CARBON COMPOUND

CHAPTER 4

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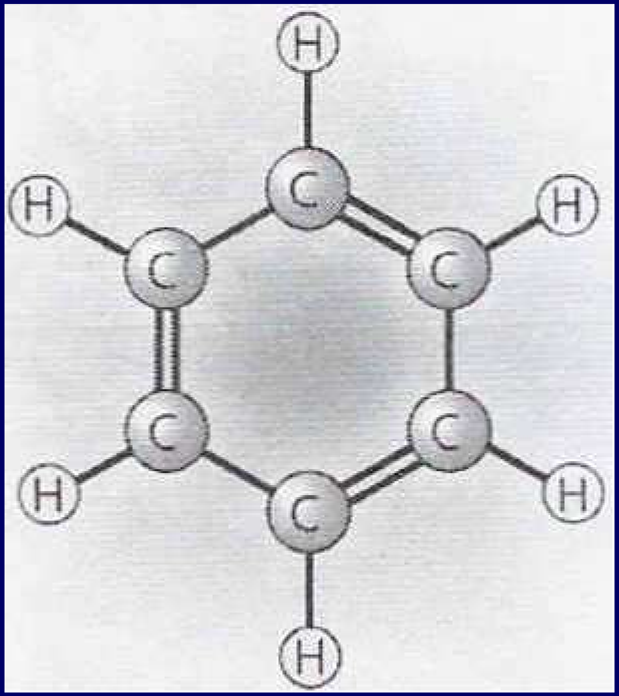
VARIOUS CARBON COMPOUNDS

- Carbon atom can bind up to four other atoms.
- It can combine with almost every other element. Carbon atoms can also combine with other carbon atoms to make chains or rings.
- Carbon compounds are molecules that contain carbon elements.

- Carbon exists in carbon dioxide in the air, and made up a large part of coal, crude oil, and natural gas.
- Also exists in the food, the clothes, the cosmetics, the paints and the gasoline that fuels car.



Benzene, a carbon compound contains a ring of carbon atoms.

- Many carbon compounds contain the same elements (for example, only carbon and hydrogen atoms), but the elements are different in quantities and arranged in different ways.
- The most important elements to bind with carbon are hydrogen, oxygen, and nitrogen

ORGANIC COMPOUNDS

- Contains carbon-hydrogen bonds
- Most of the compounds found in plants and animals contain carbon.
- Hormones, enzymes, proteins, starch, chlorophyll, cellulose are carbon compounds.
- Can be found in all living things and non-living things.

INORGANIC COMPOUNDS

- Not contain carbon-hydrogen bonds. These compounds are usually found in non-living things.
- Example:

  Metal compounds such as iron (III) oxides and aluminium oxides

- Example: carbides, carbonates, and carbon oxides
- Not have carbon-hydrogen bonds.
- Examples of carbides are calcium carbide and tungsten carbide

- Calcium carbonates, which make up the shells of clams and snails
- Their shells are not considered as the organic compounds because do not contain carbon-hydrogen bonds.
- Carbon oxides are usually found as gases.
- Example: Carbon dioxide and carbon monoxide
- A type of gas released during respiration - released during burning of fossil fuels.

- Another example of carbonates is sodium carbonate or soda ash.
- Used in the manufacture of glass and ceramic.
- Sodium bicarbonate (baking soda) is used for cleaning, washing, deodorising, and neutralising acids.

The similarity and the differences between organic and inorganic compounds.

Organic compounds	Inorganic compounds
Usually originated from living things	Usually originated from non-living things
Contain carbon-hydrogen bond	May contain carbon element but do not contain carbon-hydrogen bond
Consist of molecules	Consist of metallic compound
Do not mix with water Usually dissolve in organic solvent	Usually dissolve in water formingionic compound
Burn easily (produces carbon dioxide and carbon monoxide)	Do not burn easily

Hydrocarbons

- Defined as carbon compounds that containonly carbon and hydrogen atoms.
- The main sources of hydrocarbons are coal, petroleum, and natural gas - known as fossil fuels.
- Found in the Earth's crust.
- Petroleum is obtained as crude oil.
- The compounds are separated in oil refineries by a process called fractional distillation.

ALCOHOL AND ITS EFFECTS ON HEALTH

- Alcohols are organic compounds that contain carbon, hydrogen, and oxygen.
- Alcohols belong to a homologous series.
- The oxygen and hydrogen atoms form an oxygen-hydrogen bond in an alcohol molecule.
- The oxygen-hydrogen bond is called a hydroxyl group or O-H group.

PRODUCTION OF ALCOHOL

- Many alcohols can be created by fermentation of fruits or grains with yeast, a type of fungus
- Alcohol may also be produced using natural gas and petroleum through a process called hydration.

