THINK BEFORE YOU BUY

CHOOSE PRODUCTS WITH LESS HAZARDOUS SUBSTANCES

A TEACHER'S HANDBOOK

"Baltic Info Campaign on Hazardous Substances".
Project Nr. LIFE 10 INF/EE/108 (BaltInfoHaz)

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THINK BEFORE YOU BUY
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More information about the project: www.thinkbefore.eu

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FOREWORD

We cannot imagine our contemporary lifestyle without the products of chemical industry, but we hardly ever think about all the chemical substances surrounding us - where they come from, how they are made and are they safe for our health and the surrounding environment? Huge diversity of chemical substances exist in nature. They can be chemical elements, chemical compounds, ions or alloys. Chemical compounds are either synthetically produced by man or occur naturally.

Life without chemical substances is impossible as all objects from everyday life that we can bump into, touch or squeeze are made from them. Therefore a claim that something is "chemical-free" is not true. The production and use of chemical compounds is growing, but, because of the possible negative impacts on the environment and human health, their production and use demands responsibility and careful and constant oversight. There are numerous examples in which of the careless use of chemicals, without fully knowing their effect has resulted in disastrous consequences (either on human health or on the environment).

Although producers are becoming more responsible, and there is legislation which controls and regulates the use and production of chemicals, we as consumers have a very important role - our consumption behaviour and choices give a direct signal for the producers about what kind of products we buy and what kind we don't. We as consumers can create a demand for products with less hazardous substances; the producers need to adjust in order to stay competitive on the market. Today a lot of consumers are knowingly choosing products with less hazardous chemicals, but the awareness and knowledge needs to spread to the majority of our society. Changing environmental behaviour and changing consumption patterns is a very long process and takes generations, therefore young people – children, pupils, teenagers, are an important target group; their behaviour habits are still developing and they are most susceptible to new information.

This handbook has been developed for currently practicing teachers and future educators – student teachers who are currently learning their profession. It is intended to be used as a practical tool to raise the awareness of youth about how we may be exposed to hazardous substances in our everyday life and how our everyday choices affect our health and the environment we live in. By integrating the topics covered in this handbook into different school lessons we aim to improve the overall environmental behaviour and change the shopping habits, so young children grow up with the knowledge to consume less and to choose products with less hazardous chemicals.

HOW TO USE THIS HANDBOOK

This handbook consists of three parts:

I:

Chapters 1-6 give theoretical background information about chemicals in our everyday life, describe the negative effects of chemicals and explain how chemicals affect human health and the environment. It gives a short overview about the properties of chemicals, how the management of hazardous chemicals is organized and the main control mechanisms of chemicals. It also focuses on four product groups – household chemicals, electronic products, cosmetics and construction materials – and explains what hazardous substances can be found in these everyday products and how to avoid exposure to hazardous chemicals and protect our health and the environment. At the end of each chapter there are useful tips and references to practical classroom exercises for teachers to make the topic more interesting and understandable for pupils. The examples with exercises are included in the last part of the handbook, part III (Chapters 8-9).

II:

Chapter 7 describes different interactive teaching methods for primary and secondary schools which help students memorise and relate to what has been learned.

III:

Chapters 8 and 9 include examples and ideas for discussions, homework and practical tasks which can be used as helpful teaching material to stimulate better understanding of the topic among pupils.

ABBREVIATIONS

OECD	Organization for Economic Co-operation and Development is an international economic organisation of 34 countries founded in 1961 to stimulate economic progress and world trade. It is a forum of countries committed to democracy and the market economy, providing a platform to compare policy experiences, seek answers to common problems, identify good practices and coordinate domestic and international policies of its members.
BRIICS	BRIICS is the term used by the OECD. Brazil, Russia, India, Indonesia, China, South Africa are BRIICS countries. This is a term to name today's new high-growth emerging economies.
REACH	The Regulation on Registration, Evaluation, Authorisation and Restriction of Chemicals. It entered into force on 1 June 2007.
ECHA	The European Chemicals Agency, implementing the EU's ground-breaking chemicals legislation for the benefit of human health and the environment as well as for innovation and competitiveness. ECHA helps companies to comply with the legislation, advances the safe use of chemicals, provides information on chemicals and addresses chemicals of concern.
EU	European Union
Sin List	The SIN (Substitute It Now!) List is The International Chemical Secretariat (ChemSec) driven project to speed up the transition to a world free of hazardous chemicals. The SIN List 2.1 consists of 626 chemicals that ChemSec has identified as Substances of Very High Concern based on the criteria established by the EU chemical regulation, REACH.
CLP	The Regulation on classification, labelling and packaging of substances and mixtures, entered into force on 20 January 2009.
GHS	Globally Harmonized System of Classification and Labelling of Chemicals, addresses classification of chemicals by types of hazard and proposes harmonized hazard communication elements, including labels and safety data sheets.
PBT	Persistent, Bioaccumulative and Toxic Substance
ppm	Parts per million, for example 1 ppm equals to 1 milligram of substance to 1 kilogram (mg/kg)
PCB	A polychlorinated biphenyl is a synthetic organic chemical compound of chlorine attached to biphenyl, which is a molecule composed of two benzene rings. There are 209 configurations of organochlorides with 1 to 10 chlorine atoms. The chemical formula for a PCB is $C_{12}H_{10-x}Cl_x$. 130 of the different PCB arrangements and orientations are used commercially
DDT	Dichlorodiphenyltrichloroethane is a colourless, crystalline, tasteless and almost odourless organochloride known for its insecticidal properties

LCA	Life-cycle assessment, also known as life-cycle analysis, is a technique to assess environmental impacts associated with all the stages of a product's life - from raw material extraction through materials processing, manufacture, distribution, use, repair and maintenance, and disposal or recycling.
ChemSec	The International Chemical Secretariat is a non-governmental organisation founded in Sweden in 2002 to advocate in favour of stricter regulatory controls on potentially hazardous chemicals.
Stockholm Convention	Stockholm Convention on Persistent Organic Pollutants is an international environmental treaty, signed in 2001 and effective from May 2004, that aims to eliminate or restrict the production and use of persistent organic pollutants.
SVHC	Substances that may have serious and often irreversible effects on human health and the environment can be identified as substances of very high concern.

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1. INTRODUCTION

Atoms combine innumberable different ways to form molecules and other materials creating the universe we live in. It might be a common understanding that “chemicals” are the substances used in laboratories or something that is not a natural substance, but actually everything around us is made of chemical substances. Take a second to think about it. For example if you smell a flower – the fragrance is chemistry; when you see a flower – the colour is chemistry; when you touch a flower – the structure is chemistry!

1.1 Chemicals around us

Understanding chemistry helps us to understand the world around us. Cooking is chemistry. Everything you can touch or taste or smell is a chemical. When you study chemistry, you come to understand a bit about how things work. Chemistry isn't secret knowledge, useless to anyone but a scientist. Chemistry explains everyday things, like why laundry detergent works better in hot water or how baking soda works or why not all pain relievers work equally well on a headache. If you know some chemistry, you can make conscious choices about everyday products that you use.

Before the middle of the eighteenth century there was no such understanding of chemicals; the "chemicals industry" did not exist. People did things that seemed to work – they made soap from animal fat and plant ashes; derived substances with apparent therapeutic value from bark, roots, or plants; made glass from sand, soda ash, and other materials; made mineral colorants (iron oxide, for example) as did their Stone Age ancestors; used natural preservatives and fertilizers. But for the most part they did not understand why or how these substances worked. And they were restricted to mixing the basic materials available at that time.

That all started to change a little over two hundred years ago, when humans began to unravel the basic mysteries of matter – how it is subdivided, how it is held together, how it is transformed and how it could be re-formed into "new" substances. This has touched people directly and beneficially in almost every aspect of our daily lives through the vast array of products and systems produced by the chemical industry. And even though the modern life around us is made of chemicals, most direct products of the chemical industry are "invisible" to ordinary people. The only thing we can see and touch is the final consumer product which we buy and use. Chemcials are "invisible" even in the factories where they are.made. They are stored out of sight in barrels or tanks, circulated through pipes in distillation columns or closed reactors, and passed discreetly into tankers to be processed elsewhere into consumer goods; only in this final form do they appear in our drugstores and on the shelves of our shops.

So from the mid-eighteenth century to the present day there has been a huge development in understanding the science of chemicals and how our modern world as we know it would cease to exist if suddenly we stopped producing and consuming products made of chemicals which we have gotten so used to. But during this time, mankind has also learned how harmful chemicals can be. Many chemicals are used to improve the quality of our lives and most are not harmful to the environment or human health. However, some have the potential to cause harm. We now know about toxic chemicals that should only be used when the potential risks are appropriately managed. We should be concerned about them. Though we cannot control the naturally occurring processes, we can raise our awareness about the impact of manmade chemicals on our health and environment and be aware of the potential risks which come with the growing use and production of chemicals.

Group Discussion in Class: Benefits of modern lifestyle - how chemicals have changed our lives? (Watch the video in Chapter 8.1)
Aim: to make children aware that chemicals are actually everywhere.

1.2 Increasing production and use of chemicals

Presently, most chemicals are produced by so called 'developed countries' but production is increasing more than twice as fast in India, China, Brazil, South Africa and Indonesia (BRIICS countries). Their economic share of total world chemical production is projected to rise to about 30 % by 2020 and almost 40 % by 2030.

The potential consequences of global pollution trends include further impacts on human health and ecosystems. For Europe, unsafe drinking and bathing water and contaminated food, from both European products and imports, pose immediate risks. Risks may also be connected to the increasing import of intermediate and final industrial chemical products.

1.2.1 Chemical production in the world

Large-scale industrial production of chemicals was well underway by the middle of the 19th century. Refineries in both Europe and the United States were using coal to produce kerosene or coal oil. In 1859, western Pennsylvania became the site of the world's first oil well. As other oil fields opened in the United States, Europe, and East Asia, those coal refineries became oil refineries, and industry acquired a vast and extremely versatile supply of lubricants and fuels. Synthesis of completely novel compounds began in European laboratories at about the same time. DDT, for example was synthesized by a German chemistry student in 1874 although its pesticidal properties were not appreciated until the 1930s. The first plastics were synthesized from cellulose (the primary constituent of wood) in the 1890s. By the end of the century, organic chemistry had revolutionized a major industry: the production of dyes.

In the years following the war, synthetics flooded one manufacturing process after another, since they were often much cheaper than traditional materials such as rubber, wood, metal, glass, and plant fibre.

Not surprisingly, the volume of synthetic organic chemical production has moved continually upwards ever since large-scale manufacturing began in the 1930s. Global production escalated from near zero in 1930 to an estimated 300 million tons by the late 1980s. In the United States alone, production had soared from about 150,000 tons in 1935 to nearly 150 million tons by 1995 - almost a thousand-fold increase.

The global chemicals industry has grown rapidly over the past several decades, as well. Within the last decade, this rapid growth has been driven primarily by rapid growth in countries with economies in transition. Countries that accounted for a minimal percentage of global production forty years ago have grown to become major producers.

Over the last decade, BRIICS countries (Brazil, Russia, India, Indonesia, China, and South Africa) have far exceeded the world growth rates of the OECD countries.

For example, from 2000 to 2010, chemical production in China and India grew at an average annual rate of 24% and 14%, respectively, whereas the growth rate in the US, Japan and Germany was between 5 to 8%. China now is the world leader in chemical production sales.

The OECD presented forecasts for the global chemicals industry, looking forward to 2030 (see Figure 1). An estimated 70 000 to 100 000 chemical substances are produced in high volumes, over one million tonnes a year. OECD countries are the biggest producers of chemicals but production is increasing more than twice as fast in India, China, Brazil, South Africa and Indonesia. Figure 1 shows that the major chemicals industry is moving towards sustainable production and use of chemicals very slowly; profit remains the main index for production trends.

Discussion in class: Who are the biggest producers of chemicals – in your country, in Europe, in the world? What could be the problems related to chemicals production?
Look at the example in Chapter 8.2 about environmental, health and sociological aspects of textile production (the whole cycle of production from harvesting raw material to buying ready-to-wear products at shops).

1.3 Growing awareness of the negative effects of chemicals

Whether a substance is synthetically manufactured, copied from nature, or extracted directly from nature, that tell us nothing much about the properties of a chemical. In terms of chemical safety, "industrial", "synthetic", "artificial" and "man-made" do not necessarily mean damaging and "natural" does not necessarily mean safer. There are naturally occurring toxins (poisonous substances coming from living organisms) found in certain plants like poinsettias and even some wild mushrooms and berries.

However, our main concern should be man-made synthetic substances that can cause harm to human health and the environment. They are such substances as phtalates, polybrominated diphenyl ethers, parabens, perfluorinated compounds and others that have specific properties making their long-term negative effects very hard to predict. They are still widely used in production despite the existence of readily available safer alternatives.

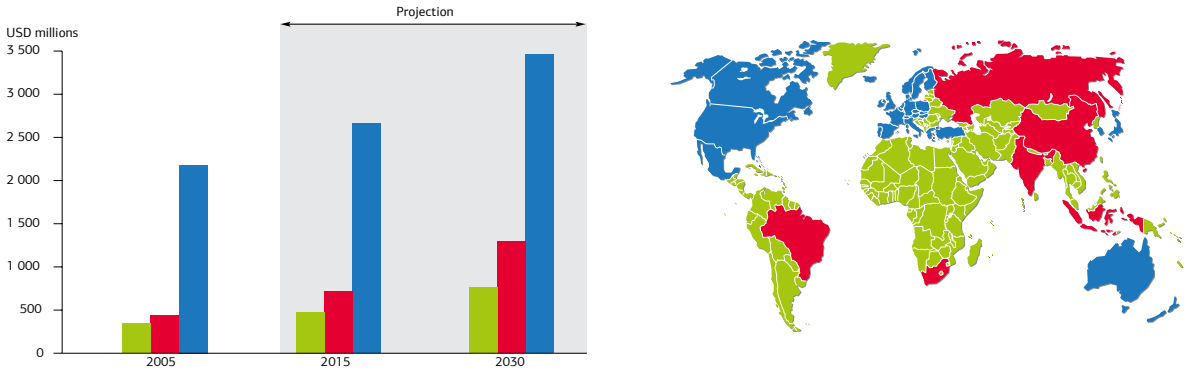


Figure 1. The prognosis of global chemicals industry until 2030 according to OECD.
The bar graphic compares 2005 and projected (2015 and 2030) chemicals production for three world regions in US dollars. The map indicates the precise the regions considered: OECD countries (green), BRIICS countries (red), and rest of the world (blue). Source: OECD, 2008, OECD Environmental Outlook to 2030.

There is growing recognition of the fact that for sustainable development one must ensure prevention of the adverse effects of chemicals. At the same time a balance has to be found between the essential needs of chemicals for attaining development goals and the urgency of recycling and conservation of non-renewable resources of the earth. It is recognized that some chemicals which are essential to sustain life and improve its quality from the viewpoint of today's lifestyle can indeed have a negative impact on human health and the environment.

These are certain physical-chemical properties which can make chemicals hazardous. Traditionally we know that chemicals may be toxic, corrosive, flammable, explosive, etc. But understanding the hazardousness of a chemical and its effects on our health and the environment is much more complex.

Ecotoxicology, a relatively young subject, represents a multidisciplinary approach to the study of the adverse effects of environmental chemicals on individuals, populations, biocenoses, and whole ecosystems. Toxicology, a much older subject, deals with the harmful effects of chemicals on a given species of the living system.

A chemical accident refers to an event resulting in the release of a substance or substances hazardous to human health and/or the environment in the short or long term. Such events include fires, explosions, leakages or releases of toxic or hazardous materials that can cause people illness, injury, disability or death.

While chemical accidentss may occur whenever toxic materials are stored, transported or used, the most severe accidents are industrial accidents, involving major chemical manufacturing and storage facilities.

Homework: Ask children to make a presentation or research some chemical-related accident and to talk about the consequences to humans and the environment.
(some examples are given in Chapter 8.3)

1.4 Exposure to hazardous chemicals

"It is the dose that makes the poison" – a principle of toxicology which was first expressed in the 16th century by *Paracelsus*. This means that even water and oxygen can be toxic if too much is eaten, drunk or absorbed. We have always been exposed to many different substances, because nature is a "cocktail of chemicals". Modern technology enables us to detect minuscule amounts of substances, but the presence of such a small amount of a specific substance does not mean that it is having any discernible effect on us or on future generations.

A chemical can't simply be classified as "hazardous" or "safe": it always depends on the amount

or dose received. The effects of a chemical will change with different amounts, so that below a

certain dose it may be harmless or beneficial and at a higher dose it may be toxic. We all know that a little aspirin can be helpful for us, whereas 50 tablets could cause acute renal failure, coma, and heart failure from salicylate poisoning. If there is no exposure, there is no adverse effect to human health or the environment. But once we are exposed to a chemical, e.g. open a paint can and start painting, we are exposed to the chemicals which vaporize from the paint can; we are directly exposed to chemicals through breathing. The severity of the health effects depends on how long we breathe in the paint fumes and whether we use any protective measures.

Figure 2. Picture below illustrates the exposure and effect relationship. (Source: ereach.dhigroup.com)

Chemicals are ranked for their toxicity, from low to high, using a 'lethal dose' value. You can't judge the effects of any chemical by simply looking up its toxicity: you also need to know the actual dose at which one is likely to be exposed. To complicate things further, individuals may react differently to the same dose. This is why the safe exposure levels that are published for chemicals are well below the levels likely to cause harm.

Similarly, hazardous substances can only cause harm to the environment if they are released into it and are contained, e.g. in water, soil or air and come in contact with living organisms, such as plants, animals, etc (Figure 2).

Substances in non-chemical products, like clothes, mobile phones, cars, furniture, etc. are not so easily released; normally they stay inside or on the product. However, small amounts may be emitted over time and cause exposure as well. Here, the problems are not so obvious because we don't feel the exposure so much and sometimes it is difficult to link the chemical exposure with a disease.

We can smoke cigarettes for, let's say a year, and then quit., but we may develop lung cancer from inhaling that cigarette smoke after 40 years. Similarly, if you work at a car cleaning company, for example, you inhale small amounts of chemical fumes every day. Such long-term exposure may lead to adverse health effects. Depending on the properties of chemicals (or whether you use proper safety measures and personal protection equipment when handling chemicals) you may feel the adverse effect immediately or after a certain period of time (Figure 3).

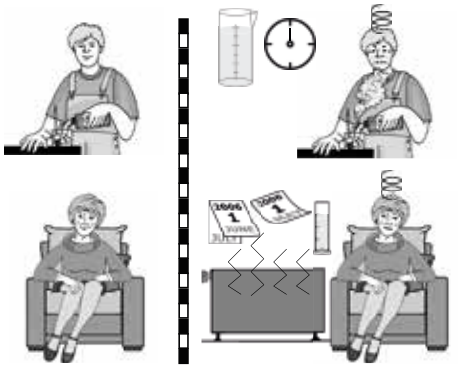


Figure 3: Chemical´s impact in time.
(Source: erech.dhigroup.com)

Claims about **potential risk from particular chemicals** should be looked at in context: how they are used; what the exposure levels are, and whether there are alternative ways to get the same benefits. Even where chemicals are potentially harmful, they must be considered in the context of their purpose.

2. HAZARDOUS SUBSTANCES

A hazardous chemical is any chemical which possesses a physical hazard or a health hazard. Physical hazard means a chemical for which there is evidence that it is a combustible liquid, a compressed gas, explosive, flammable, an organic peroxide, an oxidizer, pyrophoric, unstable (reactive), or water-reactive. Health hazard means a chemical for which there is evidence that acute (immediate) or chronic (delayed) health effects may occur in over-exposed people.
A hazardous substance means any chemical that may be harmful to the environment and to human health if inhaled, swallowed, or absorbed through the skin.

2.1 Physical-chemical properties

All substances have properties that we can use to identify them. There are two basic types of properties that we can associate with matter. These properties are called physical properties and chemical properties:

Physical properties: properties that do not change the chemical nature of a substance.

Examples of physical properties are: colour, smell, freezing point, boiling point, melting point, infra-red spectrum, opacity, viscosity and density. There are many more examples. Note that measuring each of these properties will not alter the basic nature of the substance.

Chemical properties: properties that do change the chemical nature of substance.

Examples of chemical properties are: heat of combustion, reactivity with water, pH, flammability, corrosion/oxidation resistance, etc.

The more properties we can identify for a substance, the better we know the nature of that substance. These properties can then help us model the substance and thus understand how it will behave under various conditions.

The difference between a physical and chemical property is straightforward until the phase of the material is considered. When a material changes from a solid to a liquid to a vapour it seems as if they become a different substance. However, when a material melts, solidifies, vaporizes, condenses or sublimes, only the *state* of the substance changes. Consider ice, liquid water, and water vapour: they are all simply H_2O. Phase is a physical property of matter and matter can exist in four phases – solid, liquid, gas and plasma.

Humans may be exposed to a number of hazards because of the physical-chemical properties of substances. Physical hazards may manifest as fires, explosions, excessive temperatures, or the release of large volumes of gas or toxic or flammable gases or vapours.

Properties and classification of hazardous substances are presented in detail in the chapters 2.1 – 2.5. More detailed information about hazard symbols and their meaning is included in chapter 4.4.

2.2 Routes of exposure to humans

There is an ever-increasing use of chemicals and therefore humans, animals and plants are increasingly being exposed to chemicals. Hazardous substances can only cause harm to people if they are taken up into the human body.

Remember!
Hazardous substances (chemicals) can harm you or any other human only when they enter your or any other human body/living organism.

E.g. ethanol (alcohol) is a hazardous substance, because it damages our nervous system and makes us dizzy. As long as it is kept in a bottle it does not harm us (no contact, no uptake). When we open the bottle and drink it – we expose ourselves to the chemical substance ethanol – it enters the body and affects our nervous system.

Humans can take up chemicals into their bodies in three ways: inhaling, touching, digestion (Figure 4).

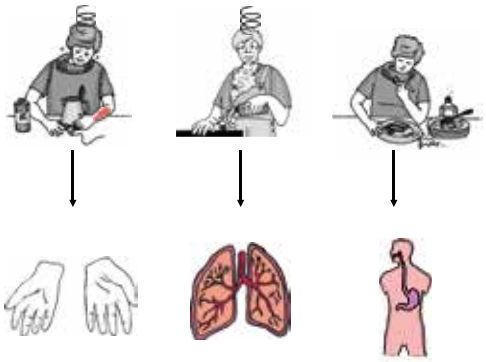


Figure 4. Ways chemicals can enter the human organism. (Source: ereach.dhigroup.com)

- **Via breathing (inhalation):** from the indoor and outdoor air – this is called an **inhalation** exposure. For example, in indoor air there may be evaporation of solvents from paints when renovating a flat, or substances may be released from products, such as carpets or by using cleaning agents for various purposes. We may also experience outdoor air exposure to chemicals, e.g. from car exhaust gases or from combustion flue gases released from factories and houses that are released into the air.
- **Via touching:** through the skin or eye – this is called an **absorption** exposure (absorption through the skin is called dermal exposure). Contact with a substance may occur by spilling it on the skin, splashing it in the eyes, or by brushing against contaminated objects. For example, when using cosmetics or household chemicals, there is a high possibility of skin contact. Also, even using non-chemical products, we may come in contact with substances which are contained within them for some reason, like treated textiles in furniture, metals in alloys of jewelery.

Remember!

- Chemicals differ in their absorption behaviour: some chemicals may not be absorbed easily unless the skin is cut, but others are absorbed quite readily regardless of the skin`s condition.
- Follow the instructions recommending the use of gloves to prevent skin contact with a chemical or its absorption through the skin.
- Take care to avoid eye contact with hazardous substances: eyes are particularly sensitive to chemicals, and since capillaries are near the surface, the substance can enter the bloodstream more readily.

- **Via digestion:** through eating and drinking - this is called an **ingestion** exposure. When people eat food that has been contaminated with hazardous substances throughout the lower steps of the food chain (as described in chapter 2.5), they are exposed to this contamination. There are other possibilities for ingestion exposure as well. For example, chemicals that have been intentionally added to food and drinks as preservatives are ingested as we consumer them. Ingestion of residue from chemicals may occur from contamination, e.g., pesticide residues on fruits and vegetables. Further, a small child who puts things, such as toys in his or her mouth can ingest substances that are released from the material used, e.g., phthalates found in some toys.

The fourth option is being born with chemicals in your body. Some chemicals are transferred from the mother to foetus; babies are already being born with a burden of chemicals in their body. This is due to the properties of some hazardous chemicals; once we are exposed and they enter our bodies, the chemicals do not break down or exit our organism, but accumulate in body fat and other organs.

Remember!

- Not all exposures cause harmful effects. Firstly, your general health plays an important role in how much you can be affected by being exposed to a chemical. Other significant factors include:
  - The type of a chemical exposed,
  - The amount of a chemical exposed,
  - How long the contact lasted,
  - How often the contact with a chemical has occurred, and
  - How the chemical has entered your body.

2.3 Hazardous substances' impact on human health

When a human is exposed to a chemical through any means of uptake, first, absorption and distribution (via the blood circulation or the lymphatic system) occur and seek out the target organ which is affected by this chemical. A toxic substance produces injury when it comes in contact with "susceptible" tissue - that part of the body which is injured after exposure to that particular substance. **This can produce either immediate or long-term effects.**

Immediate effects occur at the time of exposure, such as vomiting, eye irritation, or other symptoms linked to a chemical exposure.

Long-term effects may be observed years after the actual exposure, or as a result of chronic chemical exposure.

Causes of these effects are often more difficult to trace. Certain toxic substances can produce long-term effects – toxicity which can manifest in various representations:

- **Neurotoxicity** is any effect on the structure or function of the central and/or peripheral nervous system related to exposure of a chemical substance: mature neurons are generally incapable of regeneration, but the normal cascade of brain development during foetal and new-born life may be very sensitive to disruption by chemicals resulting in nervous system dysfunction. Human exposure to potential neurotoxic substances is an increasing public concern.
- **Reproductive toxicity** includes adverse health effects in the prospective mother, the father, the developing embryo, and infant.
- **Carcinogenicity** is an increase in individual risk of contracting cancer. This toxic effect from chemicals ranks of most concern to the public.
- **Immunotoxicity** affects the human immune system – a complex set of cellular and biochemical components that serve to recognize and protect the body against foreign materials. Effects of chemicals can manifest in allergies that affect mostly the skin (e.g., allergic dermatitis), the respiratory passages (e.g., bronchial asthma), and the conjunctiva (e.g., rhino conjunctivitis).
- **Endocrine disrupting chemicals (EDCs)** – an endocrine disrupter is "an exogenous substance or mixture that alters function(s) of the endocrine system and consequently causes adverse health effects in an intact organism, or its progeny, or (sub)populations". Hence, endocrine disrupters disturb the hormonal balance of the body or initiate body processes at abnormal times in the life cycle. The endocrine or hormone system is one of the communication systems regulating the body functions.

Remember!
Different chemicals or substances will manifest different effects in the human body.

Some organs are specifically susceptible to some chemicals. For example, carbon tetrachloride is specifically toxic to the liver, cadmium is toxic to the kidney, benzene is toxic to the haematopoietic organs, n-hexane is toxic to the peripheral nerve, 2-bromopropane is toxic to the reproductive organs, benzene is an agent linked to causes of leukemia, and so on. However, different chemicals will perform differently by their nature. A majority of the chemicals that enter the human body are metabolized – biotransformed, either to reduce or to further enhance its toxicity. Some chemicals can be stored for many years in the body, while others are eliminated via the excretion process.

On top of that, combined action of chemicals in mixtures often occurs, for example, from products containing mixtures of chemicals, from wastes. In such cases it is important to establish or to predict how the toxicological effects of the mixture will turn out when compared with exposure to individual compounds. Here we can distinguish several possibilities:

- **Dose addition:** chemicals are not interacting but they have the same effect. In this case the effects from single chemicals will add up and the combined effect can be estimated from the total dose.
- **Independent action:** chemicals are not interacting and they have differing effects. In this case the combined effect results from separate effects of each single chemical.
- **Synergism:** chemicals are interacting so that the combined effect from multiple chemicals is even enhanced and is greater than dose addition if there was no interaction
- **Antagonism:** chemicals are interacting so that the combined effect from multiple chemicals is less than if there was no interaction.
- **Potentiation:** the toxicity of a chemical is enhanced when it occurs together with another chemical that alone does not have a toxic effect on the same organ. For example, the toxicity of carbon tetrachloride to the liver is enhanced with isopropyl alcohol.

