Napoleon's Buttons:
17 molecules that Changed History

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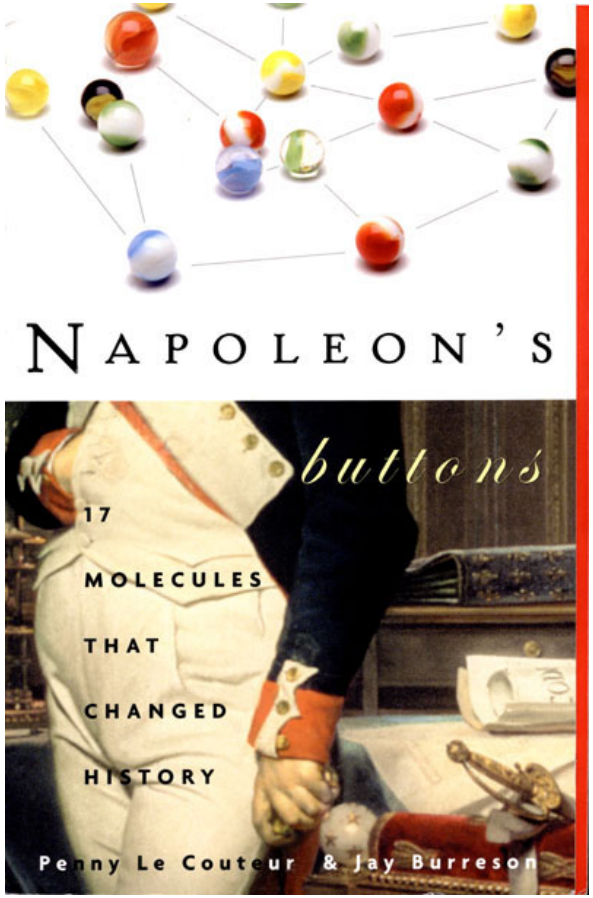
- In December of 1812, Napoleon's army consisting of 600,000 men was marching toward Russia.
- All of the army's clothing, spanning from the highest general to the most lowly private, had tin buttons sewn on to their uniforms. When exposed to the bitter cold, as Napoleons army encountered in Russia, tin disintegrates into fine powders.
- Was the army, as their buttons and uniforms fell apart, so weakened by the cold that it could not function? Were men using their hands to hold together their garments instead of carrying vital supplies? Could the disintegration of something as small as a tin button led to the downfall of one of the greatest armies throughout history?



金屬元素對歷史的改變

- 西元1650年, 美洲新大陸出產一萬六千噸的銀, 成為當時殖民霸主西班牙與葡萄牙四處興戰經費來源

- 十九世紀的淘金熱開啟美國加州、澳洲、南非、紐西蘭與加拿大克朗岱克的拓荒史

1. Pepper, Nutmeg,& Cloves

- Spices, such as pepper, were so highly valued because they disguised the taste of rotting, or spoiled meat. The active ingredient as well as the reason for the hot taste of pepper is Piperine ($C_{17}H_{19}O_3N$).

香料熱

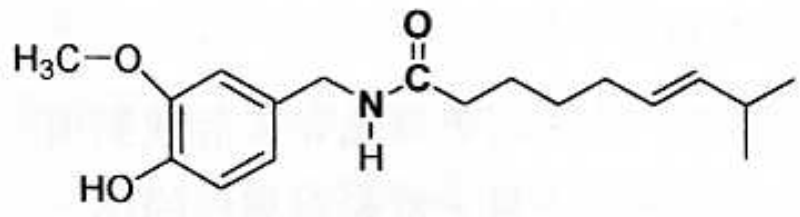
- 威尼斯藉十字軍東征之便壟斷香料市場

- 葡萄牙探索家Bartholomeu Dias繞過好望角 (Cape of Good Hope)
- 葡萄牙探索家達伽瑪(Vasco da Gama) 1498年抵達印度,並征服印度西南岸Calicut掌握胡椒貿易

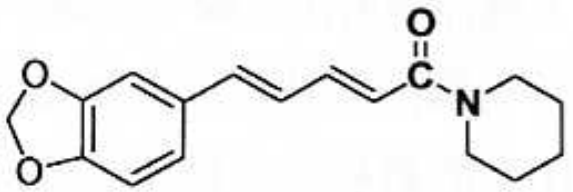
香料熱

- 1492年哥倫布(Christopher Columbus)在西班牙國王及皇后資助下,向西航行尋找向印度的捷徑,進而發現新大陸
- 現今美洲原住民仍被稱作Indians
- 雖未找到胡椒,但在海地找到辣椒 (Chili pepper)

香料熱



辣椒素

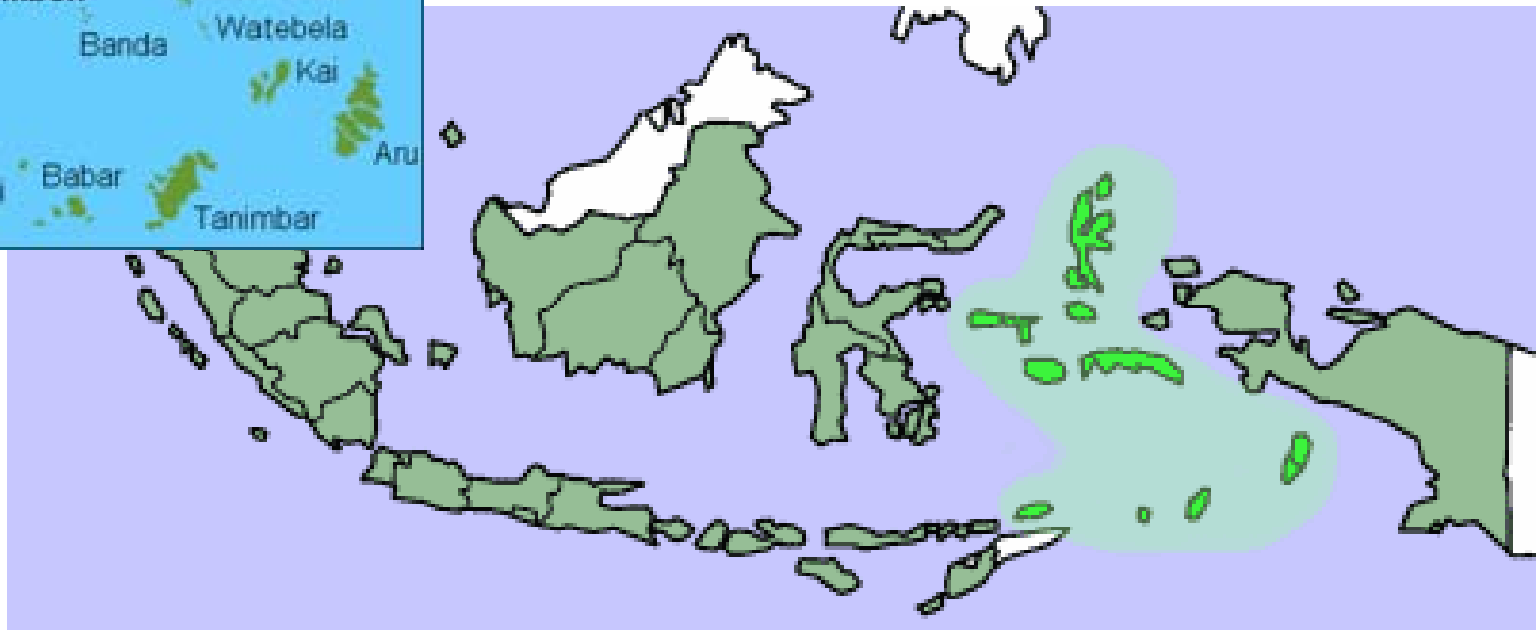


胡椒鹼

- The shape of the piperine molecule is able to fit into a protein on the pain nerve endings of our mouths
- The reason we have the desire to eat spicy and hot foods is not only to disguise the taste of spoiled meat, but because it causes an increase in saliva production, stimulates movement of food through bowels during digestion, and the painkilling natural chemicals, endorphins, are releases in our brain and provide us with a happy feeling.

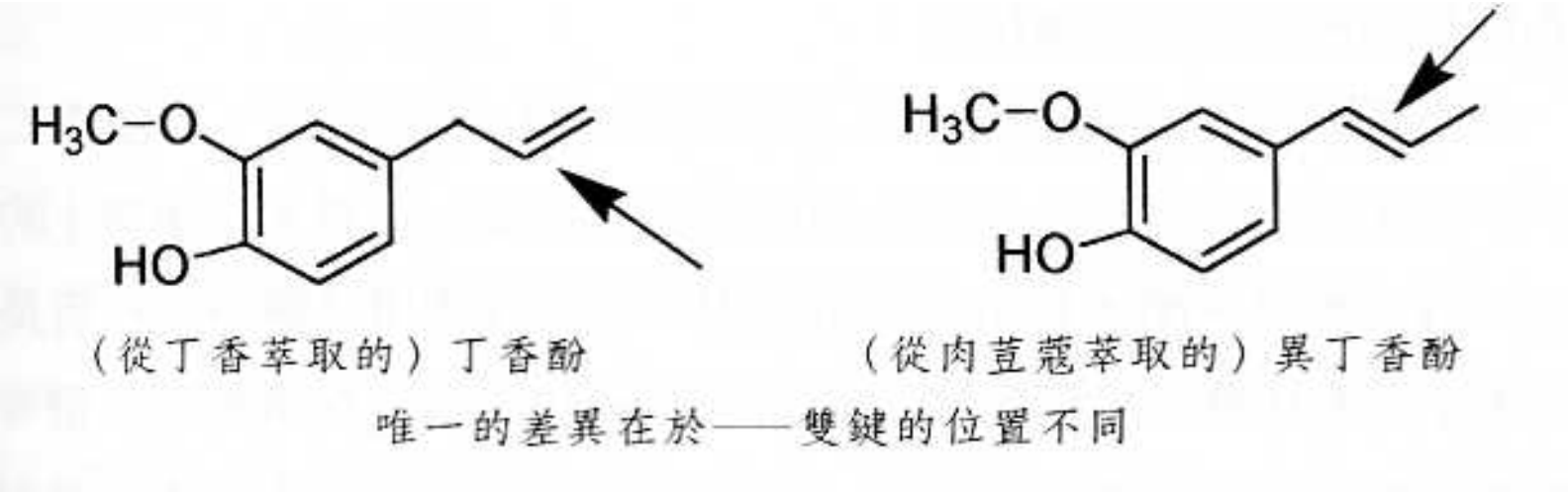
Nutmeg (肉荳蔻) & Cloves (丁香)

- Nutmeg in Banda islands
- Cloves in Ternate and Tidor



Nutmeg (肉荳蔻) & Cloves (丁香)

- Both Cloves and Nutmeg are very similar in shape, but are classified as different molecules. Nutmeg is classified as an isoeugenol (異丁香酚) compound. In contrast, Cloves are eugenols (丁香酚).



Nutmeg (肉荳蔻) & Cloves (丁香)

- Isoeugenol compounds are compounds that plants use as a natural insecticide against predators. Nutmeg in particular was believed to repel the Black Plague because of it characteristically repelled disease carrying fleas.

香料熱

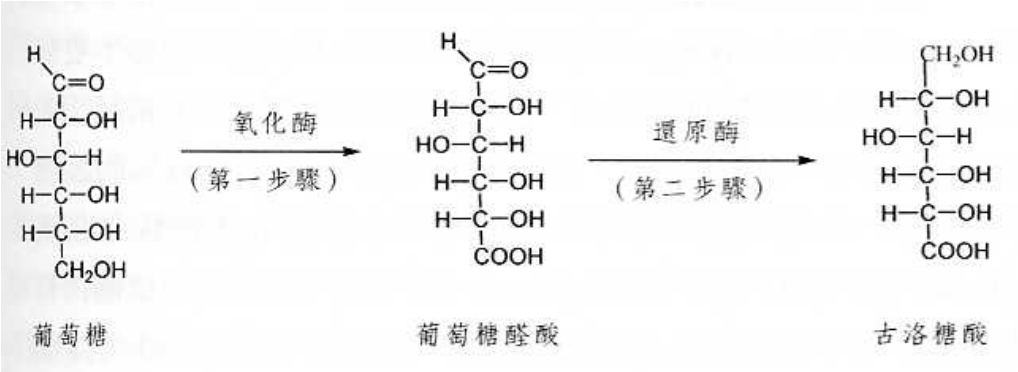
- 1519年麥哲倫(Ferdinand Magellan)得到西班牙國王資助尋找往西至香料群島的捷徑
- 1520年渡過南美南端麥哲倫海峽(Straight of Magellan)到達太平洋
- 1521年到達關島,之後死於菲律賓
- 最後生還18名船員載滿26噸香料,繞地球一圈回到西班牙

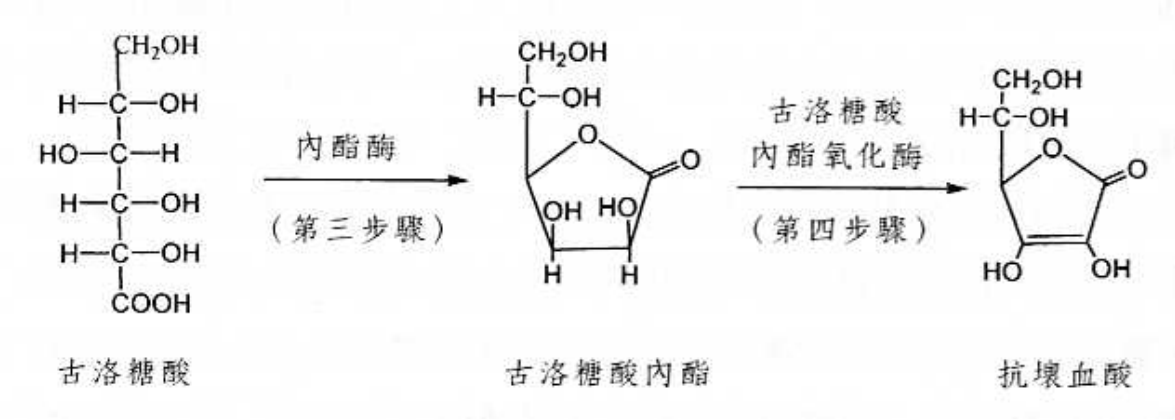
2. Ascorbic Acid (維生素C)

- During the Age of Exploration, scurvy (壞血病) was an ever-present problem. Scurvy was cause for more death at sea than all other causes, including the total number of deaths from naval battles, piracy, shipwrecks, and other causes. Scurvy is caused by an Ascorbic Acid deficiency.