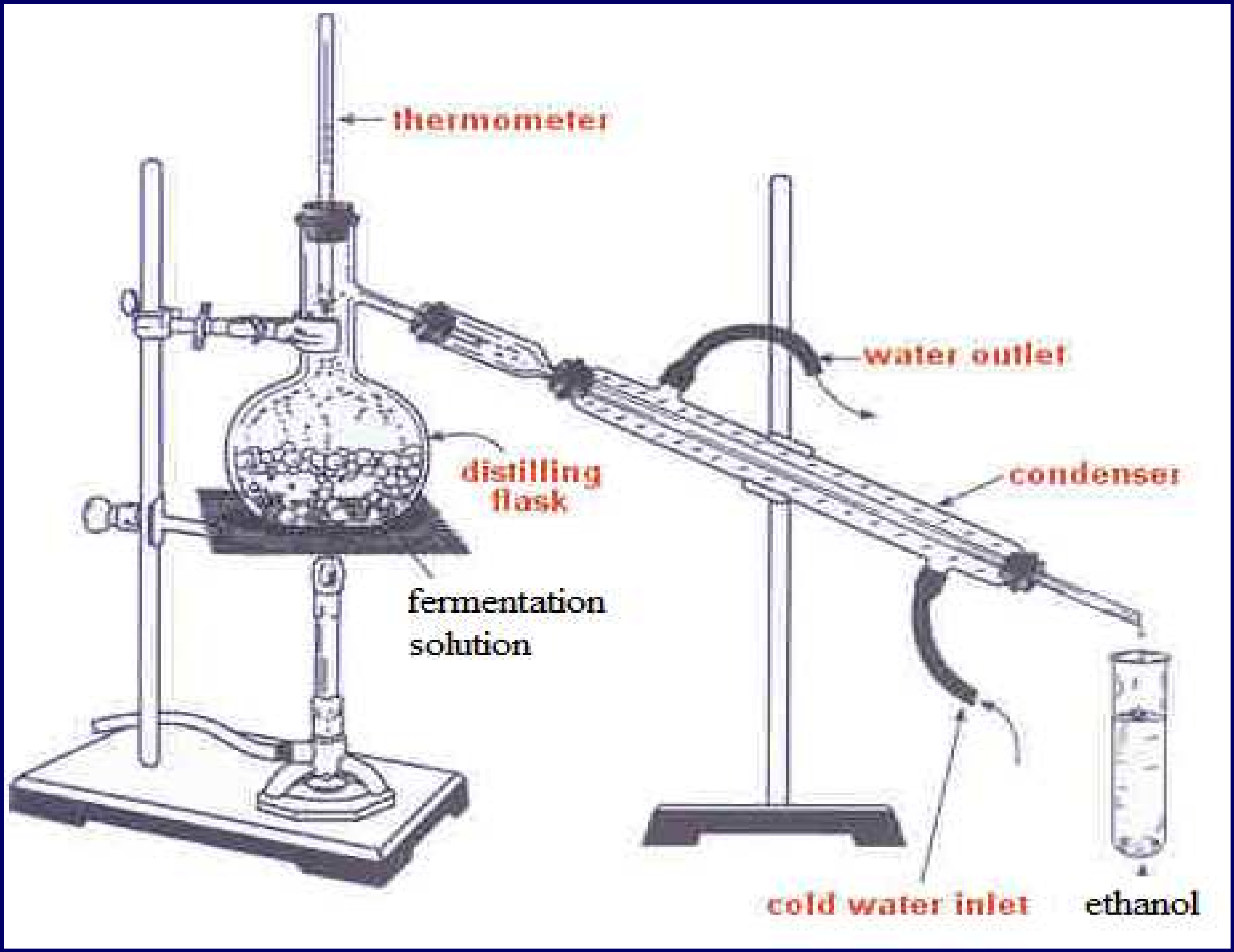
Yeast is used to ferment sugar

- During fermentation, yeast is mixed with fruit juice or grain mixtures.
- The fruit juice or grain mixtures contain sugar.
- The yeast produces enzymes.
- The enzymes convert the sugar into ethanol and carbon dioxide.
- Some heat is also released.
- Chemical equation:

$$\text{Glucose solution + yeast} \xrightarrow{\text{enzyme (zymase)}} \text{ethanol + carbon dioxide + heat}$$

- Ethanol is separated from the fermentation solution by the distillation process.
- Ethanol boils at 78°C while water boils at 100°C.
- Hydration - producing alcohol by adding water to an alkene -performed at a high temperature and pressure

Distillation of ethanol



- Another commonly used alcohol is methanol.
- Produced by fermentation of wood.
- It may also be produced from synthetic gas.
- Carbon monoxide is added to hydrogen gas and steam at high pressure and high temperature.

GENERAL CHARACTERISTICS OF ALCOHOL

- Evaporates easily even at low temperature.
- The density of alcohol is lower than the density of water.
- Alcohol dissolves easily in water and in fats,
- Alcohol is flammable- produce blue flame if burnt.
- Alcohol produces less soot compared to the burning of hydrocarbons.

USES OF ALCOHOLS

- Solvent in medical drugs, perfumes, and vegetable essences such as vanilla
- Suitable for fuel
- Methylated spirit, a mixture of ethanol and methanol, is used as surgical spirit - used for sterilisation