2.4 Pathways to the environment

Hazardous substances may be released to the environment, intentionally (e.g., by using of pesticides) or unintentionally (e.g., through combustion or manufacturing processes). When released to the environment, these substances can be contained in water, soil and air, and thus hazardous substances will come in contact with living organisms such as plants and animals, causing unwanted effects on ecosystems – harm to the environment which further spreads to people by affecting human health (see Figure 5).

Introduction (emissions) of harmful contaminants (substances, chemicals) into air, water or soil is called pollution. This can happen anytime – while chemicals are produced, used or disposed. Hazardous substances may be emitted in numerous ways:

- With the **waste air and wastewater from industrial plants and installations** that produce or use chemicals.
- From use of chemicals in professional activities, such as construction works, cleaning services, hospitals, etc., hazardous substances are emitted as well, but in much lower amounts compared to industrial installations.
- From **use of household chemicals,** such as cleaning agents, hazardous substances are washed off and released to the sewerage system; although in the majority of cases these substances are flushed with water flow to the wastewater treatment plant, some amounts of hazardous substances may end up in the environment (water or soil) if the water treatment does not efficiently eliminate these substances.
- From different types of products the **chemicals may be released** in time. You can even notice this! If you have bought new clothes made form synthetic materials you may notice a smell from these clothes. The smell comes from chemicals that evaporate in low but notable amounts from the products. If you wash a red T-shirt in water that is too hot, the water may turn red from pigments (also chemical substances) used to colour of your T-shirt.
- From **bad waste management** – waste that contain hazardous substances. You should not throw your old mobile phone or electronic devices in a household waste bin because these will be mixed with e.g., food waste and will end up in a landfill of mixed waste. Hazardous substances will be washed out by rain into the landfill leachate.

Discussion in class: How hazardous substances can be released into the environment - from households, from hairdressers, from schools, factories, ships, etc.
Look at Chapter 8.4 to see how to visualize the brainstorm.

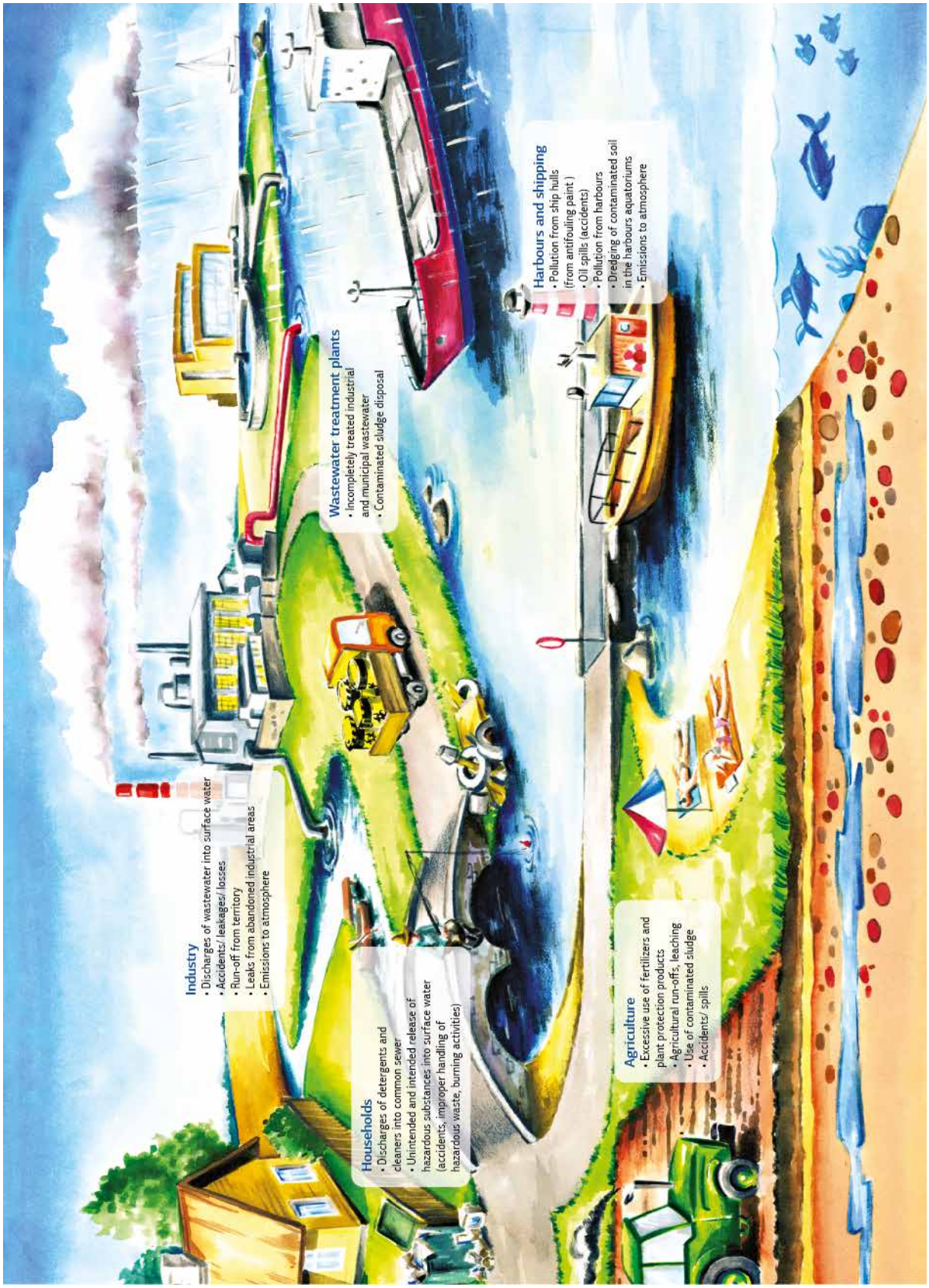


Figure 5. Illustrates the main pollution sources of hazardous chemicals (emissions) into the environment (industry, wastewater treatments plants, agriculture, households, harbours and ships). Keep in mind that consumer products are also a considerable source of hazardous substances!

2.5 Hazardous substances' impact on the environment

Once released in water, soil or air, some hazardous substances may easily break down, but others are not and persist essentially unchanged in the environment for decades. Thus there are several pathways that hazardous substances may take that will affect the environment:

- **Long range transport with wind conditions** of stable and relative volatile substances – they evaporate, are transported by wind and are deposited again. Through atmospheric processes (precipitation or settling of particulate matter) deposition of persistent substances fall on onto land or into water ecosystems where these substances may accumulate and thus may harm the environment (see Figure 6).

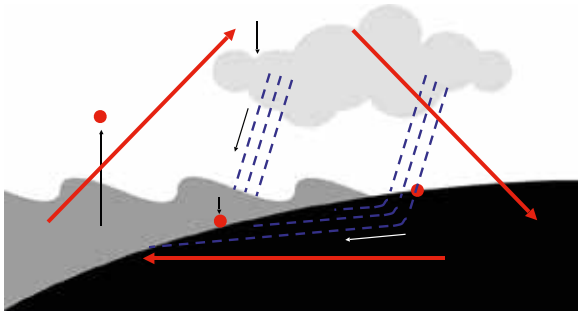


Figure 6. Transport and depositing of hazardous substances with winds. (Source: ereach.dhigroup.com)

- **Dilution** with the flow (water, air) that occurs when substances are carried away from the pollution discharge source (e.g. dark smoke plume from the chimney is dispersed over a distance). In this way the concentration of hazardous substances is decreased but pollution is spread over a wider area.
- **Destruction** by sunlight, oxidation, etc. as well as through biological degradation with microorganisms (bacteria and fungi) using hazardous substances as a food and energy source (see Figure 7). In these processes substances break down and often become less harmful, but sometimes even more harmful.

Figure 7. Destruction of hazardous substances in the environment. (Source: ereach.dhigroup.com)

- **Sorption** by attaching to soil or sediments, or plants. This process slows the movement of hazardous substances. But on the other hand, hazardous substances which have settled to the seafloor are then taken in by organisms that live or feed on bottom sediments (thus supporting a biomagnification process).
- **Bioaccumulation** – the accumulation of persistent chemical pollutants (substances and elements), that are hard to degrade or excrete, in various tissues of animals and plants; the load of such pollutants in an animal will increase with each particle of feed containing the chemical and increases as the individual becomes older (see Figure 8).

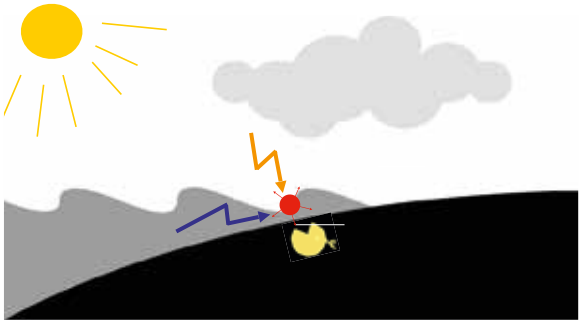


Figure 8. Bioaccumulation of hazardous substances. (Source: ereach.dhigroup.com)

- **Biomagnification** – the transit of persistent bio-accumulated pollutants in a food web from one trophic level to the next higher level, causing an accumulation of toxicants in top predators (see Figure 9); in a terrestrial nutrition web the magnification is about 10 times in each phase; in aquatic nutrition web, it is approximately 3-5 times.

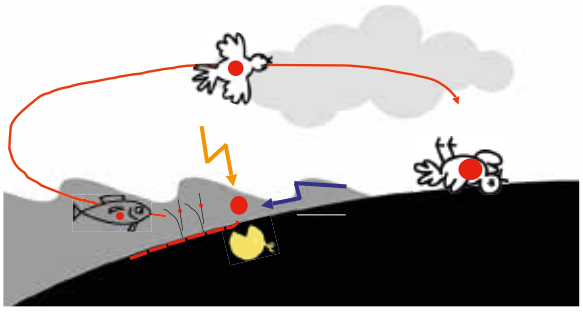


Figure 9. Biomagnification of hazardous substances. (Source: ereach.dhigroup.com)

Hazard from Persistent, Bio-accumulative and Toxic Substances (PBTs)

Substances which are persistent and which have a potential to bioaccumulate are of particular relevance for the environment. These substances are not destroyed and they concentrate in fatty tissues of animals, and eventually also in humans.

The food chain can cause the accumulation of toxic agents in tissues and thus return to humans the substances they discarded into nature!

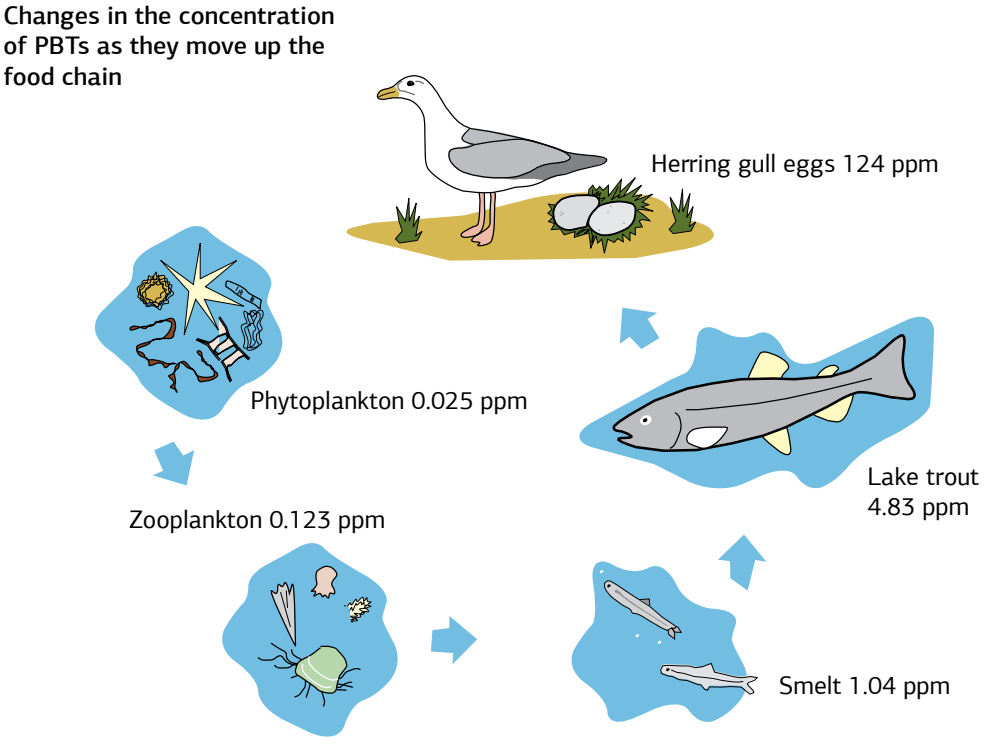
Toxicology is the study of harmful effects of chemicals on biological systems. A relatively new field is called **environmental toxicology:** this branch of toxicology is concerned primarily with the movement and impacts of toxic substances and their metabolites in the environment, in food chains, and upon the structure and function of biological systems.

An example of biomagnification

Once a toxic pollutant is in the water or soil, it can easily enter the food chain. For example, in the water, pollutants adsorb or stick to small particles, including a tiny living organism called phytoplankton. Because there is so little pollutant stuck to each phytoplankton, the pollutant does not cause much damage at this level of the food web. However, a small animal such as a zooplankton might then consume the particle. One zooplankton organism that has eaten ten pices of phytoplankton would have ten times the pollutant level as the phytoplankton.

As the zooplankton may be slow to metabolize or excrete the pollutant, the pollutant may build up or bioaccumulate within the organism. A small fish might then eat ten pieces of zooplankton. The fish would have 100 times the level of toxic pollutant as the phytoplankton. This multiplication would continue throughout the food web until high levels of contaminants have biomagnified in the top predator. While the amount of pollutant might have been small enough not to cause any damage in the lowest levels of the food web, the biomagnified amount might cause serious damage to organisms higher in the food web. This phenomenon is known as biomagnification.

For an another example changes in the concentration of PBTs as they move up the food chain are schematically shown in Figure 10.



Source: Persistent Bioaccumulative Toxic Substances, Commission for Environmental Cooperation (CEC) organisation, http://www.cec.org/soe/files/en/soe_pbts_en.pdf

Figure 10. Changes in the concentration of PBTs as they move up the food chain.

Examples of serious damage to organisms higher in the food web caused by pollutants:

- in some fish and bird species (for example, salmon and osprey) environmental pollutants in the eggs can cause the death of the embryos;
- malformations of vertebrae, jaws or fins of fishes living in water with toxins (cod, pike);
- the thickness of the shells of the eggs of birds decrease (as the result of the effect of pesticides, e.g. DDT) so the risk that the eggs will be broken before hatching increases (peregrine falcon, sparrow hawk, white-tailed eagle, marsh harrier, razor bill, osprey);
- organic mercury compounds, PCB, pesticides and others can cause muscular and nerve dysfunction, that means a decreased working capacity (disturbances of digestion, metabolism, migration and/or a reduction of the feed intake) of birds and fishes;
- increased levels of pollutants may cause decreased levels of the hormones, for example, minks exposed to very little doses PCBs (0.3 ppm PCBs) in the diet failed to reproduce;
- from the 1950s to mid-1990s the reproduction success of the grey and ringed seals of the Baltic Sea was very low due to intoxication by PCBs; in the 1980s only about 30 % of the female individuals seem to be fertile; the pollutants caused the occurrence of lesions of their uteri, the chambers of the uterus were occluded, the frequency of tumours of the uterus was high, there were inflammatory lesions of the intestine; there were pathological changes in the kidneys, the adrenals, in the skeleton, their claws were often deformed (Rydén, L., Migula, P., Andersson, M., 2003, p. 425-430).

3. MANAGEMENT OF HAZARDOUS CHEMICALS

Chemical substances and their hazards can vary widely. Usually in our everyday life we do not encounter single chemical substances but rather chemical substances incorporated into different mixtures, products, articles. For a complete view and understanding of the situation, this chapter includes the following information: how hazardous substances are made, why there is concern about the use of hazardous chemical substances, what legal acts are currently in place and why they are not strict enough, what role industry plays in the wide use of hazardous substances, what are the problems of hazardous waste management, where science goes further. All these aspects are incorporated in life cycle assessment of hazardous substances. It is essential not only to avoid significant risks to human health and the environment, along with their associated economic costs, but also to maximize the benefits of their contribution to human well-being.

3.1 Life Cycle Assessment

Life Cycle Assessment (LCA) is a widely accepted tool to evaluate environmental effects of products, processes, and services. The LCA methodology evaluates holistically the environmental consequences of a product system or activity, by quantifying the energy and material used, the waste released to the environment, and assessing the potential environmental impacts of that energy, materials, and waste.

When assessing a typical product, LCA takes into account the supply needs of raw materials or extraction of raw material to produce the product, the manufacturing, packaging, transportation, use of the product and disposal of the product after use (see Figure 11). At every stage of the production process, chemicals used can reach the human body or the environment. Use of hazardous chemical substances (as a material) is only one part of the LCA approach. The most important is the whole concept of production. The sustainability of product production can be achieved only if less hazardous substances are used, transportation of materials is minimized and, later on, safe use and reuse of the product and generation of less waste is possible.

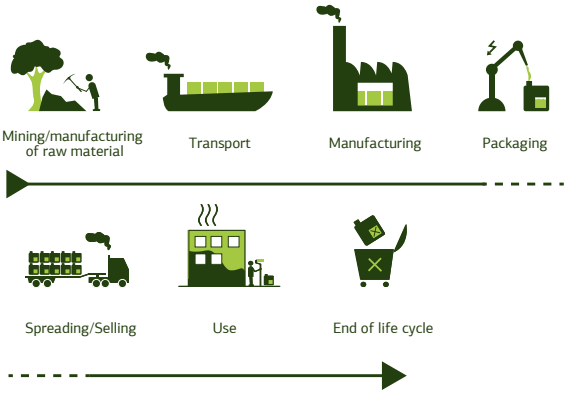


Figure 11. The lifecycle scheme. (Source: http://www.ecodesign-een.eu/)

3.2 How hazardous substances become part of a product

It takes 700 years before plastic bottles start to decompose, and can take up to 1000 years to fully decompose. About 50-90 years ago we started to use synthetic substances because of their attractive properties – phthalates make plastic soft, organotin substances have antibacterial properties and for a long time were used in paints to protect wood. For example the use of plasticizers to modify polymers began in the 1800s, when the Hyatt Brothers added camphor to nitrocellulose to increase the latter's moldability and reduce brittleness. The use of plasticizers in PVC (polyvinyl chloride, the third-most widely produced plastic, after polyethylene and polypropylene) was invented in the 1920s. At that time, nobody thought about the possible negative effects which these substances could have on the environment or human health.

Hazardous substances are usually added to a product as additives to give products certain properties. Have you ever thought why your face cream smells so good, makes your skin soft and has a long expiry date? Why some paints dry very quickly and have a very specific smell? How toys are so soft and colourful? The list is very long.

These substances usually are added during the polymerization process. Basic polymer chemistry isn't too complicated, but for most people the manufacture of the synthetic substances, such as plastics, fibres, etc. that surround us is a mystery, which no doubt suits the chemical producers very well. Knowledge of the principles involved here will make us more informed users.

The polymers themselves are theoretically quite inactive and therefore not particularly harmful, but this is most certainly not true of the *monomers*. Chemical companies usually make a big deal of how stable and inactive polymers are, but that's not what we should be interested in. A small proportion of the monomer will never be converted into polymer. It just gets trapped in between the polymer chains, like peas in spaghetti. Over time this inactive monomer can escape (together with all additives), either by vaporising into the atmosphere if the initial monomers were volatile, or by dissolving into water if the monomers were soluble. Because these monomers are so toxic, even very small quantities can be harmful to humans, so it is important to know about the monomers before you put the polymers on or next to your skin or in your home. Since your skin is usually moist, any water-borne monomers will find an easy route into your body.

3.3 Alternatives for hazardous substances

From a scientific perspective, more and more alternative substances to hazardous substances are being introduced. However, 'alternative' does not always mean 100% safety, because a new chemical has not been studied for a long time; thus initially, we know less about it than about the previously used chemical. But because of the growing awareness on the negative effects of chemicals, industry is also investing more into research on safer alternatives. A good example of safer alternatives is research initiated by BASF on non-phthalate plasticizers: In 2002, the BASF corporation introduced an alternative plasticizer for use in PVC (polyvinyl chloride) applications. Di-isononyl-cyclohexane dicarboxylate (DINCH), marketed under the Hexamoll name, was developed for use in sensitive applications where exposure to toxicological and exposure issues were of great concern, such as the manufacturing of toys, medical devices, and food packaging. According to BASF, extensive studies have shown that DINCH possesses no environmental and reproductive hazards as well as no peroxisome proliferation. In October 2006, Hexamoll DINCH received approval from the European Food Safety Authority (EFSA) making DINCH safe to use in food contact applications such as cling film, tubes, or sealants. Hexamoll DINCH now has German, European, and Japanese Food Contact approvals, with U.S. FDA (U.S. Food and Drug Administration) approval in progress.

Citrates (or citric acid esters), commercialized for more than 35 years, are also used in sensitivity applications since they show benign toxicology. Citrates have been approved for use in applications such as pharmaceutical tablet coatings, medical devices, food packaging (i.e., vinyl film wraps), and cosmetic formulations (i.e., shampoos, deodorants, and fragrances). The main component of citrates is citric acid which is used as a flavouring agent in sports drinks, soft drinks, breakfast juices, and candy bars. In 2004, the European Union Scientific Toxic Committee approved the use of acetyl tributyl citrate (ATBC) for the use in soft PVC toys. According to the panel, ATBC did not possess a safety concern when young children placed PVC-containing toys in their mouths.

DINCH and Citrates are not the only non-phthalate plasticizers that have been scrutinized for environmental and health effects. In 2001, the Danish Environmental Protection Agency (DEPA), with the help of COWI Consulting Engineers and Planners, conducted a study that involved the use, exposure, and possible health and environmental effects of 11 substances including several alternative plasticizers. According to results, the non-phthalate plasticizers are safe to use. The remaining substances couldn't be assessed for their environmental and health effects since the information on them was limited (i.e., carcinogenicity and acute toxicity). A few of the non-phthalate plasticizers can affect humans in a working environment such as the production of floor and wall covering. However, none of the non-phthalates studied are believed to cause serious damage to organs, genetic material or foetus (source: http://www.chemsystems.com/about/cs/news/items/PERP%200708S4_Plasticizers.cfm).

Another research is being initiated by non-governmental organizations working together with scientists. E.g.: The International Chemical Secretariat (ChemSec) is a non-governmental organisation founded in Sweden in 2002 to advocate in favour of stricter regulatory controls on potentially hazardous chemicals and to work with businesses on reducing the production and use of hazardous substances in their products and supply chains. ChemSec maintains the SIN List, identifying hazardous substances likely to be restricted under EU REACH regulation.

ChemSec's stated objectives are to "bridge the gap between decision-makers, industry, NGOs and scientists and offer expertise and guidance on chemical management policies in order to get progressive chemicals legislation." ChemSec also works with companies to secure their support for progressive chemicals legislation and reduce their use of hazardous chemicals by substituting harmful substances for safer ones.

The SIN (Substitute It Now!) List 2.1 consists of 626 chemicals (as of April 2014) that ChemSec has identified as Substances of Very High Concern (SVHC) based on the criteria established by the EU chemical regulation, Article 57 of REACH and whose use in the future is therefore likely to be legally restricted.

To address the challenge of replacing hazardous substances with chemicals which have a genuine pedigree of safety, ChemSec is involved in the SubsPort project, an internet portal collating legal information and case studies on substitution, and databases of hazardous substances and their alternatives (internet page: www.subsport.eu).

As more industries and companies are using these alternative substances, the production is also becoming cheaper; in our market, products without hazardous substances are also becoming affordable for the majority of buyers.

3.4 Green chemistry

Although we have begun to understand that the production and use of hazardous chemical substances should be reduced for the negative impact on environment and human health, it is impossible to remove all such hazardous chemical substances from our everyday life all at once. Industries as well as scientists are trying to determine how the elimination of hazardous substances can be done in steps and what industry can do to become more sustainable than it is at the moment. Even though industry eliminates the hazardous substances, products cannot be fully sustainable because the production processes need electricity, energy and transport. In 1991, Paul Anastas and John C. Warner from USA defined the **greener chemistry principles:**

- It is better to prevent waste than to treat or clean up waste after it is produced.
- Synthetic methods should be designed to maximize the incorporation of all materials used in the process into the final product.
- Wherever practicable, synthetic methodologies should be designed to use and generate substances that possess little or no toxicity to human health and the environment.
- Chemical products should be designed to preserve efficacy of function while reducing toxicity.
- The use of auxiliary substances (e.g. solvents, separation agents, etc.) should be made unnecessary wherever possible and innocuous when used.
- Energy requirements should be recognized for their environmental and economic impacts and should be minimized. Synthetic methods should be conducted at ambient temperature and pressure.
- A raw material or feedstock should be renewable rather than depleting, wherever technically and economically practicable.
- Reduce derivatives - Unnecessary derivatization (blocking group, protection/de-protection, temporary modification) should be avoided whenever possible.
- Catalytic reagents (as selective as possible) are superior to stoichiometric reagents.
- Chemical products should be designed so that at the end of their function they break down into innocuous degradation products and do not persist in the environment.
- Analytical methodologies need to be further developed to allow for real-time, in-process monitoring and control prior to the formation of hazardous substances.
- Substances and the form of a substance used in a chemical process should be chosen to minimize potential for chemical accidents, including releases, explosions, and fires. (Source: “Green Chemistry”. United States Environmental Protection Agency, 2006-06-28. Retrieved 2011-03-23.)

It can be clearly seen that hazardous substances are only one component of sustainable industry and production. When choosing a product, taking into account only hazardous substances in its composition, without also considering other components – transportation, waste management, etc. – is not completely rational or fair. For example, what would you choose – a T-shirt with an eco label from Indonesia or a cotton T-shirt made in the Baltic States, without the eco label?

4. CONTROL MECHANISMS OF CHEMICAL SAFETY

There is no world-wide ubiquitous regulation of hazardous substances. The use and release into the environment of hazardous substances are regulated by different legal acts. These regulations can be global (GHS system - Globally Harmonized System of Classification and Labelling of Chemicals; Stockholm Convention, etc.) when an agreement about restricting or banning a substance is taken by all countries that belong to such a global network. Regulations can also be agreed within a certain region (e.g. European Union) or locally (national laws and legislation).

4.1 Regulatory situation

There is an extensive regulatory system in the EU that controls which chemicals can be marketed, what experiments can take place, what can be used for which purpose and how they should be transported, used and disposed of. This includes also specific regulation of chemicals for use as drugs, food additives, veterinary medicines, medical devices, plant protection products, biocides, etc., as well as regulations concerned with the air we breathe and the water we drink.

The legal acts can be common for all chemicals (REACH regulation), or differentiated by product groups in which certain chemicals cannot be used (Toys Directive, ROHS - Directive on the restriction of the use of certain hazardous substances in electrical and electronic equipment) or, alternately, which chemicals in a certain group of products are safe to use (Cosmetics Directive).

Globally there is the problem that different parts of the world take different approaches towards hazardous chemicals; for example, in the EU there is stricter regulation of cosmetic products and some substances which are restricted or banned in the EU can be used in US. But today, people and goods are migrating from one side of the world to the other. The current regulatory and surveillance system is not yet sufficient to ensure a high level of protection of human health and the environment. Usually the toxicity testing is done by the companies themselves; this may not always be objective and can cause conflicts of interest. Nor do current efforts offer a realistic possibility of dealing with the testing backlog. Tens of thousands of chemicals were produced and entered commerce in the decades before testing was required and we still have no clear notion of the risks most of them pose (source: http://www.worldwatch.org/node/485). At the moment, in the EU we have the REACH regulation, which states that if there is no data about safety of the chemical, this chemical cannot be used or sold in EU market. But in reality, this looks good on paper but the implementation process is slow and requires a lot of resources.

