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

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 are potassium salts or sodium salts of long-chain carboxylic acids.

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 in 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.

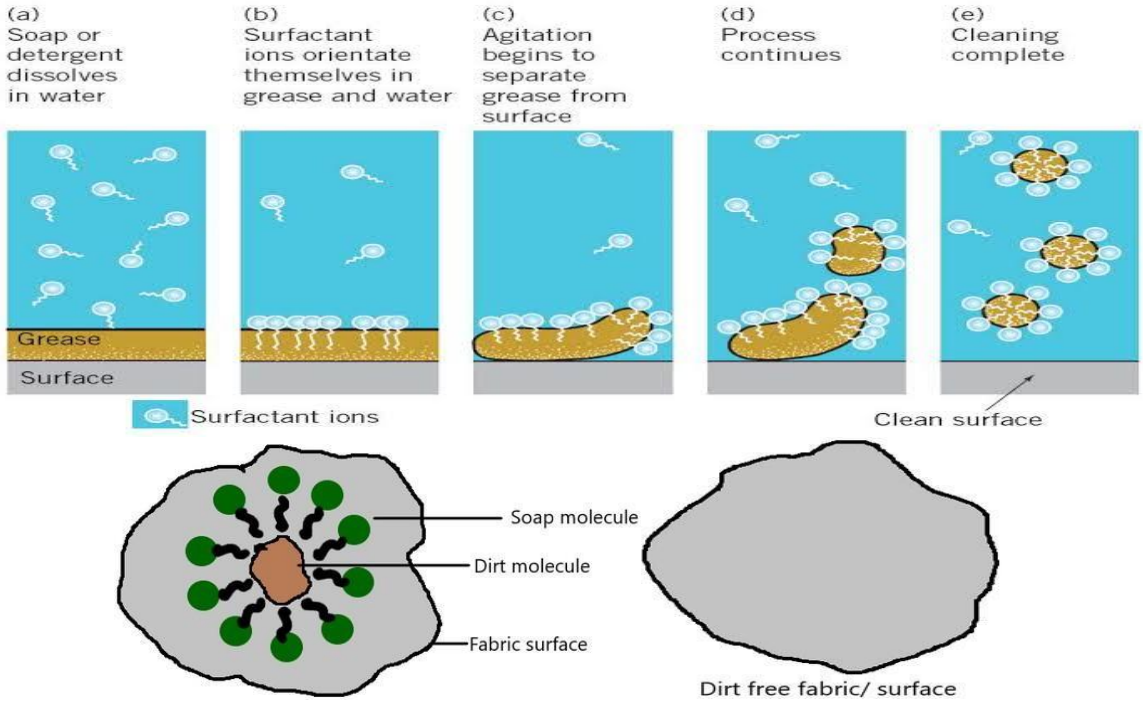
Soap molecule

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 while 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 non-polar substances such as oil and grease are held inside the ball and suspended in water.



DETERGENTS

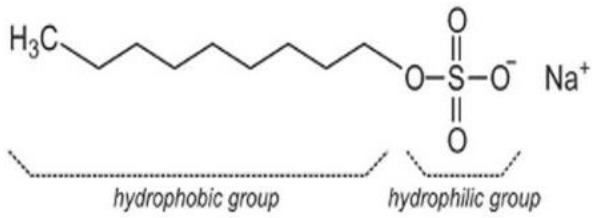
Detergents are amphipathic molecules that contain both polar and hydrophobic groups. Detergents are structurally similar to soaps, but differ in the water-soluble portion. Common detergents include omo, nomi, magic, aerial etc

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 non-polar 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. 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.

