CHEMICALS FOR CONSUMERS

INTRODUCTION

Food is one of the chemicals we use in our daily lives. But there are other chemicals, such as:

- Medicines
- Preservatives
- Washing agents
- Cleansing agents
- Stimulants

Chemicals play various important roles in our everyday lives and almost everything we use is made of chemical substances.
In Uganda, the Uganda National Bureau of Standards (UNBS) is in charge with responsibility of testing and establishing compliance with specifications and regulation of chemical limits in products such as perfumes and flavors, cosmetics, pharmaceutical products, soaps, detergents and household chemicals.

This effective regulation is an important part of safeguarding public health. Modern laws and regulations place a special responsibility on those trading to ensure the safety of their products, and make sure that they are for a purpose.

Therefore, you will appreciate that the products used in everyday life exist as chemicals and some of them can be prepared at home or in the laboratory.

SOAPS AND DETERGENTS

Soap and detergents play an essential role in our daily life. They remove dirt and stains from our clothes, dried on food from our dishes and even germs from our hands. The process of removing dirt, grease and stains found on various substances is called “cleansing action of soap or detergent”.

When we clean, we leave things better than we found them. Cleansing helps to remove dirt and kills microbes such as bacteria and viruses.

SOAP

Soaps are cleansing agents or natural detergent, made from fats and oils of animals and vegetables. Soaps are sodium or potassium salts of fatty acids formed by the reaction of fats and oils with an

The development of soap as cleansing agent and soap making has improved the hygiene and possibly helped to reduce the spread of diseases.

HISTORY OF SOAP MANUFACTURING

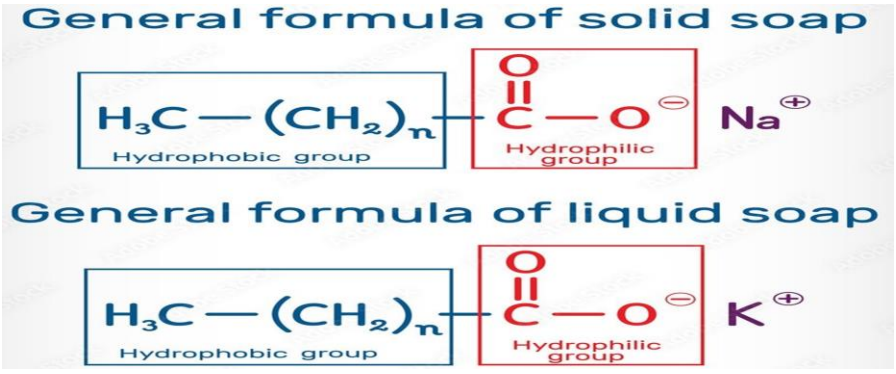
Soap got its name from an ancient Roman legend about Mount Sapo. Legend says that soap was first discovered on soap Hill in Rome when group of Roman women were washing their clothes in the River Tiber at the base of a hill, below which animal fats from the sacrifices ran down into the river and created soapy clay

The earliest recorded evidence of the production of soap-like materials dates back to around 2800 BC in ancient Babylon. A formula for soap consisting of water, alkalis and cassia oil was written on a Babylonian clay tablet around 2200 BC. By the 7th century, soap-making was an established art in Italy, Spain and France.

Chemical nature of soap

Depending on the metal cation, soaps are water-soluble potassium or sodium salts of long-chain carboxylic acid salts.

The exact chemical formula of soap is $C_{17}H_{35}COO^-$ plus a metal cation, either Na+ or K+. the final molecule is called sodium stearate and is a type of salt. Depending on the metal cation, soaps potassium salts or sodium salts of long-chain carboxylic acids.



Physical properties of soap

The physical properties include: odour, colour, texture, hardness, solubility.

Manufacture of soap

During soap preparation, concentrated sodium chloride solution is added to a boiled mixture of concentrated sodium hydroxide solution or potassium hydroxide solution and oil or fats in order to precipitate out soap. The precipitated soap is filtered off and mixed with dyes to make it coloured.

Concentrated sodium hydroxide produces hard soaps whereas concentrated potassium hydroxide produces soft soaps. Soft soaps dissolve more easily water than hard soaps.