Another problem: when the REACH regulation entered into force in the EU, it was noted that the EU chemical production industry moved a big part of its production to the third world countries (about 25% of its total worldwide production share was lost) (source: www.kpmg.com; www.5-reach.pl). On one hand, we could state that only responsible production of chemicals is left in EU; on the other hand, this also can mean that the same substances that were produced earlier in the EU are now being produced in the third countries. As a result, we get the same hazardous substances imported to the EU in different products. Campaigns such as Greenpeace Dirty Laundry (source: http://www.greenpeace.org/international/en/publications/reports/Dirty-Laundry/) drew attention to the problem.

Another issue: although we have a lot of regulations that ban or limit the use of hazardous substances, on a worldwide basis we face the problem of surveillance and control. It is especially an issue in the EU: how can we check and control products which are imported from third world countries? Those countries which have long-term environmental protection traditions (for example, Nordic countries) tend to use fewer products with hazardous substances because society is aware; consumers there tend to buy more environment-friendly products, thus the buyer is the regulator.

REACH regulation to ensure the safety of chemicals

REACH is the European Community Regulation on chemicals and their safe use (EC 1907/2006). It deals with the **R**egistration, Evaluation, **A**uthorisation and **R**estriction of **Ch**emical substances. The aim of REACH is to improve the protection of human health and the environment through an improved system to identify the intrinsic properties of chemical substances. At the same time, REACH aims to enhance innovation and competitiveness of the EU chemicals industry.

The REACH Regulation places greater responsibility on industry to manage the risks from chemicals and to provide safety information on the substances. Manufacturers and importers are required to gather information on the properties of their chemical substances, which will allow their safe handling, and to register the information in a central database run by the European Chemicals Agency, ECHA (internet page: http://echa.europa.eu/). The Agency acts as the central point in the REACH system: it manages the databases necessary to operate the system, co-ordinates the in-depth evaluation of suspicious chemicals and is building up a public database in which consumers and professionals can find hazard information.

Note!

The exact number of chemicals on the global market is not known but under the pre-registration requirement of the European Union's chemicals regulation, REACH, 143835 chemical substances have been pre-registered. This is a reasonable guide to the approximate number of chemicals in commerce globally.

On ECHA's website you can find information about the chemical substances that have been registered so far under the REACH Regulation (http://echa.europa.eu/information-on-chemicals/registered-substances).

Note!
Take advantage of your right to ask retailers about the products you want to buy. REACH Regulation provides you with the right to ask a retailer whether any "substances of very high concern" – the most hazardous chemicals – have been used in any product that you want to buy. Any consumer has the right to ask the supplier (including retailers) this question, and to receive an answer within 45 days. The ECHA's table containing data on Candidate List substances (SVHCs) in products can be found at http://echa.europa.eu/web/guest/information-on-chemicals/candidate-list-substances-in-articles-table.

Regulation to ensure the classification of chemicals

Substances fulfilling the criteria for being hazardous have to be labelled. The hazard of a substance is the potential for that substance to cause harm. In this connection hazard evaluation is the process by which information about the intrinsic properties of a substance is assessed to determine potential to cause harm. In cases where the nature and severity of an identified hazard meets the classification criteria, hazard classification is the assignment of a standardised description of this hazard present in a substance causing harm to human health or the environment. Hazard labelling allows for the communication of hazard classification to the user of a substance, to alert the user to the presence of a hazard and the need to avoid exposures and the resulting risks.

The EU regulation (EC) No 1272/2008 on classification, labelling and packaging of chemical substances and mixtures, the so called CLP Regulation (internet link: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:353:0001:1355:en:PDF) stipulates the criteria and rules for classifying and labelling substances and mixtures. The CLP Regulation entered into force on 20 January 2009. The CLP Regulation will gradually replace the Dangerous Substances Directive (67/548/EEC) and the Dangerous Preparations Directive (1999/45/EC). Both Directives will be repealed on 1 June 2015 however the new requirements for classification, labelling and packaging of substances have been in effect since 1 December 2010.

On ECHA's website you can find information about the chemical substances that are classified in some way and have to be labelled (http://echa.europa.eu/web/guest/information-on-chemicals/cl-inventory-database). They are referred to by their chemical names which may not be familiar to you – but nevertheless, with a little research, you can find out about the chemicals that you are exposed to in Europe.

You can find more about hazard symbols in Chapter 4.4 - Hazard symbols of chemicals and their meanings.

4.2 Testing methods of chemical substances

In this chapter we will highlight the testing methods of chemicals which aim to evaluate the hazards of chemicals. The ultimate goal of such testing is to collect appropriate data and results from the test systems used in order to assess the likely risks posed to human population at ambient exposure levels, i.e. realistic assessment for human risk. Several types of studies can be used in order to obtain data for toxicity of a chemical (substance).

The Laboratory studies

In most cases the chemical tests are based on results from **experiments on animals** (**or "bioassays"**): a high-dose of a certain chemical is introduced in experimental animals [on both, animals with back-bones (vertebrates) and animals without backbones (invertebrates)] Results are later extrapolated from high to lower doses to extrapolate from experimental animals to the human population (estimated human exposure standard).

Example
A small crustacean *Daphnia magna* (water flea) is perhaps one of the most well-known test species extensively used in research since the mid-1970s. The relatively small size, short life span, high ability to reproduce by asexual reproduction, and ease to culture in the laboratory makes it suitable for toxicity testing. This test organism is applied for short-term toxicity testing with immobility as the toxic endpoint (procedure prescribed: OECD, http://www.oecd.org/env/ehs/testing/seriesontestingandassessmentecotoxicitytesting.htm). In addition, *Daphnia magna* is well suited for screening studies aimed at preliminary investigation of a high amount of samples to reduce those for higher animals, like mammals.

Tests on animals, however, have caused also a lot of precaution and concern from several organizations calling for efforts to promote application of other testing procedures without compromising the current level of protection for human beings. The response was the development of the principle of 3Rs (Replacement, Refinement and Reduction): the replacement of procedures with others that do not use animals, the reduction of the number of animals used, and the refinement of procedures to minimize pain and suffering (source: http://www.animalresearchforlife.eu/index.php/en/3rsprinciples). Organizations, such as the European Chemicals Agency and OECD are making efforts to find **alternative mechanisms to avoid unnecessary animal tests**, like data sharing, use of alternative test methods and other approaches to predict the properties of substances. However, the animal testing for filling of data gaps will still be necessary.

***In vitro* assays**

This is a new approach to screen a large number of chemicals with molecular screening *in vitro* assays (for example, using bacteria or cultured cells) that can be applied rapidly to thousands of chemicals. In this way it is possible to identify those chemicals that need further evaluation, thus limiting the number of chemicals for animal testing. This has been accepted as a method for future use.

Human evidence

This group of methods includes data derived from clinical observations and information from epidemiological studies. Results in such cases are based on observed effects in case of accidents or diseases caused by exposure to a single chemical or group of substances. Epidemiological studies involve humans and their responses to actual situations, but the interpretation of the results of such studies is complicated because of the presence of other factors that occur whenever human population is involved.

Remember!

The chemical test experiments are not designed on humans. Results of evaluations of the toxicity of a chemical (substance) by human evidence are only derived from an exposed human population in case of accidents and epidemics.

4.3 Hazard symbols of chemicals and their meanings

Table 1. The hazard symbols, their abbreviations and the description of hazard according to **the old system** (directive (67/548/EEC):

Hazard symbols – Physico-chemical			
Symbol	Abbreviation	Hazard	Description of hazard
	E	explosive	Chemicals that explode.
	O	oxidising	Chemicals that react exothermically with other chemicals.
	F+	extremely flammable	Chemicals that have an extremely low flash point and boiling point, and gases that catch fire in contact with air.
	F	highly flammable	Chemicals that may catch fire in contact with air, only need brief contact with an ignition source, have a very low flash point or evolve highly flammable gases in contact with water.

Hazard symbols - Health			
Symbol	Abbreviation	Hazard	Description of hazard
	T+	very toxic	Chemicals that at very low levels cause damage to health.
	T	toxic	Chemicals that at low levels cause damage to health.
	Carc Cat 1	category 1 carcinogens	Chemicals that may cause cancer or increase its incidence.
	Carc Cat 2	category 2 carcinogens	Chemicals that may cause cancer or increase its incidence.

Hazard symbols - Health			
	Carc Cat 3	category 3 carcinogens	Chemicals that may cause cancer or increase its incidence.
	Muta Cat 1	category 1 mutagens	Chemicals that induce heritable genetic defects or increase their incidence.
	Muta Cat 2	category 2 mutagens	Chemicals that induce heritable genetic defects or increase their incidence.
	Muta Cat 3	category 3 mutagens	Chemicals that induce heritable genetic defects or increase their incidence.
	Repr Cat 1	category 1 reproductive toxins	Chemicals that produce or increase the incidence of non-heritable effects in progeny and/or an impairment in reproductive functions or capacity.
	Repr Cat 2	category 2 reproductive toxins	Chemicals that produce or increase the incidence of non-heritable effects in progeny and/or an impairment in reproductive functions or capacity.
	Repr Cat 3	category 3 reproductive toxins	Chemicals that produce or increase the incidence of non-heritable effects in progeny and/or an impairment in reproductive functions or capacity.
	Xn	harmful	Chemicals that may cause damage to health.
	C	corrosive	Chemicals that may destroy living tissue on contact.
	Xi	irritant	Chemicals that may cause inflammation to the skin or other mucous membranes.

Hazard symbols – Environmental			
Symbol	Abbreviation	Hazard	Description of hazard
	N	dangerous for the environment	Chemicals that may present an immediate or delayed danger to one or more components of the environment

Table 2. Hazard symbols according to the old classification and labeling system and pictograms according to the new GLP regulation:

Physical-chemical properties	Toxic properties	Ecotoxic properties
		
		

Table 3. Pictograms according to the **new classification system** (Regulation No 1272/2008):

Physical hazards	
	explosive
	flammable
	oxidising
	gas under pressure
Environmental hazards	
	hazardous to aquatic environment
Health hazards	
	toxic
	harmful irritant; may cause allergy
	cancerogenic, mutagenic, teratogenic
	corrosive

Hazard labelling allows the communication of hazard classification to the user of a substance, to alert the user to the presence of a hazard and the need to avoid exposures and the resulting risks.

Remember!
Product labels appear on all chemicals. Labels with hazard symbols and safety warnings give information you need to know to use the product safely. Learn the symbols!

Class Work: teach the children to recognise the hazard symbols and pictograms (see chapter 8.5)

5. HAZARDOUS SUBSTANCES IN PRODUCTS

The products we buy and use every day contribute to our comfort and well-being. The chemicals industry makes products with many beneficial uses, but they can also have negative impacts on human health and the environment.
The use of chemicals in products is ubiquitous: it would be difficult to find products which do not contain chemicals. Most of these chemicals are part of the product design and added intentionally to enhance the product functionality or performance. They can also be left in the products from the manufacturing process or as impurities. Most are benign, but many are of concern due to known or suspected risks.
Many of the products you use or find in your home may contain hazardous chemicals. Testing for human health effects is normally done on single chemicals. But in the real world, we are all exposed to a variety of chemicals every single day.
The use of hazardous substances in the composition of different products is regulated by the European Union and also by national regulations. If a chemical poses an unacceptable risk that needs to be addressed on the EU level, a Member State or ECHA (on request of the Commission) may propose a restriction on the manufacturing, placement on the market or on the use of that chemical of concern. by restricting or banning the manufacture, placement on the market or use of certain substances that pose an unacceptable risk to human health and the environment. REACH regulation Annex XVII contains the list of substances which are restricted and the conditions of restriction (http://echa.europa.eu/web/guest/regulations/reach/restriction). And even though some substances are restricted for use, they may still be contained in very low amounts (below the concentrations which are restricted) in different products.
This chapter provides information about different hazardous substances which might be found in very widely used everyday products and discusses possibilities to choose products with fewer hazardous chemicals or, where possible, alternatives without hazardous chemicals. This chapter provides advice and easy tips, which each/all of us can use to avoid exposure to hazardous chemicals and protect our health and environment.

5.1 Household chemicals

Household chemicals are, for example, all-purpose cleaners, laundry detergents, dishwashing agents, oven sprays, carpet and furniture cleaners, toilet cleaners, scouring agents, glass cleaners, etc. Cleaning products are regulated in the EU under the Detergents Regulation, the General Product Safety Directive, the Biocides Regulation and the Regulation on Chemicals and their safe use (REACH). At a certain quantity some groups of substances which are used as preservatives, fragrances or surfactants must be declared on the packaging. Also certain hazard symbols have to be used on product labels which indicate, for example, if a product is irritating or corrosive. And even though some substances are restricted for use, they may still be contained in very low amounts (below the concentrations which are restricted) in cleaning products. Most cleaning products contain different chemicals because they fulfil a number of functions in addition to just cleaning (i.e. scent, colour, preservation, etc).

Harmful substances that can be found in cleaning products:

- Cleaning requires that „dirt" is destroyed or dissolved - **acids, bases or tensides** are used for this. Acids and bases may cause burns on your skin or irritation to your lungs. Tensides are hazardous to the environment. These substances cannot be fully avoided when cleaning but you can make better choices:
  - most cleaning tasks at our homes can be easily handled with baking soda, vinegar, salt, lemon juice and soap
  - manufacturers are also offering less toxic cleaning products.
- **Disinfectants** (triclosan) are used to „remove bacteria" and many of these chemicals have serious health effects (e.g. cause cancer); all of them damage the environment and can disturb the functioning of sewage treatment plants. Actually, bacteria are not as dangerous as they appear; it is sufficient just to clean! It is not always necessary to have disinfectants in cleaning products.

Triclosan

It can irritate the mucous membranes, can cause allergies, disrupt the endocrine system (it is known to interfere with the functioning of the testosterone production in the body) and has been linked to cancer. It is potentially bioaccumulative and has been widely found in both humans and the environment (see Annex 1 "Chemicals data sheets").

- **Preservatives** are added, so that the cleaner does not mould. These substances may have negative effects similar to disinfectants. **Formaldehyde** may be used as a preservative or disinfectant. Isothiazolinones (methylisothiazolinone, chloromethylisothiazolinone, benzisothiazolinone) are preservatives found in many household products. You should avoid contact with them – they have sensitizing properties and can cause allergic reactions. A common indication of an allergic reaction is eczematous symptoms such as redness and itching on surfaces exposed to the allergen. If you use your cleaning agents regularly, the containers are empty long before they could „turn bad". Preservatives are not necessary.

Formaldehyde

Toxic by inhalation, in contact with skin and if swallowed. May cause sensitization by skin contact. Classified as a possible carcinogen, also reported to be mutagenic and toxic for reproduction. It is has been detected in both humans and the environment.
In the EU, the maximum allowed concentration of formaldehyde in finished products is 0.2%; any product that exceeds 0.05% has to include a warning that the product contains formaldehyde.

- **Solvents** are used to dissolve the substances in the cleaner. They can make you dizzy or cause nausea if they are inhaled for a long time. In the long run some may cause cancer. **2-methoxyethanol, 2-ethoxyethanol** may impair fertility and cause harm to the unborn child. They are harmful by inhalation, with skin contact and if swallowed. Products based on water don't need other solvents; hence their use can also be avoided.
- **Fragrances** are mixtures of a great many substances; many of them can cause allergens or can cause irritation to lungs and skin. Such substances could be **phthalates** or **synthetic musks. Synthetic musks (nitro-musks, polycyclic musks)** can have hormone- disrupting effects. They are also allergens. If things are clean, they shouldn't smell bad. The addition of fragrances is not necessary!

Phthalates

Phthalates disrupt the hormonal system, interfere with reproductive functioning by reducing the levels of sex hormones, which are critical for development and functioning of the sex organs. They lead to malfunctioning of kidneys, liver, lungs and may cause premature birth. Additional research suggests that these same mechanisms may link phthalates to breast cancer. These substances are also potentially sensitizing (see Annex 1 "Chemicals data sheets").

- **Optical brighteners** are used in washing detergents. They bind to the textile and change the way they look but don't actually remove dirt. This is an optical trick and these substances are hazardous to the environment. For example **benzoxazolyl** and **benzimidazolyl** can cause skin sensitisation and be toxic to fish: they are not readily biodegradable in the environment. It is

yours as a counsumer to decide whether you want to cheat the eye at the cost of the environment or to avoid the use of hazardous substances and look after your health and nature's.

- **Bleaching agents** are frequently very aggressive **chlorine** compounds. Inhaling the fumes of chlorine can damage the mucous membranes; getting it onto the skin may cause severe burns. Aggressive bleaching is normally not necessary.

Safety tips

You must think about the products you use at home - are they toxic? While these products are useful at home, some of the chemicals in these products can irritate your skin, eyes, nose and throat, or can even poison you - so be *careful!* Learn more about what's in these products, about potential health effects, and about safety and handling.

The main hazards of cleaning ingredients are acute, or immediate, hazards such as skin or respiratory irritation, watery eyes, or chemical burns. Others are associated with chronic, or long-term, effects such as cancer.

Besides the health concerns, there is also the environmental aspect. When household chemicals are poured down the drains, treated by municipal wastewater treatments plants, the treated water ends up being discharged into nearby waterways. Some of these hazardous chemicals are very persistent and do not break down into harmless substances; thereby once released into the water they may have adverse effects on the water quality, fish and other wildlife.

You may get an allergic reaction from certain cleaners containing specific substances if you are sensitive to it. Be very careful if you use the cleaning products with these symbols!

This product is an irritant! It contains ingredients that can cause skin or respiratory irritation!

This product is corrosive! It contains ingredients that can burn your skin or eyes!

Before you use household cleaners - always read the entire product label and research whether the chemicals listed on product labels are hazardous. Be aware of the hazardous chemicals in the chemical composition of the product. Follow label directions before using a cleaning product – the label is your guide to using these chemicals safely and effectively. Use personal protective equipment (e.g. gloves, masks) required for safe use of the product.

Recommendations!

- You do not need to use household chemicals every day at your home!
- Most cleaning tasks at our homes can easily be handled with everyday common ingredients like baking soda, vinegar, salt, lemon juice and soap
- Microfiber cloths can remove dirt, grease and dust without the need for cleaning chemicals
- Don't trust manufacturers' green claims! The internet makes it easy to verify the producers' company policy and "green claims" which can help in choosing products that are certified by a trustworthy, independent third party. Many products on the market have been subjected to a publicly available environmental standard that's easy to understand. Examples of labels you can trust are the EU eco-label (EU flower), the Nordic Swan or the German Blue Angel, the French ECOCERT, or the Italian ICEA.

Practical exercise: Reading the label of a household chemical. Fill in the worksheet about household chemicals in Chapter 8.6 using the table of ingredients in Annex 2. Discuss the results

5.2 Electronic products

Electronic products are a complex mixture of several hundred components, many of which contain hazardous chemicals. Electronic products are, for example, computers, cell phones, game consoles, headsets/headphones, electronic toys, etc. Over 500 different chemicals are used for manufacturing electronics; many of them are hazardous.

- These hazardous substances cause serious pollution and put people at risk of exposure when the products are disposed of. The most significant human and environmental exposures occur through products' use and disposal - the life cycle of electronic products.
- Sampling of household and office dust indicates that levels of hazardous substances in indoor environments are increasing. One cause is emissions from indoor sources such as electronic products.

There is a direct relationship between industry and nature – for example, the link between cell phones and the ecosystem. A key element essential for cell phones is called coltan (Columbite-tantalite). This is a metallic ore from which the elements niobium and tantalum are extracted for use in the production of cell phones; 80% of the world coltan reserves are in deep forests of the

Democratic Republic of Congo (DRC). The place where coltan is mined is also home to the world's endangered lowland gorillas. As the need for coltan continues to grow, uncontrolled mining practices in the DRC will continue to damage the already endangered lowland gorilla. The population of gorillas has declined from about 9000 in 1996 to just 3000 individuals. Armed groups in the region are operating mines which have paved the way for large-scale destruction of rain forests in the area, effectively decimating the gorillas' natural habitat. The value of cell phones as a means of communication is coming at the cost of whole species and important habitats *(Source: „The parts and the whole. A holistic approach to environmental and sustainability education", Wolfgang Brunner, Shepherd Urenje, Swedish International Centre of Education for Sustainable Development, Ecoprint, Tartu, 2012).*

Production of electronics has grown globally and is expected to continue to grow. Increasing consumer demand for electrical/electronic goods and materials, along with rapid technology change and the high obsolescence rate of these items have led to the increasing generation of large quantities of obsolete and near-end-of-life electronic products. These trends contribute to global electronic waste generation estimated at 40 million tons per year. These trends are expected to rise with the increased use and disposal of electronic products by developing countries and countries with economies in transition.

During just the first quarter of 2010, worldwide shipments of personal computers were estimated to total 84.3 million units, an increase of 27% from the first quarter in 2009. Worldwide sales of mobile phones were estimated to total 314.7 million units in the first quarter of 2010, a 17% increase from the same period in 2009 (Towards Sound Management of Chemicals. UNEP Global Chemicals Outlook, 2012).

The main hazardous substances that can be found in electronic products are the following:

- lead
- mercury
- cadmium
- zinc
- yttrium
- chromium
- beryllium
- nickel
- brominated flame retardants [polybrominated diphenylethers (PBDE); dibenzofurans (PBDF); tetrabromobisphenol A (TBBPA)]
- antimony trioxide
- tin
- phthalates

Hazardous substances in specific materials and components of electrical equipment:

Printed circuit boards	**Cadmium** occurs in certain components of printed circuit boards. Other hazardous metals such as **chromium, lead, mercury, beryllium, zinc** and **nickel** may also be present. **Brominated flame retardants** and **antimony trioxide** are often used.
Liquid crystal displays, LCDs	LCDs used in mobile phones and flat screen computer monitors may contain **mercury**.
Cathode ray tubes, CRTs	**Lead is used** in the cone glass and **cadmium/zinc/yttrium sulphide** in the fluorescent coating.
Batteries	Heavy metals such as **lead, mercury** and **cadmium** are present in certain batteries
Plastic casings	Plastics (PVC plastic) often contain **brominated flame retardants**, many of which are hazardous. Also, combustion of the plastics and halogenated flame retardants can produce toxic substances. In addition, antimony is often added to enhance flame retardance
Components, such as switches	**Mercury** is used in fluorescent lamps, and has historically been used in thermostats, sensors, relays and switches, for example, on printed circuit boards
Solder	Can contain **lead, tin** and other metals.
Internal and External Wiring	Wiring is often coated in PVC plastic which commonly contains numerous additives, including heavy metal compounds and softeners such as **phthalates**. Combustion of PVC can produce toxic substances.
Semiconductors	The semiconductor industry uses **brominated flame retardants** in the plastic encapsulation material.

The content of hazardous substances in electronic products is regulated under the RoHS directive (directive on the restriction of the use of certain hazardous substances in electrical and electronic equipment; 2002/95/EC). It restricts the use of six specific substances in electrical and electronic equipment: lead, mercury, cadmium, hexavalent chromium, polybrominated biphenyls and polybrominated diphenylether.

RoHS specifies maximum levels for the following six restricted substances in materials:

Lead (Pb): < 1000 ppm
Mercury (Hg): < 100 ppm
Cadmium (Cd): < 100 ppm
Hexavalent Chromium: (Cr VI) < 1000 ppm
Polybrominated Biphenyls (PBB): < 1000 ppm
Polybrominated Diphenyl Ethers (PBDE): < 1000 ppm

The WEEE Directive (The Waste Electrical and Electronic Equipment Directive; 2002/96/EC) set collection, recycling and recovery targets for all types of electrical goods. The directive imposes the responsibility for the disposal of waste electrical and electronic equipment on the manufacturers or distributors of such equipment. It requires that those companies establish an infrastructure for collecting WEEEapproved items in such a way that users of electrical and electronic equipment from private households should have the possibility of returning WEEE approved items, at least, free of charge.

Examples of electronic products with the most common hazardous substances and their effects:

What is in your laptop?	
PHTHALATES – plasticisers; used to soften PVC plastic	can be released from the PVC during the lifetime of the product – contaminants in indoor air
POLYBROMINATED DIPHENYLETHERS (PBDEs) & DIBENZOFURANS (PBDFs) & TETRABROMOBISPHENOL A (TBBPA) - flame retardants in plastics	have been detected in indoor dusts; leaching out from the products. Route of exposure: direct contact with product through the inhalation of indoor air and/or dust at home and office.
PHTHALATES (DEPH – di(2-ethylhexyl)-phthalate; BBP –benzyl butyl phthalate; DBP –dibutyl phthalate)	toxic for reproduction; endocrine-disrupting properties; persistent and bioaccumulative in environment (found as contaminants in rivers and in wastewater)
PBDEs (pentaBDE; octaBDE; nonaBDE; decaBDE)	toxic for reproduction; persistent and bioaccumulative in environment, accumulate in living organisms (have been detected in wildlife)
TBBPA	endocrine disrupting properties; very persistent in environment (has been found in human blood samples and in marine organisms)
What is in your mobile phone?	
NICKEL – used in circuit boards, soldering	causes nickel allergy - nickel eczema starts when the skin is in contact with a nickel-containing object (route of exposure is the prolonged and direct contact with the skin)
POLYBROMINATED DIPHENYLETHERS (PBDEs) - flame retardants in plastics	long-term exposure may damage the nervous, reproductive and endocrine systems
What is in your LCD display TV set?	
MERCURY – liquid crystal displays (LCDs) may contain mercury	can damage the brain and central nervous system, particularly during early development
What is in your old CRT monitor?	
LEAD - cathode ray tubes (CRTs, CRT monitors) may contain lead	can cause intellectual impairment in children; can damage the nervous, blood and reproductive systems in adults
What is in battery-powered products?	
LEAD, CADMIUM – game consoles, tablets, electric cars, electric trains may contain rechargeable batteries	poisoning risks from leaking batteries

Recommendations!

- Electrical and electronic equipment need to be disposed of carefully – electronic waste contains different hazardous materials which are harmful to human health and the environment
- The recycling of electronic products is critical and poses serious health risks and environmental dangers if not properly handled
- Consume less: Think before you by new electronic equipment: do you need to change your cell phone or lap-top so often?
- Do something useful with your old computer/mobile phone, dispose of it in a responsible way. Be aware how to recycle electronic products properly.
- Change your habits – avoid the prolonged direct contacts with electronic products; do not sit in front of your computer all the time; spend more time outdoors.
- Change your behaviour - use electronic products as long as you can. Decrease the amount of hazardous waste coming from specific components of electronic products.
- Try to avoid putting electronic equipment in your bedroom; it could be damaging for your health.
- Ventilate rooms (e.g. Open the windows!) from time to time.

5.3 Cosmetics

Do you know that the bottles and jars of moisturizers and face wash that you use can contain hazardous substances?

Cosmetic products may contain ingredients that can have long-term effects on your health. The chemicals in makeup are dangerous as they are directly absorbed by the skin. Once the chemicals are absorbed by the skin, they quickly enter the blood stream and reach vital organs like the brain, kidneys and liver. Some products are used as sprays or aerosols and could also enter the body via inhalation. Some ingredients can have irritating or allergenic effects, may be linked to cancer or are suspected of being endocrine disruptors (endocrine disruptors are chemicals that interfere with hormone system and can cause cancerous tumours, birth defects, and other developmental disorders).

Chemicals absorbed by the skin are more dangerous in comparison to those swallowed through our mouth as chemicals that are absorbed from the food or anything eaten is broken down by the saliva and later by the stomach fluids which flush out any harmful material before it reaches the blood stream.

All cosmetic products are governed by the European Cosmetics Regulation (EC/1223/ 2009) which defines which ingredients are forbidden / allowed in which concentrations in cosmetics and how they should be indicated on the label. Cosmetics ingredients have to be listed on the product label. Mandatory labelling of nano-ingredients has been in effective since July 2013 (however, the health risks posed by nano-particles have not yet been fully investigated).

