ECOLECTIVOS
CONTRA CONTAMINACIÓN POR PLÁSTICOS

MODULE #2

A WORLD of plastic

Educational objective

In this unit, participants will learn about the origin of plastic: How and why was it created? How is plastic made? What is plastic made of? What is it used for? Participants will reflect on the advantages that plastic has over other materials and learn about the problems and negative impacts that this material has on our lives and ecosystems.

Competencies

- Recognize the advantages and disadvantages of plastic materials.
- Learn about the environmental risk and impact of the extraction, production, and use of plastic materials.
- Raise awareness about the importance of reducing the use of plastic.

Activity

Participants will be organized into groups of 4 or 6 people (depending on the number of members) to discuss the following questions, which will later be presented by a representative from each group to all participants:

- What are the reasons for the accumulation of plastic garbage in your community?
- How has the scenery or landscape changed in your community with the introduction of plastics?
- What plastic materials are used now that were not used in the past?
- What can you do in your homes to live in an environment free of plastic pollution?
- What can you do in your community to achieve an environment free of plastic pollution?

At the end of this activity, videos will be shown related to the topic.

Did you know...?

Poorly managed waste is polluting the world's oceans, clogging sewers and drains and contributes to flooding. Plastic waste can also allow vectors to breed (like mosquitos that breed in standing water) which can transmit disease. Burning plastic waste creates smoke that can increase respiratory problems. Plastic can harm animals that unknowingly consume the plastic. Unsightly waste can affect economic development, for example, through the reduction of tourism.

Introduction

Plastic is one of the most innovative, widespread, and common materials on our planet. Its presence has spread to all areas of the world, and it is a fundamental part of our lives. It is found in our environment and even in the food we eat. Some plastics are also essential for modern medicine and the transition to renewable energy.

But each year, more than 40% of plastics are destined for short-term usage, such as containers or packaging. These are designed to be thrown away, not reused. That's why plastic can be an advantage or a disadvantage and is governed by three main points: The first depends on which plastic materials are used to make certain objects. The second depends on the use we give to the objects. The third depends on what do we do with those objects after we have finished using them. In this module we will learn how plastic was created, what plastic is actually made of, and what purposes plastic serves. This will help us in the next few modules to understand the impact that different types of plastics have on each of us.

What did we use before plastic was created?

Although we find it hard to believe, many years ago synthetic plastic did not exist! Before this material was created, people made use of materials that already existed in nature, such as stones, rocks, minerals, plants, wood, shells, animal skins or parts such as ivory, and some natural resins like amber and rubber. Therefore, obtaining large quantities of these materials was very difficult, expensive, and obviously terrible for some animals during prehistoric times, a period that goes from the appearance of human beings to the first written records. The Stone Age, the Bronze Age and the Iron Age were periods when human beings discovered the use of these materials to improve their life conditions. Currently, we could say that we live in the Plastic Age. Plastic items are cheap, but they do not necessarily improve the conditions of our lives.

Reflection:

What plastic items are now used in your home that were previously made of other materials?

What is plastic?

Plastic is any substance whose main characteristic is the ability to be molded under various conditions, especially when heated. Plastic is created by adding carbon-based molecules to produce larger ones known as polymers. These molecules can be of natural origin, for example, cellulose, wax and rubber, or synthetic, such as nylon and polyethylene.

It wasn't until the 19th century, 200 years ago, that scientists created synthetic materials that would eventually be called plastic. The material considered the ***first plastic*** was produced by Mr. Charles Goodyear in 1839, who modified the rubber extracted from a tree, mixing and heating it with sulfur. This mixture remained dry and flexible at any temperature. This process became known as 'vulcanization', which has had many applications. One of these uses is car tires.

A few years later, in 1861, Alexander Parkes created a material that could be used in either a solid or fluid state, which could be rigid like ivory or flexible like rubber. It could be opaque or colored. It was also resistant to water and hard like metal. He called this material ***Parkesina,*** which was produced with castor oil. However, producing this was very expensive. In 1868, a company in the United States promised to give a prize to whoever could develop a product that could replace ivory, since this company manufactured billiard balls with elephant tusks, which is very cruel to elephants. John W. Hyatt improved Alexander Parkes' process, and developed a product that used camphor, a semi-solid crystalline substance found naturally in the camphor tree. This product was called ***celluloid.*** Thus, a large number of objects that were previously difficult to produce were produced using celluloid.

In 1907, Belgian-born American Leo Baekeland invented ***Bakelite,*** which was the first fully synthetic plastic substance, named after its creator. Bakelite was one of the first thermostable synthetic polymers, meaning that it is not destroyed by heat. This product can be shaped as it hardens. It does not conduct electricity, it is resistant to water and solvents, and it does not dissolve. Bakelite is easily 'machinable', which means that machines can be used to produce it. Bakelite can be shaped as it hardens and once it cools it cannot soften again. This differentiated it from other plastics that can be melted and molded multiple times. Leo Baekeland was followed by other scientists who experimented with various chemical processes to create similar substances for the manufacture of various products.