Chemical Properties of Soap

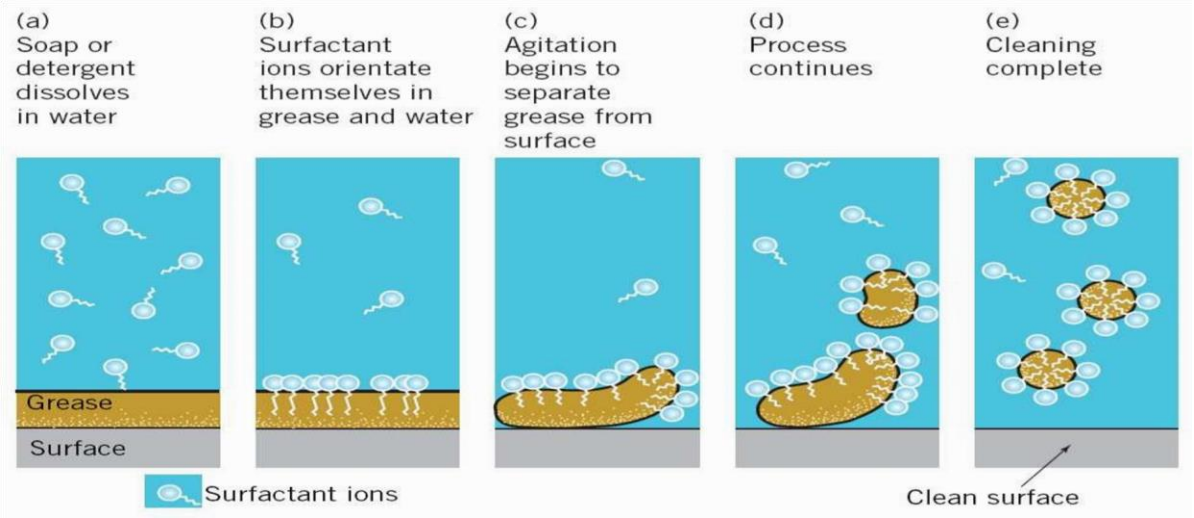
These include pH and lathering ability.

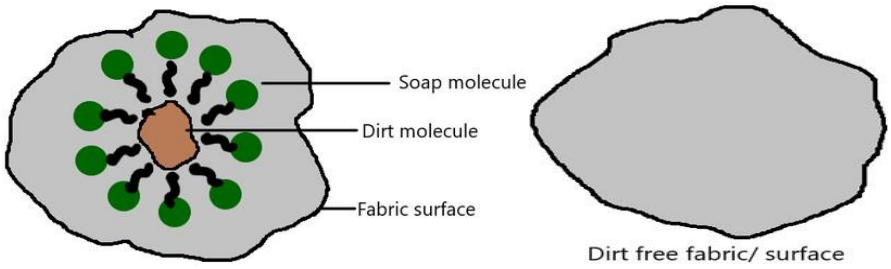
In order to perform as surface-active agents, soaps must have certain chemical structures. The structure of soap consists of a hydrophobic (water-insoluble) part, such as hydrocarbon chain and a hydrophilic (water-soluble) group such as –COONa. See the structure of a soap molecule below.

Toilet soap forms lather with water more easily than hard soap. When a blue litmus paper is dipped into the soap solution, its Colour persists whereas a red litmus paper. This shows that a soap solution is alkaline.

CLEANSING ACTION OF SOAP

Clothes become dirty due to deposition of dust and oily or greasy substances. Plain water is not capable of dissolving oily or greasy substances. However, the hydrophobic end of soap can do so. Therefore, addition of soap makes the removal of dirt and stains easier, this is called cleansing. During cleaning, the hydrophobic tails dissolve in a droplet of oil or grease, whilst the hydrophilic heads face out into the surrounding water, resulting in a ball structure. With agitation or scrubbing, the grease becomes dislodged from the surface. The nonpolar substances such as oil and grease are held inside the ball and suspended in water.





DETERGENTS

Detergents are amphipathic molecules that contain both polar and hydrophobic groups. Detergents are structurally similar to soaps, but differ in the water-soluble portion.