The 26 allergenic fragrances are listed with their technical terminology, (all other fragrances go under the umbrella term "fragrance" or "perfume or aroma"): Amyl Cinnamal, Amylcinnamyl Alcohol, Alpha-Isomethyl Ionone, Anise Alcohol, Benzyl Alcohol, Benzyl Benzoate, Benzyl Cinnamate, Benzyl Salicylate, Butylphenyl Methylpropional, Cinnamal, Cinnamyl Alcohol, Citral, Citronellol, Coumarin, Eugenol, Evernia Furfuracea Extract (tree moss extract), Evernia Prunastri Extract (oak moss extract), Farnesol, Geraniol, Hexyl Cinnamal, Hydroxycitronellal, Hydroxyisohexyl-3-Cyclohexene Carboxaldehyde, Isoeugenol, Limonene, Linalool, Methyl-2-Octynoate.

Although specific legislation exists, cosmetic products such as eye make-up, creams and shower gels may contain hazardous substances which could harm your health. If you suffer from allergies, try to avoid substances that trigger them, and read the label. People allergic to fragrances should be particularly careful in this regard.

Examples of hazardous chemicals in cosmetic products:

- **Triclosan:** commonly found in body wash, tooth paste, hand wash, deodorant, etc. This chemical is easily absorbed in the body and causes the good bacteria to die along with the pathogens which lower the immunity of the body. It can irritate the mucous membranes, can cause allergies, disrupt the endocrine system (it is known to interfere with the functioning of the testosterone production in the body) and has been linked to cancer. It is potentially bioaccumulative and has been widely found in both humans and the environment (see Annex 1 "Chemicals datasheets").
- **Parabens:** generally used as inexpensive preservatives in cosmetics. These chemicals can particularly harm women as they have a direct impact on estrogen which can increase the risk of breast cancer. In men they affect the male reproductive functions. They are also sensitizing agents.
- **Lead:** some lipsticks may contain lead in their composition. Lead is a proven neurotoxin that can cause learning, language and behavioural problems such as aggression, lower IQ levels, etc.
- **Pthalates:** found in creams, lotions, shampoos, hair sprays, hair gels, deodorants, perfumes, nail varnishes. They are used as fragrances, solvents or denaturant agents. Phthalates disrupt hormonal system, interfere with reproductive functioning by reducing the levels of sex hormones, which are critical for development and functioning of the sex organs. They lead to malfunctioning of kidneys, liver, lungs and may cause premature birth. Additional research suggests that these same

mechanisms may link phthalates to breast cancer. These substances are also potentially sensitizing (see Annex 1 "Chemicals datasheets").

- **Diethanolamine:** found in shaving creams, shampoos, moisturizers, baby washes etc. It is easily absorbed by the body and can be converted into nitrosamine, a carcinogen in the presence of other chemicals found in cosmetics. Diethanolamine is known to be hormone disrupter and steals away choline needed for brain development.
- **Sodium Lauryl Sulfate and Sodium Laureth Sulfate** (sodium lauryl ether sulfate): both could be found in shower gels, shampoos, shaving foams, lotions, creams. May dry out and irritate sensitive skin. Also irritate eyes, gastrointestinal tract and liver. May dry out hair and cause hair loss (see Annex 1 "Chemicals datasheets").
- **Synthetic mineral oils:** skincare products often contain synthetic mineral oils that can accumulate in the body (accumulates in lungs, liver and lymph nodes) and be damaging to your health. Some mineral oils could contain polycyclic aromatic hydrocarbons (PAH) which are known to be cancer-causing substances. Be careful with products which contain mineral oils. However, the type of mineral oil used by most producers in cosmetics (moisturizers) are considered to be refined mineral oil, sometimes called white mineral oil or liquid petroleum, which is highly purified and refined and produces non-threatening PAH levels. Nevertheless, always pay attention to the mineral oil content. They are of concern because some compounds have been identified as carcinogenic, mutagenic, and teratogenic. One PAH compound, benzo[a] pyrene, is notable for being the first chemical carcinogen to be discovered (and is one of many carcinogens found in cigarette smoke). Polycyclic aromatic hydrocarbons are lipophilic and can accumulate in human body (see Annex 1 "Chemicals datasheets").

There is a growing awareness about the harmful effects of using cosmetics that are loaded with chemicals. It is the responsibility of every consumer to avoid buying cosmetic products that contain such harmful chemicals. That, in turn, would force the manufacturer to avoid using such toxic ingredients. **Next time you buy a cosmetic, check out what goes into it!**

- As a rule, young skin does not need cosmetics.
- The best way to take care of your skin is not to depend on cosmetics but by having a right diet. Eating a balanced diet, drinking plenty of water and getting a good night's sleep will ensure that you have a healthy and fresh-looking skin.
- Always look for natural and herbal cosmetics which lack most of the chemicals that are used for coloring, fragrance or for preservatives. Read the labels carefully to ensure that there are no harmful substances.
- If you use make-up, make sure you remove it before going to bed. Keeping the make-up on the skin exposes the body to the chemical for a long time and also affects skin texture and quality.

Safety Tips

- Always read the label! Use fewer products and choose those with fewer ingredients.
- The risk to health and environment from products containing nanoparticles is not yet clear. Until we know nano-materials are safe, avoid products with ingredients indicated as "nano" on the label.
- If you suffer from allergies, try to avoid substances that trigger them, and read the label. People allergic to fragrances should be particularly careful.
- Avoid anti-bacterial products (also in wet wipes, cleansing products, washing additives for textile and surface cleansing). They interfere with the skin balance, disturb the skin's natural defense mechanism, and can lead to bacterial resistance.
- Especially problematic in terms of hazardous ingredients are the following cosmetic products: hair strengtheners, dark permanent hair dyes, perfumes/fragrances, skin lighteners.
- Prefer skincare products with plant-based oils (e.g. almond or olive oil) and without mineral oils.
- The term "natural cosmetics" is not legally protected and hence does not ensure that no synthetic substances are used in the so-labelled products.
- Try making your own cream or shampoo out of fresh foodstuff.
- Products with internationally accepted eco-labels have a certified good environmental quality and guaranteed technical performance. Any product bearing these recognised eco-labels have had to undergo thorough test procedures by certified third-party institutions. Eco-labels you can trust for cosmetics are:

Practical exercise: Filling the worksheet about cosmetics. Fill in the cosmetics worksheet in chapter 8.6 using table of ingredients in Annex 2. Discuss the results.

5.4 Construction materials

Many chemicals contained in construction materials [mixtures – paints, varnishes, adhesives etc.) or articles (flooring, wallpaper, etc.)] can be harmful to your health and the environment. Some substances can cause cancer, influence the hormone system, cause allergies and irritation, or disturb the development of children.

Construction materials on which we mainly focus in this chapter are intended for indoor renovation (paints, varnishes, adhesives, fillers).

According to current legislation, producers of construction products have to ensure that their products are safe, which includes that no risks occur from contained hazardous substances from indoor emissions (humans) or from outdoor emission (environment). For many types of construction products there are specific norms which specify how to conduct tests or "estimate" whether the product is safe. This is the case whenever there is a CE-marking (CE marking is the manufacturer's declaration that the product meets the requirements of the applicable EC directives) on the construction product. If there is no CE-marking, then no standard exists but the producer is still responsible for the product safety.

Although each of the products may be chemically safe, it is still important and good for your health to choose construction products with low content and/or number of hazardous chemicals. This is because low concentrations of hazardous substances could be legally contained in different products and may be emitted into your homes. There are many such sources; there may be a harmful exposure to several substances at low levels but over long periods of time.

Hazardous chemicals are used as ingredients in construction products for the following purposes:

solvents: components which keep the paint, varnish or adhesive in liquid form until it is applied. Solvents can be volatile organic compounds (VOCs) or water (solvent-based or water-based paints and varnishes). Volatile organic compounds, used as solvents in paints, varnishes or adhesives are substances which are evaporating during and after painting. When inhaling paint or varnish fumes, health effects like nausea, fatigue, headaches, skin and eye irritation might occur. Producers are obliged to indicate VOC amount (grams per litre) on the packaging (see Annex 1 "Chemicals datasheets").

- **resins or binders:** components that cause the formation of a film of paint/varnish on the surface that is painted or varnished. The main types of chemicals used as binders are oils, alkyds, and waxes.
- **pigments and fillers:** components that determine the colour and opacity (covering power) of the product and some other properties.
- **additives:** different ingredients which are added in small amounts to provide specific properties; the function could support the convenience of using the paints (prevent moulding, thickening of the paint) or could support specific visual properties, like surface structure, glossiness etc. Chlorinated paraffins, n-hexane, methyl ethyl ketoxime are used as additives. Methyl ethyl ketoxime is an important additive in almost all paints and varnishes. It prevents the formation of skin in the paint. Other products containing the substance are filling compounds and glues. Methyl ethyl ketoxime is severely irritating to eyes. Inhalation can irritate nasal passages. It is slightly irritating to the skin, and can be absorbed through the skin to cause harmful effects on the circulatory and nervous system. Getting methyl ethyl ketoxime on the skin may cause an allergic response in certain individuals (see Annex 1 "Chemicals information sheets").

Recommendations!

Create a hazardous-substance-free living environment in your home – protect your health. It is important and good for your health if you buy construction products with a low content of hazardous chemicals.

- Look for products what are more environmentally friendly and contain fewer hazardous substances. Products with eco-labels can be a good choice.
- The main principle to follow when choosing indoor paint or varnish: low VOC content. Choose paints or varnishes with little or no organic solvents instead of solvent-based products.
- During and after renovation works with construction products, ventilate, ventilate, ventilate! Always ventilate and air regularly: opening all doors and windows at the same time will allow fresh air to enter the house. Airing is very important during and after the renovation to let contaminated air out.
- Information on the label will tell you whether the paint or varnish can cause, e.g. allergic reaction, skin irritation or be harmful for aquatic organisms. These warnings indicate that paint or varnish contains harmful substances and therefore you should avoid such products.
- When storing paints, make sure the lids are on tight.
- Do not trust the 'green' claims of the producers. Use products that have been tested by an independent third party, such as the EU eco-label Flower or Nordic Swan. Labels can be used as a guide when choosing safe products, depending on what they guarantee.

6. SUMMARY: MAIN MESSAGES - WHY TO CHOOSE LESS HAZARDOUS PRODUCTS

- Hazardous substances are contained in many products we use every day. We are exposed to a high number of different substances on a regular basis.
- The individual amounts and concentrations of hazardous substances are normally very low and we don't feel that we are exposed.
- Although our knowledge on the potential effects of individual substances is increasing, we don't know what happens if they are combined and act together (chemical cocktail). Just as alcohol is known to alter the effects of pharmaceuticals, there may be stronger or different effects from exposure to combined chemicals.
- We have little knowledge of which substances could disturb the hormone system and which doses would be hazardous to us. There is some evidence that they are very potent at very low concentrations or amounts.
- We have insufficient knowledge of the long-term effects of substances on our bodies. Normally the studies conducted to find out toxic effects are conducted with test animals and don't sufficiently predict the effects for humans, who are continuously exposed over their lifetime. There is some evidence that the continuous exposure to low levels of chemicals weakens the immune system, increases the incidents of allergies and affects reproduction of humans.
- Substances released to the environment can hardly be "taken back" and may remain there over long periods of time. Some of them disturb eco-systems and/or accumulate in the food chain and finally end-up on our plates.
- Since we do know that we are exposed to hazardous substances and that potential effects of high levels of exposure are uncertain,, we recommend to take any possible opportunity and action to reduce exposure to chemicals. Even if the individual action may appear to be small, each contribution makes a difference.
- Legislation does not provide sufficient protection against hazardous substances, because it can only react to threats AFTER they become known and they only operate at the level of individual substances. Hence, the overall problems of combined exposures, continuous exposure to low doses and the concerns related to environmental damage and endocrine disruption may not be sufficiently addressed. Furthermore, the enforcement of existing legislation cannot ensure that all prohibited or restricted substances are actually absent in all products on the market.

7. TEACHING METHODS

Knowledge about dangerous chemical compounds found in our everyday environment and the skill to make the choices to avoid them are one part of sustainable development-supporting education. Many chemical compounds found in consumer goods are extremely poisonous to fish and other aquatic animals, including birds and mammals, even in very small doses, which makes this topic all the more important. Children are always influenced by their diverse and complicated surroundings. This is equally true for both the natural and social environment. Younger schoolchildren don't yet sense this effect, they take their environment for granted and only notice their positive or negative feelings.

For example, the natural environment is a comparatively stable system, but in a social environment there are stereotypes, popular trends, financial influences, etc., characteristic to a certain time period and area. Every family develops its own habits, values and attitudes in regard to buying consumer goods. Children are influenced by the atmosphere of various groups they find themselves in (yard, kindergarten, sports practice, art group, etc.): they want to belong, to be like the leader of the group. This is how they decide to wear certain clothes and shoes, to use school and hygiene products designed in a certain way, to own fashionable toys. At that moment, the last thing anyone thinks about is the safety and health impacts of the item.

7.1 The particularities of teaching about hazardous substances

In elementary school children begin to learn the basics of different subjects. Based on fragmentary observations, information learned consciously or subconsciously, and gained through positive and negative experiences, a young student must begin to construct systematic knowledge about the world in general and become conscious of their place in it. All this knowledge is not just a goal in itself – it must be put into use as early in life as possible. One's attitude towards the natural environment, along with eating and consuming habits, is formed at a very early age.

Knowledge, used optimally, means combining the following skills:

- Critical thinking
- Objective behaviour valuation of oneself and others
- Problem solving
- Making reasoned decisions
- Making a plan of actions to reach one's goals

In regards to elementary school students, there are many aspects that they are not responsible for – family's financial means and habits, invasiveness and psychological impact of advertisements, moral peer pressure. Primary school teachers' role in this situation is both educating the students and developing/influencing the characters of young people. Practical experience shows that teachers of younger classes have authority: students believe what the teachers say and bring gained knowledge into their families („But the teacher said that...").

In the primary school teaching process it is advisable to vary the teaching methods, to raise interest and develop well thought out behaviour regarding the surroundings. Positive results can only be achieved if children are able to overcome their immediate wants, to be conscious of risks and perks and also be against negative suggestions.

The psychology of elementary school students must be considered. At that stage, the development of perception and enrichment of feelings continues. Feelings develop very intensely. Perception is sharp and is related to the joy of discovery. A lively interest in what's going on often emerges, but it is spontaneous and satisfied in a completely unsystematic way. Children sense vivid but often unimportant details (and every child can sense something different). Usually, first they sense colours, then size, and only after that shape, structure and other qualities. Children may not sense something is important if teachers or parents don't point it out.

The more senses (sight, hearing, touch, smell and taste) are involved in children's practical activity, the more complete are the perceptions that are formed about their characteristics, and the better they are understood. The attention span is short and easily affected by distractions that may suddenly appear. Paying direct attention can be made easier by adding engaging features and including emotions.

On one hand, teachers should add variety to their teaching methods, on the other, they should be careful of sudden changes; it is hard for children to redirect their attention from one activity to another. The learning process is generally influenced by children's different levels of preparation for school and also by the sudden transfer to a strict study regime. Unvarying physical stimulation on the muscular system (mainly sitting behind a desk) and intense mental effort tires children. New terms and explanations of difficult processes must be added to the study material, but at the same time, a threshold where a child cannot comprehend the subject because of their current development level should not be crossed. Everything should happen gradually - today, a child needs a teacher's help to understand the subject, tomorrow, they try by themselves.

7.1.1 Compatibility with other subjects

At elementary school, children learn the basics of many sciences, but at the same time, these subjects are not very differentiated at that level. This makes it easier to view various problems from many different angles (especially when changing study plans). The richest subjects are natural and social sciences. Because most subjects are taught by a single teacher, it is easier to achieve thematic integration. The theme of dangerous substances figures in almost all classes. Such themes occur most often in natural sciences in relation to human anatomy and physiology, in health care and basics of ecology. However, themes of dangerous substances may also come up in other classes.

In classes like art or sports, students' interest can be raised and knowledge cemented in an untraditional way via exchange, e.g. creating drawings about the themes of ecology and health care, thus enabling the development of children's attitudes and creative thinking; in physical education, games can be used as a tool to reinforce learned information. In language classes students can read topical texts, learn the names of chemical substances and reinforce this knowledge through language-based games. It is crucial to involve mathematics in teaching the students how to compare dates and analyse numerical indicators.

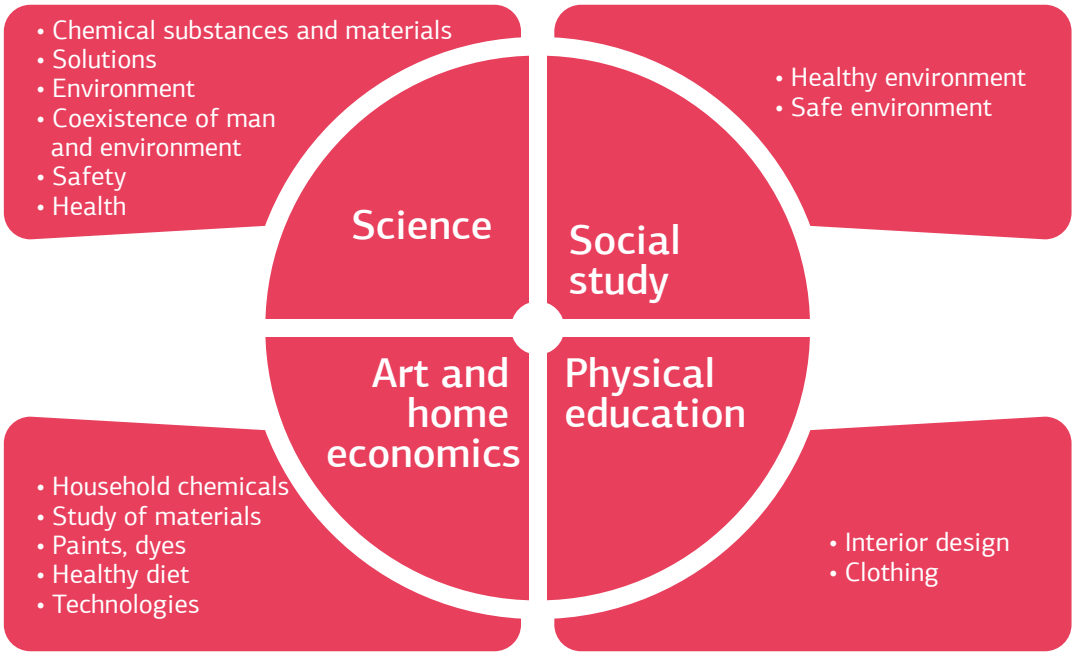


Figure 12. Compatibility of topics

7.1.2 Diversity of methods

It is extremely important to introduce the subject of dangerous substances to elementary school students, but the difficulty of the subject and children's lack of necessary knowledge make this challenging. Children cannot yet remember the names of chemical substances nor their composition. At this stage, the main objective is to bring the problem to students' attention, to help develop a critical attitude, to teach how to differentiate dangerous products from safe ones. Utilizing elements of play, practical lessons and bringing lessons closer to real life can be effective. Teachers can encourage students to seek out information from literary sources and to listen to other teachers and experts, and to be careful in everyday life. Even for this age group, there is a wide array of study methods to choose from.

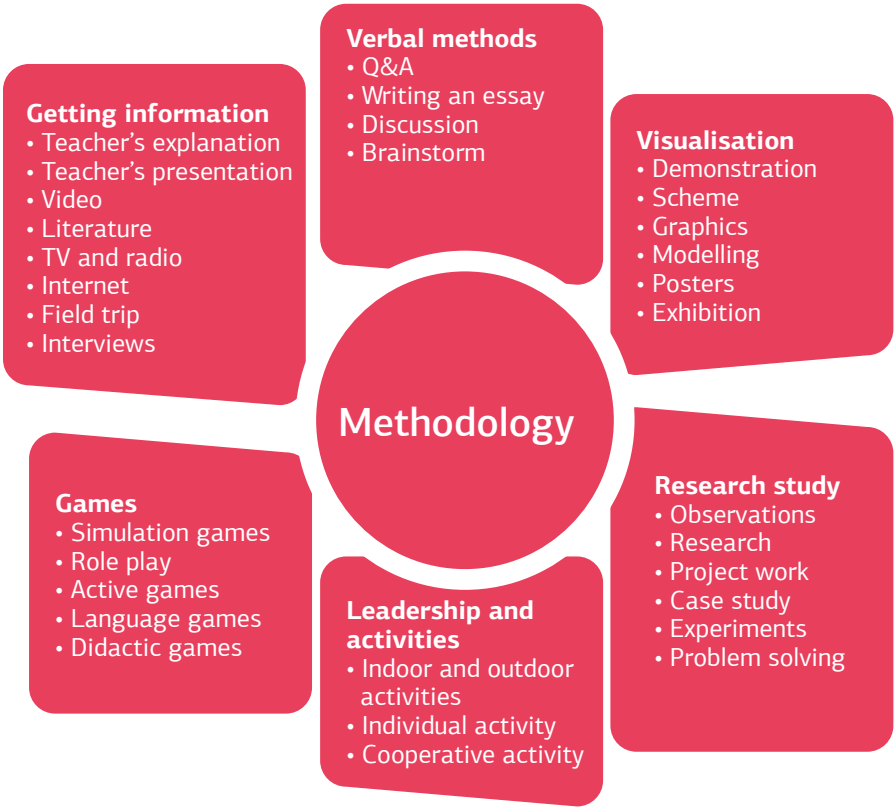


Figure 13. Methodology. A variation of working methods to teach about hazardous substances

7.2 Identifying values and previous knowledge

People are in daily contact with consumer goods and thus with the dangerous substances those goods contain. Dangerous chemicals can also be found in furniture, rendering materials, food and products such as television sets, laptops, mobile phones and smartphones, cosmetics, household chemicals (e.g. cleaning products), toys, some food packages and kitchen utensils. It is part of sustainable development-friendly education to know about the dangerous compounds found in our living environment and to be able to make choices to avoid them. Many chemical compounds found in consumer goods are extremely poisonous to fish and other aquatic animals, including invertebrates and vertebrates, even in very small doses, which makes this topic all the more important.

While choosing studying methods and activities it pays to think about following questions:

- Previous knowledge: what are students' previous knowledge and attitudes?
- What knowledge and skills should the students learn and what attitudes and values do you wish to instil in them?
- What are the goals of addressing the subject?
- Which methods and activities are suitable for reaching those goals?
- How can the students take part in planning and developing the classes?
- How do you grade and analyse what has been learned?

We refer to the ideas of Dr Iann Lundegård at Stockholm University (*Education for Change: A Handbook for Teaching and Learning Sustainable Development, http://www.balticuniv.uu.se/).* Dr Lundegård's first point is that knowledge is always connected to values, although knowledge on its own can never tell you which way is best. Knowledge is important in that it can indicate what consequences can be expected from particular choices of action, but in the end it is up to people to decide for themselves.

The second is that teaching/learning is a process that implies that you have to make a commitment to human values. Learning something is not just about piling facts in a heap or drawing a more or less exact map or diagram of the situation. That people learn things means that they define a problem and weigh up the advantages and disadvantages connected with it. Those people who continually create a more eco-centric perspective of the world will take the side of nature and preserve it more or less as it is for the coming generations. That is meaningful for them. Others maintain that other values are more important for the future of their own generation and that of future generations. As a teacher Dr Lundegård believes it is vitally important in dealing with values to be humble and, above all, think about how far one can go in allowing the democratic process to have priority. One should think about what is primary and secondary for people in other parts of the world. This information can only be acquired by directly asking those involved.

Merely learning the facts cannot guide or influence human behaviour. We are not always aware of the attitudes and values we have, how they control our actions or where they originated. Our attitudes and values are often based on our particular culture and experiences from childhood, adolescence and growing up. But behaviour can be changed by changing people's attitudes, opinions and values.

First, it is important to clarify students' previous knowledge and values. Many different activities can be used for that. They must be used with care and respect for the participants. The rule of thumb is to accept all the answers, i.e. there are no right or wrong answers. Everyone must have the right to express their attitudes or values without feeling that they are wrong. Everyone must know that participation is voluntary.

Among the first to use values clarification was John M. Steinberg (behavioural psychologist, Uppsala University), who used it in health education to help young people identify their values, talk about them, behave in ways that were consistent with them and to respect other people's values. Many people find it difficult to express their opinion and change their stand openly in front of a group. People can react differently to these exercises, as our viewpoints are private and personal and we can easily be hurt if these opinions come under attack.

The following section, which provides a number of exercises for values clarification, is based on the publication *Education for Change: A Handbook for Teaching and Learning Sustainable Development* and the materials are used with written permission of the authors.

Concrete Examples

Incomplete sentences

This exercise can be used to find out what the students think about certain issues. The exercise can be done in groups or pairs. In a group where the participants don't know each other very well it is advisable to do this exercise individually and in writing. Incomplete sentences are written on a piece of paper or on the whiteboard. The participants are asked to complete the sentences according to their own opinions. The participants may be asked to voluntarily read some of their sentences aloud or discuss them in pairs.

Examples of sentences are the following:

1. A natural environment where I feel most happy is ...
2. Individual: "The most important things for me to learn in school are..."
3. Small group: "The most important things to learn in school are..."
4. Individual: "I want a car because ... "
5. Small group: "Cars are very useful because ..."
6. I would like to live in a private house, because...
7. The most important things at home for me are...
8. ...(who?) should take interest in the health of fish and other marine animals, because...
9. It is necessary to measure the level of pollution of the sea, lakes and rivers because...

Ranking

Values clarification exercises can be used as an introduction to a particular topic or for getting to know one another in a group. This exercise involves ranking and prioritising from a given list. The idea is to rank the alternatives from 1 to 3, where 1 has the highest priority. The exercise can be individually or group based.

Ask the participants to indicate their answers on paper first and then discuss their rankings with classmates. In closing, you can ask some of the participants to explain their opinions to the whole group. It is possible to vary the degree of difficulty by having alternatives that are not quite so clear cut and that depend on a variety of circumstances.

Examples of ranking questions are:

What would scare you most of all to meet in nature?

- a moose
- a dog
- an unknown person

What needs to be prioritised in your home community?

- waste water treatment
- cycling routes
- a football arena

What do you prioritise?

- travel opportunities
- sporting opportunities
- watching TV and films

Which organisation would you prefer to be a member of?

- WWF (World Wide Fund for Nature)
- The Red Cross
- I would prefer to start a new organisation

Another good example of ranking is to ask the students to individually reflect and write down lists. For example, ask the students to write down at least five important things at their home, five things that they would like to buy today, five things they find hard to imagine their life without and five favourite foods.

The students should make their lists without speaking to one another. It is important to allow everyone to think for themselves without being influenced by other people's opinions. When the students have written their lists they can prioritise them according to taste, transportation, cost, Ecological Footprint, etc. When the participants are ready they can compare their lists in pairs and discuss their priorities and reasons.

Change Circles

In this exercise, participants can indicate their viewpoints in relative anonymity because there isn't time to observe how others are responding. Begin the exercise with basic and neutral questions so that the participants get some idea about how it works. You can also use change circles as a warm-up exercise to get people's ideas flowing and to get an overview of what your students already know about a subject and what they think about various issues.

This is how it works. The group or class forms two circles, an outer circle and an inner circle. The circles move slowly in opposite directions. The teacher or facilitator reads out questions and if you agree you change circles, and therefore direction. If you don't agree with the question you stay in your existing circle and continue moving in the same direction.

Examples of statements that can be used:

- Autumn is a pleasant time of the year
- My feet never get cold
- In school I learn important things
- We are all responsible for the future
- Politicians are responsible for sustainable development
- I like meat
- I am interested in agriculture
- I do not pollute soil or water
- We are all fighters!

Standing on a Line

This is a values clarification exercise that enables positions to be challenged and encourages people to communicate their opinions. The teacher introduces the specific issues one at a time and asks the participants to think very carefully about their responses. The first issue is introduced and the participants are asked to draw a horizontal line on a piece of paper and mark 6 positions on it, numbered from 1 to 6. Each person has to mark their own position on the line with a cross, depending on their viewpoints.