Ascorbic Acid (維生素C)

- Ascorbic Acid is not produced naturally in the body because humans lack gulonolactone oxidase, the enzyme necessary for the final step of the production of vitamin C. Therefore, we must get or daily supplies of Vitamin C from our food.



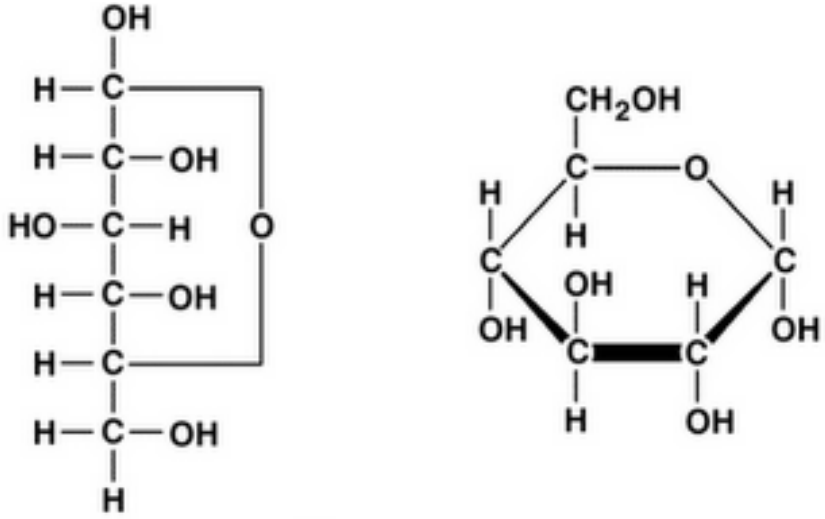


Ascorbic Acid (維生素C)

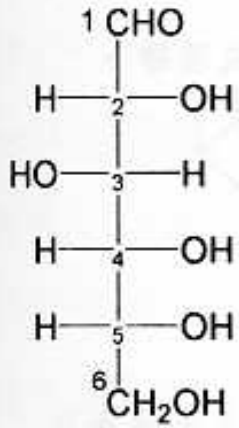
- Ascorbic Acid also affects the production of collagen, which is responsible for skin's firmness and elasticity. Ascorbic acid had an influence on the course of history by directly affecting where ships had to stop, because of the need for fresh fruits to prevent scurvy, and therefore, dictating which islands were to be discovered, and which islands were not

3. Glucose

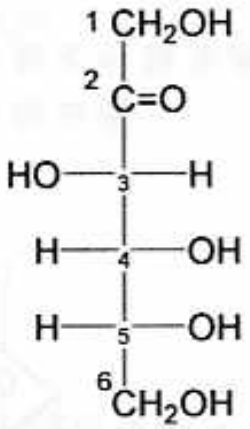
- Glucose is the most common of the monosaccharides, or simple sugars. The Human Body, in particular, the Brain, uses glucose for energy.
- If blood glucose levels fall below 50% of the normal level, symptoms of brain dysfunction occur, and if it falls below 25% of the normal level then a coma may result.



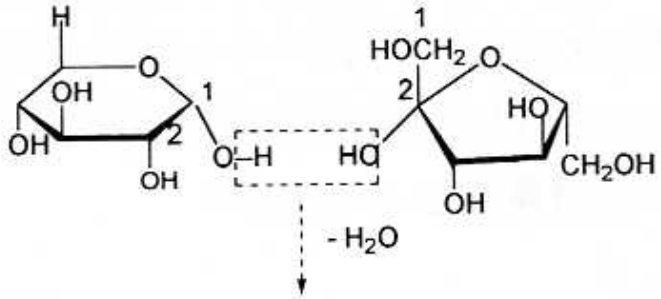
Glucose



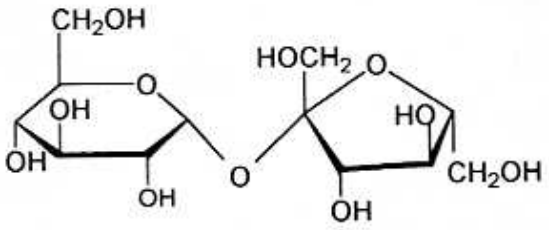
葡萄糖



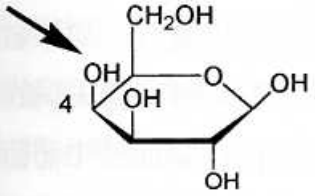
果糖



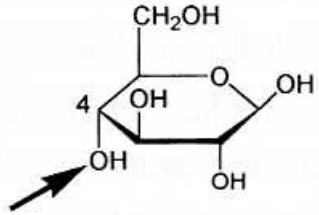
葡萄糖和果糖結合並脫去一個水分子而形成蔗糖。圖中的果糖分子被反轉了一百八十度



蔗糖結構

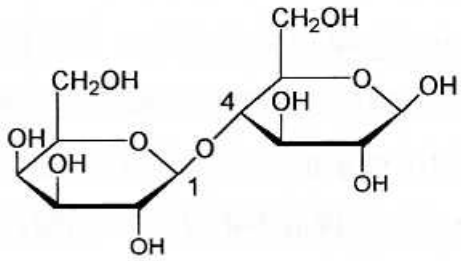


β半乳糖



β葡萄糖

β半乳糖的箭頭指出4號碳上的羥基位於環的上方，而β葡萄糖4號碳上的羥基則在環的下方。這兩個分子結合後則形成乳糖。

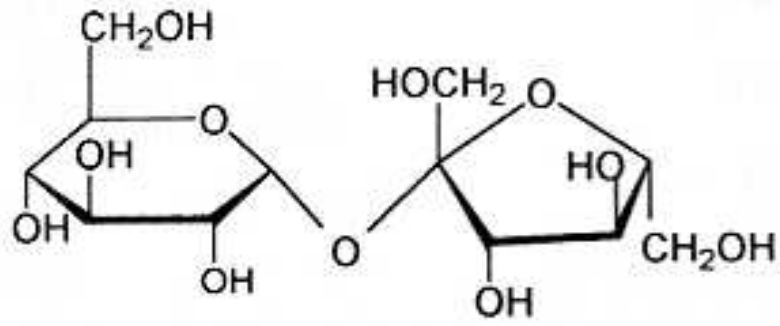


乳糖

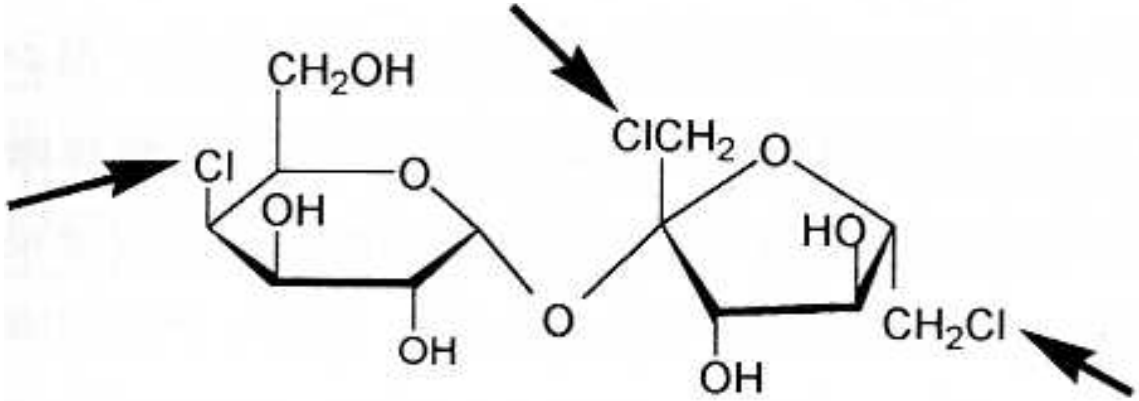
左邊的半乳糖以1號碳與右邊葡萄糖的4號碳連結。

Glucose

- During the age of Exploration, sugar was one of the many things that caused and supported the slave trade. The harvesting, and processing of sugar from the sugar cane was a labor intensive process that required many slaves to work in the plantations of the Caribbean and Latin America.
- Great Circuit:
  - 歐洲帶加工製造的食物前往非洲交換奴隸
  - 奴隸運送至新大陸栽種甘蔗
  - 礦石、菸草、棉花、蘭姆酒自新大陸送至歐洲



蔗糖結構



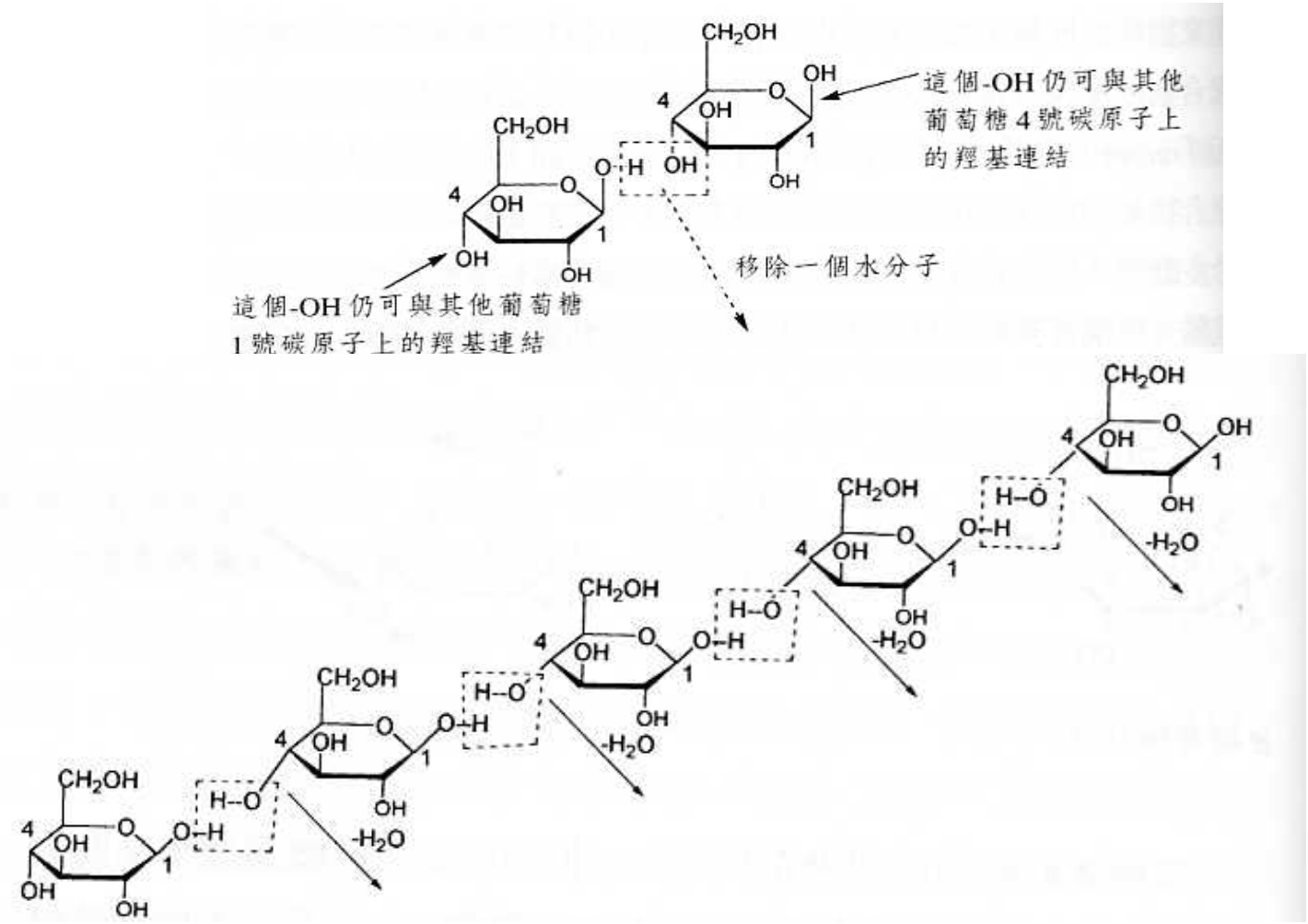
蔗糖素的結構。箭頭所指的是取代羥基的氯原子。

- 氯原子不會影響蔗糖素的甜味, 亦不會被人體代謝, 也不含熱量

4. Cellulose

- The main component in cotton is cellulose. Cellulose, as well as making up over 90% of cotton, is also a major component of plant cell walls, and is a polymer of glucose. Cellulose is a structural polysaccharide, which means that it provides structural support to organisms, plants in particular.