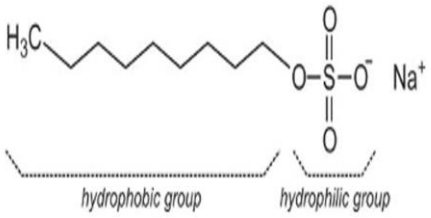
Chemical nature of detergents

Molecules of detergents contain both polar or charged hydrophilic groups (heads) and non-polar or hydrophobic parts (tails). In the same molecule of the detergent, the different parts have different affinities for the solvent and dirt.

One part possesses a high affinity for polar solvents such as water and another part has a strong affinity for nonpolar dirt particles. They are also known as surfactants, because they decrease the surface tension of water.

A detergent may also refer to a surfactant or group of surfactants with cleansing properties in dilute solutions. These substances are usually alkyl benzene sulphonates, a family of compounds that are similar to soap but are more soluble in hard water.

Structure of a detergent molecule



Additives in Detergents

Detergents do not only differ from soap in terms of the main component chemical structure, but rather the other additives they contain. Detergents are made to suit different purposes, such as household detergents, the additives keep metal components clean and free of deposits. Biological enzymes and whitening agents are among the many additives in detergents. Further, detergents neutralize acids that form in the oil. This is key for areas where thorough cleanliness is essential.

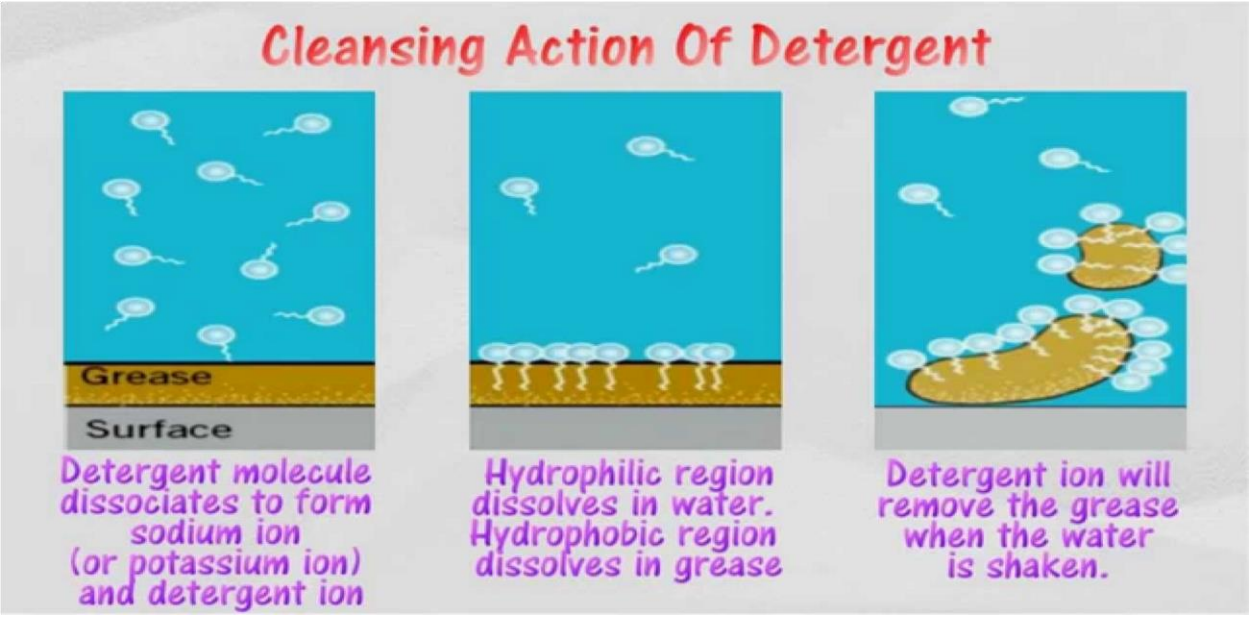
Uses of Some Additives in Detergents.