The students are then asked to stand in or on a line (which can be imaginary or marked in some way on the floor of the room) and take up their positions according to the issues being presented – all this in silence. Each person then moves to the position of their choice and thereby indicates their individual standpoint. When everyone has taken their position, the participants are then asked to tell the person standing next to them why they are standing where they are. As it is likely that a few people will be standing in each position – thus forming a group – the students in each group can be asked if someone would like to be spokesperson for that particular group and tell the class why they are standing in that position.

As a result of the arguments presented, people might want to change groups – and people can be invited to do this if they wish.

Two different versions of the exercise are indicated below:.

Version 1.

Who has precedence, nature or man?
Nature 1 2 3 4 5 6 Man

Version 2.

Make a line on the floor with the words AGREE and DISAGREE at each extreme end. If you stand in the middle of the line it can either mean that you are unsure or you don't care. Example:

Everybody should know the ingredients in the products they buy!
Agree ---------- Disagree

The participants are asked to communicate their views. It is important to explain at the beginning that everyone has the right to express an opinion and that no-one will be judged or corrected for having a belief or opinion that is different to that of others. Tell everyone that they can change their standpoint on any particular value at any time, if they so wish. When the exercise is over ask everyone to return to their original seats. As follow-up at a later date you can, if so desired, use the same questions and assess whether changes of views have occurred and what kinds of changes have taken place.

Four Corners

This exercise is suitable for more complex questions. It is formatted as a series of multiple choice questions. The students can make a choice between three set answers or give their own alternative answer. Each corner of the room is assigned for a specific answer (see the example below) with one corner being reserved for alternative responses.

Question: What is most important to you when buying curtains/ shampoo/ cream/ cosmetics/ kitchen utensils?

- Corner A. The price
- Corner B. The colour or style – whether it's in fashion/easy to use
- Corner C. Where it comes from and how it has been produced
- Corner D. Open for alternative responses

The teacher reads out the question and indicates which corner of the room has been allocated for each alternative. Each person is encouraged to silently reflect on which alternative to choose before moving to the relevant corner. If somebody goes immediately to a corner, there is a risk that others will simply follow and choose the same alternative without first reflecting on why they are making that particular choice. When people have assembled in their various corners, ask them to discuss – as a group – why they have chosen that particular alternative. Each group can then choose a spokesperson and that person can tell the whole group why they have chosen that particular corner. The participants are allowed to change corners if they change their minds. Encourage the participants to think independently and make their own decisions.

The Hot Seat

One of the most important aspects of values clarification exercises is not the actual position taken by the students but the fact that they begin to reflect about the questions for themselves. The actual process – thinking, motivation and oral communication – is more important than the end product, e.g. their response.

Arrange chairs in a circle and ask the students to be seated. The teacher then reads out a statement (prepared in advance) that is relevant to the topic or theme being studied. Those students who agree with the statement move to a different chair and those who do not agree remain in their places. The students are then encouraged to explain their thinking to a classmate sitting next to them or to the whole group. The teacher then reads out the next statement and the same procedure is followed.

Examples of statements are:

- Eating fish from the Baltic Sea is dangerous.
- Skin creams and hair products contain hazardous ingredients.
- Chemical substances of cosmetics products and hair dyes that end up in water bodies are dangerous to fish.
- People in the past had a better life than people of today.
- Every polluting factory should be shut down as soon as possible.
- Car-care chemicals are dangerous to your health.
- Shops are selling carpets that release dangerous pollutants into the atmosphere.
- When household chemical compounds disintegrate at waste water treatment plants, even more hazardous and lasting compounds are formed.
- Poisons used for pest control end up in water bodies and, through fish, on our dinner table.

As with the other values clarification exercises there are no "correct" answers to these questions. As a teacher you should avoid giving your own answers as there is a risk that the students may construe yours as the "correct" one. You can also allow the students to formulate statements themselves.

Baseline

A baseline questionnaire is something that gives the teachers a basic idea of students' previous knowledge and is a useful planning aid. The same questions can be used at a later stage to see whether group members have changed their views or opinions.

With each question, the students can choose between four answers: **1) Fully agree; 2) Agree; 3) Don't agree; 4) Don't agree at all.**

Questions:

1. In my opinion questions about nature and environment are important.
2. I want to act positively for nature, the environment and the good of our society´s/country´s future.
3. I like to be out in nature.
4. Together we can change a lot.
5. It is important for the school to provide knowledge and motivation to act for sustainable development.

Green or red, show your opinion

This exercise is a more provocative version of values clarification and involves problem-solving in groups with only two possible alternatives. The discussions that are held both before and after "voting" are the most important educational aspects, so be sure to allow time for discussions either in pairs or in groups. Voting is also a useful way of interrupting or drawing never-ending discussions and debates to a close.

Prepare green and red "voting" papers for each person in the group in advance. As this voting system is open and visible, all people need to do is to hold up whichever colour they choose to register their vote. If they agree with the statement they hold up a green paper; if they do not agree they hold up a red paper.

Agree = GREEN Do not agree = RED

Examples: Is it possible to catch and process cod more rationally? It is possible to get a healthy population of cod back? Is it possible to change methods for catching cod? Is it possible to change the culture of consumption?

Note that in this exercise the voting results give a very clear picture of whether people agree or disagree, but do not say anything about how, why or what needs to be done to improve the situation.

Critical thinking about products and food

This exercise is designed to develop critical thinking skills and practice expressing an opinion based on values and facts.

The students answer the questions for each product individually. Although they do not have to write anything down, they do have to be able to formulate and express their arguments to others.

Why will I buy this product (cream, perfume, cleaning product...) ?

Why won't I buy this product (cream, perfume, cleaning product...)?

Why I will buy this food (meat, dairy, packaged products - e.g. cereals, pastas, desserts)

Who won't I buy those items?

When the students have worked out their answers to these questions they should discuss their responses in small groups. The teacher can also ask spontaneous questions, for example:

What is the most important feature of your decision? The price, how the product has been produced, how long it takes to cook, others? You can also use values clarification in conjunction with the 'four corners' exercise.

Feedback Questions for Teachers

Answer the following questions after you have tried some of the above exercises and have become familiar with values clarification.

- What is important to consider when "designing" values clarification exercises?
- What is important for you as the leader of a values clarification exercise?

8. PRACTICAL EXERCISES FOR HIGHER SCHOOL GRADES AND FOR GYMNASIUM

8.1 WATCHING A VIDEO: A DAY WITHOUT CHEMISTRY

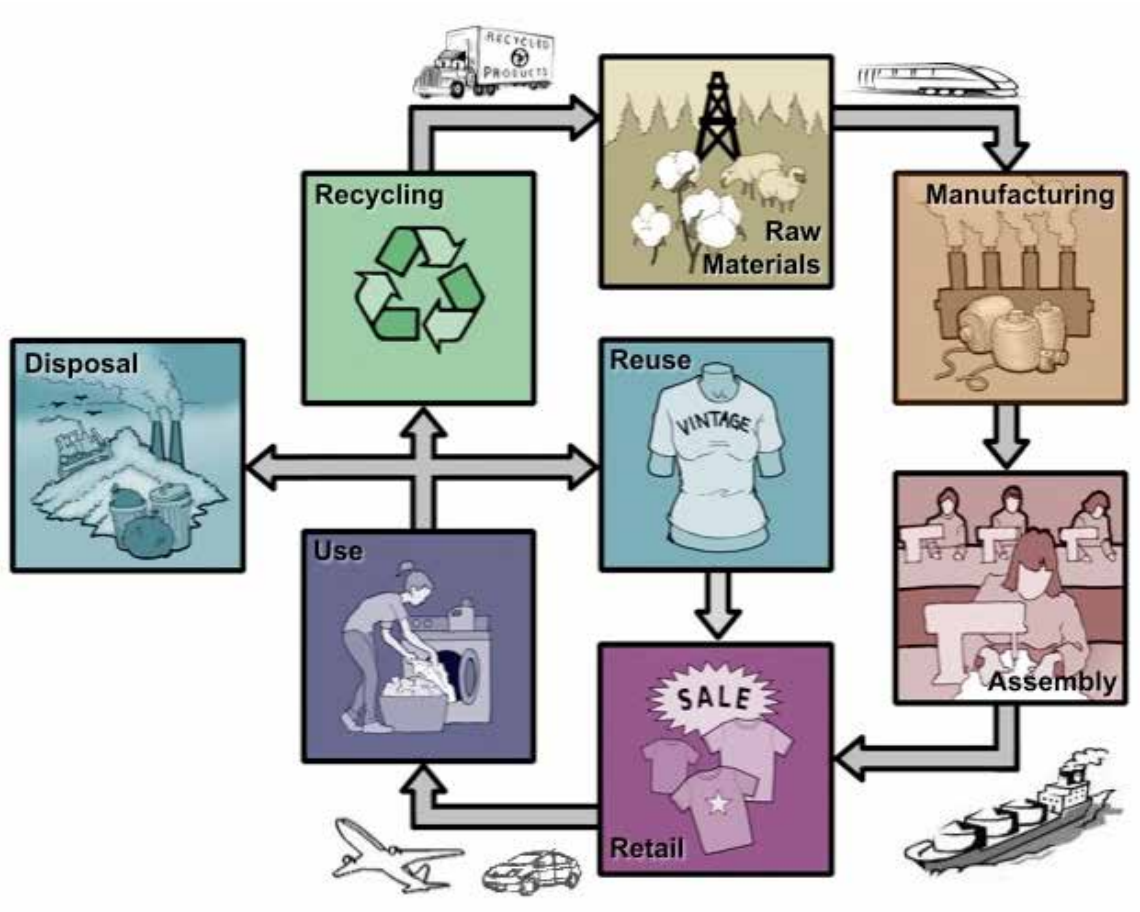
Discuss in the class: What are the benefits of modern lifestyle? How have chemicals changed our lives? Imagine a day without a car, electricity, TV, telephone, clean food and water, medicines, clothes, one's own house and thousand other everyday things. Watch a short video together in class which you can find at www.youtube.ee by the search phrase „A day without Chemistry" or „Chemistry – All about you".

- **A DAY WITHOUT CHEMISTRY**
- **CHEMISTRY – ALL ABOUT YOU (in English: http://www.youtube.com/watch?v=YDRDpa6rKbc)**

8.2 CLASS DISCUSSION OR WRITTEN HOMEWORK: THE PRODUCT LIFE CYCLE ANALYSIS

Company X is selling jeans and is located in Europe. It is not exactly known where the raw material (fabric) is coming from and what chemicals are used for production of the fabric. The jeans are sewn together, wrapped and packed in China and sent to Company X for selling in Europe.

Discuss in class or give as written homework for the students – what is/could be the whole life cycle of the product (from harvesting the raw material, production of the product, labour force, transport to different countries in the world, buying, use, disposal and/or recycling) of the product.



Life cycle of clothes

8.3 A PRESENTATION OR RESEARCH PAPER: ACCIDENTS RELATED TO CHEMICALS

Ask the students to make a presentation or research about a disaster that happened in the world, where chemicals have caused significant environmental pollution and/or harmed the health of people. Students could give an overview of why the accident happened -was it human error? - what was the damage to the living environment and property of people in the area, what were the consequences of the accident and could the accident have been avoided?

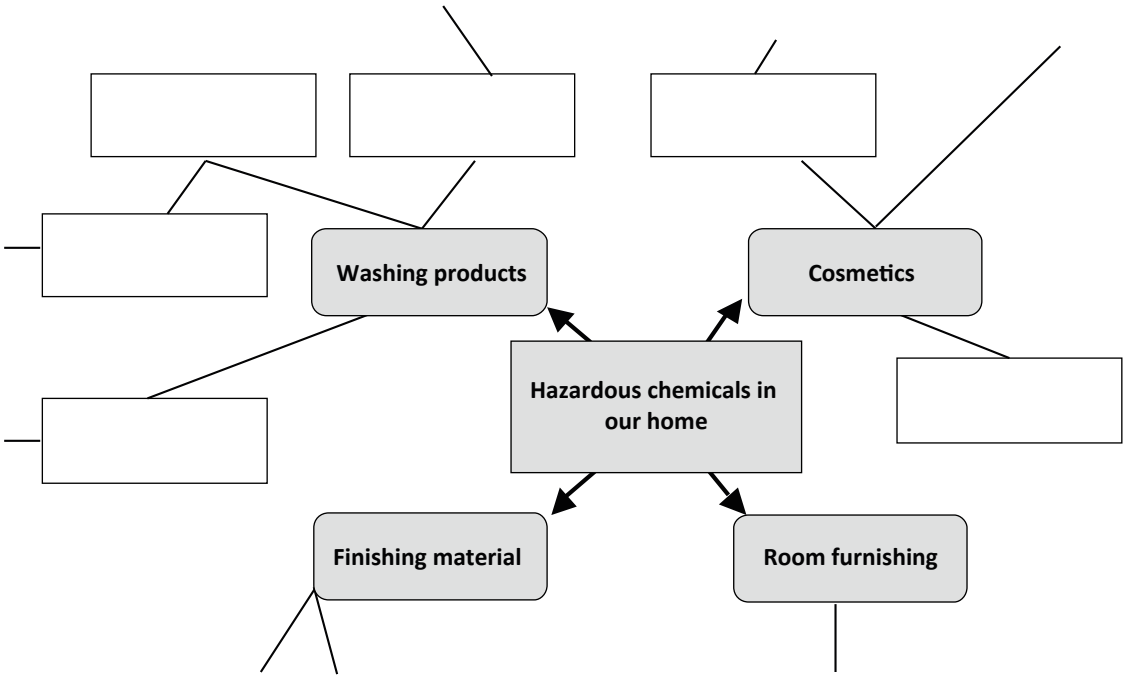
Show the photo below to the students and discuss what is special about the picture? Is the photo photoshopped/digitally edited or real? How is the scene in this picture possible in nature? What caused the situation? Look at the info given below about the chemical-related accident in Hungary*.

***Chemical related accident in Hungary.** On October 4, 2010 in Ajka (165 km west of Budapest, Hungary) an industrial accident in an alumina plant took place. The Ajka alumina sludge spill was caused by a collapse of the north-western corner of the dam of a caustic (highly alkaline) waste reservoir, thus freeing ca. 1million m3 of liquid waste from red mud lakes. The mud was released as a 1-2 m wave, flooding several nearby localities; about 40 km2 of land were initially affected. The spill was presumably a human error. The main damages caused by the accident first arose from the high pH of the mud; that was responsible for both severe chemical burns to people and animals, and the killing of live organisms in the rivers and in the contaminated soil. The flood wave flow was powerful enough to move cars and vans. The toll of casualties reported was of 10 deaths, and 120-150 injured. The red mud contamination extinguished all life in the smaller (Marcal) river, and reached the Danube on October 7, 2010. Acute effects caused by high pH were remediated by dilution and progressive carbonation of the NaOH by CO2 from the air; however, the chronic toxicity of heavy metal contamination is an environmental concern. **Photo shows where the toxic sludge flooded the land!!!**

8.4 IDEA CARD

*Buehl 2002: 91

An idea card is well suited for writing down students' prior knowledge, ideas and thoughts for group brainstorming, as well as for giving a graphical overview of the text (i.e. on topic: hazardous substances in our home).



8.5 QUIZ: WHAT DO THESE PICTOGRAMS MEAN?

Part 1: HAZARD PICTOGRAMs

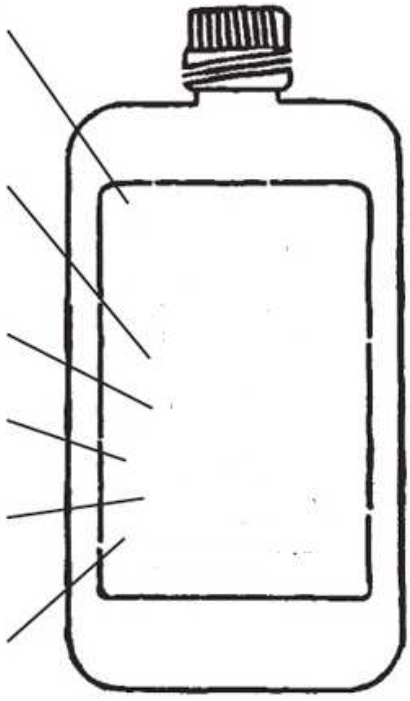
	What does this pictogram mean?	Name a product on which you have seen this pictogram
		
		
		
		
		
		

Part 2: ECOLABELS

Which of the below labels are ecolabels?

8.6 WORK IN CLASS: DOES MY HOUSEHOLD CHEMICAL AND/OR COSMETICS CONTAIN HAZARDOUS CHEMICALS?

Ask students to bring from home a cosmetic or cleaning product. Examine the product labels and mark down hazardous chemicals that the products contain. Look at the additional information on the label (hazard symbol, ecolabel, user's guidance etc.). Use as an example Worksheet I or Worksheet II and for use in class, hand out the summary table of ingredients (Handbook Annex II). Discuss the results together – what could be the alternatives for these products that contain hazardous substances? How can we minimize contact with hazardous substances in the products?



Name _____ Grade _____ Date _____

WORKSHEET I

What ingredients could be found in toothpaste, sunscreen, bathroom cleaner or in another product?

1 Write the type (toothpaste, shower gel, ...) and name of the product in the table header.
2 Find the product' ingredients listed on the package. If necessary, use a magnifying glass!
3 Write each of these ingredients in the table below.
4 Fill in the rest of the table. Please use the summary table of ingredients which the teacher gave out.
5 Mark the chemical compounds what are hazardous with the red color!

Type of the product and name: .....

Nr	Name of the ingredient in ENG language	Why added to the product? Purpose	Impact to human	Impact to environment and/or other living beings: yes/no

If the table is full, continue on the next page.

Nr	Name of the ingredient in ENG language	Why added to the product? Purpose	Impact to human	Impact to environment and/or other living beings: yes/no

6. Compare the ingredients in your product with the ingredients in your classmate's product. You both should have the same type of product, like toothpaste. Read together, how many ingredients are in your product and how many in your classmate's product.
Draw blue circle around the compounds that are in both products and green circle around the compounds which do not exist in your classmate's product.

7. Compare prices of the products and price per product weight (kg) or volume (liter). _____

_____

8. Discuss with each other what kind of product do you prefer in the future.
Why? _____

9. Introduce your product to other classmates.

Name _____ Grade _____ Date _____

WORKSHEET II

What ingredients could be found in toothpaste, shampoo, hand cream and in other products?

1 Write the type (toothpaste, soap, ...) and the name of the product in the table header.
2 Find a list of the product' ingredients on the package. If necessary, use a magnifying glass!
3 Check the ingredients in the product with those listed in the table below.
4 Mark the chemical compounds in the table which are in the list of the ingredients of your product.
5 Fulfil table cells for these ingredients. Please use the summary table of ingredients which the teacher gave out.

Type of the product and name: .....

Nr	Name of the ingredient in English	Why added to the product? Purpose	Impact to human	Impact to environment and/or other living beings is known: yes/no
	3-Benzylidene Camphor (3BC)			
	4-Methylbenzylidene Camphor (4 MBC)			
	Ammonium Laureth Sulfate & Ammonium Lauryl Sulfate			
	Benzyl Alcohol			
	Benzyl Benzoate			
	Chlorhexidine			
	Cocamide DEA			

Nr	Name of the ingredient in English	Why added to the product? Purpose	Impact to human	Impact to environment and/or other living beings is known: yes/no
	Diazolidinyl Urea			
	DMDM Hydantoin			
	Ethylparaben			
	Imidazolidinyl Urea			
	Methylparaben			
	Methyl-chloroisothiazolinone			
	Methyl-isothiazolinone			
	Propylparaben			
	Salicylic Acid			
	Sodium Lauryl Sulfate & Sodium Lauryl Ether Sulfate			
	Triclosan			

What ingredients did classmates find in their products? .....

Discuss with each other:

1. What can you do to reduce hazards to your own and your family members' health:

    a) Start by thinking about the easiest steps first

_____

_____

    b) further possibilities?

_____

_____

2. What can you do in order to reduce environmental load:

    a) What are the easiest steps to take first?

_____

_____

    b) further possibilities?

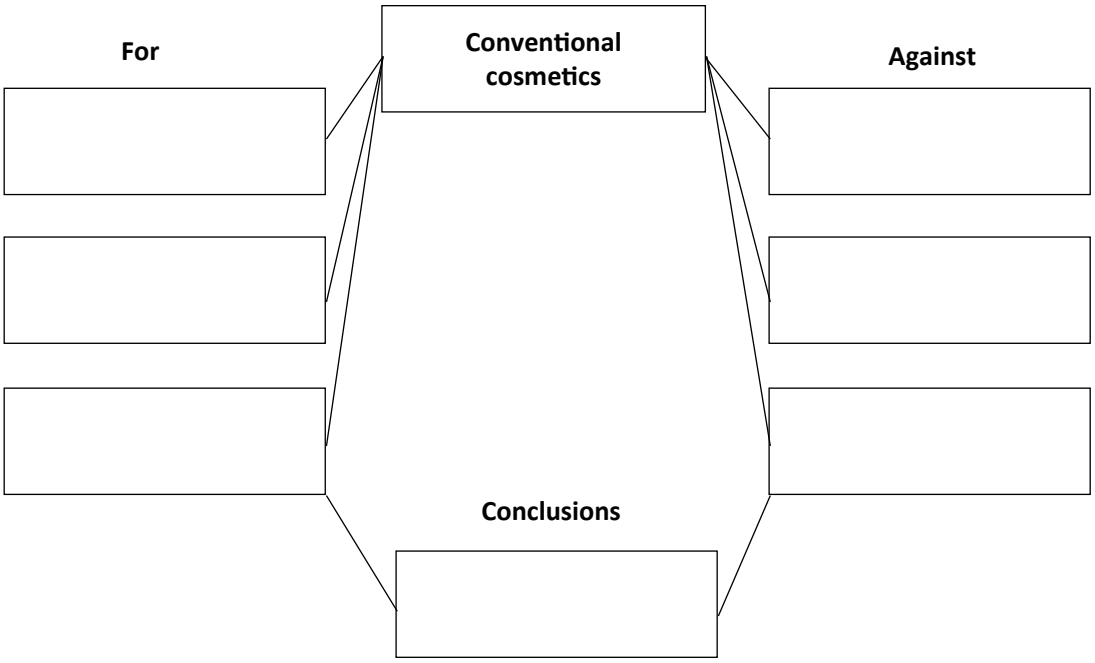
._____

_____

8.7 DISCUSSION NET: FOR OR AGAINST CONVENTIONAL COSMETICS

* Buehl 2002: 51

1. Group work
2. Good preparation for writing a discussion essay
3. Pointing out different viewpoints



8.8 SWOT ANALYSIS

*LeMill 3

1. SWOT analysis is a well-known, simple and widespread analysis model that identifies strengths, weaknesses, opportunities and threats.

2. The name of SWOT analysis comes from the first letters of the words: S - strengths; W – weaknesses; O – opportunities; T – threats.

3. The teaching method aims to find and analyse different aspects of a concrete problem. The method can be used for finding solutions for almost any kind of problem requiring decision-making. It can also be implemented to assess your skills or current situation, for analysing and assessing a company, etc.

4. Often in the case of analysing the situation and action, the strengths and weaknesses are connected to inner resources, while opportunities and threats are focused mainly on external factors.

5. The work can be carried out in pairs or groups.

Example: conventional cosmetics

Strengths:	**Weaknesses:**
....	....
Opportunities:	**Threats:**
....	....

Example: a product used/found at home; product sold in a shop

VENN DIAGRAM
*Steele, Meredith, Temple 1998b: 21

A good method for visualizing differences and finding intersections,
i.e. what to keep in mind when buying the following :

- creams/perfumes and hair care products,
- cosmetics and toys,
- cleaning products (including those used for furniture, carpets),
- washing products for dishes, clothing, etc ,
- finishing materials and home textiles (curtains, sheets, blankets; table linens),
- chemicals used in garage,
- electronic equipment.

Examples of what might be compared:

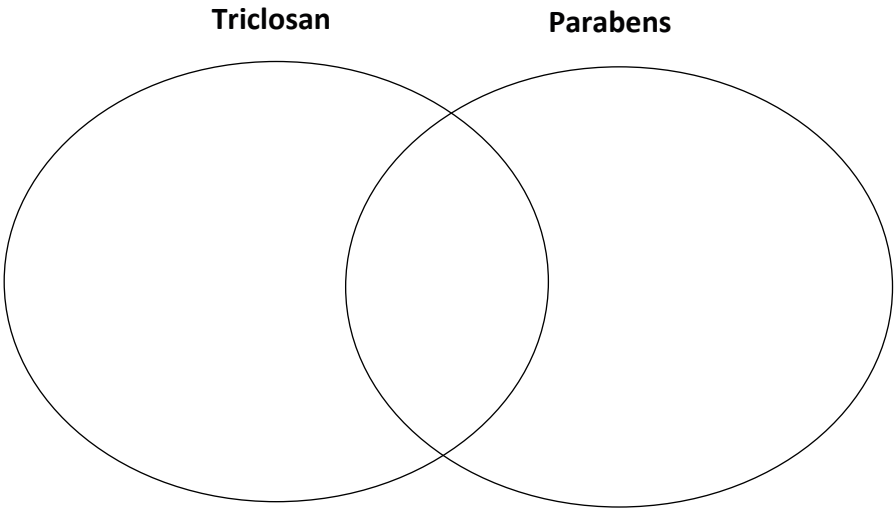
1. Comparing triclosan and parabens:
a) Compare the fields of use of triclosan and parabens (i.e. ethylparaben): what is their main purpose?
b) Compare the ways triclosan and parabens get to living organisms: how and with what substances can triclosan get into a living organism, how parabens?
c) Compare the harmful impact of triclosan and parabens to the human organism: what is similar, what is different?

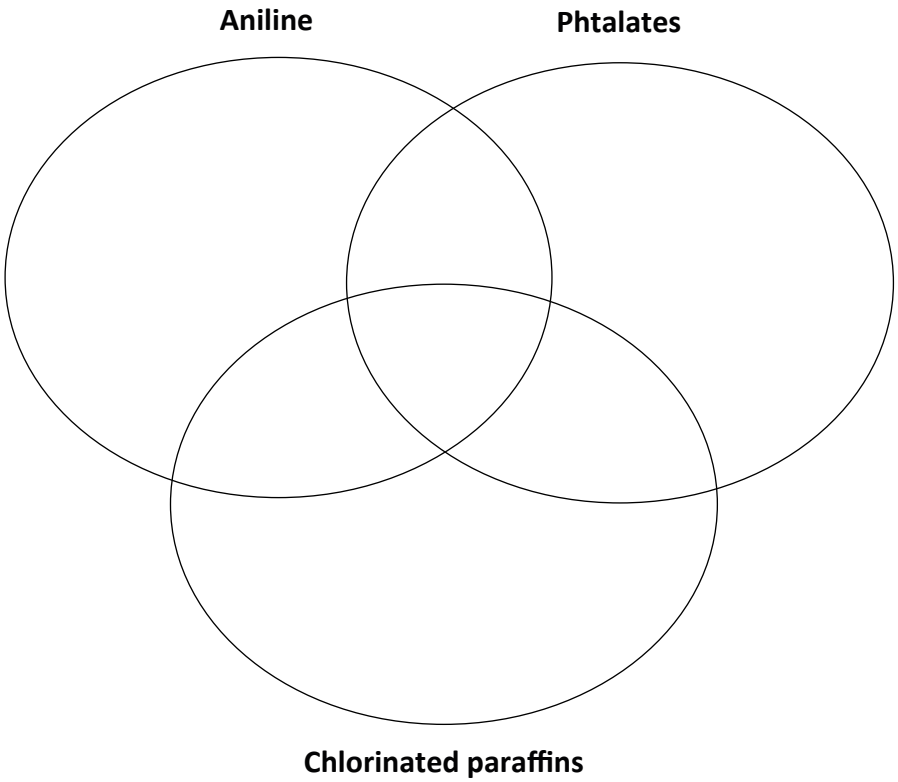
2. Comparing heavy metals lead and cadmium:
a) For what purpose are these metals used?
b) How do these metals get into natural environment?
c) What is the impact of these metals to other living organisms besides humans?

Venn diagram for 3 sets

The Venn diagram makes it possible to compare three components and bring out similarities and differences (see product groups from previous list).