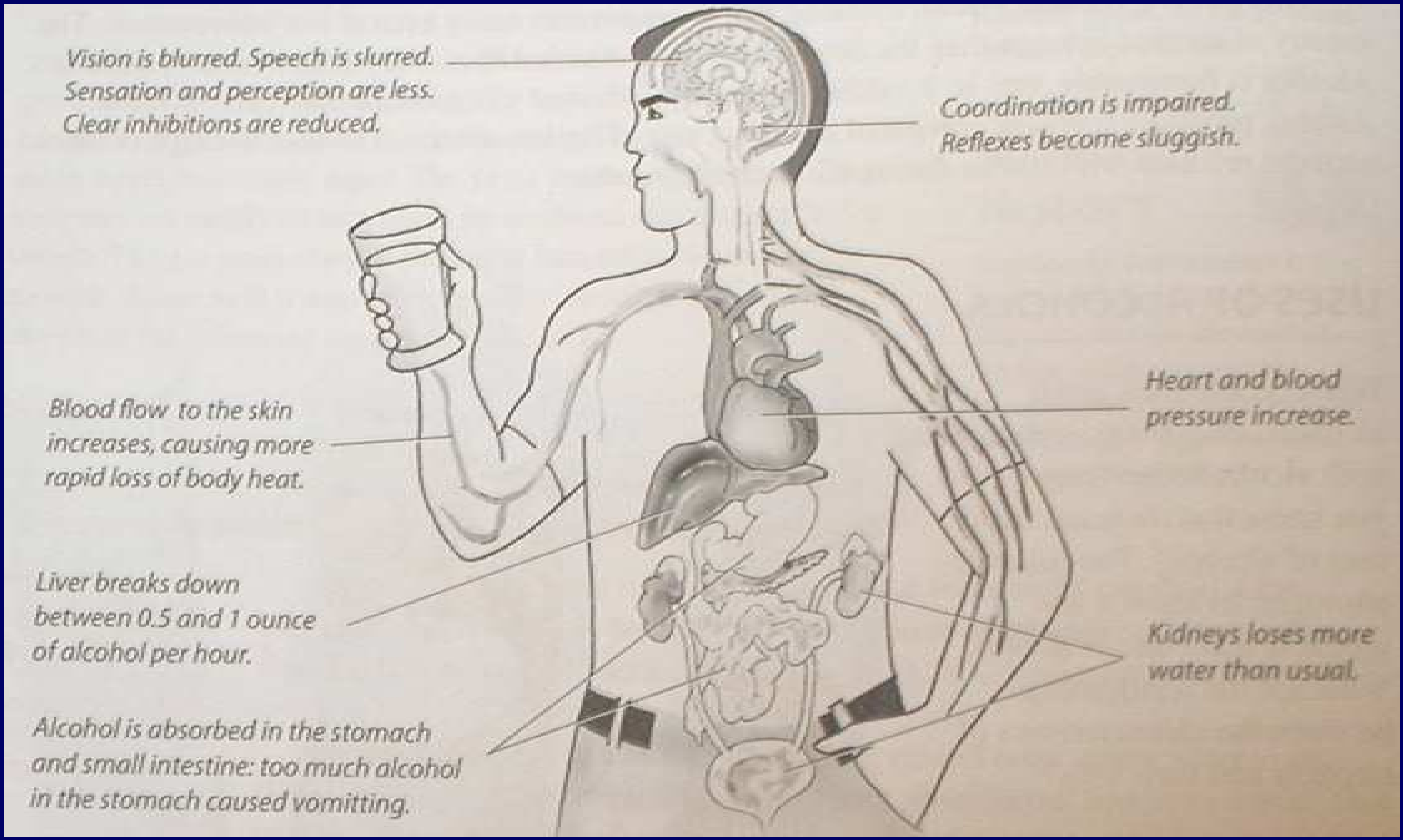
EFFECTS OF ALCOHOL ON HEALTH

- Vision is blurred. Speech is slurred. Sensation and perception are less. Clear inhibitions are reduced.
- Coordination is impaired. Reflexes become sluggish.
- Blood flow to the skin increases, causing more rapid loss of body heat.
- Heart and blood pressure increase.

EFFECTS OF ALCOHOL ON HEALTH

- Liver breaks down between 0.5 and 1 ounce of alcohol per hour.
- Alcohol is absorbed in the stomach and small intestine: too much alcohol in the stomach caused vomitting.
- Kidneys loses more water than usual.

EFFECTS OF ALCOHOL ON HEALTH



EFFECTS OF ALCOHOL ON HEALTH

- The long-term effects of alcohol consumptions include the damage to the brain, liver disease, and kidney failure.
- Other alcohols are more poisonous than ethanol.
- Example, methanol can cause blindness or even death.

FATS AND THEIR EFFECTS ON HEALTH

- Needed in the diet to supply essential fatty acids and other substances for growth.
- Fats can be found in meat, cooking oil, butter, margarine, ghee, and beans.

Photograph 4.12 - Examples of saturated and unsaturated fats.

SATURATED AND UNSATURATED FATS

- The saturated fats are usually originated from animals - not melt at room temperature.
- The unsaturated fats are usually originated from plants - melt at room temperature.
- This is why the unsaturated fats are in liquid form.

Similarity
Greasy (oily)
Insolube in water (do not mix with water)
Source of essential fatty acids

SATURATED AND UNSATURATED FATS

Differences

Saturated fats	Unsaturated fat
Normally originated from animal (butter, ghee, fats from fowl and meat)	Normally originated from plants (margarine, sunflower oil, palm oil and olive oil)
Solid at room temperature	Liquid at room temperature
Cannot add hydrogen atoms	May add hydrogen atoms
Not preferred food for health reasons	Preferred food for health reasons

FATS IN YOUR DIET

- Vitamins A, D, E, and K are fat-soluble, which means they can only be digested, absorbed, and transported with fats.
- The only way to get these vitamins is to eat fats.
- The essential fatty acids are important for the body to function, example, linoleic acid:

  - used to build cell membranes.

- Fats are a good source of energy - contain twice as many calories per gram as do carbohydrates or proteins
- Broken down in the body to release glycerol and free fatty acids.
- The glycerol - converted into glucose by the liver and thus used as a source of energy.
- The fatty acids - good source of energy for body tissues, especially the heart and skeletal muscle.