polysaccharide



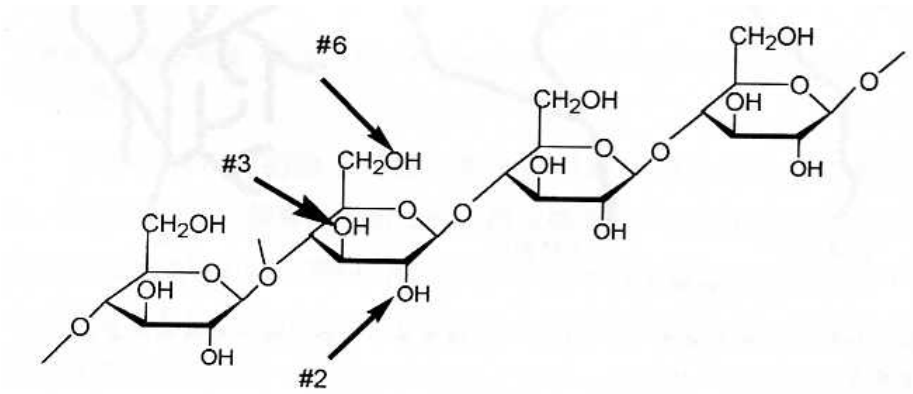
- 纖維素末端自由-ＯＨ可幫助吸水性

Cellulose

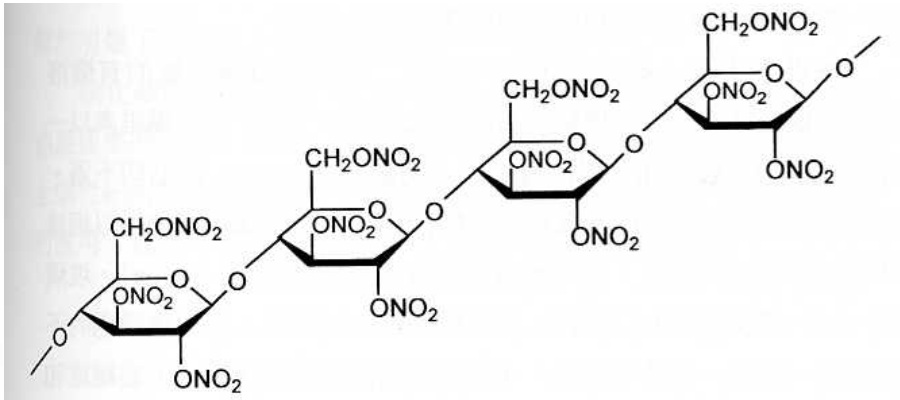
- The cellulose molecule is shaped in long chains. When these chains are packed closely together then they make the rigid, insoluble fiber that plant cell walls are constructed of. The same bundling and twisting of the cellulose molecule is required to make textile fibers also.

Cellulose

- Cellulose can be used as an explosive molecule. When combined with a concentrated form of nitric acid, and then poured into water would yield a highly flammable and explosive white powder. This white powder became known as guncotton. Guncotton was found to be highly unstable and extremely sensitive, an inconvenient property when talking about explosives.



棉質圍裙的纖維素部分結構。箭頭指出硝化可能發生的位置，即葡萄糖單位分子的2、3、6號碳原子上的羥基。



硝化纖維素（或硝棉）的結構圖——每個可能發生反應的羥基（-OH）上其氫原子被硝基（-NO2）取代。

Cellulose

- Chemists were able to use the nitrocellulose compound and form some of the first films used in photography. In fact, the photography and movie industry would probably look quite different without cellulose.

5. Nitro Compounds

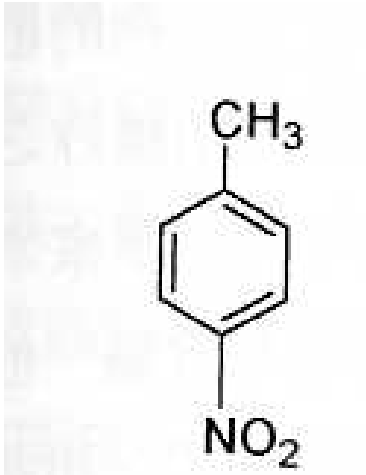
- 火藥

$$4KNO_{3(s)} + 7C_{(s)} + S_{(s)} \rightarrow 3CO_{2(g)} + 3CO_{(g)} + 2N_{2(g)} + K_2CO_{3(s)} + K_2S_{(s)}$$

硝酸鉀　碳　硫　二氧化碳　一氧化碳　氮氣　碳酸鉀　硫化鉀

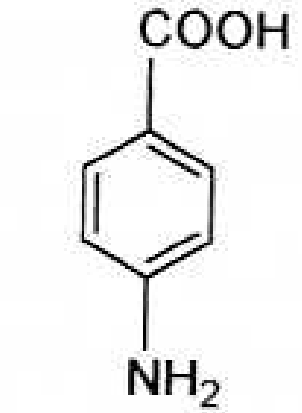
5. Nitro Compounds

- Although the structures of explosive molecules vary greatly, most of the time, they contain a nitro group. This combination of one Nitrogen, and two Oxygen (NO2), attached at the right position has greatly increased the world's ability to wage war.
- The destructive powers of an explosion come from a shock wave caused by the very rapid increase the volume of the nitro compound as it changes from solid or liquid into gas. This shock wave occurs because gases have a bigger volume than similar amounts of solids or liquids.
- The final product after explosion of nitro compound is nitrogen. Great energy will be released during this reaction.
- Nitro compounds are an important component of explosions because, as we all know, an explosion cannot occur with out the presence of oxygen. The oxygen required for an explosive reaction must come from the molecule itself because oxygen from the atmosphere does not collect quickly enough. Thus, molecules with nitrogen and oxygen bonded together are often explosive.



對硝基甲苯

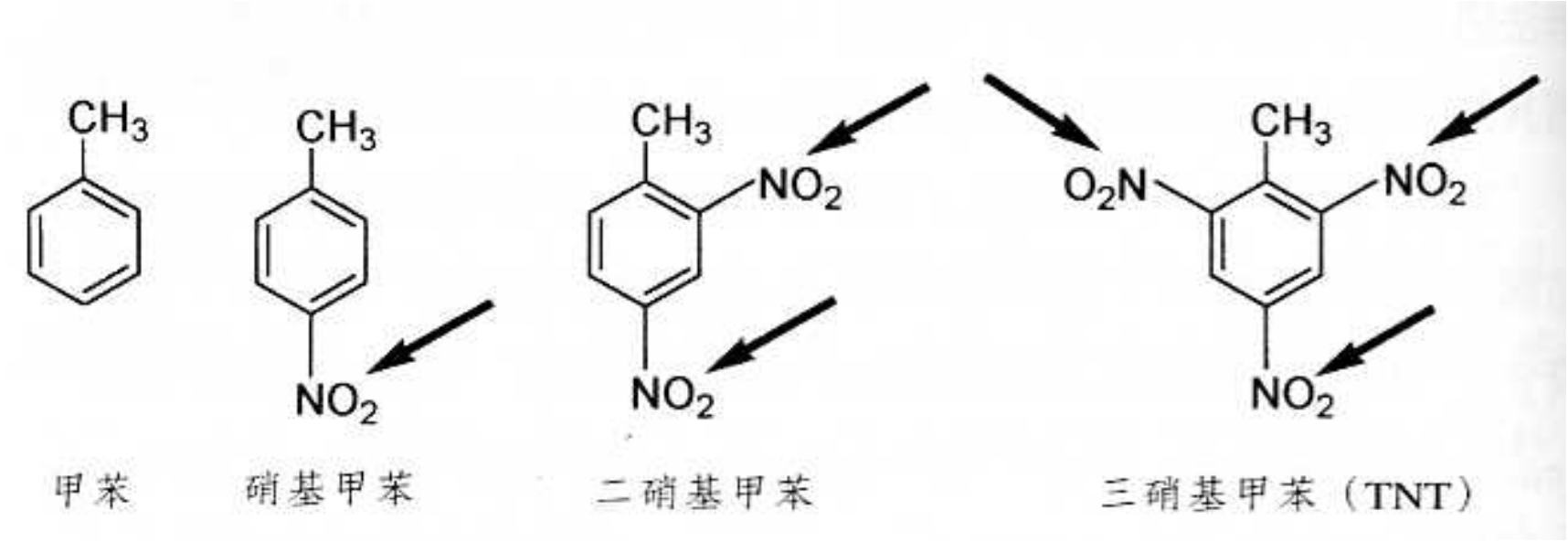
具爆炸性



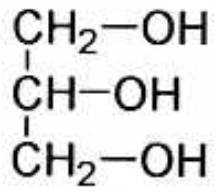
對胺基苯甲酸

防曬油

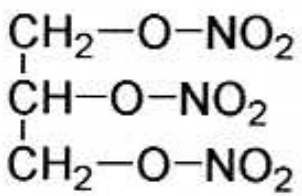
- 硝基化合物的威力決定於硝基數目



- 甘油低入流酸與硝酸冷卻混合液中, 載到入水中形成油狀硝化甘油

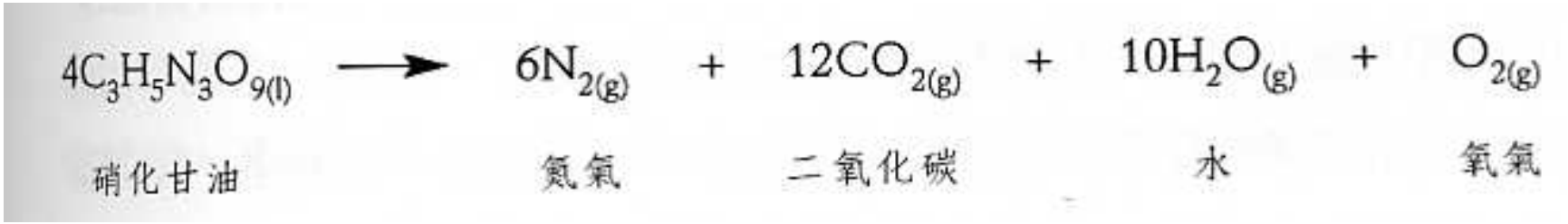


甘油

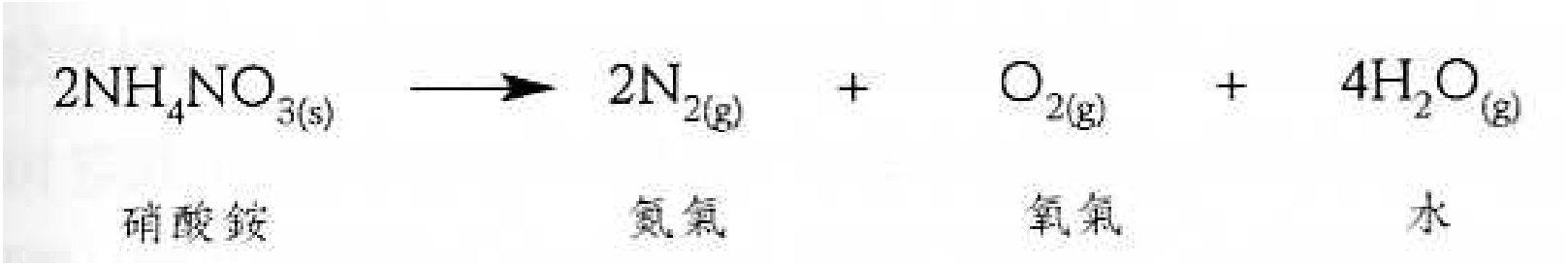


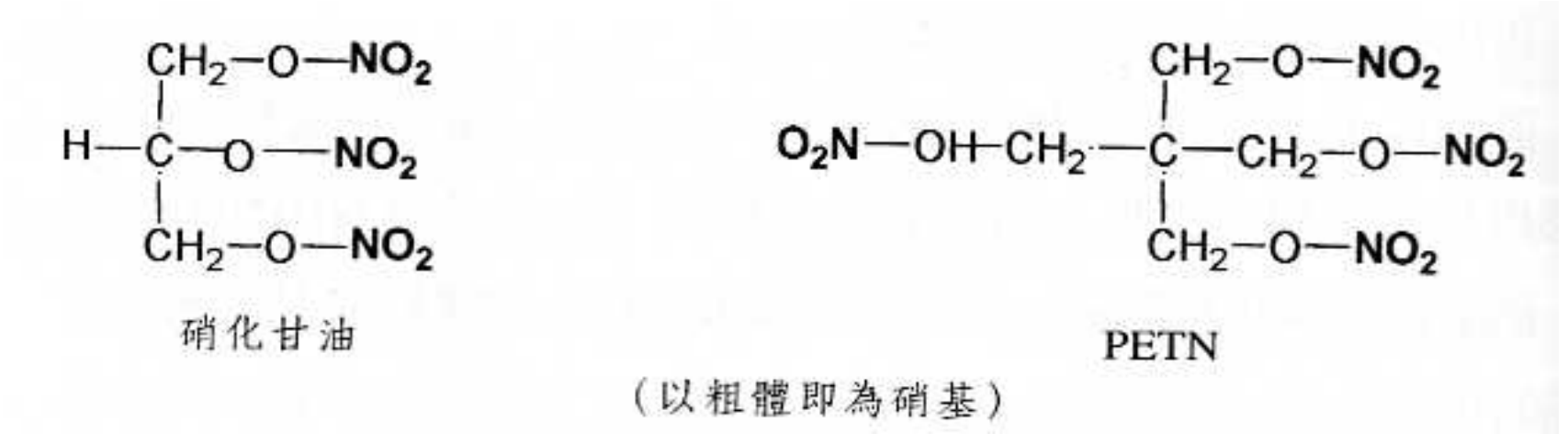
硝化甘油

- 心絞痛的患者服用硝化甘油後, 釋放出一氧化氮, 使原本緊縮血管得以擴張.
- Same mechanism resulted in Viagra



- 火藥可在千分之一秒內產生六千的大氣壓的威力
- 等量硝化甘油可再百萬分之一秒內產生二十七萬個大氣壓的威力
- 諾貝爾(Nobel)以硝化甘油與矽藻土３：１混合,發明較安全穩定的炸藥(Dynamite).