Additive	**Use**
Optical brighter (eg Fluorescent dye)	Convert stain to colourless substances
Fragrances	Add fragrances to fabrics and detergents
Bleach	Make fabric appear whiter
Biological Enzymes (eg amylase, protease, lipase)	Breakdown fat and protein molecules in food stains
Fabric softening agents	Soften hard water
Drying agents (eg sodium sulphate)	Make the solid detergent to dry and enable the liquid detergent to be poured out easily.
Colourants	Change and improve on the final Colour of the detergent

Cleansing Action of Detergents

Washing with plain water may not remove all stains in clothes. However, sometimes soap may fail to remove stains in clothes as well. The application of detergents may not spare stains trapped in clothes. The cleansing action of soap is as follows:

A detergent emulsifies grease into tiny droplets (micelles) in water. The polar end of the detergent dissolves in water and its ions surround fat droplets. Non-polar end of the detergent dissolves in grease that holds dirt on fabric and emulsifies it into a suspension. When washing is done, the oil is pulled of the fabric and floats free and dirt rinsed away by water.



Comparing the Cleansing Action of Soap and Detergents

Soap is potassium or sodium salts of a carboxylic acid attached to a long aliphatic chain whilst detergent is a potassium or sodium salt of a long alkyl chain ending with a sulfonate group. Soap is a metal salt of fatty acid that we use for cleaning Sand lubrication.

Detergents can work with hard water too while soaps cannot. Detergents can work even in acidic medium while soaps cannot. Synthetic detergents are stronger cleansing agents than soaps. Their solubility is higher than that of soaps.

DANGERS OR SIDE EFFECT OF SOAP AND DETERGENTS.

(a) Soap contains chemicals that can cause:

- Skin burns / blisters / irritation and hence pain or cancer.
- Eye redness and pain; hence loss of vision.

- Mitigation can be done by thoroughly washing the affected areas (or irrigation of the affected areas) like skin or eyes.

(b) Soapless detergents contain phosphates which cause algae bloom/alagalbloom and hence water pollution.

N.B. Algae/algal bloom already means accumulation.

(a) Similarities:

- Both soapy detergents and soapless detergents are salts of Organic acids of long carbon chain.
- Both soapy detergents and soapless detergents are effective cleansing agents in soft water / rain water.

(b) Differences;

Soapy detergents	Soapless detergents
Forms scum with hard water	does not form scum with any form of water.
Gentle on skin during cleansing.	not gentle on skin during washing
Sodium salts of carboxylic acid of long chains and cannot be used in strongly acidic solutions.	Sodium salts of long chain benzene sulphonic acids and can be used in strongly acidic solutions.
Biodegradable	Non-biodegradable

Task:

1. Differentiate between soap and detergents
2. What are the advantages of detergents over soap?
3. How is the use of detergents a problem to the environment?
4. Compare the effectiveness of soaps and detergents in soft and hard water

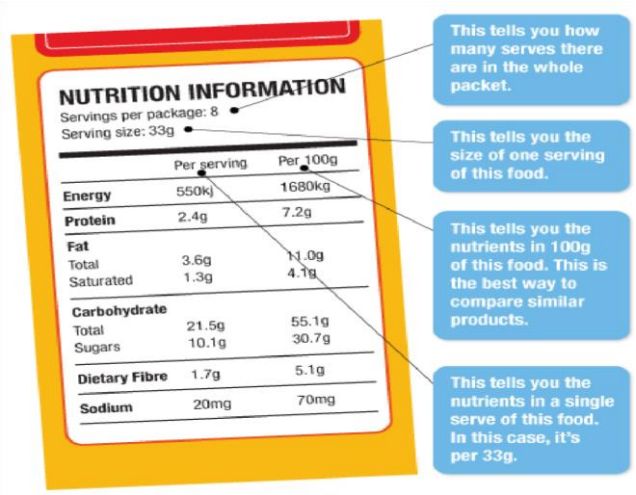
FOOD ADDITIVES

Food, especially that which is processed, comes with attractive colour, appearance and smell. Substances that are added to food to maintain or improve its taste, freshness, texture or appearance are called food additives.