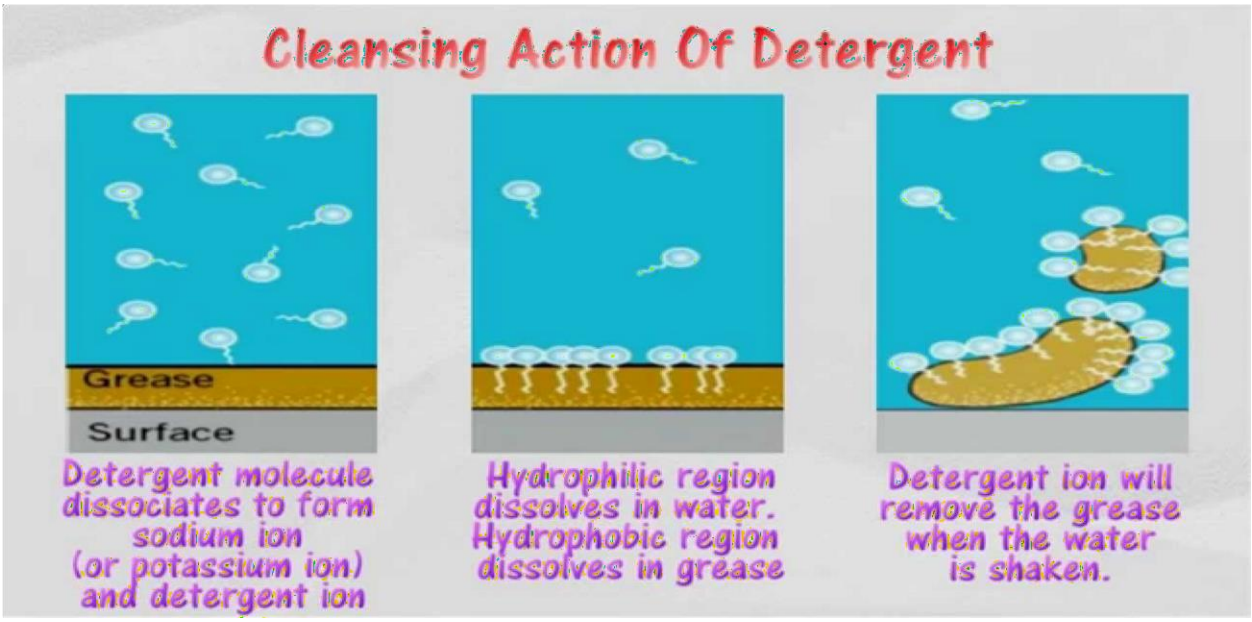
Additive	**Use**
Optical brightener eg biphenyl compounds	Make fabrics appear whiter and brighter
Fragrances	Add pleasant scent to fabrics
Biological enzymes eg amylase, protease, lipase.	Break down fats and protein stains for better cleaning.
Bleach agents eg sodium per carbonate, sodium hypochlorite	Remove stains and whiten fabrics by breaking down colored molecules.
Drying agents eg sodium sulphate	Help absorb moisture thus keeping powdered detergents dry.
Colorants	Change and improve on the final color of the detergents

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 while detergent is 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 and 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 like skin or eyes.

(b) Soap less detergents contain phosphates which cause algal blooms and hence water pollution.

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

Similarities

Both soapy detergents and soap less detergents are salts of Organic acids of long carbon chain.

Both soapy detergents and soap less detergents are effective cleansing agents in soft water / rain water.

Differences;

Soapy detergents	**Soap less 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 substances added to food to enhance its flavor, appearance, texture, shelf life or nutritional value. 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.

Types of food additives and their functions

Some food additives have been in use for centuries for preservation. For example: salt in meat and fish, sugar in beverages 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) Flavoring agents

These are added to food to improve aroma or taste. These are applied to foods like soft drinks, cake, yoghurt and cereals. Natural flavoring agents include; nut, fruit and spice blends, as well as those derived

from vegetables and wine. In addition, there are flavorings that imitate natural flavors.

(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 eg aspartame, stevia.	Add sweetness without extra calories
Flavours eg monosodium glutamate	Add specific flavours to food
Nutritional additives eg iron, vitamin D folic acid	Strengthen or enhance foods like cereals, milk, bread to improve their nutritional value.
Emulsifiers eg lecithin, mono and diglycerides	Allow smooth mixing of ingredients eg in mixing oil and water in products like in ice cream.
Stabilizers and thickeners gelatin, gum	Produce uniform texture
Preservatives eg sodium benzoate, potassium sorbate.	Prevent food spoilage by inhibiting microbial growth Prevents changes in color, flavor and texture
Food color eg beta-carotene and tartrazine	Is added to improve its visual appeal
Anti-caking agents eg calcium silicate	Used to keep the product from clumping together
Antioxidants eg ascorbic acid	Added to products to prevent oxidation in snacks and fried foods

Examples of Food Additives.

Food additive	**Example**
Preservatives	Sodium benzoate, potassium propionate, benzoate, calcium ethylene oxide.
Antioxidants	Sulphur dioxide, ascorbic acid
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 fast-food 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 tumors 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 tumors 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 the environment

✓ Some food additives like artificial colors can cause allergies, headache and stomach upsets when

consumed by some people.

- ✓ Some food additives cause asthma and respiratory issues eg sulphitesc which are commonly used as preservatives.
- ✓ Some additives such emulsifiers and thickeners may cause gastro intestine 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 National Bureau 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 chemistry's most significant contributions is in the field of medicine. Chemicals are used to produce medicines. The effective use of chemicals in medicine has revolutionized our ability to prevent and cure diseases, and will continue to be a pivotal component of medical advancement.

Categories of medicine.

Medicine is *any substance used in treating a disease or relief from pain OR.* Medicines are *chemicals or compounds used to halt, prevent disease, ease symptoms, or help in the diagnosis of illnesses.*

Medicines are classified as,

(a) Traditional medicine, Is the one that utilizes culture and spiritual treatments, mostly obtained locally as extracts from mainly plants, applied singularly or in combination to treat, diagnose and prevent illnesses or cure symptoms. Examples of traditional medicine and their uses are summarized in the table below.

Traditional medicine	Use (function)
Aloe vera	Treats malaria, allergic reactions, treats diabetes, skin disease. Treats burns.
Guava leaf extract.	Treats malaria, ulcers, cough, diarrhea
Paw paw leaf extract	Improves liver and kidney function.
Garlic extract	Controls cholesterol levels, regulates blood sugar, reduces cancer risks, treats fungal and bacterial infection.
Momordica foetica (Bombo)	Used for fever, malaria infection, treating body odour.