You can compare 3 groups of chemical compounds, i.e. to compare sources for how the compounds end up in humans and their impact to humans, to compare sources for how the compounds end up in living/water environment and impact to biocenoses, etc.


Triclosan
Parabens


Aniline
Phtalates
Chlorinated paraffins

8.9 DIFFERENT TOPICS FOR DISCUSSIONS

1. Triclosan or ethyl paraben?

Which one is more hazardous? Why? Which one do you come into direct contact with more often and via what? Does not using them as antibacterial and fungicidal substances outweigh spoilage of the products? What could be the damage and negative impact to human organisms caused by the spoiled product? Are there alternatives?

2. Pros and cons of nickel – do the good properties of nickel outweigh its hazardousness?

One student group describes the hazardousness of nickel and its alternatives; the other group explains the good properties of nickel and its profitability, its advantages compared to alternatives.

3. Strict banning of hazardous substances – a safe future?

To discuss: Will banning the substances that are currently known to be hazardous, and starting to use new alternatives that do not have years of research behind them guarantee a safe living environment for living organisms?

4. Cosmetics – comfort and solution or disservice?

Discussion - if and to which extent cosmetic products need to be used. When buying a product, how big a role is played by the appearance, scent, colour and promises that the producer makes? How much attention is given to impacts of possibly hazardous chemicals in the product?

8.10 ZIC-ZAC (MOSAIC)

*Steele, Meredith, Temple 1999: 12

The **Zic-zac (mosaic) method** works the following way:

1. Forming the home groups. The class is divided into groups of three, four or five students. It is suggested to divide the students into groups in a way that would let them acquire experience in working with different classmates. When the groups have been formed, each member of the home group gets a numerical designation 1, 2, 3 or 4.

2. Forming the expert groups. All number ones, twos, threes and fours are asked to come together. Depending on the group (class) size, two groups of ones, twos, threes and fours can be formed.

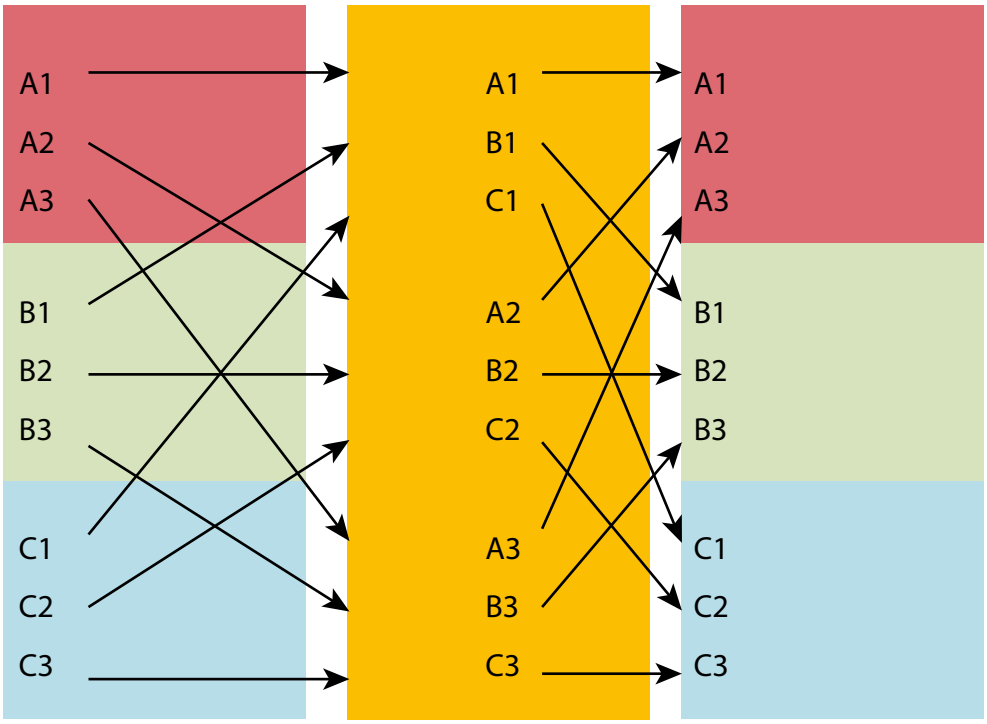
3. Distribution of materials. The text is divided into parts. All number ones are responsible for the first part, twos, for the second part, etc. Their task is to get to know their section of the materials very well by carefully reading it through, discussing it with other group mates and making sure that everything is understood correctly.

4. Working in the expert groups. Each expert group member has an obligation to teach his/her part in their home group. Therefore, in addition to understanding the material, the students have to decide how they can most effectively convey it (text, section) to their home group members. As a group, members should decide which teaching methods to use. The teacher can prepare questions to for them to answer.

5. Expert work in home group. When the expert group has finalised their work, the members return to their home groups and teach the corresponding part to their home group members. Each home group member has to get a complete overview of the whole material. When the expert group member cannot give clear answers to the questions raised by the home group members, then the question will be marked down. Experts can ask questions of their home group members to make sure that the material was understood. The teacher moves between the expert groups and helps when needed.

6. If needed, then the expert groups can come together again in order to find answers to questions that have come up.

Helping tool – ANNEX I of the handbook - „Chemicals info sheets" – cards about compounds and compound groups (aniline, phtalates, sodium lauryl ether sulfate, PAH-compounds, parabens, triclosan, et al).



Examples of study topics

1. Groups of hazardous organic compounds:
Chlorinated paraffins, organotin compounds, alkylphenols, phtalates
a) presence in home furnishings;
b) how they get into the human organism;
c) impacts to human organism;
d) measures for avoiding hazards.

2. Hazardous metals: lead, cadmium, nickel, mercury
a) presence in nature;
b) presence in electronic equipment;
c) how they get into the human organism;
d) how they get into other living organisms.

8.11 READING IN PAIRS

* Steele, Meredith, Temple 1999: 16

1. Reading in pairs method is suitable for working with dense text.

2. Students form pairs that work together during the whole lesson. The text is divided into four parts; the first group of pair members studies the first part, the second pair the next one, etc. Later (after reading), the text is presented to whole group.

3. At first, one of the pair members summarizes and the other one asks clarifying questions. After half of the text is read, the roles change. The summarizer's task, after reading and summarizing half of the text, is to tell his partner about it in his/her own words. The asker is also reading the text at the same time and listens carefully to the summary. The asker´s task is to ask clarifying questions that would emphasize important thoughts and draw out more information. Using this thoroughgoing approach, the whole text is read and discussed.

4. Reporting to the whole group can be done in different ways. One possibility is to let the students jointly present their section of the text graphically. The gallery method may be used.

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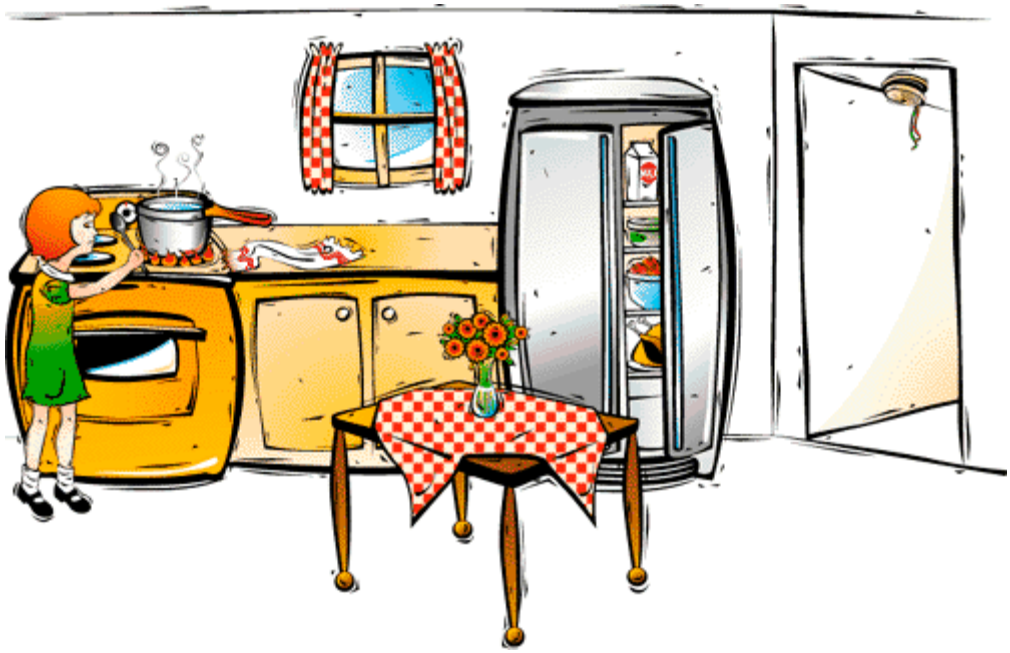
9. PRACTICAL EXERCISES FOR PRIMARY SCHOOL

Work sheet 1: Exposure to chemicals

(Source: www.theplumbingdetectives.com, www.incity.com)

Describe which hazards can ambush us in the kitchen.



Finish the drawing. Where does the water flow from our toilet and kitchen sink?

Work sheet 2: Are there hazardous chemicals around you?

(Source: www.overallpicture.com, www.napofi lm.net)

Imagine that you are sitting on the couch in your living room.
Think about different objects that surround you. Draw these objects around the couch below.

Now think about what is invisible to our eyes.

What gives properties that people want (for example, dirt-repelling carpet, colourful furniture, etc.) to the things around us?

Work sheet 3: Does my home contain products that contain hazardous substances?

Mark with a cross (X) products that can be found in your home.
Did you know that these may contain hazardous chemicals?

Products	In my home	Not in my home
Hairspray		
Toys		
Cleaning products		
Paint		
Bubble bath		
Soap		
Deodorant		
Washing powder		
Electronic equipment		
Baby/feeding bottle		
CD		
DVD		
Canned foods		
Waterproof clothes		
Cosmetics		
Plastic kitchenware		
Curtains		
Wallpaper		
Floor covering		

Where you surprised that there are so many different products in your home that might contain hazardous chemicals? Are your parents aware of that?

Group the products from the table above into following categories:

Very hazardous	Moderately hazardous	Not hazardous

Work sheet 4: Which hazard pictograms are on the products found in your home?

Look at the different product packages and labels. Which products have the hazard pictograms given below? Write these products down.

What do these pictograms mean? Why do you have to be especially careful when using these products? How could you avoid using such products?

Work sheet 5: Let´s take a closer look at toys!

Toys can also contain chemicals that might be harmful to our health and environment. All toys that are produced or sold in the European Union must have CE conformity marking that assures that the toy complies with all main safety requirements. Play a detective in the shop and investigate how many toys you can find with this marking:

CE

Research in the shop

Date:

Name of the shop:

How many toy packages were investigated:

How many toys had CE marking?

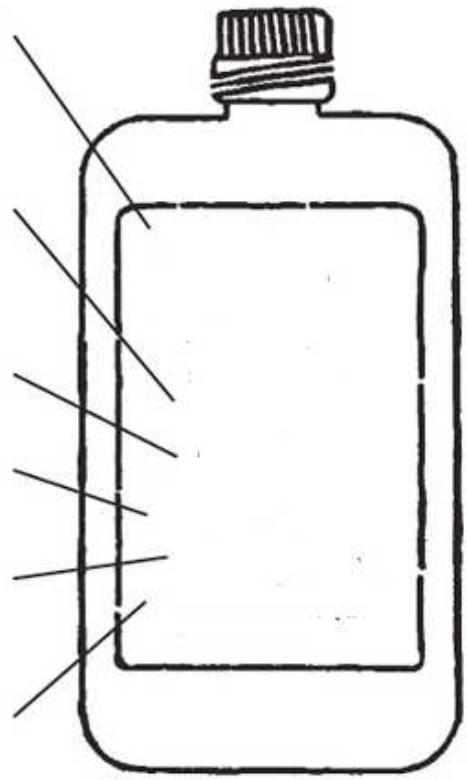
Describe these toys:

How many toys did not have CE marking?

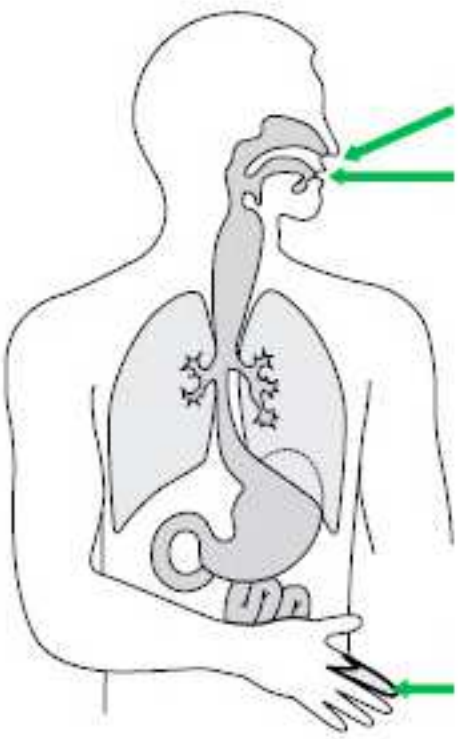
Draw these toys:

Work sheet 6: Information on the product label

What kind of information do we get about the product from the product label?
Draw the label of one product and tell what you found out about that product.



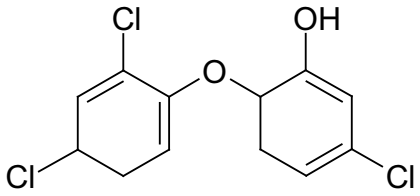
Work sheet 7: How can chemicals end up in our body?



ANNEX I

CHEMICAL INFORMATION SHEETS

TRICLOSAN



1) Where can it be found?

In toothpastes, mouthwashes, soaps, shower gels, deodorants, cosmetics.
In toys, shower curtains, socks, bed linen, mattresses, insulation materials, flooring underlay, carpets.
In cleaning products (dishwashing, glass-cleaning products), garbage bags. In some pesticides.
In EU countries triclosan may not be used as a food preservative or in products that come into contact with food (cutting boards, dishes, packaging).

2) For what is it used?

Against proliferation of bacteria and mould.
In toothpastes for proliferation of gingivitis, however, the benefit has not been scientifically proven.
In EU countries the content of triclosan in a product can be up to 0,3%. Although this amount is also considered to be the safe dose, it can be exceeded when using several products containing triclosan at the same time.

3) How does it get into a human organism?

Absorbs through skin and mucosa. By respiratory tract when using aerosols. Orally, when drinking water or eating food that is contaminated with triclosan. In babies, via breast milk.

4) How does it impact the human organism?

Trioclosan irritates eyes and skin. Exacerbates allergies, especially hay fever.
Disrupts functioning of the endocrine system. Possible carcinogen when it reacts with chlorine in drinking water and, as a result, forms carcinogenic halogenated alkanes (i.e. chloroform).

5) How does it impact other living beings?

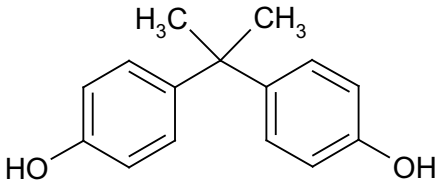
Triclosan acts like a biocide (ecocide a.k.a. a chemical that is fatal to living organisms). In the case of diatoms, inhibits photosynthesis (diatoms are one of the most important ones for photosynthesis on Earth). Triclosan hinders renewal and generation of the cell membrane in most bacteria. There is the risk that bacteria can become resistant to low concentrations of triclosan, which necessitates raising triclosan content in the product later on.
Triclosan causes hormonal, growth and development disorders in dolphins.
Sunlight causes formation of chlorophenols and dioxins from triclosan (both compounds are disrupting organisms).
In nature triclosan is decomposed by microorganisms.

6) What can you do to avoid hazards?

Do not buy or use products that contain triclosan (keywords in the product description: “antibacterial”, “removes microbes”).
Cleaning products that do not contain triclosan are as effective as products containing triclosan (except products used for medical purposes). If the aim of the cleaning is just cleanliness and not disinfection, then triclosan is not needed. Use lemon juice or a vinegar solution for cleaning greasy surfaces.
As an alternative to triclosan, use cleaning products containing silver or copper ions or natural biocides (essential oils of lavender, rosemary, peppermint, orange, lime, grapefruit and lemongrass).

BISPHENOL A

Abbreviation: BPA



1) Where can it be found?

In soft plastic, baby bottles, reusable food and drink packaging, inner surfaces of metal cans, electrical and electronic devices, plastic parts of cars, sporting safety equipment, CD-s and DVD-s, thermal paper (cash orders, cinema tickets), carbon-free copying paper.

2) For what is it used?

For making polycarbonate plastic (abbreviation: PC; light, durable, transparent, high resistance to heat, good electrical resistance).

3) How does it get into the human organism?

Orally (especially when plastic is in contact with hot liquid, food), less through skin.

4) How does it impact the human organism?

Disrupts endocrine system (imitates the work of the body´s natural hormones), toxic to reproduction. Causes obesity, neurological disturbances, skin hypersensitivity, damage to kidneys and liver.

5) How does it impact other living beings?

Damages the reproduction, growth and development of organisms living in water.
In the case of fish, it prolongs the maturing period of germ cells and degrades the sperm quality of male fish.

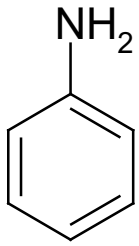
6) What can you do to avoid hazards?

Eat fewer packaged and canned foods – this is safer both for you and the environment.
Choose porcelain, glass and stainless steel dishes instead of disposable ones.
When using disposable dishes and plastic food storage containers:

- Do not warm food in a box made of polycarbonate plastic;
- There are special drinking cups meant for hot drinks (usually from paper, which has a waterproof inner layer). Pay attention that you use the right cup for hot drinks.

Use plastics with recycling codes (2), (4) or (5); avoid plastics with recycling codes (3) and (7) which probably contain BPA. (These codes are usually marked on the bottom of the package.)

ANILINE



1) Where can it be found?

Mainly in rubber, rubber toys, paints, colorants, varnishes; less in photographic developers, herbicides, aroma and explosives; in food (corn, grains, beans, rhubarb, apples, black tea, rape in animal feed); in tobacco smoke and natural fire smoke.
The smell of rotten fish is typical to aniline.

2) For what is it used?

Aniline is an important raw material used in the production of polyurethane and other chemicals, and as a solvent. Aniline dyes are used for colouring clothes (mainly blue jeans), leather, wooden furniture and wooden floors.
In pharmaceuticals, aniline is used for producing paracetamol.

3) How does it get into the human organism?

Through the respiratory tract - food, drinks - and/or skin.

4) How does it impact the human organism?

Possible carcinogen and mutagen. Causes irritation and hypersensitivity of skin, respiratory tract and eyes. Oral ingestion of aniline causes irritation to the digestive tract, nausea, vomiting and diarrhoea.
Long-term aniline intoxication causes methaemoglobin (haemoglobin that does not have ability to bind oxygen) which causes skin to turn blue.
Aniline in larger amounts is very toxic, causing difficulty in breathing, dizziness, headache, cardiac arrhythmia, cramps, methaemoglobin, spleen damage; in extreme cases (toxic dose 50-500 mg/kg), also coma and death.

5) How does it impact other living beings?

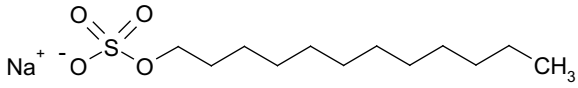
In nature (mainly in the air and shallow water) aniline decomposes in sunlight in a few hours to different phenols and nitrobenzenes that may damage plants. It contributes to the creation of the ground level/tropospheric ozone layer that also damages plants as well as other living beings. Aniline hinders plant germination. In the soil aniline is decomposed by microorganisms in 10-20 days. Large amounts of undecomposed aniline are very toxic to water organisms. Algae are able to decompose aniline but fish, can only do so to a small extent.
Aniline is not a bioaccumulating compound but it can end up in groundwater more easily than other pollutants as it does not bind in soil as readily.

6) What can you do to avoid hazards?

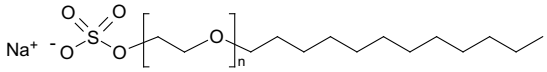
Use as few rubber materials containing aniline as a raw material as possible. When selecting paints, choose mineral paints that do not contain either lead or chrome. Do not smoke or stay in the room where others smoke. Aniline is also present in tobacco smoke.
Do not burn plastic or rubber.

SODIUM LAURYL SULFATE and –ETHER SULFATE

Abbreviation: SLS
Chemical structure:
Other names: Duponol; sodium dodecyl sulfate, SDS.



Abbreviation: SLES
Chemical structure:
Other names: sodium laureth sulphate.



1) Where can it be found?

In 90% of products that foam: shampoos, hair dyes, bath and shaving foams, toothpastes, mouthwashes, liquid soaps, floor cleaning and dishwashing products. In non-foaming products: emulsions (in cosmetics), mascaras, moisturizing body lotions, bleaches.

2) For what is it used?

Effective and cheap surfactants and foaming agents. Good degreasers. To make topical creams dissolve better and foster their absorption in the skin. To a small extent SLS is used as toxicant for virus protection and in medicine as a purgative. In biochemistry SLS is used as a cell membrane decomposer in order to separate DNA and proteins from cells.

3) How does it get into the human organism?

Penetrates through skin to blood circulation system and from there to organs, where it remains for several days.

4) How does it impact the human organism?

Irritates eyes, throat, skin and digestive system. May cause headache, nausea, vomiting, allergic reactions; skin and hair dryness, scalp getting greasy fast, dandruff, hair loss due to damaged hair follicles. Causes comedos (clogged hair follicles – pores - in the skin). Damages liver, lungs, heart, brain and immune system. When a product contains both SLS and SLES together with mono-, di- and/or triethanolamine, that forms nitrosamines that foster generation of cancer cells. In The production of SLES forms carcinogenic by-products (ethylene oxide and 1,4-dioxane) that may also end up in the finished product.
SLS reduces the ability to taste "sweet" in the mouth, especially after brushing teeth. Using oral hygiene products containing SLS causes mouth ulcers to heal more slowly.

5) How does it impact other living beings?

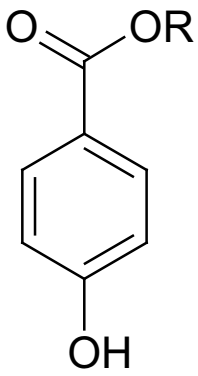
Insects: washes off the protective layer of insects and as a result SLS and SLES can enter into insect´s body. There they disturb the function of cell membranes and cause leakages inside cells causing death of the insect.
Birds: SLS washes off the water-repellent layer of birds' plumage. As a result the water can get between the feathers. That means their feathers no longer hold enough warmth, which can lead to hypothermia in colder climate.
Fish: SLS is slightly toxic to nematodes and plathelminths, moderately toxic to freshwater fish and invertebrates.
Plants and bacteria: Damages to cell membranes hinder the growth of bacteria and plants and may cause their death. Other organisms: SLS and SLES increase the solubility of pollutants; as a result, larger amounts of pollutants end up in living organisms.

6) What can you do to avoid hazards?

- Avoid using products containing SLS and SLES.
- After using products containing SLS and SLES, carefully rinse skin, hair and mouth.
- If your skin has a tendency to form pimples, stop using skin care products containing these substances.
- SLSA - sodium lauryl sulphoacetate – is a safer alternative for SLS and SLES). Ammonium lauryl sulfate (ALS) is almost as unhealthy as SLS and SLES.
- Don't be misled by a product information sheet where says that SLS is produced from coconut oil, thus is safe.
- To avoid SLS and SLES getting into nature – soil, water, atmosphere - channel water you have washed with into the sewerage or water purification system.
- Always wash the car in places allocated for that purpose, not in nature. Especially avoid washing cars near lakes, rivers, etc.

PARABENS

Examples:
methylparaben; E218
ethylparaben; E214
propylparaben; E216



(R = alkyl group, i.e. methyl)

1) Where can parabens be found?

Cosmetics and personal care products: body and face creams, sunscreens, (roll-on) deodorants, hair care products, cosmetics, tooth paste. Baby and "natural" products.
Food products: processed meat, baked goods, snacks.
Parabens can be found in natural state in some plants, for example, blueberries.

2) For what are parabens used?

Parabens are used as inexpensive preservatives against proliferation of bacteria, mould and other microbes. Compared to other preservatives, the effectiveness of parabens comes from their non-species specificity.
In EU countries the content of one paraben in a product can be up to 0,4%.

3) How do they get into the human organism?

Absorbed through skin. Orally.

4) How do they impact human organism?

Parabens may cause skin irritation, rashes.
Fosters skin aging and DNA damage when reacting with UVB-radiation.
Disrupts endocrine system functions:

- Females - parabens have an oestrogen(female sex hormone)-imitating effect; this hormone plays an important role in the formation of breast cancer.
- Males - causes decrease in number of spermatozoids; can lead to formation of testicular cancer.

5) How do they impact other living beings?

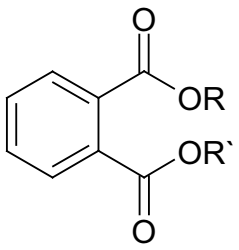
Mammals and insects: parabens reduce reproductive function.
Lower organisms: changes permeability of cell membranes and function of proteins located in membranes; as a result the microorganism cannot develop nor reproduce.

6) What can you do to avoid hazards?

To protect yourself and nature, choose products that do not contain parabens. In many cases, an alternative to parabens can be salicylic acid and benzoic acid (so-called natural preservatives, found in many berries) or some plant oils (thyme, oregano, rosemary, golden root, lavender).
If the product range does not have any paraben-free products, then choose a product that contains parabens with shorter alkyl groups (i.e. methylparaben). The latest are more easily soluble in water, thus do not accumulate in the organism and are therefore less hazardous.

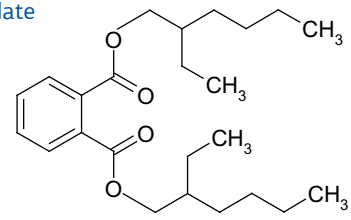
PHTHALATES

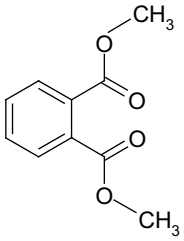
Chemical structure of phthalates



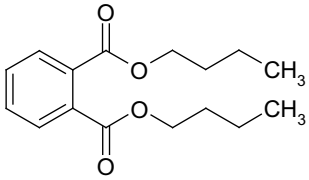
Examples:

bis(2-ethylhexyl)phthalate





dimethyl phthalate



dibutyl phthalate

1) Where can phthalates be found?

In cosmetic products – creams, body lotions, shampoos, hair sprays and gels, deodorants, perfumes, nail polishes; In soft toys, plastic and plasticized products (plastic packages, drinking bottles, films, plasticine, shower curtains, suitcases, shoe soles, fitness mats, folders and briefcases, imitation leather, book covers and bindings, PVC-floors, -windows, -doors, -roofs; wires, pipelines).
In detergents, home care products, car care products;
In wood finishing materials (paints, varnishes), glues.
Phthalates are not very strongly bound with plastics and, during the product´s life cycle, can easily be released into the environment.

2) For what are phthalates used?

As plasticisers, surfactants and binders, emulsifiers.
The main use is to make PVC (polyvinylchloride) plastics soft and flexible. Flexible plastic has ~30% of phthalates.

3) How do they get into the human organism?

Through skin and food. In infants, also through chewable toys.

4) How do they impact the human organism?

Phthalates disrupt, damage the endocrine system; exacerbate hives. Possibly generate overweight and breast cancer. Cause shortage of spermatozoids, increase formation of testicular cancer. In the foetal stage, they can have a harmful impact on the development of baby boys´ genitals and change the level of sex hormones. May cause premature birth; can cause nervous system development disorders of babies and later, even in teenagers.

5) How do they impact other living beings?