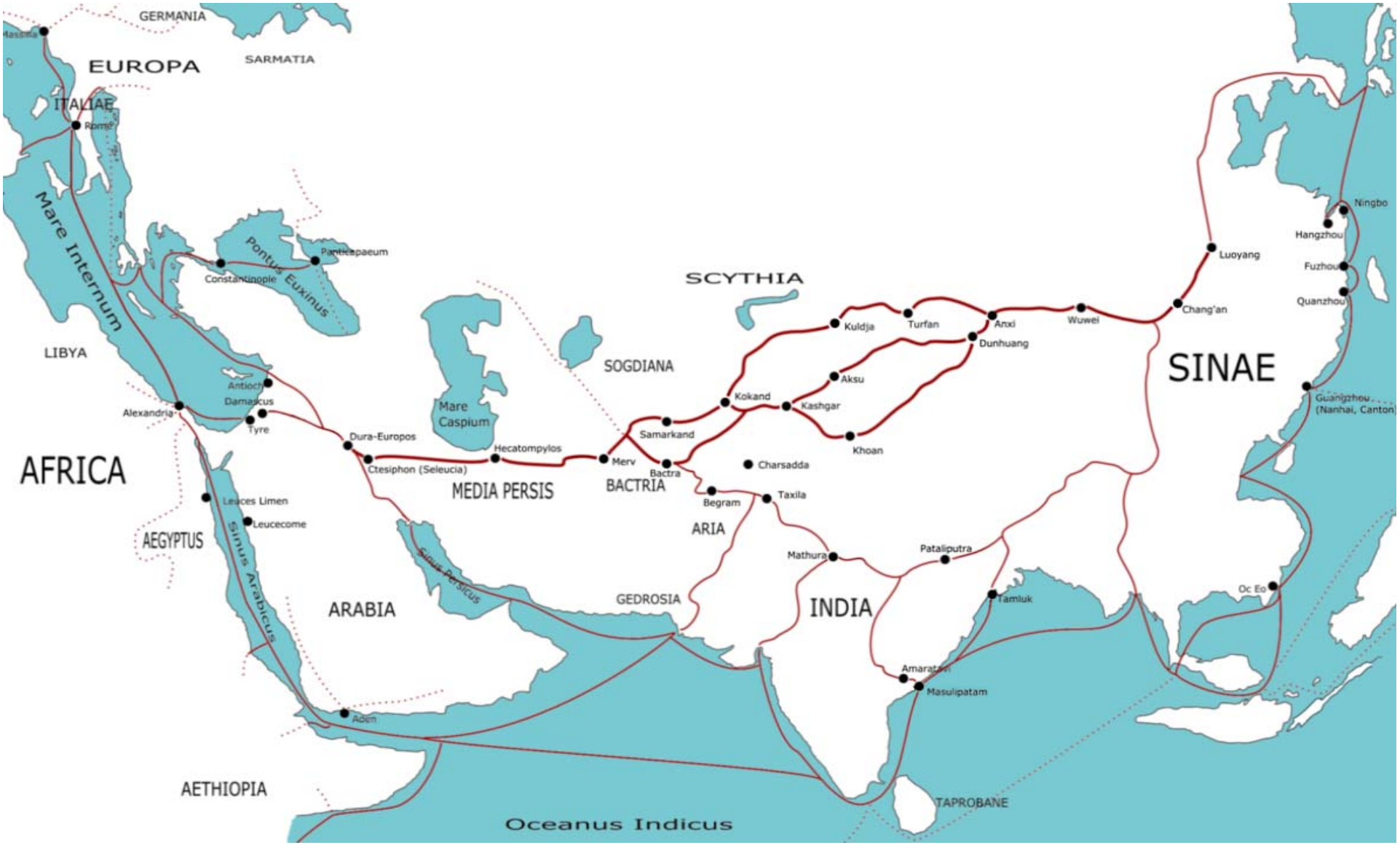




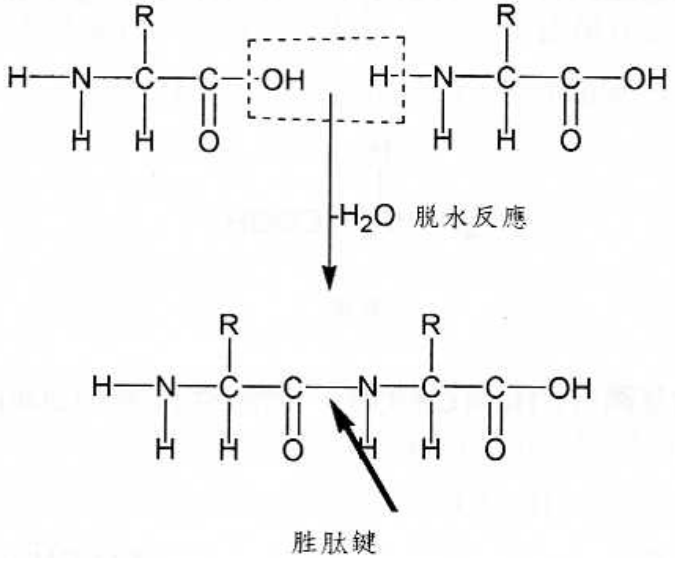
- PETN與橡膠混合可置初塑膠炸藥

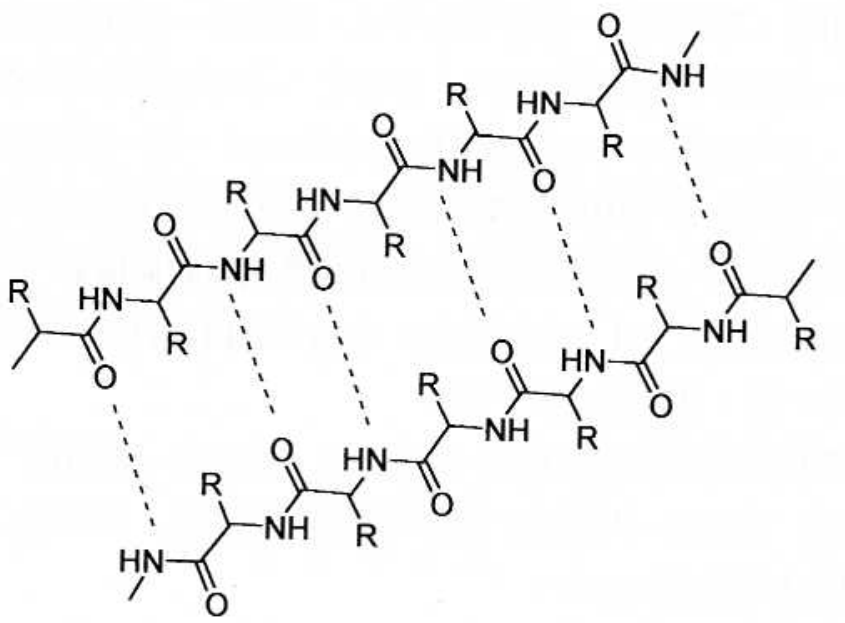
6. Silk and Nylon

- Silk was first discovered by the Chinese in 2600 BC. Princess Hsi-ling-shih first learned of this valuable thread when an insect cocoon fell into her tea and she realized that the silk could be unwound and was viable for textile use. The cocoon that fell into the Chinese Princess's tea was a silkworm's (*Bombyx mori)* cocoon. Ever since then, silk has been obtained from the silkworm.


GERMANIA
SARMATIA
EUROPA
ITALIAE
Rome
Mare Internum
Pontus Euxinus
Panticapaeum
Constantinople
LIBYA
Antioch
Damascus
Alexandria
Tyre
AFRICA
Dura-Europos
Ctesiphon (Seleucia)
Hecatompylos
Mare Caspium
SCYTHIA
SOGDIANA
Samarkand
Merv
Bactra
MEDIA PERSIS
BACTRIA
Kuldja
Turfan
Anxi
Wuwei
Dunhuang
Kokand
Aksu
Kashgar
Khoan
Charsadda
Taxila
Begram
ARIA
Leuces Limen
Leucecome
AEGYPTUS
Sinus Arabicus
Sinus Persicus
ARABIA
GEDROSIA
Mathura
Pataliputra
INDIA
Tamluk
Masulipatam
Aden
AETHIOPIA
Oceanus Indicus
TAPROBANE
Luoyang
Chang'an
SINAE
Ningbo
Hangzhou
Fuzhou
Quanzhou
Guangzhou
(Nanhai, Canton)
Oc Eo

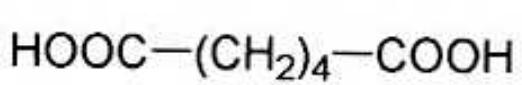
- 絲是聚合物,但並非由相同蛋白組成（下圖中的R可能是22種氨基酸其中一種）



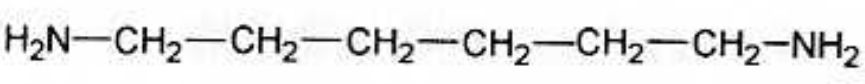


絲蛋白鏈藉側鏈間的吸引力彼此相結合。

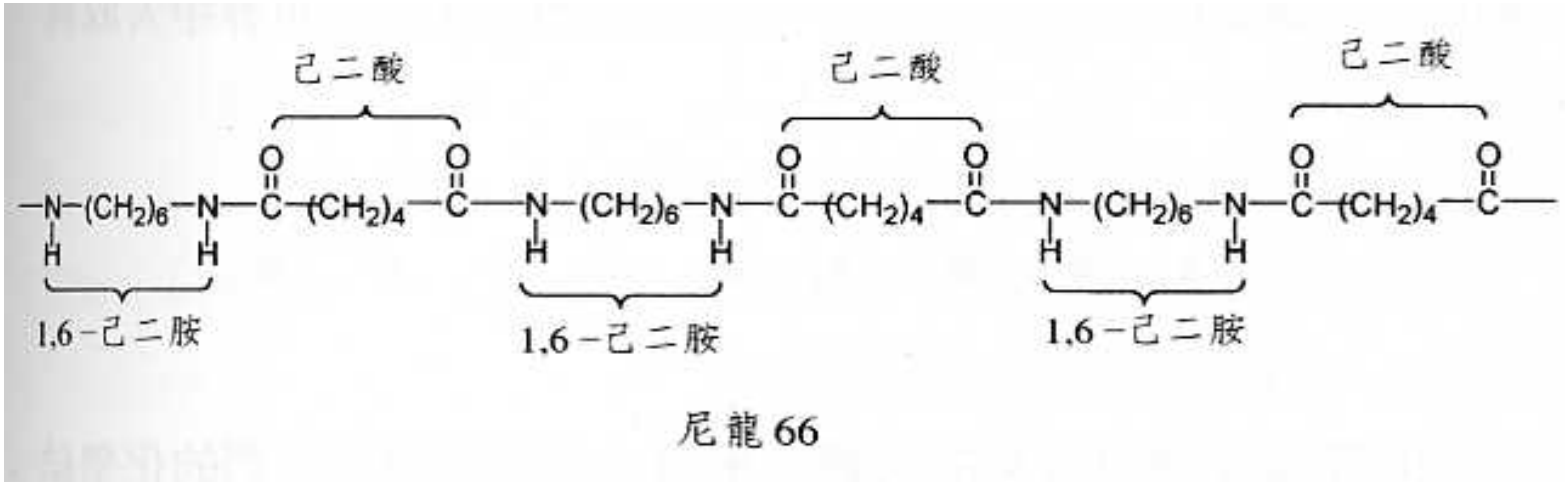
- 杜邦公司提供經費給Wallace Carothers合成聚酯纖維polyester.而最終製造出尼龍（Nylon.



簡化的己二酸結構。



1,6-己二胺的結構



尼龍66

Nylon

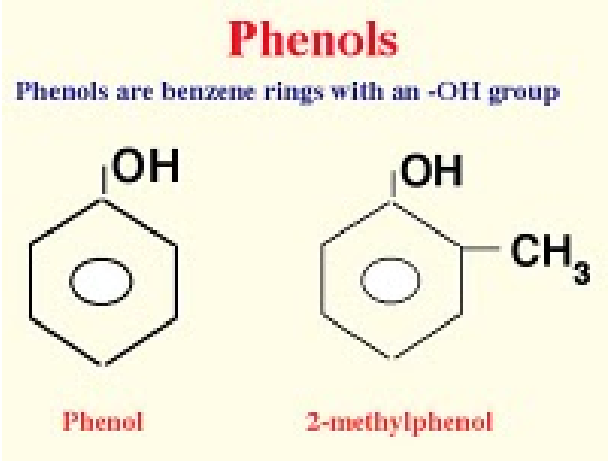
- Nylon 應用於牙刷, 絲襪, 釣魚線, 漁網, 球拍線, 手術縫線, 絕緣體, 輪胎簾子線, 降落傘, 工程塑膠等.

7. Phenol

- In the 1820s, hospitals were filthy. Many patients died from a preventable disease such as gangrene or the infamous "hospital disease". Because of these unsterile condition, Joseph Lister, an American doctor, began experimenting with carbolic acid, a waste product of coal gas, for use as an antiseptic. Lister first tested this method on a boy with a compound fracture. He applied the carbolic acid to the boy's wound and it formed a scab-like covering over the injury. The boy's wound never became infected and thus proved carbolic acid as an effective antiseptic. The active ingredient in the carbolic acid was Phenol.