Food additives are any substances the intended use of which results may reasonably be expected to result directly or indirectly in its being a component or otherwise affecting the characteristics of any food. Food additives are applied to food during:

- Production ➢ Treatment ➢ Transportation
- Processing ➢ Packaging ➢ Storage

Food additives need to be checked for potential harmful effects on human health before they can be used. Information regarding food additives is written on packaging label stickers, see figure below.



Direct food additives are those added to food for a specific purpose in that food. For example, xanthan gum used in salad dressings.

Indirect food additives become part of the food in trace amount due to its packaging, storage or other handling. For instance, minute amount of packaging substances like microplastics may find their way into food during packaging.

Types of food additives and their functions

Some food additives have been in use for centuries for preservation. For example: salt (in meats such as bacon or dried fish), sugar (in marmalade) and Sulphur dioxide (in wine).

Many food additives have been developed over time to meet the needs of food production, as making food on a large scale is very different from making them on a small scale at home. Additives are need to ensure processed food remains safe and in good condition throughout its journey from factories, during transportation to warehouses and shops, and finally to consumers.

The use of food additives is only justified when their use has a technological use, does not mislead consumers and serves as well defined technological function, such as to preserve the nutritional quality of the food or enhance the stability of the food.

Food additives can be derived from plants, animals or minerals or they can be synthetic. They are added intentionally to food to perform certain technological purposes which consumers often take for granted. There are several food additives used, all of which are designed to do a specific job in making food safer

or more appealing. WHO together with FAO groups food additives into 3 broad categories based on their function.

a) **Flavouring agents**

These are added to food to improve aroma or taste. These are applied to foods like soft drinks, cake, yoghurt and cereals. Natural flavouring agents include; nut, fruit and spice blends, as well as those derived from vegetables and wine. In addition, there are flavourings that imitate natural flavours.

b) **Enzyme preparations**

Enzyme preparations are a type of additive that may or may not end up in the final food product. Enzymes are naturally occurring proteins that boost biochemical reactions by breaking down larger molecules into their small building blocks. They can be extracted from plants or animal products or from micro-organisms such as bacteria and are used as alternatives to chemical-based technology. They are mainly used in baking (to improve dough), for manufacturing fruit juices (to increase yields), in wine making and brewing (to improve fermentation)

c**) Other additives**

Other food additives are used for a variety of reasons, such as preservation, colouring and sweetening. They are added when food is prepared, packaged, transported or stored and they eventually become a component of the food.

Summary

Food additive	**Function**
Sweeteners	Add sweetness without extra calories
Flavours	Add specific flavours to food
Nutrients	Replace vitamins and minerals
Emulsifiers	Allow smooth mixing of ingredients
Stabilizers and thickeners	Produce uniform texture
Preservatives	Prevent food spoilage Prevents changes in colour, flavour and texture
Food colour	Is added to improve its visual appeal
Anti-caking agents	Used to keep the product from clumping together
Antioxidants	Added to products to prevent rancidity

Examples of Food Additives.

Food additive	Example
Preservatives	Sodium benzoate, potassium propionate, benzoate, calcium ethylene oxide.
Antioxidants	Sulphur dioxide, ascorbic acid
Sequestrants	Iron or copper
Flavouring agents	Amyl acetate for banana flavour, Benz aldehyde for cherry flavour, Ethyl butylate for pineapple flavour.
Anti-caking agents	Magnesium carbonate, Calcium phosphate
Stabilizers and thickeners	Pectin, Amylose.
Food colour	Turmeric, caramel, carotene
Bleaching and maturing	Hydrogen peroxide, Benzoyl peroxide

BANNED FOOD ADDITIVES.

Some food additives can trigger allergic reactions and other mild health problems. However, some food additives pose serious health risks and have been banned for consumption. If food contains any of such chemicals, warning is always given on the label.

Monosodium glutamate, or MSG is a common food additive used to intensify and enhance the flavour of savory dishes. It's found in a variety of processed foods like frozen dinners, salty snacks and canned soups. It's also often added to foods at restaurants and fastfood places. MSG has been a subject of heated controversy since a 1969 study of mice found that large amounts found harmful neurological effects and impaired growth and development.

