA nucleotides have a uracil base instead of thymine (see R-groups above).

The process by which an RNA sequence complementary to the DNA sequence of the gene to be expressed is synthesised is termed transcription; the process by which a protein is synthesised, with its sequence determined by the RNA sequence, is termed translation. Besides the protein-coding genes, there are also sequences in the human genome (as in all genomes) that are transcribed into functional RNA molecules, and these are sometimes termed RNA genes. Without proteins in the first place however these is not DNA.



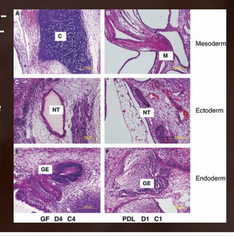
polarized light microscopy (PLM) image showing collagen fiber architecture of posterior pole and optic nerve.

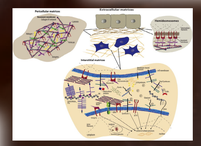
Collagen's role in wound healing is fascinating and it also has a role in the bodies other defense processes. Inflammation plays a role in collagen degradation to prevent the toughening of tissue.

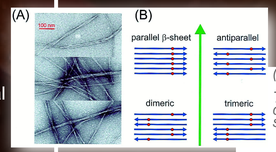


Inflammation is one of many biological responses within the body's tissues to harmful stimuli, protecting us from pathogens, damaged cells and irritants. Inflammation appears to be connected to a wide range of chronic diseases such as heart disease, cancer, diabetes, obesity, allergies, asthma and arthritis. Some of these ailments can be called autoimmune conditions, whereby the immune system responds inappropriately to stimuli, and results in the body attacking its own tissues. It is s an ongoing internal barrel that is directly related to either an external irritant or an epigenetic malfunction.

A variety of diseases that are characterized by fibrosis share common features including the proliferation of fibroblasts and the deposition of excess collagen in the extracellular matrix of our cells.







(A)Anti-parallel (B) Parallel

Triose phosphate isomerase contains both beta-pleated sheets and alpha-helices.

Proteins are formed by chains of nucleotides which as they are formed fold and twist into different and more complex three dimensional forms. Some of the shapes proteins can take as they form are helices and folded sheets and the basic structural unit of collagen is a triple helix. From the microscopic view of the helix to macroscopic structure of collagen fibres, its mechanical properties make it strong and flexible and during the wound-healing process, collagen fibres with grow across a wound and begin to stabilise.

Critical Media Lab Basel
Institute of Experimental Design and Media Cultures
FNSNF Swiss National Science Foundation

Published by Shift Register – www.shiftregister.info
For the workshop The Eye Altering (cur. Garance Malivel)
Within the event We Are Not the Number We Think We Are
February 2–3, 2018, Cité Internationale des Arts, Paris
Edited by Jennifer Crouch
Designed by Merle Ibach

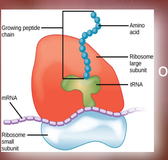
DNA makes RNA makes Protein - CONNECTS US TOGETHER

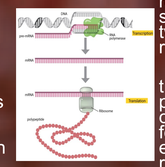
RNA is a single stranded molecule similar to DNA with some key differences. It contains ribose as part of its sugar backbone and contains uracil instead of thymine. RNA is necessary in protein synthesis.

A piece of Messenger RNA (mRNA) must be copied – or transcribed – from DNA, in order to make proteins. The information held by the mRNA is encoded in its nucleotides.

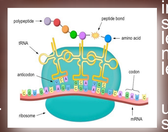
More precisely, each group of three nucleotides (called a codon) is used to construct each amino acid needed to make a specific protein. An mRNA molecule begins with a 5 prime non-reading end (made of five nucleotides) known as the 5' untranslated region (UTR). This is followed by a specific sequence of nucleotides which bind to the ribosome.

This binding section is next (reading linearly from left to right), and is called the Shine-Dalgarno (SD) sequence. The SD section if followed by another non coding region which is followed by the start codon – commonly with the indicator nucleotide sequence AUG – which always codes for methionine, until it reaches the stop codon (usually UAA, UAG or UGA) which is followed by another non-coding region. mRNA resembles a sequence of nucleotides, much like the primary structure of a protein (polypeptide) this structure allows it to be read and transcribed by the ribosome, as it must slide between the component molecules of the some to be useful.

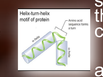




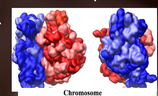
Protein synthesis is called translation. Protein translation takes place within an organelle in our cells called found the ribosome, which can be found in the cell cytoplasm and rough endoplasmic reticulum. The mRNA runs through the ribosome, as it does the ribosome fills in the corresponding nucleic acids in the correct sequence. The ribosome itself is made from two molecular components, and the mRNA must run between these two molecular components to be translated.



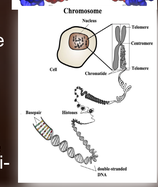
These are referred to as subunits, called the large subunit and small subunit. They are each composed of Ribosomal RNA (rRNA) and proteins, which are both structured to form each subunit. The ribosome subunits usually exist separately in the cytoplasm. Once the smaller subunit finds, and binds to a specific site on the mRNA (the start codon) then the large subunit is toed in and forms the complete ribosome.

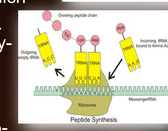


In order to get the necessary amino acids to carry out translation the ribosome needs a protein called Transfer RNA (tRNA), which brings (or transfers) the different amino acids to the ribosome. The tRNA is much smaller than the ribosome and has a clover-like structure. If you imagine a clover shape, with three leaves and a stem, and imagine that there are three nucleotides along the edge of the leaf in the middle of the clover. These three nucleotides that are found at this point in the tRNA structure are what determines the amino acid is has to collect.



This part of tRNA's structure is called the anticodon. The anticodon will collect an amino acid, made from the complementary sequence of nucleotides, which is the codon. So UUU (which happens to codes for phenylalanine) will in fact collect AAA (lysine) and bring it to the ribosome to build into a required protein, as requested by the mRNA. Other proteins and enzymes are involved throughout the entire process, one example is aminoacyl-tRNA synthetases, which consists of an amino acid which makes us of a high energy ester bond to bind to the 3'-hydroxyl group of a tRNA molecule.





The process of translation is made up of different steps. First initiation: where the SD section of the mRNA is detected by the ribosome and some, and read until it gets to the start codon AUG. At this point a tRNA molecule will bring (transfer) the amino acid UAC (formyl-etheline in eukaryotes) to the ribosome. The second phase is called elongation: where the mRNA, ribosome and tRNA start to build the polypeptides. The final phase is termination where the end codon goes through the ribosome.