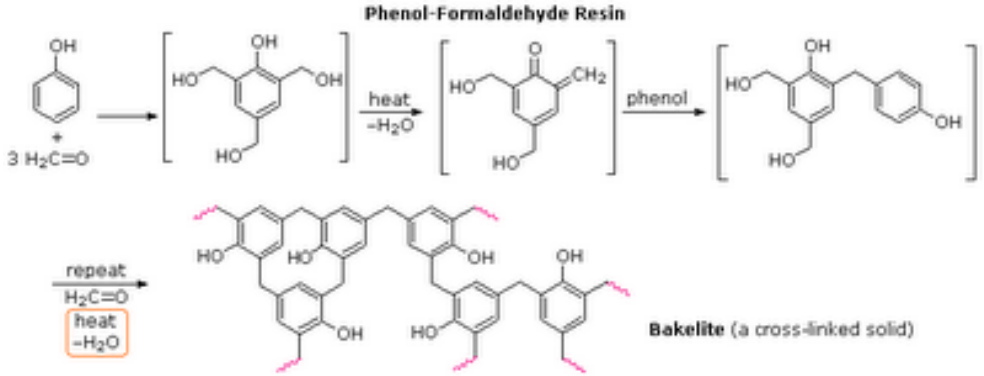
Phenol

- Through the years, carbolic acid usage became more widely used and more refined. Carbolic acid was use in surgery to prep and clean the surgical area and a machine was even made to spray a fine carbolic acid solution into the air to kill airborne bacteria in the operating room. But as many surgeons learned, the main ingredient in carbolic acid, Phenol, was highly toxic. Even in dilute solutions, it caused bleaching, cracking, and numbness of the skin and when inhaled, it caused severe illness. Because of this fact, many doctors refused to use phenol.



Phenol

- The most important use of phenol however, is its use in the discovery and manufacture of plastics. Leo Baekeland was able to use a formaldehyde and phenol compound to create the first plastic called Bakelite.
- Bakelite was a liquid that hardened rapidly into a transparent, amber colored solid that could completely conform to the shape of the mold into which it was poured. Once bakelite was formed, it was was frozen into its shape forever and would not melt. These characteristics made it ideal for electrical insulation.



Phenol

- Baekeland發明了以氯化銀為感光劑的相紙, 並將其賣給George Eastman (Eastman Kodak創辦者)
- Baekeland接著發明Bakelite 取代“蟲漆”做為電器絕緣材料.
- Bakelite最終被製成撞球, 減少了非洲大象被大量屠殺(撞球原以象牙製成)

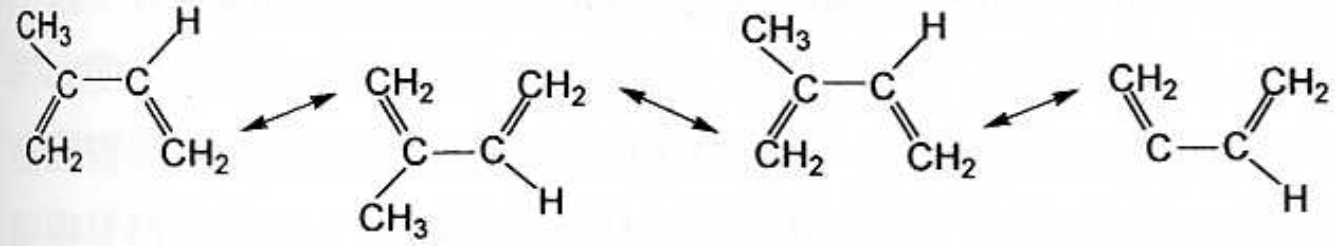
8. Isoprene

- Where would the world be today without rubber? There would be no tires, no gaskets or fan belts, no elastic for clothes, no waterproof soles for shoes, and no rubber bands.
- The birth of rubber came from the gum of the *caoutchouc* tree. During the 18th century. French Explorer, Charles-Marie de La Condamine observed the Omegus Indians collecting the caoutchoc sap, holding it over a smoky fire and molding the sap into different shapes.

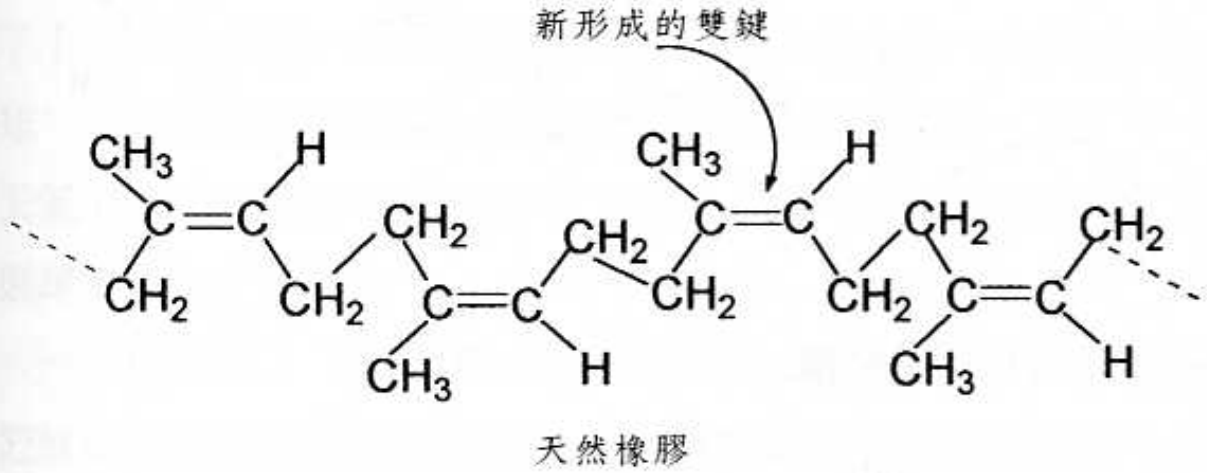
8. Isoprene

- But when La Condamine tried to send samples of the caoutchoc sap over seas back to France, it fermented in the hot weather and by the time it arrived in Europe, it was a sticky, smelly mess. This was a problem of rubber for many years to come. The various rubber compounds would become hard and brittle during the winter, and would melt during the hot summer months.
- In 1839, nearly 100 years after the caoutchoc sap's discovery and numerous other failed attempts at forming viable rubber compounds, Charles Goodyear discovered that adding powdered sulfur to rubber could absorb the excess moisture that made the substance sticky during the summer.

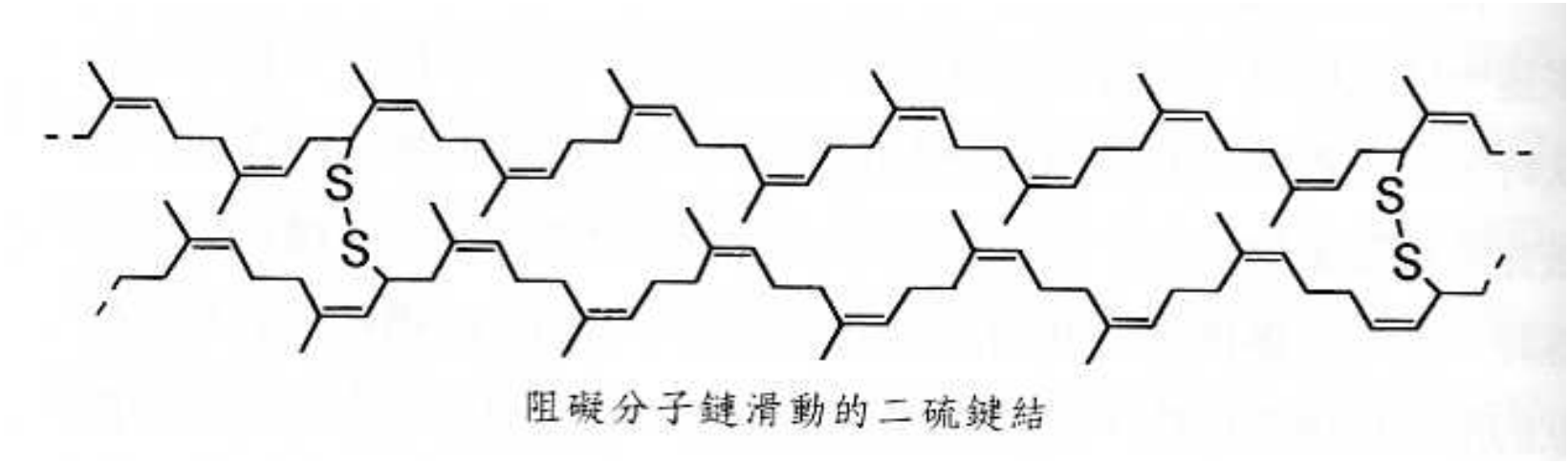
Natural Rubber



四個異戊二烯分子以末端彼此相接（如圖中雙箭頭標示處），而形成天然橡膠的過程如下圖所示。



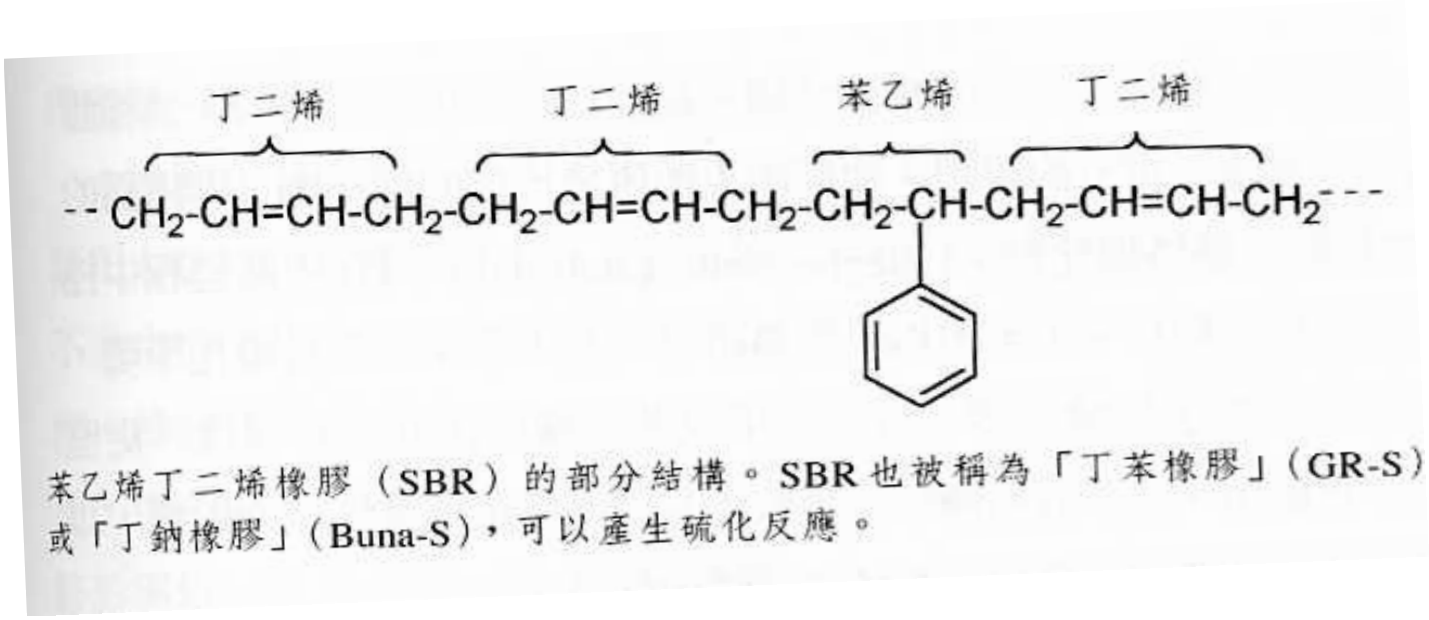
- 藉著天然橡膠和硫粉形成二硫鍵, 不但保持住橡膠的彈性, 同時也減少分子間因張力產生的形變



阻礙分子鏈滑動的二硫鍵結

- 亞馬遜熱帶雨林橡膠樹
- 人工採收每年3磅,但砍伐1顆橡膠樹可得到100磅乳膠,導致熱帶雨林橡膠樹枯竭問題
- 英國Wickham偷運七萬顆橡膠種子出巴西,這些種子之後被運往亞洲栽培,中國及其他民族勞工因而湧入東南亞.
- 非洲原住民亦受到象牙及橡膠需求的苦難.
- 二戰時期,德軍東南亞橡膠來源受阻,便著手製造合成橡膠.

- 苯乙烯丁二烯橡膠 (SBR)



苯乙烯丁二烯橡膠（SBR）的部分結構。SBR也被稱為「丁苯橡膠」（GR-S）或「丁鈉橡膠」（Buna-S），可以產生硫化反應。

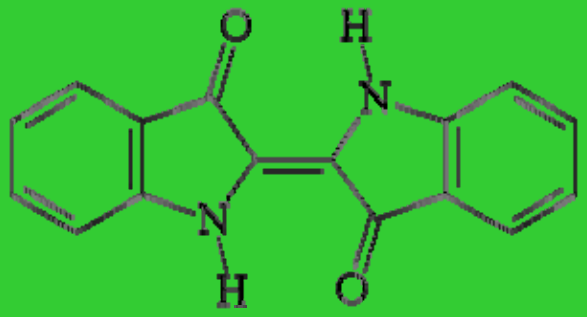
9. Dyes

- The dye industry goes back several thousand years. The early dyes were obtained mainly through plants roots, leaves, bark or berries.
- Most of the dies produced did not adhere permanently to untreated fibers and therefore fabrics had to be treated with mordant, which is a compound designed to help fix the color to the textile fiber by forming a coordination complex with the dye which then attaches to the fabric or tissue
- While many dyes in 3000 BC were highly treasured and very expensive there was several problems with the dyes themselves. The dyes were difficult to obtain, color range was limited, and the colors were not strong, but faded quickly to dull colors in the sunlight.