Dangerous of saturated fat

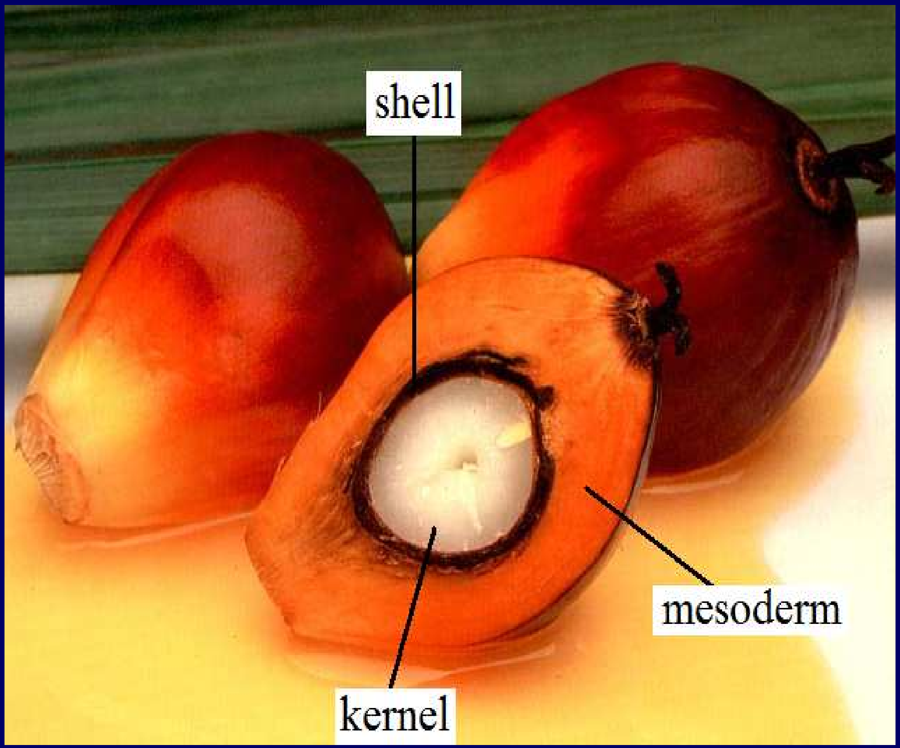
- Too much saturated fats can raise the cholesterol level in the bloodstream
- Contribute to cardiovascular diseases when they are consumed in excess.
- Increases risk of arteries blockage and coronary heart disease.

- The unsaturated fats can replace the saturated fats in the diet.
- Substituting the saturated fats with the unsaturated fats helps to lower the cholesterol level in blood.
- Examples of the unsaturated fats are:

  - palm oil, canola oil, corn oil, and sunflower oil.

OIL PALM

- The mesocarp contains the palm oil cells.
- Palm oil is obtained from this part.
- The kernel contains the palm kernel oil.
- Palm kernel oil is different from the palm oil.



PALM OIL EXTRACTION

(i) **Sterilisation**

- The fruit bunches are exposed to steam at a high temperature (about 140°C) for 75-90 minutes.
- The purposes of sterilisation are:

· to loosen the fruits from bunches,

· to soften nuts, that will minimise kernel breakage,

· to destroy enzymes that are responsible for the breakdown of the oil molecule so that the oil quality is maintained,

· to break the oil cells.

PALM OIL EXTRACTION

(ii) **Bunch Stripping**

- The fruit bunches are fed into a rotary drum stripper.
- The fruits are knocked loose from the bunches by lifting and dropping them.
- The loose fruits will fall through the spaces between the bars on the stripper.
- Then, they are collected in a conveyor - sends the loose fruits into a digester.

PALM OIL EXTRACTION

(iii) **Digestion**

- A process involving mashing up the fruits under steam.
- The digester is a vertical cylindrical vessel fitted with rotating blades.
- The action of the rotating blades breaks up the oil cells of the mesocarp, forming a digested mash.

PALM OIL EXTRACTION

(iv) **Oil Extraction**

- The oil is pressed out from the digested mash.
- Twin screw presses are used in this process.
- Hot water may be added to enhance the oil flow.
- The crude palm oil mixture, known as CPO is collected in the crude oil tank.

PALM OIL EXTRACTION

(v) **Clarification and Purification**

- The CPO consists of a mixture of crude oil (35-45%), water (45-55%), fibrous materials and other by-products.
- The oil is maintained at about 90°C to enhance oil separation.
- The oil is centrifuged and dried in a vacuum dryer to a moisture content of less than 0.1 %.
- Later, the oil is sent to a storage tank.
- Now it is ready for further processing.

PALM OIL EXTRACTION

Sterilisation

↓

Bunch Stripping

↓

Digestion

↓

Oil Extraction

↓

Clarification and Purification

THE USES OF PALM OIL

- Make food products such as margarine, vegetable shortenings, artificial flavourings, and vegetable-based ghee.
- Based food products include substitute cocoa butter and mayonnaise.
- Make skin-care products and cosmetics use palm oil as their ingredients
- Make cleaning products such as soap and laundry detergent.
- Other non-food palm oil-based products include hydraulic fluids, coloured-printing ink, wax and strong adhesives.

PALM OIL IS NUTRITIOUS

- Nutritious vegetable oil
- Contains unsaturated fats, which can prevent artery blockage and coronary heart diseases.
- Reduce the cholesterol level in the blood.
- Supplying the fatty acids to our body.
- Contains carotenoids, the necessary substance to build vitamin A
- Contains high dose of vitamin E
- Rich in vitamin K and dietary magnesium.