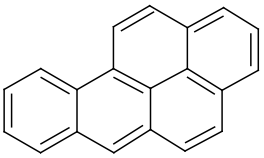
In higher organisms phthalates are bioaccumulating compounds. Toxic for mammals, aquatic animals and plants; shortens their lifespan and reduces reproduction. May change the behaviour of animals.
May be toxic also for microorganisms, but in general microorganisms are able to decompose phthalates.
Very high concentrations of phthalates have been found in sewerage sludge and wastewater of waste-water treatment plants, on the surface water of rivers, sediment of water bodies. Phthalates decompose in the air in 1-2 days, in soil and water during ~ 1 month.

6) What can you do to avoid hazards?

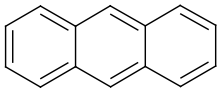
- Avoid PVC-products when building or reconstructing a house.
- There are many substitutes and alternatives for phthalates as plasticisers and PVC toys that contain phthalates – do not choose an unhealthy product.
- Use plastics with recycling codes (2), (4) or (5), because phthalates are often used in PVC-plastic with unsafe recycling code (3) These codes are usually marked on the bottom of the plastic packaging.
- Prefer wooden and textile toys to plastic toys.
- Read labels and limit the use of body care products, cosmetics and perfumes – thus limiting absorption of phthalates through skin.
- Be careful about the term „fragrance“ – these products may contain phthalates.
- Clean home regularly with vacuum cleaner with HEPA filter (or use moist cloth) to reduce exposure to phthalates through dust. A HEPA filter can prevent a large number of tiny particles that other vacuum cleaners allow to re-enter your home indoor air.
- Phthalates are already banned in plastic toys meant for children under 3-years old. In the European Union, they have been banned in the since 2015. Buy children's products produced in the EU.

POLYCYCLIC AROMATIC HYDROCARBONS

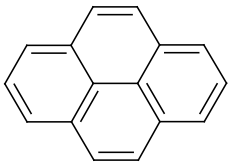
Abbreviation: PAH
Examples:



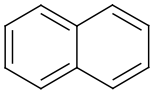
benzopyrene



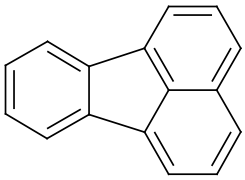
anthracene



pyrene



naphthalene



fluoranthene

1) Where can PAHs be found?

PAHs are found in paints, varnishes, car care products, wood preservatives, cosmetic products containing mineral oil. In residues of incompletely burned wood, gasoline, coal and oil, wood and coal tar, asphalt. In exhaust gases of motor vehicles, fireplaces, tobacco and incense smoke, smoke and soot coming from burning of car tyres and impregnated wood.
In smoked, grilled or roasted food (mainly in fatty meats). In some cooking oils and edible fats.
As PAHs are lipophilic compounds, they accumulate well in fatty tissues of plants and animals and do not accumulate in tissues with high water content (thus transmission from soil to root vegetables is scarce).

2) For what PAHs are used?

PAHs are not directly used or produced industrially but they are generated during heating or burning processes which contaminate the end product.

3) How do PAHs get into the human organism?

From eating food (mainly fatty meat) that is smoked, grilled or roasted.
In vegetarian food, most PAHs can be found in the waxy surface of vegetables (peel, leaves) due to surface adsorption.
PAHs also end up in the human body through breathing polluted air and contact with products containing PAHs.

4) How do PAHs impact the human organism?

Not all PAHs are carcinogens, mutagens and teratogens – PAHs with a smaller number of aromatic nuclei are less hazardous.
When PAHs get on the skin they may cause redness, blisters and/or scaling, in long-term contact skin cancer; when inhaled, may cause lung cancer; after ingesting contaminated food, may cause liver and/or stomach cancer. During pregnancy, high levels of PAHs in the organism can cause premature birth, low birth weight and heart malformation of babies, lower IQ level during childhood, behavioural difficulties and asthma.

5) How do PAHs impact other living beings?

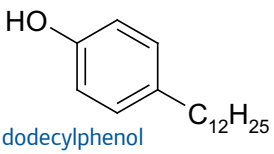
PAHs do not dissolve completely in water, therefore their impact to marine organisms is little. In nature, PAHs decompose through photosynthesis over a period of days or months.
High PAH content in the ground disturbs reproduction and development of invertebrates and may cause formation of cancer. They have toxic impact on animals (including water birds) in an aquatic environment

6) What can you do to avoid hazards?

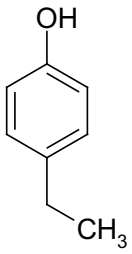
To reduce contamination of food with PAHs: choose leaner meat and fish for grilling (PAHs bioaccumulate mainly in fatty tissues) and avoid contact with open fire (heat source should be placed over the food, rather than under it, so that the fat does not drip onto the open fire); cook food for longer periods, at lower temperatures. Do not burn the food!
Do not stay in the same room with smokers and do not smoke yourself.
Choose mineral oil-free cosmetics and shampoos; water-based wall and ceiling paints.
Prefer hardwoods for indoor fireplaces and make sure that the fireplace gets enough air. Do not burn petroleum products!

ALKYLPHENOLS

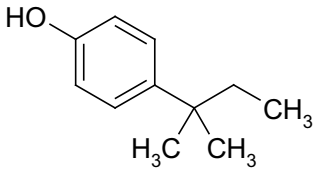
Examples:



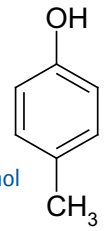
dodecylphenol



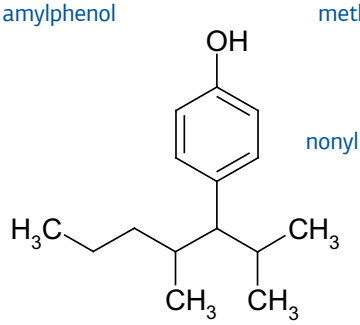
ethylphenol



amylphenol



methylphenol



nonylphenol

Methylphenols are also called *cresols* and ethylphenols *xylenols*.

1) Where can they be found?

In household detergents and cleaning products, car washing and car care products, emulsions, cosmetic and hygiene products; in textiles, varnish, paints, degreasers, pesticides, medicines. In the production and treatment process of cellulose, plastic and metal. In lesser amount in tyres, copying paper, rubbers. Commercially most important alkylphenolethoxylates are nonylphenol ethoxylates (NPE); octylphenol ethoxylates (OPE) are less common. More than half of nonylphenol ethoxylates used end up via sewerage in wastewater and effluent of wastewater treatment plants; they travel from there to natural water-bodies and aquatic organisms. As a result of decomposition of alkylphenothoxylates in wastewater treatment plants, more persistent and toxic alkylphenols like nonylphenols (NP) and octylphenols (OP) are formed.

2) For what are they used?

Mainly to stabilize emulsions (medicines, cosmetics, body lotions and creams; mayonnaise and some other food products), in production of surfactants and polymers, as perfume.

3) How do they get into the human organism?

Orally, from food and drinking water; through skin when using cosmetic products; through contact with consumer goods.

4) How do they impact the human organism?

Alkylphenols imitate oestrogen (female sex hormone), thus damaging the human hormonal balance. Degradation products of nonylphenol ethoxylates and octylphenol ethoxylates disturb hormone function, cause formation of tumours (breast, testicular, prostate cancer) and impact the development of the nervous system. They foster early puberty, obesity, the development of diabetes, cause infertility problems (reduce male fertility and the size of testicles, lower sperm quality).

5) How do they impact other living beings?

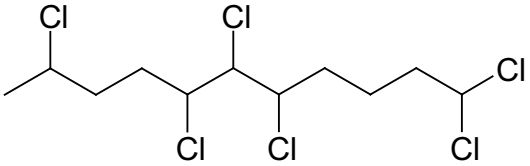
As alkylphenols are fairly persistent and accumulate in fatty tissue, they are bioconcentrating compounds. They have harmful impacts on the reproduction of fish (decreased number of roes, reduced fertility of fish eggs, unviable or abnormal foetuses) as well as mammals.

6) What can you do to avoid hazards?

Avoid cosmetic and textile products that are produced outside EU; these can contain alkylphenols. However, pay attention to the fact that many EU companies have production units outside Europe. Choose textiles with eco-labels (EU Flower or Öko-Tex 1000) because the use of alkylphenothoxylates is prohibited when so labelled. In the European Union and a number of other countries, cosmetic products that contain 0,1% or more nonylphenols or nonylphenol ethoxylates are prohibited. Also, in the EU, the use of octylphenol ethoxylates has been limited and nonylphenols are prohibited in plant protection products.

CHLORINATED PARAFFINS

Abbreviation:
SCCP (short chain chlorinated paraffins, C10-13)
Examples of names: *polychlorinated alkanes, chlorinated waxes, chloroparaffin*



1) Where can SCCP be found?

In paints, varnishes, plastic toys, floor coverings, insulating materials (of wires), conveyor belts, imitation and animal leather. In metal industry in coolants and lubricants used in cutting the metal.

2) For what are SCCP used?

As a plasticiser, flame-retardant agent. Can also be in products as an unwanted by-product.

3) How do they get into the human organism?

Through skin. Orally from food (meat, fish, crustaceans, fats) and drinks (mainly milk); in case of infants, by chewing plastic toys.

4) How do SCCP impact the human organism?

Accumulates in the body, especially in fatty tissue. Possible carcinogen (additional research is needed to confirm it).

5) How do SCCP impact other living beings?

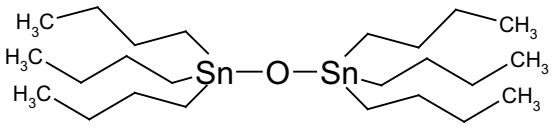
Ends up in nature when products wear off, wastes are improperly handled; from industry when producing SCCP. Has same impact on vertebrates as on humans – bioaccumulating (especially in fatty tissue of freshwater fish) and as a carcinogen mainly causing liver, thyroid and kidney cancer). Causes thinning of birds´ eggshells so embyros may not survive.
Harmful and toxic for aquatic plants (algae) and invertebrate aquatic organisms.

6) What can you do to avoid hazards?

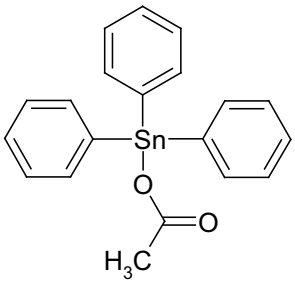
Choose products that do not contain SCCP. Alternatives for SCCP are medium (MCCP, *medium chain chlorinated paraffins*; C_{14-17}) and long (LCCP, long *chain chlorinated paraffins*; $C_{17-...}$) chain chlorinated paraffins. Depending on use, some natural oils and esters are suitable alternatives.
Sort wastes! Take plastic products to designated collection points or containers.
The production and use of SCCP should be limited. Telling a salesclerk *why* you are choosing an alternative will help promote the marketing of safer products.

ORGANOTIN COMPOUNDS

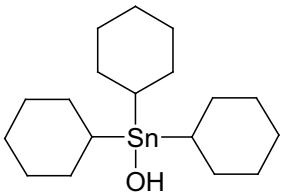
Examples:
tributyltin oxide – wood preservative.
triphenyltin acetate – insecticide, fungicide.
tricyclohexyltin hydroxide – pesticide (kills mites, ticks).



tributyltin oxide



triphenyltin acetate



tricyclohexyltin hydroxide

1) Where can they be found?

In biocides (chemicals that kill living beings), polyurethanes (polymer), silicones, PVCs (polyvinylchlorides), paints, glass (including glass bottles) surfaces; in carpets, textile.

2) For what are they used?

As catalysts when producing polyurethanes and silicones, for avoiding decomposition of PVC products, covering glass against micro cracks; as a toxicant in marine paint used on ships' hulls to prevent fixating of barnacles, which in turn lowers resistance and thus fuel consumption; as a fungicide in carpets, textile, wood; as a pesticide to protect citrus, grapes and other fruits, potato, sugar beet, pecan nuts, vegetables and hops coming from outside the European Union.

3) How do they get into the human organism?

From contaminated food and water, through skin (i.e. baby diapers) and respiratory tract. They are bioaccumulating compounds.

4) How do they impact human organisms?

Most organotin compounds damage the liver, nerve cells and immune system and have a negative impact on reproductive function. They cause headaches, dizziness, amnesia, hyper-excitability and convulsions. Acute poisoning results in severe skin irritation and renal dysfunction. The anorganic form of tin is generally non-toxic but its organic compounds are toxic. The biological impact of organotin compounds depends primarily on the number and type of organic compounds bound with the tin atom. The toxicity of organotin compounds reduces when the number of alkyl-groups decreases and the alkyl-chain lengthens (i.e. most toxic are tin compounds with three alkyl-groups that have short chains; trioctyltin compounds are considered safe). The best-known and most toxic organotin compounds are trimethyltin, triethyltin and tributyltin (TBT).

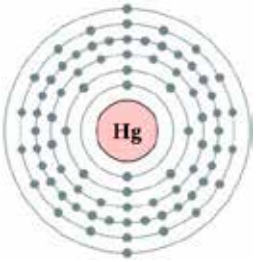
5) How do they impact other living beings?

The wide use of organotin compounds in the composition of coating paints of ships has caused a global problem not only in sea waters but also in fresh waters. These compounds are persistent and remain in sediments for a very long time. In mammals, they cause liver necrosis (death of liver cells) and hemolysis (disease, in which erythrocytes are decomposing faster than the organism can produce them in bone marrow). In small mammals and fish, they harm reproductive function (e.g. sperm cells do not develop the tail or their mobility is damaged). May cause sex change from female to male fish. Organotin compounds are extremely toxic to some sea organisms (e.g. whelks), damaging their reproductive function and development even in a concentration of 1 nanogram per litre. Also, small concentrations are lethal to barnacles, preventing their attachment to hulls treated with organotin compounds.

6) What can you do to avoid hazards?

Avoid home products containing PVC (floor coverings, shoe soles, rainwear, vinyl carpet; T-shirts with PVC-print, bags, beach balls, cycling shorts, shower curtains, earplugs); that will help to reduce the amount of organotin compounds in the air and dust in your home. Avoid clothes and shoes labelled as "anti-fungus" (against fungus) and so-called allergy-free pillows. Choose eco-labelled (e.g. Nordic Swan eco-label, German Öko Test) diapers and hygiene products for women. Research! Get information about producers and their environment and health policy. Step-by-step, prohibiting organotin compounds on an international level reduces their environmental impact. In the EU, the use of organotin compounds in marine paints was prohibited in Since 1 July 2010, the EU has prohibited the use of tributyltin and trifenyltin compounds in products with tin concentration over 0.1% percentage by weight.

MERCURY



Symbol: Hg

1) Where can it be found?

In Hg-cathodes (used when producing alkali and chlorine), light sources (fluorescent lamps used, for example, in liquid-crystal (LCD) displays of laptops; high-intensity discharge (HID) lamps used widely for lighting streets, secured areas and parking lots; compact fluorescent lamps a.k.a. energy-saving bulbs), diffusion vacuum pumps, measuring devices (thermometers, barometers, manometers), valves, switches; in batteries, accumulators, rectifiers; in paints; in dental amalgam (usually contains 50% mercury, 22-32% silver, 14% tin and 8% copper), cosmetics and vaccines. In thermal power plants that use coal and gas as fuel and in industrial processes that help to produce gold, steel, cement; from textile industry. Mercury is released to the environment from different natural processes: volcanic eruptions, weathering of rocks. Most mercury pollution comes from the particles emitted to the atmosphere from thermal power plants and other combustion plants and their fallout to the ground. Through wastewater, Mercury originating from dental amalgam ends up in sediments which may be used in agriculture, for example.

2) For what is it used?

As a fungicide and pigment in paints, as a disinfectant; in medicine and industry, as a catalyst in the production of polyurethanes (polymers); as a preservative in vaccines and cosmetics; as part of a filling in dentistry; for producing ultraviolet lights; for calibration in science.

3) How does it get into human organism?

Primarily from eating fish (Hg does not occur in plant products unless the plants/fields have been sprayed with compounds containing Hg). From the atmosphere (uptake by humans is around 80%). Absorption through skin. Mercury is a metal that accumulates in the body of living beings. Chemical and physical properties – persistence, mobility or toxicity depending on the chemical form of Hg. In nature, Hg can occur in different chemical forms, e.g. Hg(0), Hg(II), metthylmercury (MeHg), dimethylmercury (Me_2Hg), vermilion (HgS). The soluble form of Hg (e.g. mercury chloride, methylmercury) is toxic and particularly hazardous, less hazardous when insoluble.

4) How does mercury impact human organisms?

Damages DNA, chromosomes (causes Down syndrome); individual organs (especially kidneys); nervous system, causing disorders and reduction of perception, thinking and the ability to learn, feeblemindedness, amnesia, muscle un-coordination. Causes changes in vision, deafness, allergic reactions (eye irritation, skin rashes, fatigue, headache), vomiting and/or diarrhoea. Acute and chronic intoxication is life-threatening. As Hg^{2+}-ions are able to penetrate the placenta; areas contaminated with Hg are characterized by a high rate of neonatal mortality. Has negative impact on generative power (sperm damages, birth defects and miscarriages). Excretion of Hg from human organism takes at least 70 days, from fish ca 2 years. The lethal dose (in case of single intake) of soluble Hg-compounds for humans is ca 200-300 mg.

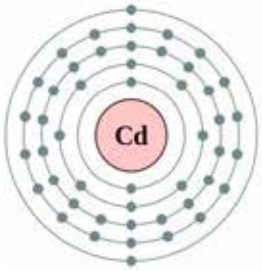
5) How does it impact other living beings?

Due to long half-life (a few months until a couple of years), mercury vapours may spread to long distances and deposit both in soil and water. Microorganisms switch during their metabolic processes inorganic mercury into the composition of organic compounds, which generates extremely toxic dimethylmercury $(CH_3)_2Hg$ and methylmercury ion CH_3Hg^+. Hg content in natural water increases at around pH-value 5-7, because at that pH level Hg-salts present in ground are more soluble in water. This makes Hg more "accessible" to organisms (e.g. Hg present in ground may accumulate in mushrooms). In fish, methylmercury damages intestines, the nervous system and kidneys, and causes indigestion, reproductive disorders and DNA mutating. Methylmercury accumulates in fish as well as in crustaceans and animals eating fish (including humans).

6) What can you do to avoid hazards?

Choose products that contain extremely little or preferably no mercury or its compounds. Hg-free products for lighting equipment and batteries/accumulators are available. Exceptions: button-cell batteries; Hg can amount up to 2% of the weight). Measure body temperature using a thermometer that does not contain mercury (e.g. based on thermistor, gallium-indium-tin-alloy or alcohol). This reduces the danger of inhaling Hg vapours, if the thermeometer should break and also prevents mercury from ending up in nature. In dentistry choose filling(s) that do not contain an amalgam. Legislation limits industrial and commercial applications of mercury. The use of Hg in consumer products is reducing. The majority of chloralkali factories are becoming unprofitable or are at the end of their technical life-time, therefore the industry has voluntarily agreed to shut down most factories based on mercury use in the European Union by 2020. Old technologies are being replaced by modern and environmentally-friendly technologies.

CADMIUM



Symbol: Cd

1) Where can it be found?

In accumulators, batteries, fusible alloys (e.g. wood alloys), semiconductor materials, phosphorus fertilizer, cement, plastics, diesel fuels, internal combustion engines; in control rods of nuclear reactors; in wastewater treatment plant sludge. Cd is generated as a by-product in production of non-ferrous metals (zinc, lead, copper).
In nature, mainly in rocks as erosion allows the metal to be emitted to the environment, but it also reaches the atmosphere as a result of volcanic eruptions, forest fires and various industrial enterprises and thermal power plants.

2) What is its purpose?

To protect metals from corrosion: it has good covering power and plasticity (e.g. a 0.05 mm thick layer gives sufficient corrosion protection in seawater). To stabilize plastics. In ceramics and glass industry, mainly to get a yellow hue and as (reprographic) colour pigment in developing and copying machines.

3) How does it get into human organism?

From food – mainly vegetarian food; from animal products – kidneys, liver, molluscs. When inhaling contaminated air (mainly cigarette smoke), cadmium enters the blood circulation more easily than from food.

4) How does it impact the human organism?

Bioaccumulative (accumulates mainly in kidneys, liver, hair), release from organism is extremely slowly (half-time is 13-38 years). Cadmium is a mutagen and carcinogen that penetrates placenta. It can irreparably damage the central nervous system and kidneys (damage is irreversible; kidneys are not able to remove acids from the body). Disturbs the calcium and phosphorus metabolism, which results in muscle weakness. Causes loss of minerals from bones, leaving them softer and weaker and causing bone pain. Cadmium poisoning is known as *itai-itai* disease (named after a Japanese river). It is approximately 10 times more toxic than lead. Acute poisoning from cadmium vapours/dust causes flu-like symptoms: chills, fever, cough, runny nose, dizziness, weakness, headache and muscle pain; in severe cases, bronchitis, pneumonia, pulmonary oedema and chest pains. The sense of smell can be lost.

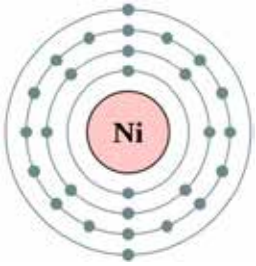
5) How does it impact other living beings?

In freshwater, Cadmium absorbs mainly in suspended solids. In sediments, it's a relatively mobile metal but exists mainly in a form that is not absorbable by living beings. Cadmium accumulates mainly in plants, where it disturbs the flow of enzymatic processes, causes smaller growth of plants, lighter colour of leaves (changes in chloroplasts), reduced activity of photosynthesis and lower yield. But cadmium is a necessary trace element for some seawater diatoms.
Cadmium is extremely toxic for earthworms (and other invertebrates living in soil), killing these organisms even in the case of very low concentrations.
Causes similar damages to vertebrates and humans: damages kidneys, bones, central nervous system, immune system and DNA (reduces reproductive function and increases the risk of cancer).

6) What can you do to avoid hazards?

Wash fruits and vegetables carefully. Do not eat fruits that have grown near motorways (the distance from motorway should be at least 100 m).
For growing vegetables, use soil with pH value that is not below 6.5 and that is not mixed with wastewater treatment plant sludge. Do not use phosphorus fertilizers.
Avoid the liver and kidneys of older animals in foods.
Sort wastes (certainly separate batteries and accumulators from other waste materials). Do not burn plastics and rubbers. Do not smoke.

NICKEL



Symbol: Ni

1) Where can it be found?

In alloys (mainly steel and special alloys), rocket engines, propellers of marine engines, nickel-plated (i.e. covered with nickel) metallic objects and jewellery, coins, electric guitar strings, microphones, magnets, accumulators, green coloured glass, some detergents; in cigarette butts, cigarettes and their smoke.
In nature, mainly as part of iron ore and clayey soil.

2) For what is it used?

As corrosion protection of metal surfaces. For making magnets (nickel has magnetic properties). Nickel compounds are used as colorants (green, blue tones) in glasses, as catalysts in synthetic chemistry and in the food industry (e.g. hydrogenation of oils for making margarine).

3) How does it get into the human organism?

From inhaling contaminated air and eating food. Through skin. Nickel-rich foods are beans, dried tea-leafs, chocolate and margarine.

4) How does it impact the human organism?

Essential a microelement (mainly component of active centres of enzymes), but in larger amounts it's hazardous both to health and environment.
Causes contact allergy (more on women than men), hypoxia (oxygen deficiency of an organism or individual organs or tissues), prostate cancer, birth defects (teratogen) and cardiac disorders.
Air contaminated with nickel (near cooking oil refineries) causes respiratory diseases and cancer ("safe" is considered to be the amount of nickel and/or nickel compounds up to 0.2 µg/m^3 that is inhaled during 15 to 364 days).
Nickel's bio-effect to organism depends on its chemical and physical form. In general, eating or drinking low amounts of nickel compounds are considered to be safe, but inhaling (ca 100 times more hazardous) the dust of nickel compounds (nickel tetracarbonyl, nickel oxide, nickel sulphide) causes severe health problems.

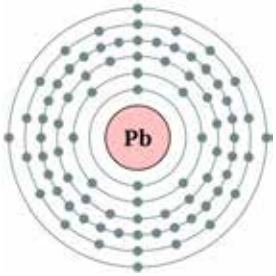
5) How does it impact other living beings?

Nickel is an essential microelement in both plant and animal organisms. Bioaccumulation in animal organisms is low but plants accumulate this metal very well. Only very high nickel concentrations in the soil damage the metabolism of plants (reducing photosynthesis power and growth). Excessive nickel hinders the number and growth of some vegetarian insects, zooplankton and algae. In vertebrates nickel causes lack of appetite, convulsion, gastritis (stomach mucosa inflammation), hypoxia (oxygen deficiency), smaller growth; in fish, balance disorders and death. One of the characteristics of nickel intoxication of fish is the low content of glycogen in muscles and liver and the increase of lactic acid and glycose concentration in blood.

6) What can you do to avoid hazards?

Do not buy nickel-plated jewellery and metallic objects. Use neutral or alkaline soil for growing vegetables because nickel is absorbed better taken up by plants in acidic soil. Do not smoke - either actively or passively!

LEAD



Symbol: Pb

1) Where can it be found?

In lead accumulators, solder lead, in the material covering cables, in computer and TV screens, detonators, buckshot, bullet cores, covers and screens protecting from radioactive radiation, oil(paint) pigments, paints protecting against corrosion, crystal glass, enamels, sailboat keels, organ pipes, printing plates. Ends up in environment mainly when mining and treating ores and minerals. The smoke and ashes generated by burning of coal and naphtha contains lead.

2) For what is it used?

Lead is used because of its softness, low melting temperature, poor electrical conductivity, high density, good corrosion protection and cheapness. Lead additive in alloys changes alloy´s properties (e.g. improves durability). Lead is used in accumulators for generating electrical current. In divers' belts and sailboat keels, lead is used as weights. Lead additive in computers and television screens absorbs hazardous radiation. In additional to radiation protection, lead also absorbs, therefore, lead sheets are used for making rooms soundproof. In the ceramics industry, lead compounds are used for getting red and yellow hues.

3) How does it get into the human organism?

From food, drinking water and inhaling dusty air. Dissolved lead compounds are toxic and have a sweet taste. The usual amount of lead in fresh undried food products is up to 0.02-3 mg/kg, in drinking water 0.01-0.03 mg/l and in atmosphere 0.03-0.1 mg/m^3. In the case of lead contamination, these indicators can be several times higher.

4) How does lead impact the human organism?

Damages nervous system (especially hazardous for children, slows down mental and physical development), kidneys and genitals. Accumulates in bones and brain and is released from there very slowly. Acute lead intoxication (lead content in blood 500–800 µg/l) causes fatigue, sleepiness, headache, irritability, joint pains, gastro-intestinal ailments, lack of appetite, weight loss; impaired memory, prolongs response time of movements, induces muscle weakness in fingers, wrists and ankles. Lead reduces the dehydratase activity of delta-aminolevulinic acid, which is an essential enzyme for generating haemoglobin; as a result, the number of red blood cells decreases in the organism. Lead acetate [$Pb(CH_3COO)_2$] and lead phosphate [$Pb_3(PO_4)_2$] foster cancer formation. Lead penetrates the placenta and damages the foetus, which may result in miscarriage, premature delivery or low birth weight.. School age children affected by lead can be small in size and have mental development disorders. Acute lead intoxication (lead content in blood 1–1.2 mg/l in adults, 0.8–1 mg/l in children) causes headache, muscle tremors and pains, stomach ache, hallucinations. One characteristic of lead intoxication is a thin, grey-blue line visible along the margin of the gums, at the base of the teeth (so-called Burton line) or a vague metallic taste in the mouth.

5) How does it impact other living beings?

Large lead amounts in soil damage plants. As a rule, lead does not accumulate in plants. Algae are resistant to the hazardous impact of lead as lead accumulates in the algae cell wall and does not move further from there. Lead may kill some soil bacteria and fungus, that in turn causes proliferation of bacteria and fungus that are less sensitive to lead. Among aquatic organisms molluscs accumulate the highest amount of lead in their body. In vertebrates, lead is mainly accumulated in bones, liver, kidneys and brain; in fish, mainly in skin and gills. The darkened or black tail part and scoliosis (deviation of the vertebral column in transversal direction) of fish may indicate lead intoxication. Lead intoxications of birds are mainly connected to swallowing of lead shot, which often kills the bird. The most lead-sensitive animals are dogs and horses; less sensitive are mice and rats. Domestic animals that live outside and clean their fur often (dogs and cats) are the most threatened by lead intoxication.