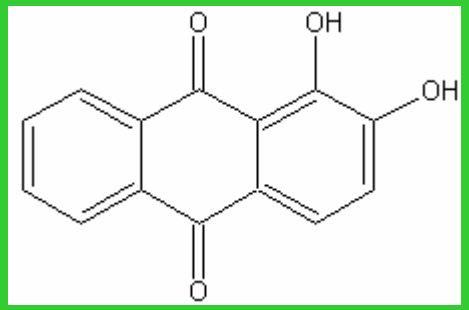
Dyes

- Dyes are organic compounds that are Incorporated into the fibers of textiles. The molecular structure of these compounds allows the absorption of certain wavelengths of light from the visible structure. The relationship between the wavelength absorbed and the chemical structure depends on the presence of double bond alternating with single bonds. The Primary colors, Blue, Red, and Yellow all come from either Indigotin, alizarin, or Crocetin, respectively.

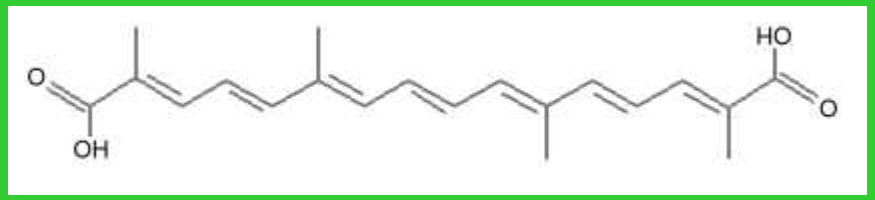
Blue: Indigotin



Red: alizarin



Yellow: crocetin



- Blue dyes were especially valued because, compared with red or yellow, blue shades were not as common in plants.
- The blue dye was harvested from the *Indigofera tinctoria*. The fresh leaves of this indigo producing plant are at first colorless, after fermentation under alkaline conditions followed by oxidation, the blue color appears.
- Fermentation of indican splits off the glucose unit which produces the indoxol/indigotin molecule. Indican is initially colorless, but after it goes through the fermentation process and turns into indiogotin, the color changes to blue. The same is true for alizarin, and crocetin. Initially, they are colorless, but after a chemical reaction the gain their color.

Color

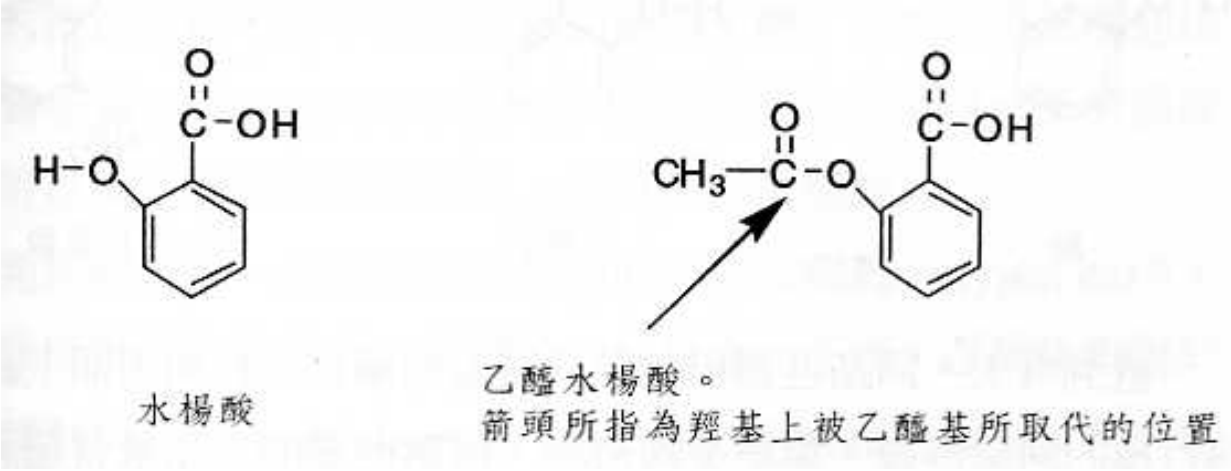
- Pigment manufacturers assume the source light will be white, or of roughly equal intensity across the spectrum. If the light is not a pure white source (as in the case of nearly all forms of artificial lighting), the resulting spectrum will appear a slightly different color. Red paint, viewed under blue light, may appear black. Red paint is red because it reflects only the red components of the spectrum. Blue light, containing none of these, will create no reflection from red paint, creating the appearance of black.

10. Wonder Drugs

- For thousands of years, medicinal herbs have been used to treat a variety of ailments such as wounds, sickness, and to relieve pain. But none of these herbal remedies could do anything for infection. The use of Phenol as an antiseptic prevented the actual contraction of infectious bacterium, but once the infection was in your body, it was practically a death sentence. For this reason, antibiotics were developed through a process of trial and error.

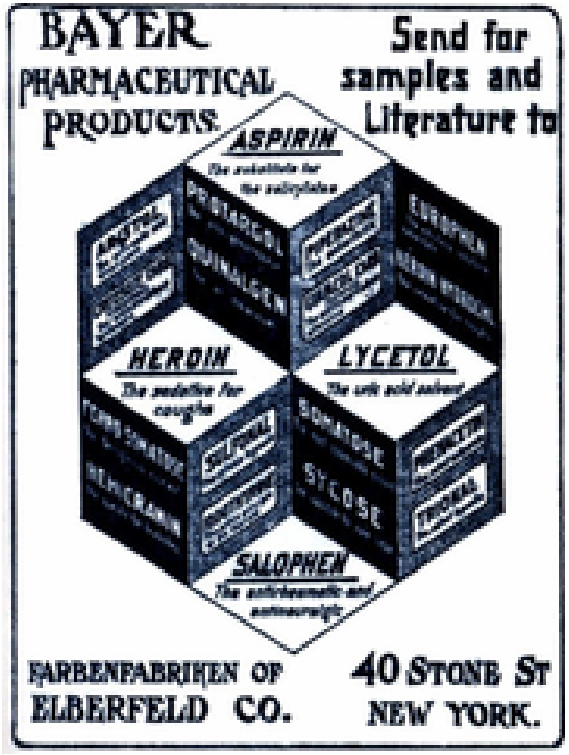
Aspirin

- 1893年, Bayer公司的Felix Hofmann改變水楊酸的結構得到aspirin.
- Aspirin 可鎮痛, 解熱, 並抑制發炎.



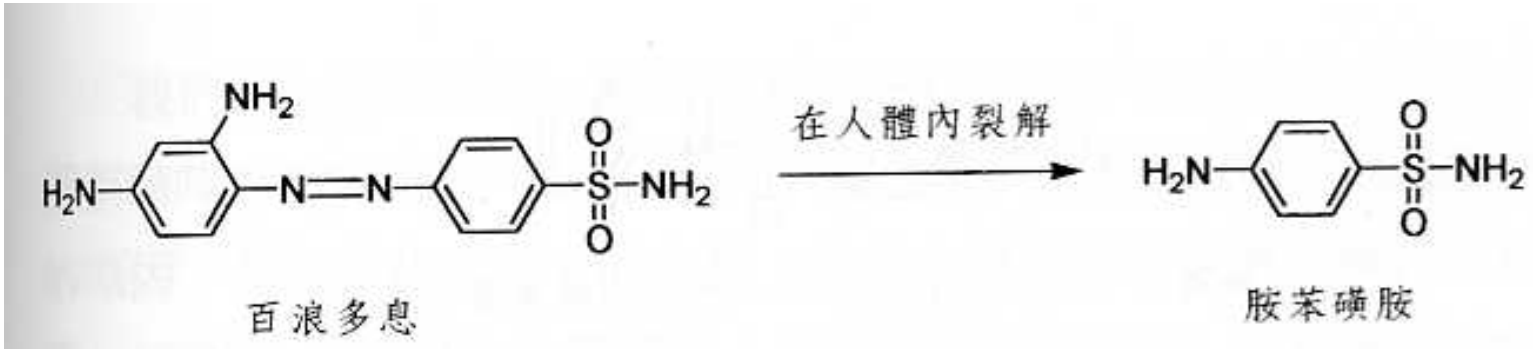
水楊酸

乙醯水楊酸。
箭頭所指為羥基上被乙醯基所取代的位置



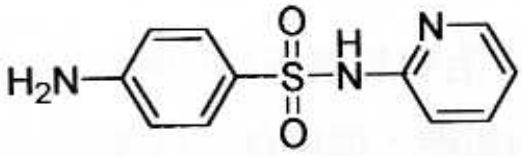
Sulfanilamides

- In the early 1930‘s, Gehard Dogmark discovered the use of *prontosil red* dye（百浪多息）as an antibacterial agent. When prontosil red enters the body, it breaks down into *sulfanilamide*, which was the active bacteria fighting ingredient of the prontosil red molecule.

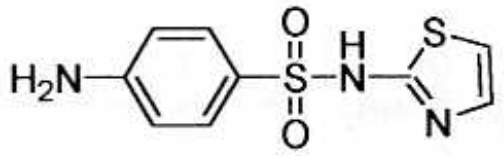


Sulfanilamides

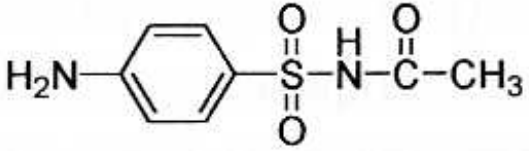
- Once it was discovered that sulfanilamide was the molecule responsible for the antibacterium properties, the structure of this molecule was changed many times in hopes that it would make the drug more effective. The resulting molecules are all part of the family of antibiotics that came to be known as sulfanilamides of *sulfa drugs*.



磺胺啶（sulfapyridine）——用以治療肺炎



磺胺唑（sulfathiazole）——用以治療腸胃道感染



乙醯磺胺（sulfacetamide）——用以治療泌尿系統感染

Sulfanilamides

- Sulfa drugs were found to be very effective against infections such as pneumonia, scarlet fever, and gonorrhea, but they also had a long list of side effects including an allergic response, rashes, fever, and kidney failure.

Sulfanilamides

- The size and shape of the sulfanilamide molecule prevents bacteria from making an essential nutrient, folic acid. Folic acid is made from a smaller molecule, *p-Aminobenzoic.* The chemical structures of p-Aminobenzoic and sulfanilamide are so similar that bacteria will mistake sulfanilamide for p-Aminobenzoic and use sulfanilamide in its place. The bacteria then, are unable to make enough folic acid, and die. Humans are not affected by the sulfanilamide because our source of folic acid comes from our food and is not made within our bodies.

Penicillium

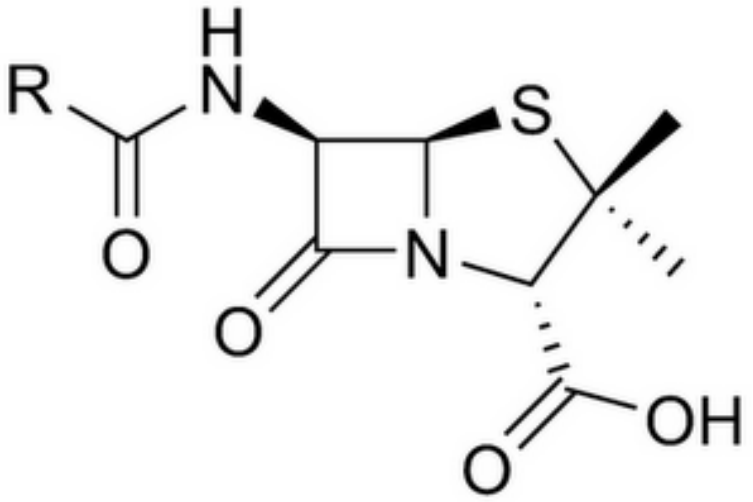
- In 1877, **Louis Pasteur**, develop the science of bacteriology when they discovered a link between bacteria, fermentation and disease.
- In 1928, **Alexander Fleming** discovered penicillin by accident.
- **Howard Walter Florey** discovered Alexander Fleming's work on penicillin about 10 years later. He purified the active ingredients, tested the antibiotic on mice and saw that it worked. Antibiotics helped us win World War Two. He was awarded the Nobel Prize for physiology or medicine in 1945 for work on penicillin.

Penicillium (青黴菌屬)

- This mold is so important because it was nontoxic, nonirritating, had none of the side effects of the sulfa drugs and could be applied directly to the tissue.

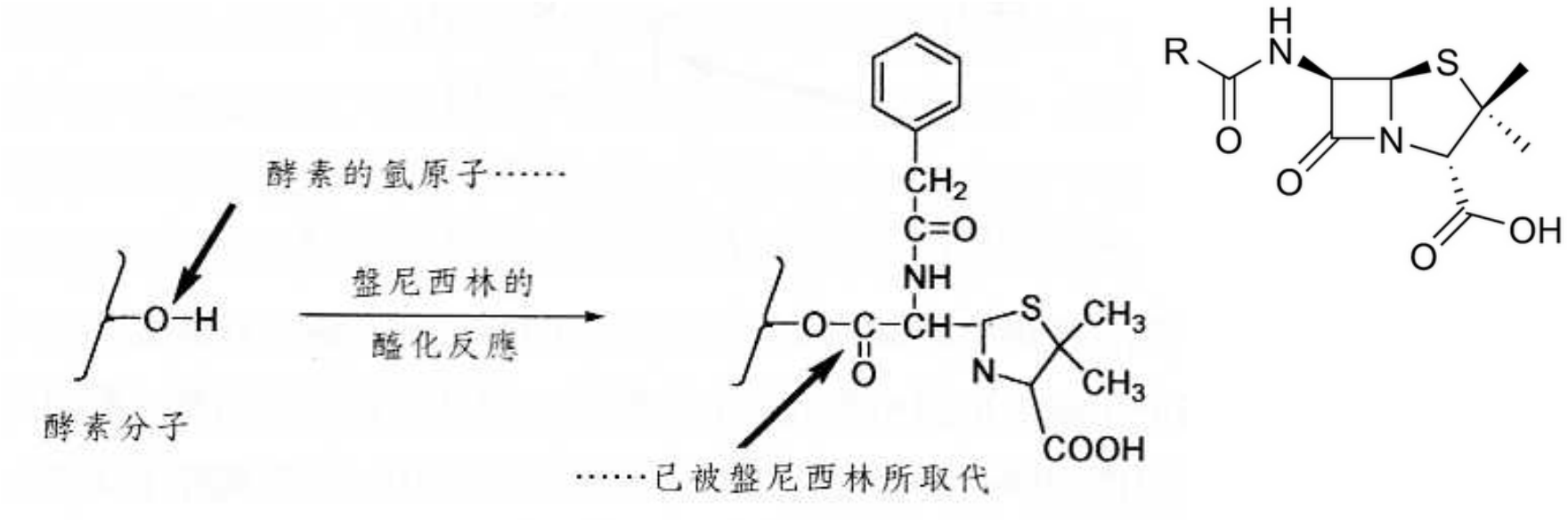
Penicillium

- Penicillin is effective because of the shape of its molecule. Penicillin's structure contains a four member ring in which the bonds form a square, and consequently 90 degree bond angles.