LOCAL RESEARCH AND DEVELOPMENT

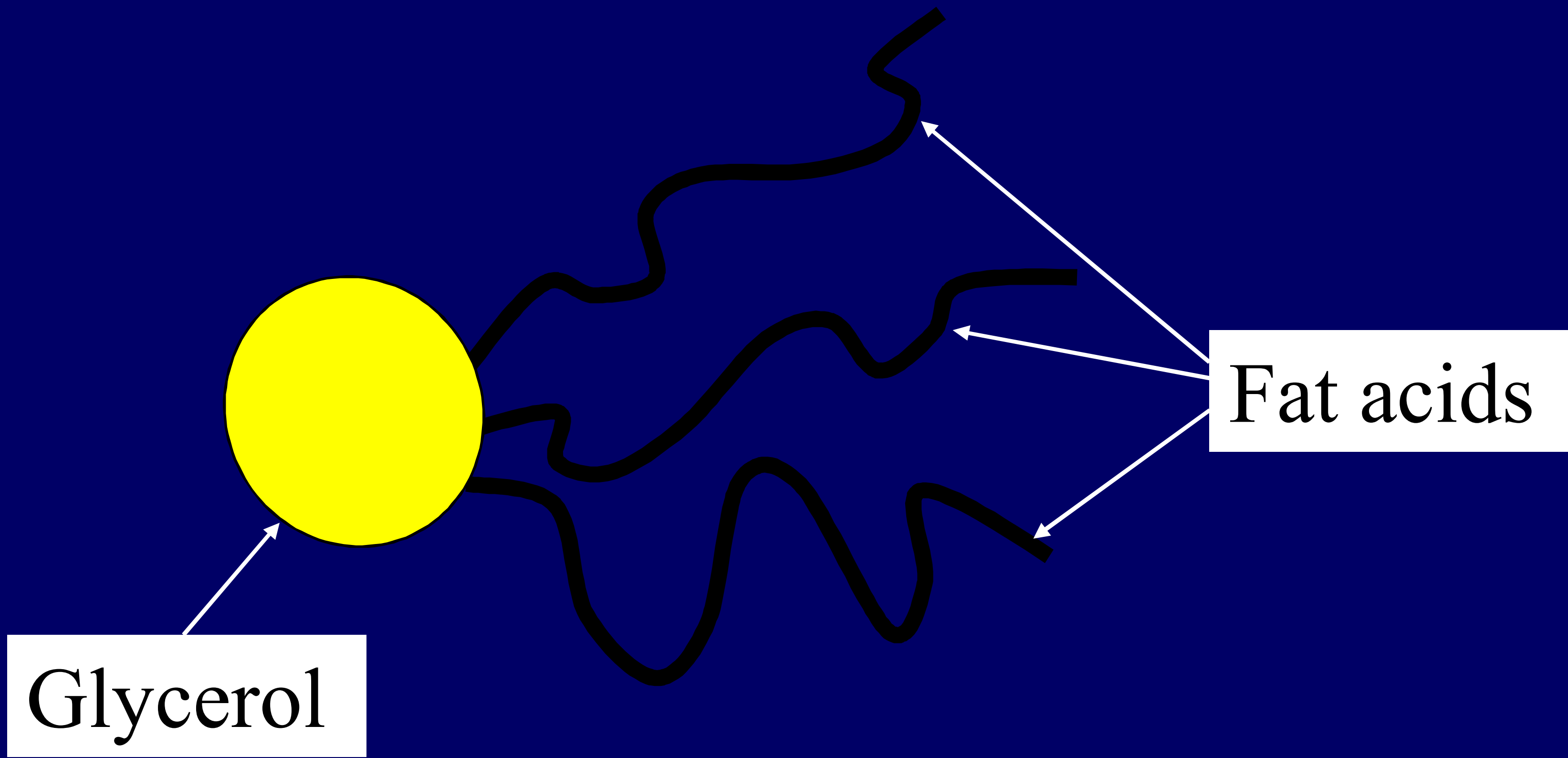
- Malaysian Palm Oil Board (MPOB) - developing palm oil based additives to improve the lubricity of biodiesel

  - biodegradable and non-toxic, and significantly has less emissions than petroleum-based diesel when burnt and has potential to replace fossil fuels.
- Developed strong and biodegradable plastics from palm oil
- Processed the trunks of oil palm trees into medium density fibreboard.
- The fibres are also suitable to make high quality paper and processed into high-quality peat soil.

SOAP MAKING AND CLEANSING ACTION

- Soap is a chemical compound which possesses cleaning properties.
- Soap is a salt formed by the reaction of fats or oil with an alkali.
- Fats and oils are made of fatty acids and glycerols.
- Palm oil contains fatty acids called palmitic acids.

Fat molecule



SOAP MAKING

- Soap making is a neutralisation process - acid reacts with alkali to form salt and water.

acid + alkali → salt + water

- fatty acids from fats or oil react with alkali to form salt (soap) and water.