6) What can you do to avoid hazards?

Do not grow fruits and vegetables closer than 30 meters to a motorway. For growing vegetables, use soil that has high humus content and alkaline reaction (in soils with alkaline reactions lead is least assimilated by plants). Use liming to increase soil alkalinity. Do not buy gasoline that does not correspond to European Union requirements (e.g. cheap gasoline imported illegally from Russia that most likely contains tetraethyl lead $Pb(C_2H_5)_4$ – very toxic, easily volatilised organometallic liquid, abbreviation: TEP; when using leaded gasoline, lead travels from the internal combustion engine to outdoor air). Old ceramic dishes in red and yellow tones most likely contain lead – do not use these for serving or storing food. When purchasing ceramic items, make sure that it is not painted with lead-containing paint. In old buildings, check which paints have been used.

ANNEX II

INGREDIENTS USED IN PRODUCTS

Explanation for using the table: Ingredients used in products

NB! The table of ingredients is the working document of Baltic Environmental Forum and could be used as supporting material for conducting practical work during the lessons in school. Table is not comprehensive and the ingredients which are classified as hazardous is the expert opinion of Baltic Environmental Forum and Tallinn University.

Ingredients ENG A-Z: Ingredients are given by English names in alphabetical order

Meaning of colours used in the table:

	hazardous substance, harmful impact proven; may cause damage to health
	potentially hazardous substance; additional reseach needed to prove harmful impact
	no damage to health
-	no harmful impact, no damage to health or environment
Antioxidants	Substances which are added to cosmetic products to inhibit reactions promoted by oxygen, thus avoiding oxidation and rancidity.
Emollients	Substances which are added to cosmetic products to soften and smooth the skin.
Emulsifying agents	Substances which are added to cosmetic products and which are surface-active agents that promote the formation of intimate mixtures of immiscible liquids.
Chelating agents	Substances which are added to cosmetic products to react and to form complexes with metal ions which could affect stability and/or appearance of cosmetics.
Solvents	Substances which are added to cosmetic products to dissolve other components.
Surfactants	Cleaning agent, foam forming agent, degreasing properties. They reduce the surface tension of the water so it can wet the fibres and surfaces, they loosen and encapsulate the dirt and in that way ensure that the soiling will not re-deposit on the surfaces.
Preservatives	Natural or synthetic substance that hinders spoiling of the product. Substances which are added to cosmetic products for the primary purpose of inhibiting the development of micro-organisms therein.
Herbal extracts	Extract (polysaccharide, xanthan gum, oil), that is extracted from herbal matter. In the name of the extract is usually given the latin name of the plant from which the extract is taken (i.e. Chamomilla Recutita Extract, Echinacea Purpurea Juice). As a rule, herbal extracts used in products are harmless (some herbal extracts that are used as fragrance may cause allergy for some people).
Chemical is not in the table	As there are thousands of different chemicals used in consumer products then in this table we have presented mainly the most used hazardous chemicals. You can also find some broadly used non-hazardous chemicals from the table. If chemical is not mentioned in the table then most probably it is harmless chemical.

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Ingredients used in products (in English in alphabethical order)

Nr.	Name of the ingredient in English		Why added to the product? Purpose	Impact to human	Impact to environment and/or other living beings
1	1,2 - Hexanediol		Preservative	Contact with skin, eyes or inhalation may cause irritation	No information about significant impact. Harful impact is not proven.
2	1,4-dioxane; (1,4-Diethyle-neoxide; by-product of ethylene oxide)		Pollutant that is generated in the course of producing surfactants (ethoxylation); also such surfactants as PEG compounds can be polluted with it	Cancerogenic substance that is easily sucked into skin. May cause eye and skin irrita-tion and damage nervous system, liver and kidneys.	May be irritating or poisonous for animals in certain amounts. Damage to environment, persis-tent and bioaccumulative.
3	2-ethoxyethyl acetate		Solvent	Retards fertility, harmful in case of inhalation, swallowing and skin contact, also harmful for fetus.	
4	2-methoxyethanol, 2-ethoxyethanol		Solvent	Retards fertility, harmful in case of inhalation, swallowing and skin contact, also harmful for fetus.	
5	3-Benzylidene camphor (3 BC)		UV-filter	Damages endocrine system, accumulates in living organisms (i.e. breast milk) and environment.	Persistent and bioaccumulative in the environment
6	4-Methylbenzylidene camphor (4-MBC)		UV-filter	Damages endocrine system, accumulates in living organisms (i.e. breast milk) and environment.	Persistent and bioaccumulative in environment
7	Acrylates copolymer		Emollient (softener), thickener, film former	Akrylates are strong irritants. Substance may be toxic in case of skin contact.	Harmful for environment, especially for fish.
8	Allantoin		Skin moisturizing active agent. Oral care substance.		

Nr.	Name of the ingredient in English		Why added to the product? Purpose	Impact to human	Impact to environment and/or other living beings
9	Ammonium Laureth Sulfate		Surfactant, cleaning agent, foam former.	Harmful impact is proven. Skin and mucosa irritant, predisposes brickle hair. Irritates and dries skin.	
10	Ammonium Lauryl Sulfate (ALS)		Surfactant, cleaning agent, foam former.	Harmful impact is proven. Skin and mucosa irritant, predisposes brickle hair. Irritates and dries skin.	
11	Ammonium Xylenesulfonate		Surfactant, agent that regulates viscosity		
12	Amyl Cinnamal		Fragrance	May cause allergy. Is included in the list of 26 allergenic fragrances that have to be marked on the packaging in EU.	
13	Aniline		Different colors and pigments. Chemical that is forbidden or with limited use in case of toys.	Very toxic, cancerogenic and mutagenic. Irritates skin, eyes, respiratory system. Incurs nausea, vomiting and diarrhoea. Longer term intoxication causes development of methemoglobin (hemoglobin without the ability to bind oxygen) an as a result of that skin turns blue.	Sunlight causes in few hours degradation to different phenols and nitrobenzenes that may harm plants. Partly responsible for the creation of earthbound ozone layer.
14	Anionic surfactant		Surfactants consists of two parts: hydrophobic (water repellent) and hydropfilic (water absorbing). Hydrophobic part consists of noncharged carbohydrates' group, based on hydrophilic part substances are classified into different groups (anionic, nonionic, cationic and amorphous surfactants). If surfactant´s hydrophilic part is from negatively charged group like sulphonate, sulfate- or carboxylate, then that kind of surfactant is called anionic.	A lot of anionic surfactants (like ammonium lauryl sulfate or ammonium lauryl ether sulfate etc) irritate and dry skin and their harmful impact has been proven.	
15	Anise Alcohol		Fragrance	May harm human immune system, allergen.	
16	Aqua		Solvent		
17	Arginine Hydrochloride		With moisturizing properties, antistatic substance		

Nr.	Name of the ingredient in English		Why added to the product? Purpose	Impact to human	Impact to environment and/or other living beings
18	Azocolourants		Different colours and pigments. Chemical that is forbidden or with limited use in case of toys.	Cancerogenic, cause allergies	
19	Beeswax		Softener, moisturizes skin, thickener, surfactant.		
20	Benzyl Alcohol		Preservative, fragrance, solvent; Ingredient of jasmine, hyacinth and other plants. Syntethically made from petroleum or coal tar.	May cause allergy. Is included in the list of 26 allergenic fragrances that have to be marked on the packaging in EU. Possible effects of the substance are vomitting, diarrhea, irritation of eyes and skin.	
21	Benzyl Benzoate		Preservative, fragrance, solvent	May cause allergy. Is included in the list of 26 allergenic fragrances that have to be marked on the packaging in EU. May also cause headache.	
22	Brominated flame retardants		Flame-retardants	Persistent, bioaccumulative, toxic; Some of them have been classified also as cancerogenic, toxic and damaging reproduction; some damage endocrine system.	
23	Butylparaben		Preservative	Endocrine disrupting chemical. Causes sensitivity.	
24	Butylphenyl Methylpropional (LILIAL)		Syntetic fragrance	May damage human immune system. Allergen. May be toxic in certain amounts, may damage endocrine system.	Persistent and bioaccumulative
25	Butyrospermum Parkii (Shea Butter)		Softener, natural moisturizer, thickener, maximizes viscosity.		
26	C10-C30 alkyl acrylate crospolymer		Emulsion stabilizer, boosts viscosity		

Nr.	Name of the ingredient in English		Why added to the product? Purpose	Impact to human	Impact to environment and/or other living beings
27	Cadmium		Colour and pigment: gives yellow colour. Used for covering metals to avoid corrosion and for stabilizing plastics.	Bioaccumulative. Muta- and cancerogenic, penetrates placenta. Damages central nervous system and kidneys. Disturbs calcium and phosphorus metabolism. Causes demineralization of bones that results in bone softening and weakening causing bone pains. Toxic when inhaled, damages fertility, disturbs the development of child' s brain. Use is forbidden for example in toys.	Causes smaller size of plants, lighter colour of leaves, lower production. Highly toxic for invertebrates living in soil. invertabrates have similar damages as humans.
28	Calcium carbonate		Abrasive (abrading) substance		
29	Caprylyl Glycol		Preservative. Moisturizer, softener.		
30	Carrageenan (polysaccharide from red algae)		Thickener, emulgator.		
31	Cellulose Gum		Binder, emulsion stabilizer, film former, viscosity regulating substance		
32	Cetearyl Alcohol		Emollient lubricant, skin conditioner), stabilizator, tranparency reducing substance, viscosity regulating substance, foam former.		Probably toxic to environment
33	Cetyl Alcohol		Emollient lubricant, skin conditioner), stabilizator, tranparency reducing substance, viscosity regulating substance, foam former.	Believed to be toxic or harmful for humans	Believed to be toxic to environment
34	Chlorhexidine		Preservative	Irritating (irritates eyes and skin), may cause allergies and change the colour of teeth	
35	Chromium		Colour and pigment give green colour	Cancerogenic, mutagenic, toxic: causes severe inflammations, damages fertility. Use is forbidden i.e. in toys	
36	Cinnamyl Alcohol		Fragrance	May cause allergy. Is included in the list of 26 allergenic fragrances that have to be marked on the packaging in EU.	
37	Citrate		Buffering agent/chelating agent/ fragrance/pH regulator		

Nr.	Name of the ingredient in English		Why added to the product? Purpose	Impact to human	Impact to environment and/or other living beings
38	Citric Acid		Buffering agent/chelating agent/ fragrance/pH regulator		
39	Citronellol		Fragrance	May cause allergy. Is included in the list of 26 allergenic fragrances that have to be marked on the packaging in EU.	
40	Cl + number (nt Cl 19140)		Colorant	Many colorants may be harmful, cause skin and mucosa irritation. As a rule colorant is colored coal tar.	
41	Cl 42090 (disodium salt)		Hairdye		
42	Cl 45100 (sodium salt)		Hairdye		
43	Cl 77891 (titanium dioxide , titanium(IV)okxide (TiO2)		Cosmetic colorant		
44	Cocamide DEA		Emulgator, emulsion stabilizator, surfactant, viscosity regulating substance, foam booster	Substance may cause cancer, allergy and be toxic	
45	Cocamidopropyl Betaine		Surfactant, viscosity controlling substance	May cause skin irritations, allergy, reddness of eyelids	
46	Coumarin		Fragrance, masking substance (reduces or inhibits the basic odour or taste of the product)	May cause allergy. Is included in the list of 26 allergenic fragrances that have to be marked on the packaging in EU. Known as human endocrine disruptive chemical for humans or allergen. Use in food is forbidden	
47	Cyclohexasiloxane		Emollient (lubricant, moisturizing skin conditioner), solvent, moisturizer, hair conditioner, softening substance	There are some evidence that it may be toxic or harmful for organisms	Persistent, bioaccumulating substances for wildlife: assumably toxic or harmful for organisms and to environment.
48	Cyclopentasiloxane		Emollient, solvent, moisturizer, hair conditioner, softening substance	There are some evidence that it may be toxic or harmful for organisms and may be endocrine disrupting chemical	Persistent, bioaccumulating substances for wildlife: assumably toxic or harmful for environment.
49	Decyl Glucoside		Surfactant, cleaning agent, emulsion stabilisator		

Nr.	Name of the ingredient in English		Why added to the product? Purpose	Impact to human	Impact to environment and/or other living beings
50	Diazolidinyl urea		Preservative, antiseptic	May emit formaldehyde that is very toxic and causes dermatitis (allergy), strong skin irritant and allergen	
51	Diethanolamine		Emulgator (substance that fosters formation and staying of emulsion), pH-regulator	Has been associated with allergic reactions and eye irritation. Irritates skin. Allergen. Presumably toxic and harmful.	Possible toxic impact to organisms
52	Dimethicone		Silicon used for moisturizing, anti-foam substance, emollient	Forms on skin a layer that does not let skin to breath or exit residues. If a product that contains this substance is used extensively then it may accumulate in liver and lymph nodes and at the end start forming tumours	
53	Disodium EDTA (EDTA)		Stabilisator, chelating agent, viscosity regulationg substance	Fosters absorbtion of substances. Accumulates in organism.	Accumulates in the environment
54	DMDM Hydantoin		Preservative	May emit formaldehyde that is very toxic and causes dermatitis (allergy), strong skin irritant and allergen	
55	Ethylene oxide (used to “ethoxylate” SLS), 1,4 Dioxane (by-product of ethylene oxide, could be indicated by the following suffixes in the ingredient list: “myreth,” “oleth,” “laureth,” “ceteareth,” any other “eth,” “PEG,” “polyethylene,” “polyethylene glycol,” “polyoxyethylene,” or “oxynol”		Surfactant, washing agent	Cancerogenic, toxic impact to brain and central nervous system, kidneys and liver	Byproduct 1,4-dioxane is one of the main groundwater pollutants
56	Ethylhexylglycerin		Deodorant / skin conditioner	Irritates skin	
57	Ethylparaben		Preservative	Endocrine disrupting chemical	
58	Extract		Extract made of plant/herb; herbal name is usally given in latin in front of the word extract		

Nr.	Name of the ingredient in English		Why added to the product? Purpose	Impact to human	Impact to environment and/or other living beings
59	Formaldehyde		Preservative, antiseptic	Irritates mucosa and skin, may cause hypersensitivity, cancerogenic. Maximum allowed formaldehyde content in finished products is 0,2% and any product with higer content than 0,05% has to include a warning that product contains formaldehyde.	
60	Fragrance (Perfum, Aroma)		Fragrance, perfume, flavor. General indication of fragrances. In fact we do not know what substances are hidden behind that name. It is always worth to be sceptical if you find this name in the ingredients list. In case these compounds are not of natural origin then they may contain solvents and denaturant substances, for example pthalates, that are not obligatory to be marked on the label.	Allergy hazard, irritates skin, accumulates in the environment, organism and breast milk, some may damage endocrine system.	May be ecotoxic and accumulate in environment
61	Glycerin		Solvent, emulgator, emollient (lubricant, moisturizing skin conditioner), moisture preservant		
62	Glyceryl Glucoside		Skin moisturizing substance		
63	Glyceryl Stearate		Emulgaator, emollient		
64	Glycol Distearate		Emollient (lubricant, moistirizing skin conditioner), emulgator, transparency reducing substance, viscosity regulating substance		
65	Hexyl Cinnamal		Fragrance	May cause allergy. Is included in the list of 26 allergenic fragrances that have to be marked on the packaging in EU.	
66	Hydrogenated polydecene		Softening agent, solvent, emmolient, moisturizing		
67	Hydrogenated Polyisobutene		Emollient, thickener		
68	Hydroxypropyl methylcellulose		Binding agent, emulsion stabilizator		

Nr.	Name of the ingredient in English		Why added to the product? Purpose	Impact to human	Impact to environment and/or other living beings
69	Imidazolidinyl urea		Preservative	May emit formaldehyde that is very toxic and causes dermatitis (allergy), may cause allergic reactions	
70	Isopropyl Myristate		Binding agent, softening agent, solvent, skin conditioner, fragrance	May case irritation of skin, eyes and lungs.	
71	Laureth-4		Emulgator, surfactant	May contain potentially hazardous production residues. May case irritation of skin, eyes and lungs.	
72	Lead		Colour and pigment: gices white colour. Used in ceramics industry to get red and yellow colour. Changes the properties of alloys. Radiation protection.	Use is forbidden for example in toys. Cancerogenic. Damages nervous system, kidneys and reprductive organs. Impacts developing brain. Causes fatigue, headache, irritability, joint pains, disorders of gastrointestinal tract, lack of appetite, weight loss; worsens memory, extends reaction time of movements, wreaks muscle weakness in fingers, wrists and ancles. One indication of lead poisoning is grey-blue longitudinal stripe with black lining on gums (so-called Burton Line) or unusual metallic taste in mouth.	Damage photosynthesis ability and balance of water and minerals of plants. Very toxic organic lead compounds could be formed during the life activities of bacteria
73	Limonene		Fragrance	May cause allergy. Is included in the list of 26 allergenic fragrances that have to be marked on the packaging in EU.	
74	Linalool		Fragrance	May cause allergy. Is included in the list of 26 allergenic fragrances that have to be marked on the packaging in EU. In case of swallowing is slightly toxic, irritates skin and eyes, may damage liver.	
75	Methylchloroisothiazolinone		Preservative	May cause allergic reactions, inflammation of skin. Is associated with mutagenicity.	
76	Methylisothiazolinone		Preservative	May cause allergic reactions, inflammation of skin. Is associated with mutagenicity.	
77	Methylparaben		Preservative	Endocrine disrupting chemical. Causes sensitivity.	Reduces reproductive function of mammals and also bugs

Nr.	Name of the ingredient in English		Why added to the product? Purpose	Impact to human	Impact to environment and/or other living beings
78	Mineral Oil		Moisturizer, emollient, skin protection, solvent	Possible immune system toxicant or allergen.	
79	Nano titanium dioxide, nano zinc oxide		Nanoparticle	Possible toxic impact on cells. Accumulates in organism - health risks are not known at the moment	
80	Nitromusks, polycyclic musks		Fragrance	May cause allergy, irritate skin, damage endocrine system, accumulate in organism and breast milk.	Accumulate in the environment and do not disintegrate.
81	Nonylphenol (ethoxylates)		Plastic stabilizators, surfactants in textile processing. Chemical that is forbidden or with limited use in case of toys.	Endocrine disrupting chemicals, accumulate in the environment	
82	Octamethylcyclotetrasi-loxane		Softening and moisture preserving substance	Endocrine disrupting chemical	Persistent, bioaccumulating ssubstances in the environment . Haermful for the environment.
83	Octyl methoxycinnamate (OMC, Ethylhexylmet-hoxycinnamate, Octinoxate)		UV-filter	Damages endocrine system, accumulates in living organisms (i,e breast milk) and the environment	Persistent and bioaccumulative in the environment
84	Octyl-Dimethyl- para-Ami-nobenzoic-Acid PABA (OD-PABA)		UV-filter	Biochemical or cellular level changes, multiple additive exposure sources, can cause photo allergic reaction.	
85	Organotin compounds		Plastic stabilizators, usually found in transparent plastic. Chemical that is forbidden or with limited use in case of toys.	Irritate eyes and skin. Damaging impact on fertility, in case of swallowing also to central nervous system, endocrine system and reproductive system.	
86	Oxybenzone (Benzophe-none-3)		UV-filter	Causes biochemical or cellular level changes. Damages endocrine system. Accumulates in living organisms (i.e. breast milk)	Persistent and bioaccumulating in the environment
87	Palm Acid		Transparency reducing substance, surfactant		
88	Palm Kernel Acid		Transparency reducing substances, surfactant		
89	Palmitic Acid		Emollients, emulgators, film formers		
90	Panthenol		Moisturizing antistatic		

Nr.	Name of the ingredient in English		Why added to the product? Purpose	Impact to human	Impact to environment and/or other living beings
91	Paraffinum Liquidum (Paraffin oil, liquid oil hydrocarbons, wax)		Moisturiser, emollient, skin protection, solvent	Possible immune system disturbers and/ or allergens. Accumulate in lungs, liver and lymph nodes.	
92	Parfum		Fragrance, perfume, flavor. General indication of fragrances. In fact we do not know what substances are hidden behind that name. It is always worth to be sceptical if you find this name in the ingredients list. In case these compounds are not of natural origin then they may contain solvents and denaturant substances, for example pthalates, that are not obligatory to be marked on the label.	Allergy hazard, irritates skin, accumulates in the environment, organism and breast milk, some may damage endocrine system.	May be ecotoxic and accumulate in the environment
93	PEG - X (PEG 10, PEG-12, PEG-40 etc.) PEG-compounds, ethylene oxide's polyethylene glycols or polymers where X is the average number of monomeric ethylene oxide units (i.e. PEG-10)		Softener (softens and smoothens skin), moisturiser (moisture preserving substance), emulgator	PEG-compounds may be polluted with 1,4-dioxane, ethylene oxide, lead or arsenic and thus may be cancerogenic and toxic to humans. Disturb natural moisture balance of skin by brining out natural oils from skin.	
94	PEG 40 Hydrogenated castor oil		Surfactant, emulgator	May be polluted with 1,4-dioxane and for what reason may be cancerogenic and toxic	
95	Pentasodium Pentetate		Chelating agent		
96	Pentylene Glycol		Preservative, solvent		
97	Perfluorinated chemicals (PFC)		Repels water, grease and dirt.	Cancerogenic, damage fertility	
98	Phenoxyethanol		Preservative, fragrance	May irritate skin, eyes and lungs. Neurotoxic. Allergen.	

Nr.	Name of the ingredient in English		Why added to the product? Purpose	Impact to human	Impact to environment and/or other living beings
99	Phthalates: di(2-ethyl-hexyl)-phthalate (DEPH), dibutyl phthalate (DBP), benzyl butyl phthalate (BBP), di-isononyl phthalate (DINP), – di-isodecyl phthalate (DIDP), di-n-octyl phthalate (DNOP)		Plasticiser , mainly tracable in soft plastic and granules used as filling of cuddly toys; May be used as stabilisator for fragrances. Chemical that is forbidden or with limited use in case of toys.	Damages development and endocrine system, inhibits fertility.	
100	Poloxamer 124		Emulgator/surfactant	May irritate skin, eyes and lungs	
101	Polyacrylamide		Antistatic substance, binding agent, film former		
102	Polyquaternium-10		Antistatic substance, film former		
103	Potassium Cetyl Phosphate		Surfactant		
104	Propylene Glycol		Moisturizing substance, solvent	May cause skin inflammations and rashes, dry skin, neurotoxisity of respiratory tract, allergy. Improves absorption of other ingredients.	
105	Propylparaben		Preservative	Endocrine disruptive chemical	
106	PVM/MA Copolymer		Antistatic substance, binding agent, emulsion stabilizator, film former		
107	Retinyl Palmitate		Antioxidant	Toxic for reproduction. Retinyl Palmitate consists of palmitic acid and retinol (vitamin A). UV radiation causes degradation of retinol compounds and releases toxic free radicals, that may damage DNA and cause gene mutations.	
108	Salicylic Acid		Preservative, antiseptic	Aborption of large doses my cayse vomitting, stomachache, skin rash. Allergic reactions and skin inflammations, teratogenic. People allergic to aspirin should avoid it.	
109	Silic acid, (hydrated silica)		Abrasive, absorbent, transparency reducing substance, viscosity regulating substance		

Nr.	Name of the ingredient in English		Why added to the product? Purpose	Impact to human	Impact to environment and/or other living beings
110	Sodium Benzoate (E211)		Preservative		
111	Sodium bicarbonate or sodium hydrogen carbonate (baking soda; E500)		Abrasive (abrading) substance, soral care product		
112	Sodium chlorate		Surfactant	Very toxic when swallowed	Harmful for environment
113	Sodium Chloride		Preservative, viscosity regulating substance	In large doses may be irritating and etching for skin	
114	Sodium Citrate (E331)		Buffering agent, chelating agent		
115	Sodium Cocoamphoacetate		Surfactant		
116	Sodium Fluoride		Anti-caries substance	May cause irritation of skin, eyes and lungs.	
117	Sodium Hyaluronate		Additive		
118	Sodium Hydroxide		Emulgator, alkali	Scalp inflammation, swallowing may cause vomitting, diarrhea.	May be hazardous to environment, mainly water organisms.
119	Sodium Laureth Sulfate (SLES)		Surfactant, cleaning agent	May cause slight irritation of skin and eyes, headache, nausea, vomitting, allergic reactions, formation of comedos. Damages liver, lungs, heart, brain and immune system. May cause formation of nitrosamines (foster creation of cancer cells).	Toxic to water organisms. Washes off the protective layer of insects and birds plumage. Slightly toxic to nematodes and plathelminths, moderately toxic to freshwater fish and invertebrates. Hinders the growth of bacteria and plants, may cause their death. Increases solubility of pollutants.

Nr.	Name of the ingredient in English		Why added to the product? Purpose	Impact to human	Impact to environment and/or other living beings
120	Sodium Lauryl Sulfate (SLS). Also knowns as Sodium dodecyl sulfate, Monododecyl ester, Sodium salt; Sodium salt sulphuric acid; Monododecyl ester sodium salt		Surfactant, cleaning agent, foam former	Irritates skin, mucosa. Fosters occuring of brittle hair. May cause headache, nausea, vomitting, allergic reactions, formation of comedos. Damages liver, lungs, heart, brain and immune system. Reduces cognition of sweetness in mouth after washing teeth.	Toxic to water organisms. Washes off the protective layer of insects and birds plumage. Slightly toxic to nematodes and plathelminths, moderately toxic to freshwater fish and invertebrates. Hinders the growth of bacteria and plants, may cause their death. Increases solubility of pollutants.
121	Sodium monofluorophosphate		Anti-caries substance	May harm organism in case of swallowing; overdose may damage tooth enamel	
122	Sodium Palm Kernelate		Surfactant		
123	Sodium Palmate		Surfactant, emolgator, viscosity regulating agent		
124	Sodium Polyacrylate		Viscosity regulating agent, absorbent, stabilizer, film former, emollient.	May cause skin irritation	
125	Sodium Saccharin		Additive, oral care substance		
126	Sorbitol		Moisturizing substance		
127	Stearic Acid [$CH_3(CH_2)_{16}COOH$]		Emulgator, emulsion stabilizator		
128	Stearyl stearate		Emollient, viscosity regulating substance		
129	Sucrose Stearate		Emollient, moisturizer		
130	Tetrachloroethylene (perchloroethylene)		Solvent	Presumably cancerogen, irritates skin	Harmful for environment
131	Tetrasodium EDTA		Surfactant, emollient, thickener		
132	Tetrasodium etidronate		chelating agent, emulsion stabilizator, viscosity regulating substance		
133	Tetrasodium pyrophosphate		Buffering agent		

Nr.	Name of the ingredient in English		Why added to the product? Purpose	Impact to human	Impact to environment and/or other living beings
134	Titanium Dioxide, titanium(IV)oxide, titania		Thickener, transparency reducing substance.	In aerosol form harmful in case of inhalation. Toxic and harmful for human health. Possible cancerogen	
135	Tocopheryl acetate		Antioxidant	May cause allergies, larger doses have caused tumours on test animals	
136	Triclosan		Preservative, antiseptic	May cause allergies and bacterial resistance. Damages endocrine and hormone system. Possible cancerogen if reacts with chlorine in water	Persistent and bioaccumulative in environment. Functions as biocide (chemical lethal to living organisms). Inhibits photosynthesis of diatoms. Causes hormonal, growth and development disorders of dolphins. Sunlight causes the formation of triclosan into chlorophenols and dioxines (both compounds strongly harm organisms, dioxines are one of the most toxic compounds). In nature microorganisms cause decomposition.
137	Triethanolamine		pH regulator, surfactant	May cause hypersensitivity. Longer exposure is very irritating and toxic.	
138	Trimethylolpropane Tricaprylate/Tricaprate		Emollient		
139	Trisodium EDTA		Chelating agent		
140	Xanthan gum (polysacccharide produced by bacteria)		Binding agent, emulsion stabilizator