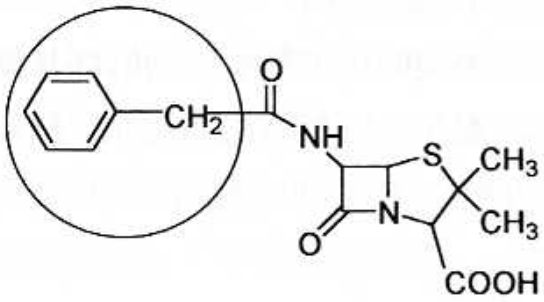


Penicillium

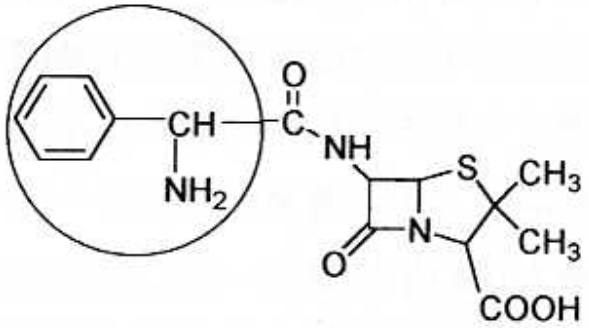
- When the penicillin encounters bacterial, the four member ring opens and effectively deactivates the an enzyme that creates the cell wall. Without the ability to grow cell walls, growth of new bacteria is severely inhibited.



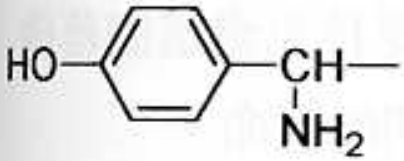
Penicillium



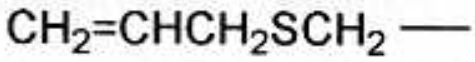
盤尼西林G分子。圈出部位為不同衍生物的相異之處



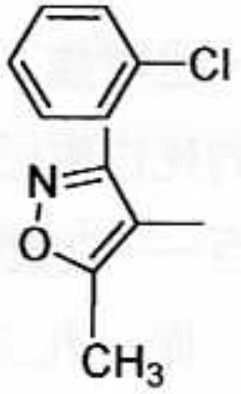
胺比西林



阿莫西林的側基團



盤尼西林O分子的側基團



氯唑西林的側基團

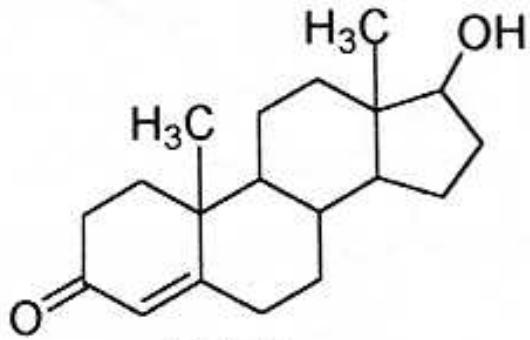
11. Pills

- In the 1960s, *norethindrone* (炔諾酮) was isolated for use in the first oral contraceptive which came to be known as the pill. The pill brought on the "Free Love" movement of the 60s, as well as women's liberation movement, the rise of feminism and, eventually, the breakdown of the family.

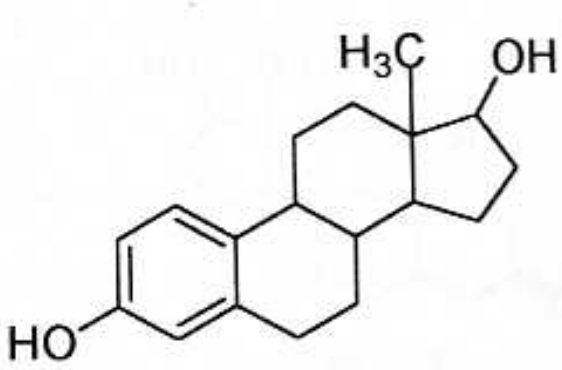
Progesterone

- A more primitive form of birth control was the use of the female hormone, progesterone. Progesterone is released naturally by the female's body during pregnancy to suppress ovulation, and therefore, prevents the woman from getting pregnant again, during her first pregnancy.
- The only problem with this method is that it was very difficult and expensive to isolate the necessary quantity of progesterone to prevent ovulation. Also, progesterone had to be injected to maintain it potency.

Steroid

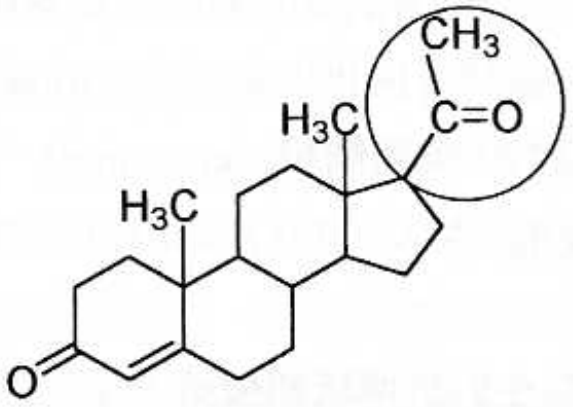


睪固酮



雌二酮

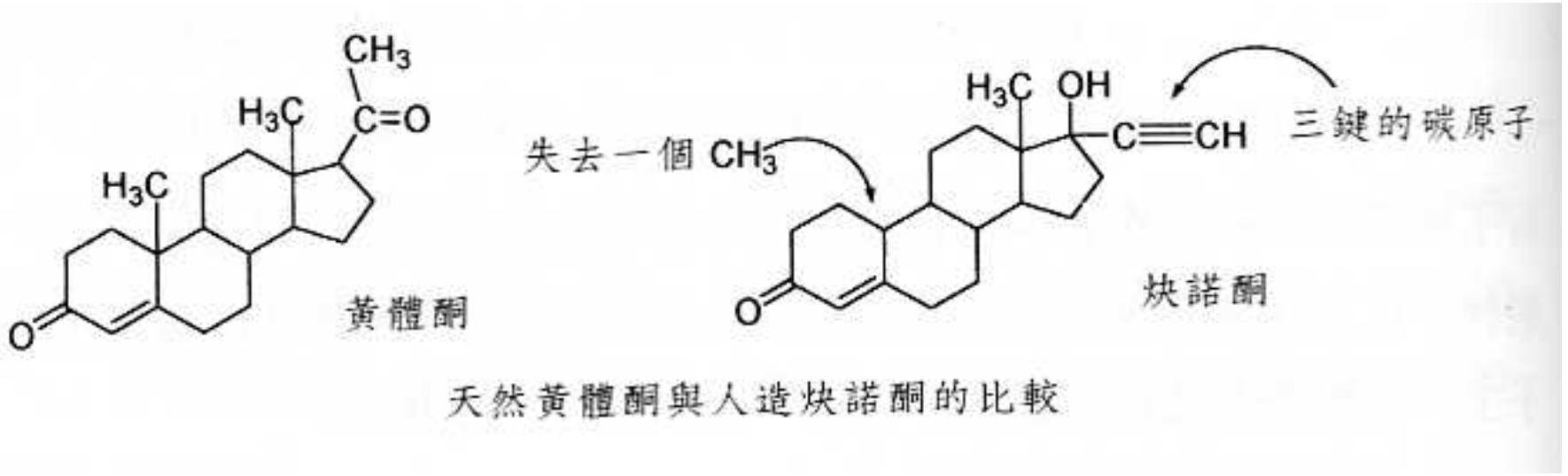
- Progesterone（黃體酮）可刺激子宮內膜增厚，並抑制排卵，但口服效果不佳



黃體酮

Norethindrone

- To battle the problems of progesterone, norethindrone was synthesized in 1951. Norethindrone is 8 times more powerful than progesterone and can be taken orally.



天然黃體酮與人造炔諾酮的比較

12. Molecules of witchcraft

- During the Iron Age, millions of women and children were burned at the stake, hanged, or tortured because they were accused of being witches. Many of the accused confessed to flying during the night to have meetings with the Devil and to cast hexes on their enemies.

Molecules of witchcraft

- While many confessed after severe torture, other accused "witches" sincerely believed that they had been on a magical adventure. It is now believed by historians that one of the widely used "potions" of the witches was an alkaloid, a compound with hallucinogenic properties.

Alkaloids

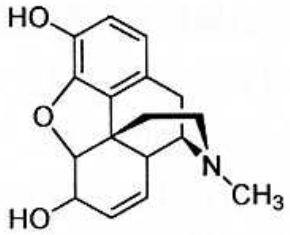
- Alkaloids are extremely toxic and affect the central nervous system. Alkaloids were used by witches in their flying salves, which often included extracts from mandrake, belladonna, and henbane. Mandrake, Belladonna, and henbane all contain the alkaloids, atropine and hyoscine. Large concentrations of these alkaloids produce blurry vision, agitation, delirium, and euphoria. As one can see, the symptoms of alkaloid ingestion are very similar to a substance induced high and is the probably cause of the accused witch's believe that she actually was a witch.

13. Morphine, Nicotine, and Caffeine

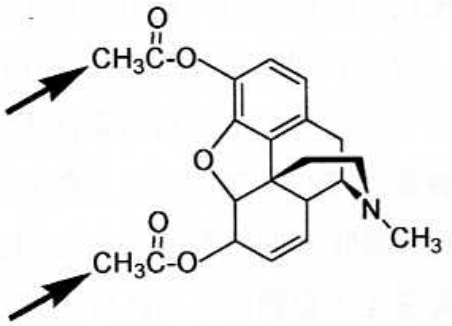
- Morphine, nicotine, and Caffeine are all addictive alkaloid molecules that had a great impact on trade relations between various nations throughout history.

Morphine

- Morphine, the active ingredient in Opium, is an extremely effective painkiller, and in some cases has a narcotic, and hallucinogenic effect. Variations of the morphine compound, are heroin and methadone.
- Morphine mimics the natural painkilling endorphins in our brains and explains their effectiveness as painkillers. Morphine has generally been prescribed throughout history as a cure for many different symptoms including coughing, headaches, asthma, emphysema (肺氣腫) , and tuberculosis (肺結核).



嗎啡



二乙醯嗎啡（海洛英）

Nicotine

- Use of Tobacco was first discovered in Latin America and the brought back to Europe by Christopher Columbus. The use of tobacco spread wildly throughout Europe because of its addictive qualities. Tobacco has at least 10 different alkaloids, the most common being Nicotine.
- Biologically, Nicotine acts as a stimulant in small doses and a depressant in large doses. Furthermore, it has been discovered that nicotine is 1000 times more potent when it is absorbed through the skin than when it is taken orally. Nicotine is also used as an extremely effective natural pesticide.

Caffeine

- Caffeine is naturally found in tea leaves, coffee beans, cacao pods, and cola nuts. When in the body, caffeine goes to the brain where it blocks the absorption of adenosine at the synaptic gap. Adenosine slows down the firing of Neurotransmitters which therefore makes you tired, but if caffeine inhibits the absorption of this neurotransmitter, then it explains caffeine's awakening effect.
- Caffeine is also toxic as well as highly addictive, it is estimated that 80g-100g is the lethal dose for an adult. But, it is nearly impossible to consume that much caffeine at one time.

咖啡因

14. Oleic Acid

- Oleic Acid is the main ingredient in Olive Oil. This golden oil was always the foundation upon which the post-classical Mediterranean societies based their economic prosperity on, and this beloved oil was at the heart of their culture.
- Throughout history, olive oil has been used as fuel in lamps, for cosmetic purposes, fragrances, as a cure for numerous diseases and a painkiller. One of the reasons that olive oil was so effective as a painkiller, was because it also contains salicylic acid, the same molecule that is the active ingredient in aspirin.

Olive Oil

- Another Reason why olive oil was so valued was because it did not spoil as quickly as other oils. This is due to olive oil's lower proportion of polyunsaturated fatty acids is 10% lower than other oils. Furthermore, olive oil contains small amounts of polyphenols and vitamin E and K. These molecules are all antioxidants, which play an important role in the natural preservation of the olive oil.

15. Salt

- There are 3 main methods of collecting salt: evaporating seawater, boiling salt solutions from brine springs, and mining rock salt.
- Seawater evaporation is the most commonly used method of salt production. It is a slow, yet cheap process and is more effective in tropical climates. Raw sea salt is of a lower quality of brine salt. Seawater is about 3.5% pure salt and contains impurities such as magnesium chloride, and calcium chloride.
- Brine springs are underground solutions of highly concentrated solutions of salt, often times 10 times more concentrated than seawater. It is also a very effective method of collecting salt in any climate. Brine salt also lacks the impurities of sea salt and is more desired and therefore, more expensive.