Fatty acid + alkali → salt (soap) + water

- The soap making is also known as saponification

Fats or oil + alkali → soap + water + glycerol

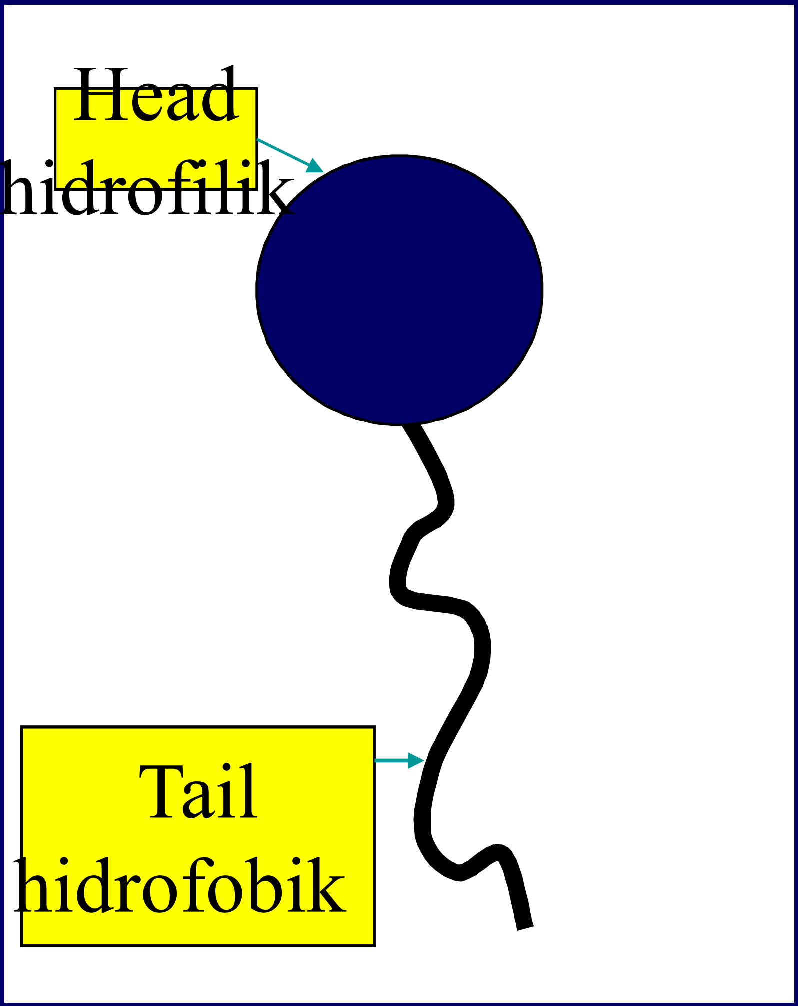
- Soap usually exists in liquid form.
- To turn the soap solution into solid, salt needs to be added.
- The soap flakes are then filtered.
- At this stage, perfumes or colours may be added.
- Then the soap may be pressed into moulds to get its shape.

- You can make your own soap by adding sodium hydroxide to palm oil.
- The mixture should be heated at 80°C to lOO°C.
- The following equation represents the saponification of palm oil and sodium hydroxide:

palm oil + sodium hyroxide → soap + glycerol

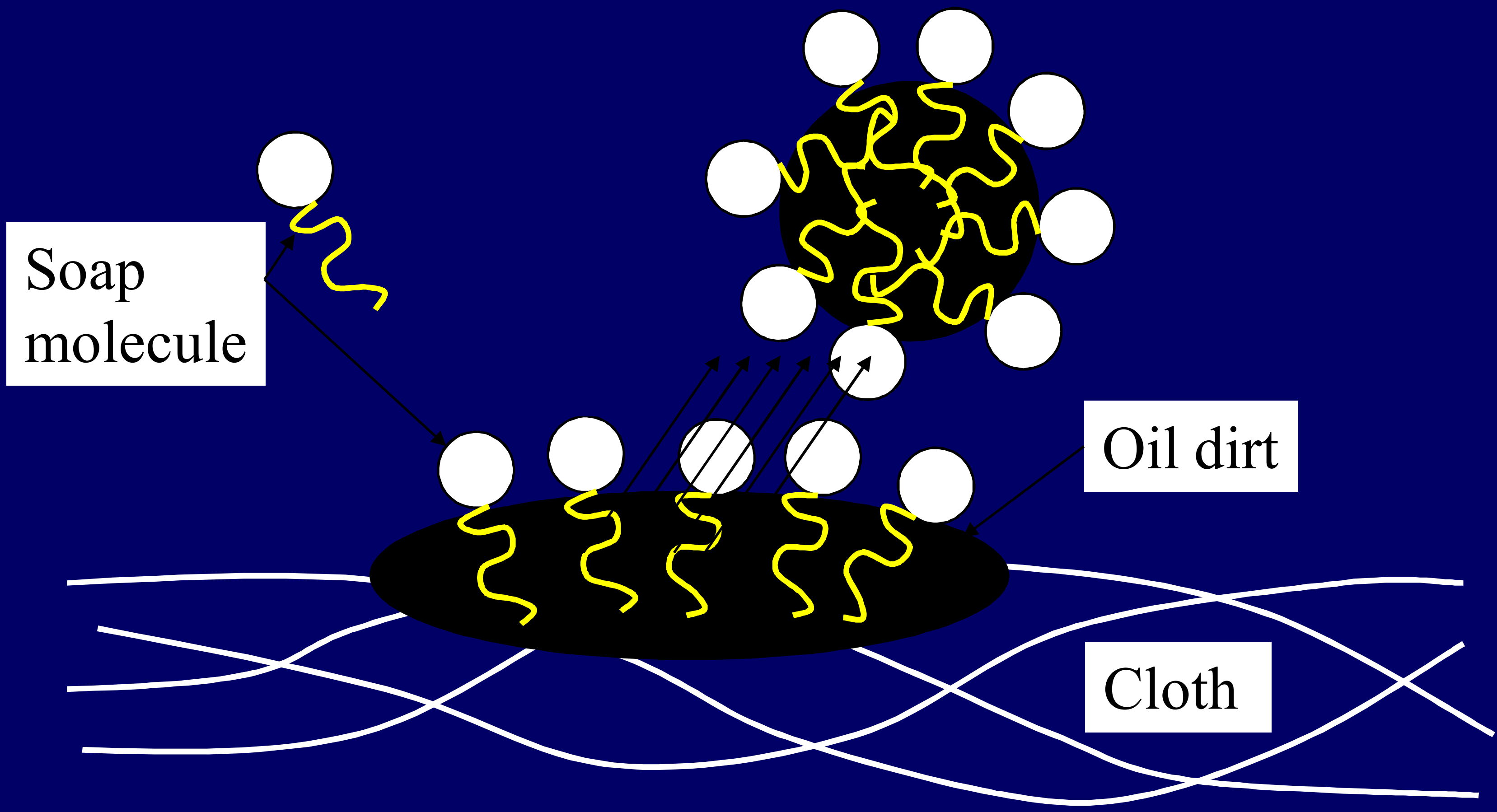
SOAP CLEANSING ACTION

- A soap molecule has two parts: head and tail.
- The head is soluble in water while the tail is insoluble in water.
- The tail is soluble in oily component such as grime and dirt.
- A soap molecule has a tadpole-like structure.



- When soap is used to wash clothes, the tail ends of the soap molecules attach themselves to the oily components of the dirt.
- Soon, the dirt is surrounded by the soap molecules, leaving only the heads in contact with water.
- When the clothes are moved during washing, the dirt is washed away.
- Soap is produced from fatty acids such as palm oil, detergent is produced from petroleum

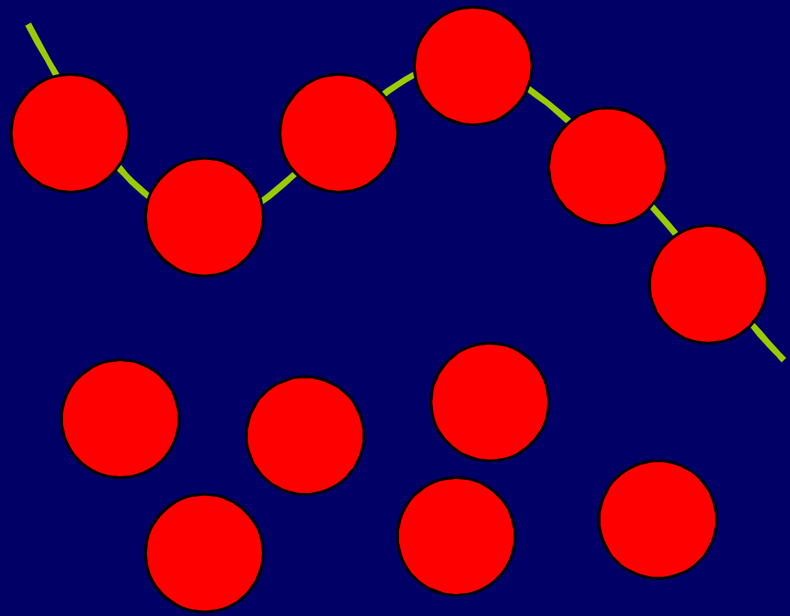
SOAP CLEANSING ACTION



NATURAL POLYMERS

- Rubber, wood, starch, silk, plastics, the tiny fibres of paper, the muscles, and a tiny hair are example of natural polymers.

- **Beads in a strand represents a polymer.**



- **Loose beads represent monomers**

The polymers and their respective monomers

Polymer	Monomers
Polyethene (plastics)	Ethene
Polyvinyl chloride (PVC, another type of plastics)	Vinyl chloride
Polystyrene (found in styrofoam)	Styrene
Cellulose (found in wood fibres)	Glucose
Polysaccharide (found in DNA, our genetic material)	Saccharides
Polyisoprene (found in natural rubber)	Isoprene

POLYMERISATION AND DEPOLYMERISATION

- **Polymerisation** is a chemical process of making a polymer from monomers.
- Example: in the manufacture of polyethene (a type of polymer found in plastics), the ethene monomers are heated at high temperature and pressure is bound.
- **Depolymerisation** is a reverse process of polymesation.
- It is a chemical process of breaking a polymer into its monomers.

NATURAL AND SYNTHETIC POLYMERS

- Natural polymers : the polymers are found in many carbohydrates.
- Example: Cellulose (found in wood fibre), polypeptide (found in silk), and rubber (found in latex from rubber tree).
- Synthetic polymers are artificial polymers.

  - can be shaped, strong, and lightweight.
- Examples: Plastics

NATURAL RUBBER

- Elastic material obtained from the latex of rubber trees
- The latex is poured into flat pans and mixed with formic acid, which serves as a coagulant.
- After a few hours, the wet sheets of rubber are put through a pressing tool to remove excess water.
- Then they are sent to factories where **vulcanisation** and further processing are done.

- Some latex is sent to factories in liquid form.
- **Ammonia** is added to the latex to prevent it from coagulating or clumping.
- Liquid latex is used to make disposable gloves, foam rubber, latex thread, and other products

CHARACTERISTICS OF NATURAL RUBBER

- Elastic
- Strong
- Stick to itself and other materials
- Water resistant
- Poor electrical conductor.
- Moderate resistance to environmental damage caused by heat, light, and ozone

REACTION OF LATEX WITH ACID AND AMMONIA

- The latex particles contain rubber polymers that are wrapped in protein membranes with negatively charged.
- This prevents the particles from coagulating because similar electrical charges repel each other.

- Acid contains positively charged hydrogen ions.
- When acid is added into the latex, the hydrogen ions neutralise the negatively charged protein membranes.
- This causes the membrane to break and let the rubber polymers free.
- The free rubber polymers combine with each other causing the latex to coagulate (clump).