Cancers have also been raised about the potential cancer-causing effects of certain food dyes. Red 3, also known as erythrosine, has been shown to increase the risk of thyroid tumours in some animal studies, causing it to be replaced by Red 40 in most foods.

Frequently found in processed meats is sodium nitrite which acts as a preservative to prevent the growth of bacteria while also adding a salty flavour and reddish-pink colour. When exposed to high heat and in the presence of amino acids, nitrites can turn into nitrosamine, a compound that can have many negative effects on health.

Summary

Food additive	**Reasons for banning**
Bisphenol A	Acts like estrogen in the body and change the timing of puberty, decreases fertility and increase body fat.
Phthalates	Affect male genital development and increase childhood obesity
Nitrates/nitrites	Cause tumours in the digestive and nervous system
Synthetic artificial food colours	They have effects on child behavior and attention

IMPACT OF FOOD ADDITIVES TO HEALTH AND ENVIRONMENT

- Some food additives like artificial colours can cause allergies, headache, stomach upsets when consumed by some people.
- Some could be carcinogenic.
- The non biodegradable nature of food additives.
- Some food additives cause asthma and respiratory issues eg sulphites which are commonly used as preservatives.
- Some additives such emulsifiers and thickeners may cause gastrointestine discomfort to people.
- Once poorly disposed can cause environmental pollution.
- Containers having food additives can cause environmental pollution especially if they are not recycled

Mitigations

- Regulatory agencies like Uganda Natioanal Burea of Standards (UNBS) should assess the safety of food additives before use.
- Consumers make informed choices by reading ingredient labels before consuming substances

CHEMICALS IN MEDICINE

One of the major contributions of Chemistry is the healthcare sector. Medicines are made from chemicals. New drugs are developed from chemical analysis and synthesis of new compounds. This field is so vast that a new field in chemistry known as medical chemistry has emerged.

Medical chemistry is a discipline that surrounds the design, analysis, development and synthesis of pharmaceutical drugs. This discipline needs expertise from synthetic organic chemistry, pharmacology including biological sciences. There are numerous amount of chemicals in medicine.

When one feels unwell, the doctor finds necessary to prescribe some drugs to help him/her get better. Someone's healthcare greatly depends on the work of chemists.

Medicine and drugs.

Medicine or drugs can be classified in a number of ways. For example, they can be grouped according to the;

- Body system they treat
- Chemical compounds in them
- Disease or illness they treat

Classification based on chemical compounds would classify medicine as;

- Antibiotics • Haematics • Sedatives
- Antiseptics • Antifungals • Antipyretics
- Analgesics • Antipsychotics

Each category of drugs has specific chemical components which are useful in treating a particular illness.

TRADITIONAL MEDICINE

Traditional medicine	**Function**

Garlic extract	Controls cholesterol level Regulates blood pressure Reduces cancer risks. Treats fungal and bacterial infections, heart burn and nausea
Aloe vera	Treats burns, malaria, ulcers, allergic reactions, fever, diabetes, indigestion, skin diseases.
Lemon juice	Treats hypertension, obesty, fever and bronchitis
Guava leaf and flower extract	Treats malaria, ulcers, coughs and diarhoea
Pawpaw leaf and root extract	A neutral contraceptive. Improves liver and kidney function
Bombo (Momordica foetida)	Used for fever and malaria treatment
Cofta tablets	Treats flu and cough

The herbal medicines are administered through squeezing or crushing and mixing with water. Then, the resulting solution is decanted and drunk. Herbal medicine was discovered from the Holy books, for example, herbs were mentioned in Genesis.

To improve on traditional medicine, herbal medicines should be prescribed by qualified and registered practitioners. The methods of extraction and preparation should be improved in order to extract a reasonable quantity of the active ingredient. Methods of packaging and conservation should also be improved.

Side effects of traditional/herbal medicine

Being "natural" does not necessarily mean they are safe for people to take. Just like conventional medicine, herbal medicine will have an effect on the body, and can be potentially harmful if not used correctly. Herbal medicine contains an active ingredient or chemicals got from plant parts such as leaves, roots or flowers. The chemical can be toxic and result into body reactions.

Task:

How can the side effects of traditional medicine be minimized?