Commercial production of this first synthetic plastic, ***Bakelite,*** began in both Germany and the United States in 1910. During World War II, between 1939 and 1945, the production of plastics was further accelerated. War contracts expanded the infrastructure to produce items made from this material. For example, acrylics (used in the manufacture of aircraft), phenolics (various items that, due to their ability to withstand very high or low temperatures, are used in various products), PVC (such as pipes), and polystyrene (used in electrical and electronic systems, spare parts, packaging) were developed. The military helped certain companies obtain the necessary licenses to start the production of polyethylene (then an emerging industry). Polyethylene is used for gasoline tanks, cables, pipes, among others. As a result, during the 1940s, production rates in the United States increased more than sixfold.

Plastics and plastic fibers are evident in marine sediments, in samples taken off the coast of the sea, even in sedimentary layers formed before the war. Their presence increased dramatically after 1945, as plastics were introduced into consumer markets.

Where do we get the raw material to produce the plastic?

Most plastic is obtained through the distillation of petroleum, which is extracted from the ground and taken to refineries to begin a process called ***polymerization.*** Oil is a viscous liquid that was formed between 10 and 600 million years ago, when the remains of plants and animals buried in sediment. With the weight of water, earth, stones on top of this sediment, and combined with high temperatures inside the earth, these fossilized remains were transformed into petroleum, also known as fossil fuel.

- **Natural Compounds**
  Natural plastics don't need to be produced in a laboratory or factory, as they are made from organic materials, like animals and plants. Two examples of natural plastics are resins and rubber.

- **Semi-synthetic Compounds**
  Here two types of raw materials are combined, some come from nature and the others are created through chemical processes, An example of this is celluloid.

- **Synthetic Compounds**
  These substances are obtained through the polymerization of simple molecules. This means that long chains of carbon atoms are synthesized and give rise to a hot malleable substance that becomes resistant to heat. This chemical process is done in laboratories and factories

During the manufacturing of plastic, the use of these three different compounds will depend on the function, or use, of the object being manufactured.

Benefits

Plastic materials are versatile, that is, they are easily adapted to various uses, because they are light, can resist high and low temperatures without breaking, and can be created in large quantities at very low prices.

The latter means that plastic has advantages but also carries with it important disadvantages.

Disadvantages

Because many plastic objects can be created quickly and at very low costs, this material is one of the main sources of pollution on the planet. Due to its high resistance and its inability to biodegrade, which are advantageous characteristics while we are using it, when we discard it, we see a negative effect. Discarding plastic leads to high levels of pollution, mainly because it costs a lot, in economic and practicable terms, to get rid of plastic. For this reason, some plastics can spend centuries on earth in their original state. Plastic compounds have been found in human blood and urine. People ingest plastic through food and drink. How can this happen? Well, many foods and drinks come in plastic bottles or containers. Plastic substances can be transferred from these containers into food or drink. Additionally, if people burn plastic, the risk and danger of air and soil contamination increases. Ingestion and inhalation of plastic can damage our health.

Plastic is an environmental problem

According to the World Health Organization (WHO) in a 2018 report, globally 79% of plastic waste is found in landfills or indiscriminately thrown into the environment, while 12% is incinerated and only 9% is recycled. Each person's daily consumption of plastic will depend on their lifestyle, available economic resources, waste management systems, and awareness about the problem. Because plastic materials allow an infinite number of items to be manufactured quickly and at low cost, without being reused or recycled at the end of their use, the extraction of oil and the use of other materials to manufacture more plastic has rapidly increased. Manufacturing plastic also requires high levels of consumption of resources that are needed for its manufacture, like energy and water. Overproduction and excessive consumption produce negative impacts on the environment and each of us contributes to the problem. We can calculate our patterns and amounts of consumption using the ***ecological footprint.***

Figure: Own edition adapted from: Alexandra Barbu https://www.dreamstime.com/eco-carbon-footprint-carbon-footprint-defined-as-total-amount-greenhouse-gases-produced-to-directly-indirectly-image99690329

The **ecological footprint** is used to measure the environmental impact that a person, group or society creates through the demand for existing natural resources on our planet. This is compared to the capacity for these resources to regenerate and includes the ability to manage all the waste that resulted from using these resources. The more things are produced and the more we consume to meet our needs increases our ecological footprint. The bigger the footprint, the less likely that our planet can recover. The ecological footprint measures, for example, what types and how much food we consume, how it is produced, where it comes from, how it is packaged and how it is disposed of. The ecological footprint is calculated with the rest of the items that we use, which is directly related to our lifestyle and habits.