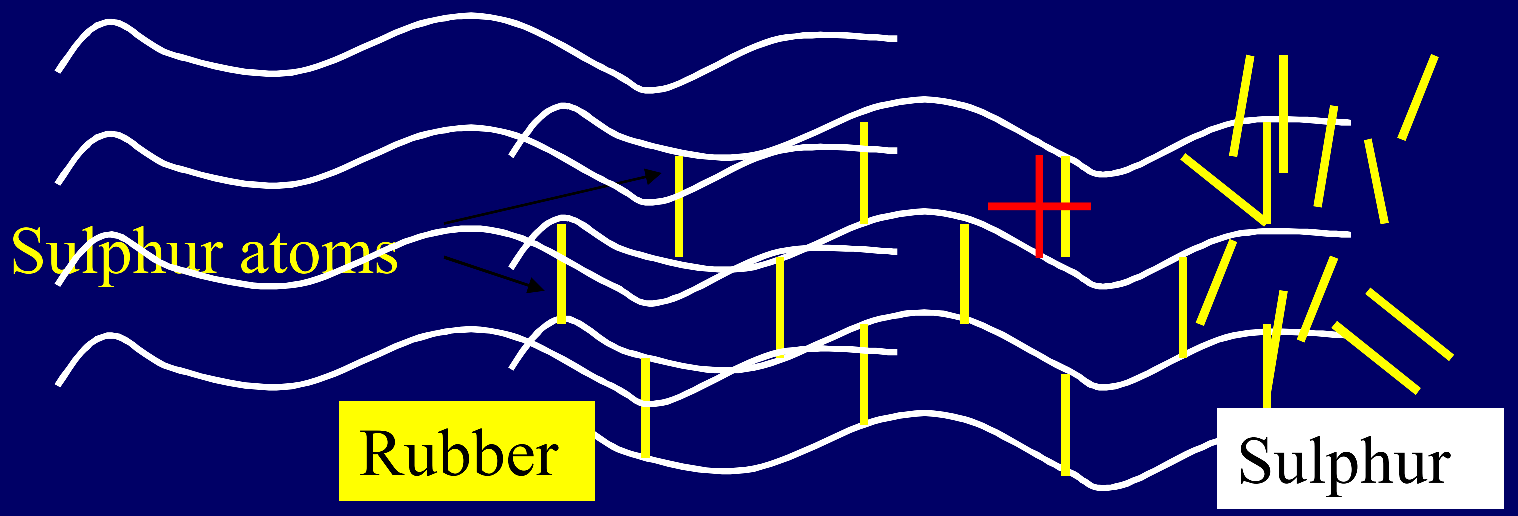
- The latex may coagulate without addition of acids.
- This happens naturally due to the activities of bacteria in the latex - produce acids
- Takes a longer time and the clumped latex has a very bad odour (smell).

- To prevent latex from coagulating, ammonia is added into the liquid.
- The ammonium solution is alkaline - contains negatively charged ions called hydroxide ions.
- Negative charged ions neutralise the positively charged ions, produced by the bacteria in the latex.
- Prevents the protein membrane from breaking, thus maintaining the liquid form of the latex .

VULCANISATION

- The chemical process of treating rubber with sulphur at high temperature to improve its elasticity and strength.
- The vu1canised rubber neither soften nor becomes sticky when heated.
- This process is irreversible (cannot be reversed).
- Each rubber polymer molecule is linked to other rubber polymer molecules by sulphur atoms.
- These sulphur atoms hold the rubber polymers together, causing the springy rubber molecules to be locked together.

VULCANISATION



Advantages of vulcanised rubber

- Much harder
- More durable
- Transforms the surface of the rubber from a sticky feel to a smooth surface
- Used to make tyres, machine parts, conveyor belts, electrical insulators, rubber boots, and rubber bands

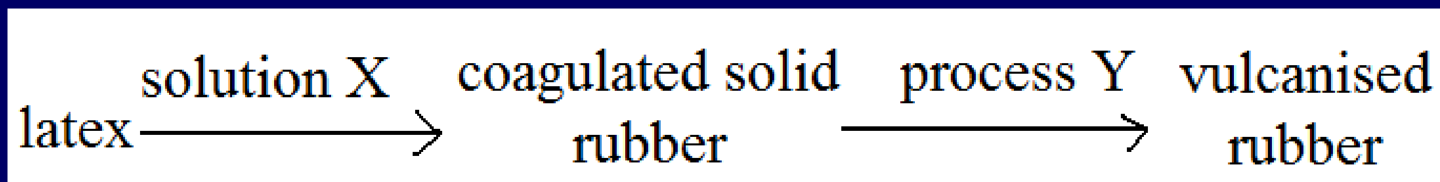
APPRECIATING SCIENTIFIC RESEARCH ON THE USE OF CARBON COMPOUNDS

- Carbon technology uses the carbon compounds to make many kinds of materials.
- Important for the production of medicines, paints, synthetic fabrics, food flavourings, plastics, cosmetics, carbon fibres, and glues
- Normally used from coal, crude oil, natural gas, and plants

Photograph 4.39 - A scientist performing research on carbon compounds.

Exercises

1. Figure below shows the stages involve in the process of making vulcanised rubber.



a) What is the monomer of rubber?

b) Name the following:

i. solution X:

ii. Process Y:

c) Draw the structure of vulcanised rubber molecules.

d) List 2 uses of vulcanised rubber.