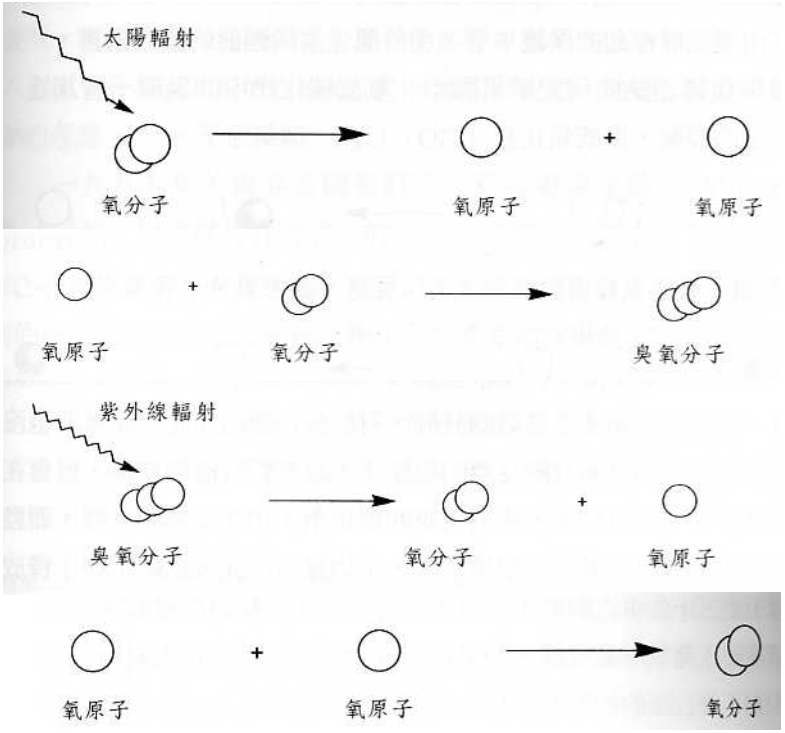
- Rock salt is the dried remains of old oceans or seas. These salt deposits must be mined out of the earth.

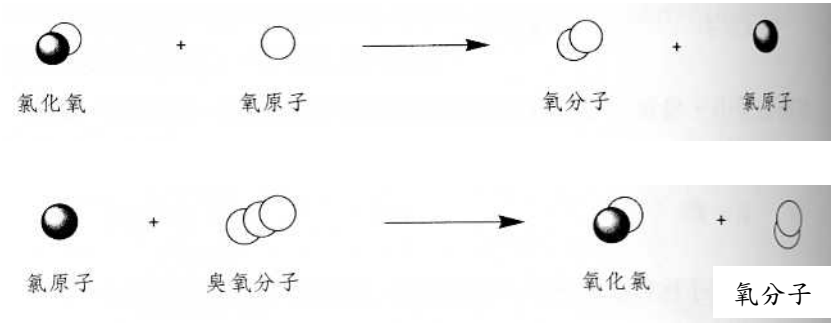
16. Chlorocarbon Compounds

- Chlorocarbons are vital components of refrigeration. Other attempts at refrigeration included molecules such as Ammonia, ether, methyl chloride, sulfur dioxide were good refrigerants, but they either decomposed, were fire hazards, poisonous, or extremely bad smelling.
- Chlorofluorocarbons (CFCs) met all the requirements for a good refrigerant, extremely stable, and had none of the unfortunate downsides of the other refrigerants. CFCs started the air conditioning industry because of its cooling properties, and because it reacted with almost nothing, it was ideal propellants for virtually everything that could be applied through a spray can.

Chlorocarbon Compounds

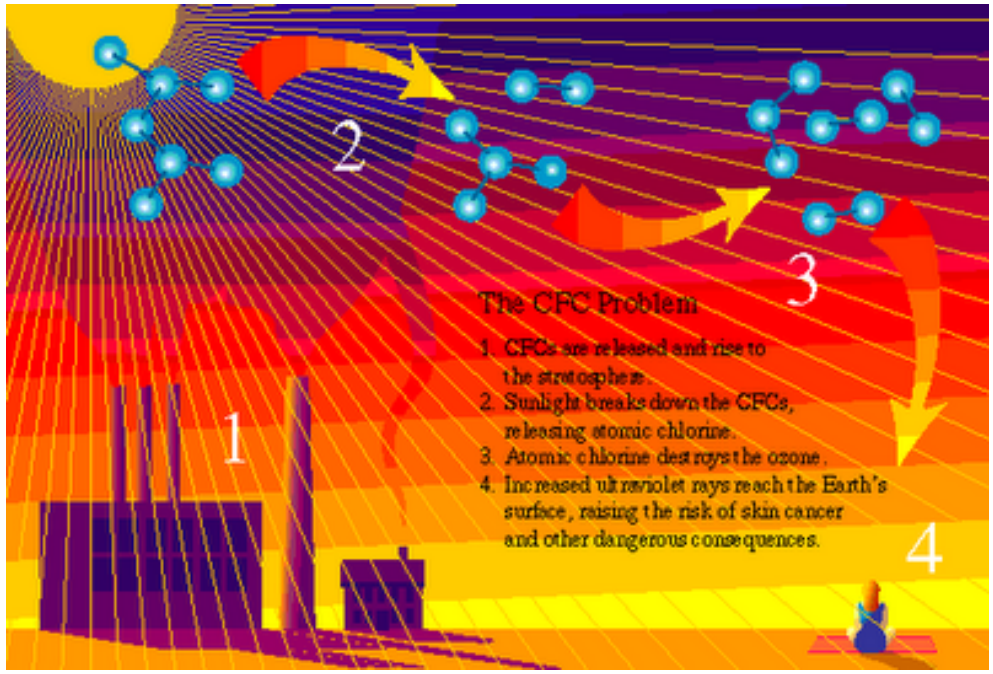
- Because CFCs are not easily decomposed, after use they rise into the atmosphere. There, they act as a catalyst for the decomposition of ozone (O_3).





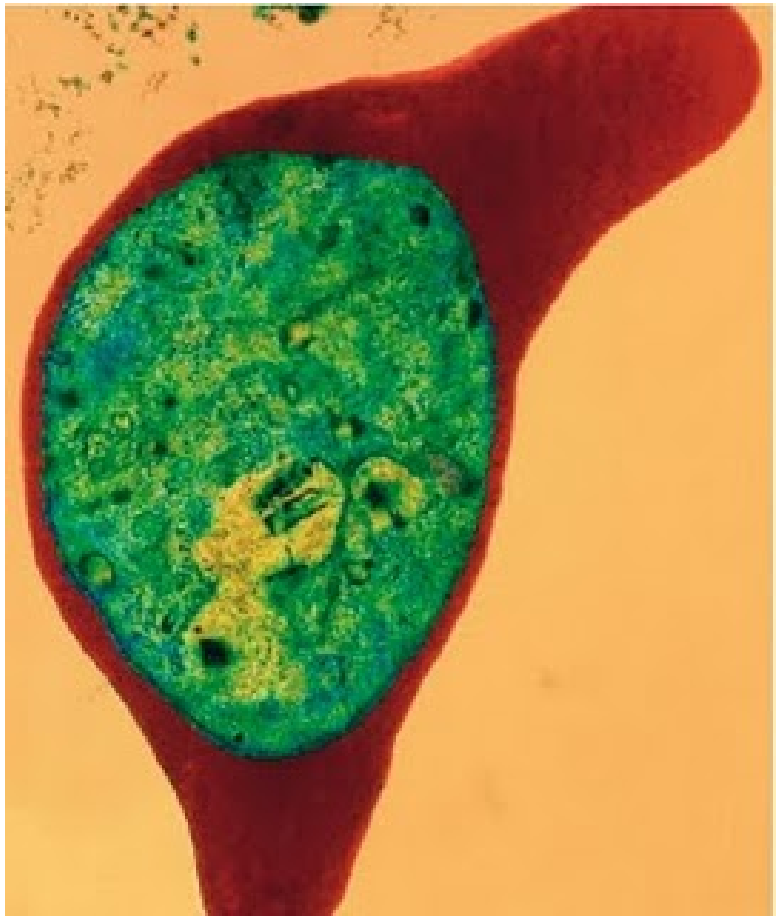
Chlorocarbon Compounds

- This destruction of ozone takes the ozone layer out of equilibrium. The ozone layer is important because it protects us from the most dangerous ultraviolet rays from the sun. It estimated that for every 1% of ozone depletion, 2% more harmful ultraviolet rays penetrate the earth's atmosphere



17. Molecules Vs. Malaria

- Malaria is a nasty little parasite that is the greatest killer of humanity for all time. In other cases of epidemics, an infected person runs the risk of spreading the disease to 4 -10 people, but if the person has malaria, then that person can possible infect 100 other people.



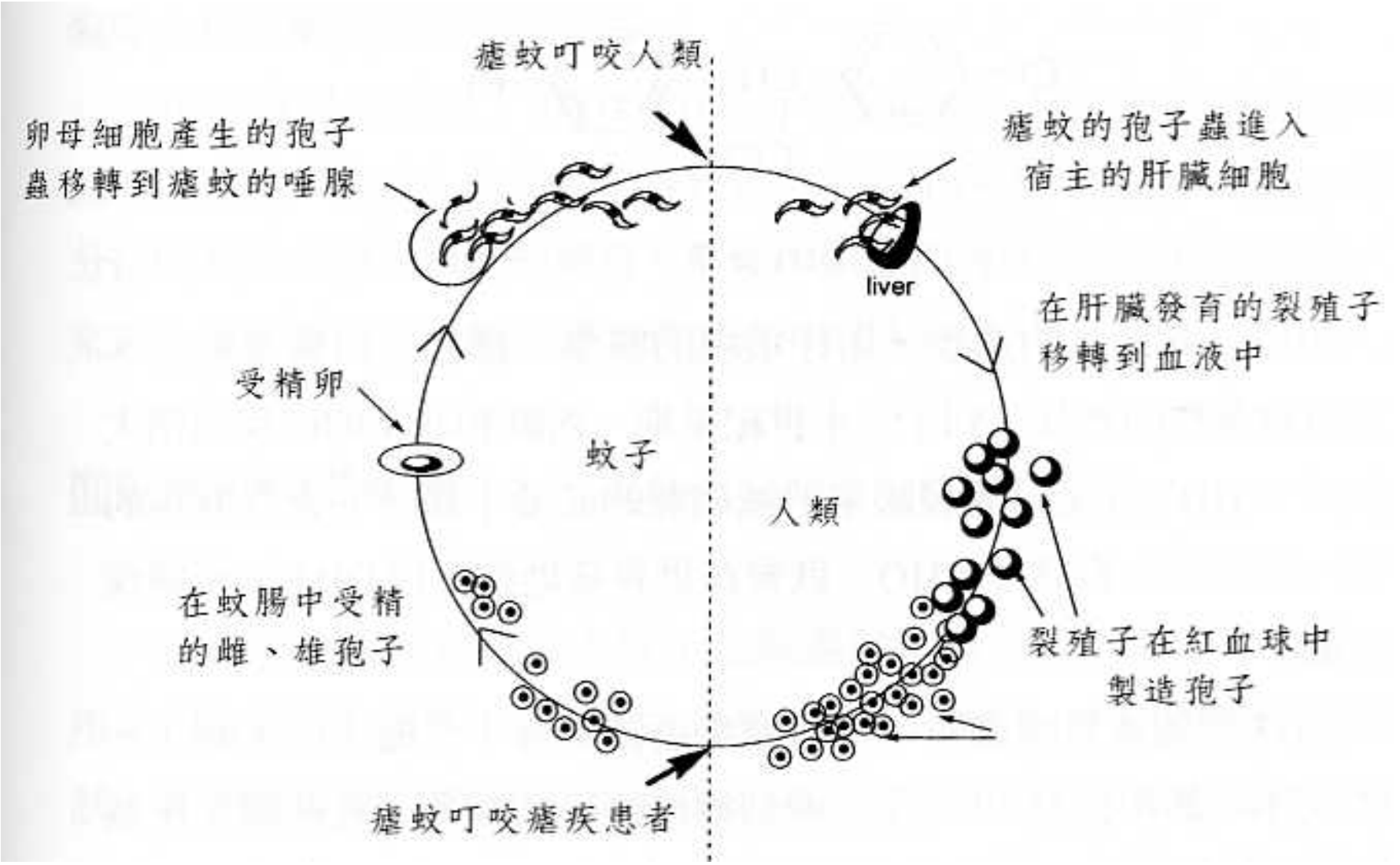
Cross section of the Malaria parasite

Malaria

- The Malaria parasite is found in the blood and is transmitted and spread when mosquitoes bite people. Symptoms of malaria include intense fever, chills, terrible headache, and muscle pains. Eventually, an infected patient will become jaundiced, lethargic, and confused before lapsing into a coma and dying.

Quinine

- Quinine, an alkaloid from the bark of *Cinchona* genus has proved very effective against fighting malaria.
- The demand for quinine had become so great over the years that the cinchona trees would sound be extinct if the rate of harvest continued. Therefore, the compound was synthesized into chloroquine. Chloroquine was an effective treatment for around forty years and then a chloroquine resistant strain of malaria evolved and it was no longer useful.



The best way to stop malaria, or so it seemed, was to stop its transmission by killing the mosquitoes.

DDT

- DDT是一種長效殺蟲劑.大量噴灑DDT曾有效幫助歐洲減少瘧疾的侵害.
- 然而,DDT副產物使得鳥類蛋殼脆弱而大量減少 (Silent Spring by Rachel Carson),在自然平衡的破壞下使得蟲類問題反而更難解決.

血紅素的保護

- Sickle-cell anemia in Africa prevented infection of Malaria but resulted in slavery.

Conclusions

- 化學合成幫助我們減少對原物料的依賴, 使我們生活更好
- 人類慾望追求下的悲劇
- 自然界的平衡
- 無知的恐懼