Modern (conventional) Medicine

Modern medicine are chemical compounds used to cure diseases or relieve pain. They are artificially synthesized in the laboratory. Modern medicine has undesirable side effects. It should also be taken in a therapeutically prescribed manner to avoid any side effects. They can be classified as:

a) Analgesics medicine

Paracetamol such as Panadol, hedex and others are drugs we take to relieve pain. The term analgesic refers to a medication that provides relief from pain without outing someone to sleep or making one lose consciousness. They are also known as pain killers. They work by interfering with the transmission of pain signals to the brain.

They are divided into two classes:

i. Non-narcotic analgesic

Antipyretics are medicine that reduce fever by lowering body temperature. The most famous example of this class of medicine are aspirin and paracetamol. Aspirin is chemically known as acetylsalicyclic acid. It is used to reduce fever, pain or inflammation. Paracetamol is also used to treat moderate pain, body aches and fever. They are nonnarcotic analgesics ie. They are non-addictive.

ii. Narcotic analgesics

Produce desired pharmacological effects like they reduce fever and induce sleep. Morphine narcotics (obtained from the opium poppy) are mostly used to get relief from pain after medical operation, cardiac pain and labour pain during child birth, several stage of cancer and many more.

Chemical component in analgesics

Analgesics are also known as anti-inflammatory drugs, due to its action to reduce local inflammatory responses. Most anti-inflammatory analgesics are derived from two compounds: salicyclic acid and phenacetin. Acetylsalicyclic acid or aspirin, which is derived from salicyclic acid, is most widely used mild analgesic.

b) Antibiotics medicine

Antibiotics being less toxic for humans and animals are used as medicine to treat bacterial infections. Antibiotics refer to a substance produced wholly or partially by chemical synthesis which inhibits the growth or destroys the pathogens.

The growth of antibiotics was started by Paul Ehrlich, a German bacteriologist. The real evolution in the field of antibiotics was brought by the discovery of penicillin from fungus by Alexander Fleming in 1929.

Both traditional and modern medicine are used to treat common illness like cough and diarrhoea mostly caused by bacteria.

Task:

1. Which medicine do people take to get relief from bacterial infections?
2. What chemical component do antibiotics medicine contain to suppress bacterial activity?

Chemical components antibiotic medicine

With advances in medicinal chemistry, most modern antibacterials are semisynthetic modifications of various natural compounds. For example, the beta lactam antibiotics, which include the penicillin, cephalosporins and carbapenems.

Antibiotics can be classified in several ways. The most common method classifies them according to their chemical structure as antibiotics sharing the same or similar chemical structure will generally show similar patterns of antibacterial activity, effectiveness, toxicity and allergic potential.

Class of antibiotics (chemical component)	**Description or Function**	**Example**
B-lactam	Inhibit bacterial cell wall synthesis	Penicillin: - Amoxicillin, flucloxacillin, penicillin G
		Cephalosporins: - cefoxitin, cefotaxime, ceftriaxone
		Carbapenem: - Imipenem
Macrolides	Inhibit bacterial protein synthesis	Erythromycin, Azithromycin, Clarithromycin
Tetracyclines	Inhibit bacterial protein synthesis	Tetracycline, Minocycline, Doxycycline, Lymecycline
Fluoroquinolones	Inhibit bacterial DNA synthesis	Ciprofloxacin, Ofloxacin, Enoxacin
Sulphonamides	Block bacterial cell metabolism	Trimethoprim + sulphamethoxazole
Peptides	Inhibit bacterial cell wall synthesis	Bacitracin

Anti-fungal Medicine

Fungal infections such as athletes feet, ringworms and candidiasis are some of the most common.

Task:

1. How do we contract fungal infections?
2. Which medicines do you know that can treat fungal infections?
3. Which chemical component in anti-fungal medicine combat infectious fungi?