Vernonia amygdalina. / Bitter leaf (omululuuza)	Treats malaria, relieves fever, regulates blood sugars (treats diabetes) , lowers cholesterol, improves digestion.

Traditional medicines contain active ingredients that provide relief from pain (especially those for that work on pain) and others for bacterial infections work by killing the bacteria thus preventing them from multiplying**.**

Side effects associated with uses of traditional medicines.

The use of traditional medicines though often perceived as natural and safe, can have a dark side with potential side effects that can have serious and even life threatening. These side effects include,

- ✓ Allergic reactions and rashes
- ✓ Headache.
- ✓ Stomachache.
- ✓ Diarrhea.
- ✓ Kidney and liver damage

Mitigations to above side effects.

Use of small amounts of traditional medicines other than excess.

Use of modern medicine to counteract the effect of traditional medicine.

(b) Modern medicine is the one that utilizes scientific knowledge, technology and evidence based practices to diagnose, treat and prevent illnesses and diseases.

Students group activity.

In your respective groups, use Internet or any other source of information such as textbooks, and make research about the different traditional medicines you use in everyday life, their uses(functions) and the different modern medicines, the classifications of different modern medicine, their examples and uses (functions) of each example of medicine. Share your group answers to the rest of other groups in class.

(b) Modern medicines. These are classified into three types,

- ✓ Analgesics.
- ✓ Antibiotics.
- ✓ Psychotherapeutic medicine

What are analgesics?

These are medicines that are used to relieve pain. They are known as pain killers or pain relievers. Technically, the term analgesic refers to a medication that provides relief from pain without putting you to sleep or making you lose consciousness. Examples of analgesics, their uses (functions), their side effects and mitigations are summarized in the table below.

Medicine.	**Use of medicine**	**Side effects**	**Mitigations**
Aspirin	Used to relieve pain from conditions of muscle aches and fever.	Abdominal pain , chest pain	Taking right prescription. Seek immediate medical attention. Switch to different medicine.

Paracetamol	Used for pain relief and reducing high temperatures	Loss of appetite. Excessive sweating. Nausea Allergic reactions.	Follow recommended dose. Switch to different medicine Seek immediate Medical attention.
Codeine	Used for pain relief and cough suppression.	Nausea. Vomiting. Fatigue. Headache.	Taking enough rest. Seek immediate Medical attention. Switch to different medicine.

How do analgesics work (function)

Analgesics work by inhibiting the sensation of pain, thus providing relief from pain.

Analgesics work by inhibiting the sensation of pain.

What are antibiotics?

These are medicines that are used to treat or prevent some types of bacterial infection. They kill bacteria or prevent them from reproducing and spreading. Examples of antibiotics their uses (functions), their side effects and mitigations are summarized in the table below.

Example of Antibiotics	Use (function)	Side effects	Mitigations.
Penicillin	Treat infections bacterial infections	Fatigue, dizziness, Nausea, vomiting, allergic reactions.	Seeking immediate Medical attention. Taking plenty of fluids. Taking enough rest.
Streptomycin	Treating bacterial infections for example tuberculosis	Chest pain, dizziness, Nausea, vomiting,	Seeking immediate Medical attention. Taking plenty of fluids. Taking enough rest.
Amoxicillin	Treating chest infections for example Phenomenia.	Nausea, allergic reactions, fatigue, vomiting, dizziness.	Seeking immediate Medical attention. Taking plenty of fluids. Taking enough rest .

How do antibiotics work (function)

Antibiotics work by killing the bacteria, thus preventing them from multiplying.

What are psychotherapeutic agents?

These are medicines used to treat psychosis which refer to a group of mental disorders eg depression, schizophrenia, manic-depressive disorders. They affect mood and behavior. Examples of psychotherapeutic medicine, their uses, side effects and mitigations.

Example of psychotherapeutic Medicine.	**Use (function)**	**Side effects**	**Mitigations**
Stimulants.	Awakens alertness, confidence and energy. Treats attention deficit hyperactivity disorder (ADHD)	Loss of appetite. Headache. Nausea. Vomiting. Increased blood pressure.	Taking enough rest Seeking immediate Medical attention. Taking medicine in right amount as prescribed.
Antidepressants.	Treats generalized body anxiety disorder. Treats stress and depression.	Dizziness Loss of appetite. Feeling headache. Loss of libido. Erectile dysfunction.	Seeking immediate Medical attention. Taking medicine in right amount as prescribed.
Antipsychotics.	Treating bipolar disorders such as extreme moods (stabilizing mood) and reducing anxiety.	Dizziness. Weight gain. Headache. Sexual problems.	Taking medicine at different times of the day. Seeking Immediate medical attention.

Evaluate (similarities and differences between traditional medicines and modern medicines)

Similarities.

Both aim to prevent and treat illnesses.

Both use natural ingredients from plants and animals.

Differences.

Traditional medicine	**Modern medicine.**
Less effective in healing illnesses.	More effective in healing illnesses.
Increased risks of side effects.	Often less side effects.
Has no dosage instruction.	Has required dosage instructions.
Often lacks standardization in preparation.	Strong standards in production.