Chemical components in anti-fungal medicine

- Ketoconazole ➢ Clotrimazole
- Miconazole ➢ Fluconazole

Herbal medicine used to treat bacterial infections

- Garlic • Honey • Ginger
- Neem • Clove • Echinacea

Herbal medicine used to treat fungal infections

✓ Garlic ✓ Grape fruit seed extract ✓ Black walnut ✓ Echinacea

c) Psychotherapeutical Medicine

Mood and behavior can be a sign of mental illness. Emotional and mental disorders for example depression, schizophrenia, manic-depressive disorders are treated with Psychotherapeutical medicine.

Psychotherapeutical medicine can be grouped into; stimulants, antidepressants and antipsychotics.

i. Stimulant medicine

Stimulants, sometimes called "uppers", temporarily increase alertness and energy. The most common used street drugs that fall into this category are cocaine and amphetamines.

Energy drinks marked as providing mental and physical stimulation contain stimulant chemical compounds like caffeine.

Chemical components in stimulant medicine

Fungicides are used both in agriculture and to fight fungal infections in animals. Chemicals used to control oomycetes, which are not fungi, are also refered to as fungicides, as oomycetes use the same mechanisms as fungi to infect plants. Fungicides can either be contact, translaminar or systemic.

The azole anti-fungal agents have five-membered organic rings that contain either 2 or 3 nitrogen molecules (the imidazole and the triazoles respectively). The clinically useful imidazole are clotrimazole, Miconazole and ketoconazole. Two important triazoles are itraconazole and fluconazole.

ii. Depressant medicine

Fear, anxiety and stress are some of the common conditions that cause serious mental conditions. The conditions can lead to sleep disorders and eventually mental breakdown. Central Nervous System (CNS) depressants are medicine that include sedatives, tranquilizers and hypnotics. Drugs that slow brain

activity and therefore useful in treating anxiety, panic, acute stress reactions and sleep disorders are called depressant medicine.

Depressant medicine can be categorized as:

a. Tranquilizers or anti-psychotics eg Zyprexa, Seroquel and Haldol. They reduce symptoms of mental illness.
b. Benzos such as Xanax, Halcion and Librium.
c. Barbiturates are used as sedatives and sleeping pills such are Seconal, Numbutal and Amytal.

Chemical components in depressant medicine

Benzodiapines enhance the effect of the neurotransmitter gammaaminobutyric acid (GABA) at the GABAA receptor, resulting in sedative, hypnotic and muscle relaxant properties. These chemicals include serotonin, dopamine.

Antiseptic and Disinfectants

Antiseptics are chemicals that prevent the growth or kill the microorganisms without harming the living tissues. They can be applied to wounds, cuts and infected skin surface. They are also used in deodorants, mouthwashes and mouth fresheners to reduce unpleasant odours caused by bacterial decomposition in the body.

Difference between antiseptics and disinfectants

The basic difference between antiseptics and disinfectants is that an antiseptic is applied to the living cells, while disinfectants are applied to nonliving surfaces to kill germs. A commonly used antiseptic is Dettol; it is a mixture of chloroxylenol and terpineol. Chlorine and phenol solutions are known as disinfectants. **Chemical components in antiseptics and disinfectants**

Antiseptics:

Alcohols, chlorhexidine, hypochlorites, antibacterial dyes, inorganic iodine compounds, halogenated phenol derivatives, quinoline derivatives.

Disinfectants:

Alcohol, chlorine and chlorine compounds, formaldehyde, hydrogen peroxide, peracetic acid.

IMPORTANCE AND CONTRIBUTION OF CHEMICAL INDUSTRY TO PEOPLE'S LIVES

Chemical industries are the prime factors to convert the raw materials into desired products that we use in our day-to-day life. This has brought a great change in the way the things operate. The chemicals from the chemical industry serve as the raw materials for other industries. The chemical industry supports industries like food, pharmaceuticals, textile, agriculture, environment, hygiene, decoration and transportation. It has also significantly been used in recycling industries to control the use of new products.

Sector	Importance to people's lives
Transportation	Source of fuel which provides energy for moving vehicles
Decoration	Chemical dyes have pigments of different colours for colouring objects
Food	Additives in making food stuffs to improve appearance, taste and quality.
Water treatment	Provides safe water for domestic use
Hygiene	Sanitizers improve health of people by killing disease causing organisms on the body
Agriculture	Manufacture of fertilizers and pesticides which improve crop yield