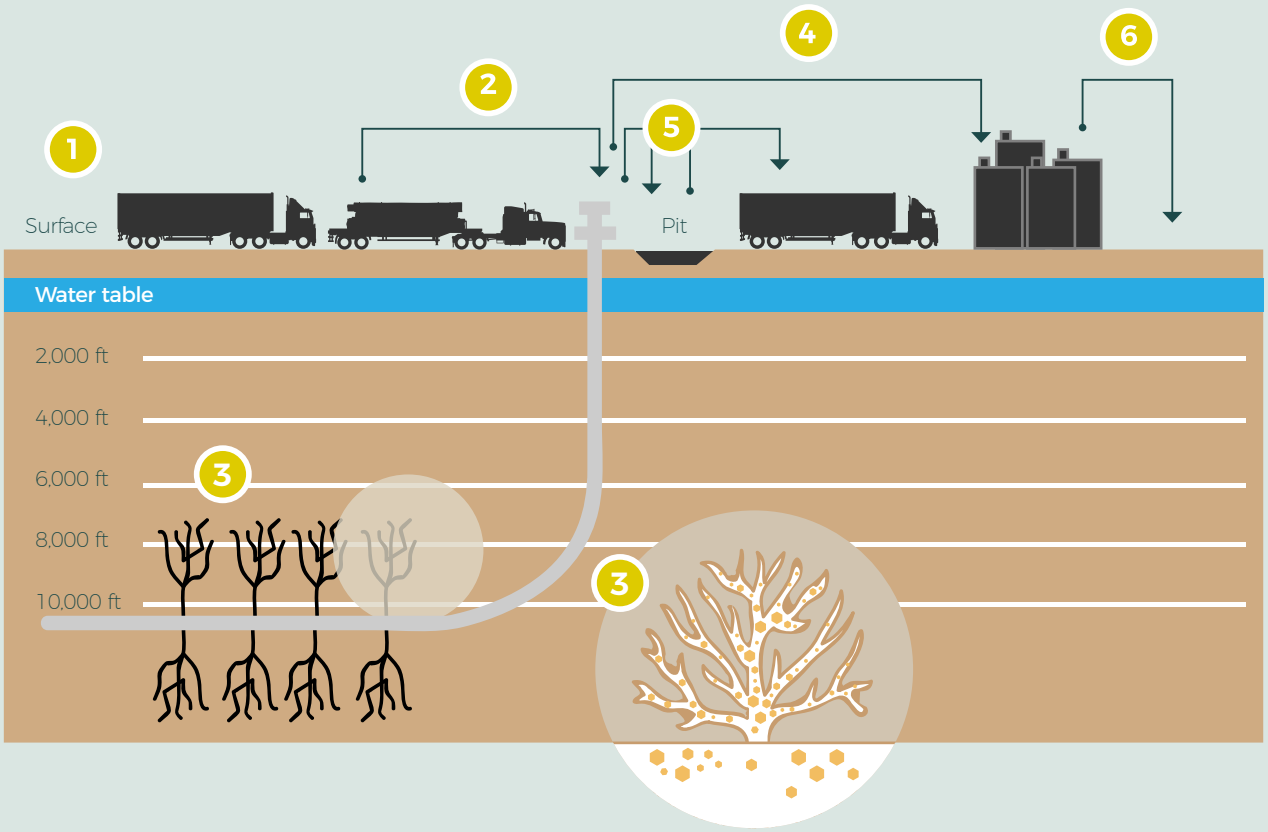
Reflection: **Look at the packaged items you buy and read the labels. Where were they made? What materials and/or ingredients are the packaging and content made from?**

Unconventional oil and gas production

Almost all plastic parts start out as fossil fuel, emitting greenhouse gases at every stage of the plastic life cycle:

- Extraction and transportation of fossil fuels
- Refining and manufacturing of plastic
- Plastic waste management
- Continued impact of plastic once it reaches water sources and land surfaces

Added up, the extraction of oil and gas through hydraulic fracturing (fracking) has a large negative environmental impact, since a large consumption of water and energy is required to extract the raw material from the subsoil, a process that has been increasing over time.



1. Water, sand, and chemicals are hauled to the well pad.
2. Well pad is prepared, drilled, and fracked.
3. Pressurized mixture causes the shale to crack, oil and gas to flow into the well.
4. Active extraction of oil, gas, and waste fluids.
5. Transmission, storage, and distribution of oil and gas.
6. Processed water, oil, and gas are hauled to treatment plants for use.

Figure: Adapted from: Plastic & Climate: The Hidden Costs of a Plastic Planet. https://www.ciel.org/wp-content/uploads/2019/05/Plastic-and-Climate-FINAL-2019.pdf

Glossary

Biodegradable

This refers to the natural process carried out by various substances or objects, which break down into other elements or types of organic matter, with the help of certain bacteria, viruses or fungi that help break down the materials. The duration and process of the biodegradation cycle will depend on the environmental conditions, the number of micro-organisms existing in the environment, as well as the material from which the object is made. An example of things that can biodegrade are fruits, vegetables, wood, and plants, among others.

Carbon

This is the main element needed for life to exist. Therefore, all elements or living organisms contain carbon. Many elements contain carbon, such as oxygen and sulfur. Wood is made of carbon, our body is partly (18%) made of carbon, and when we exhale, we exhale carbon too!

Rubber

This is an elastic polymer, which is generated as a milky emulsion (known as latex) in the sap of various plants. It can also be produced synthetically.

Synthetic materials

This is the name given to all the materials that have been created in factories or industries, mainly with oil. These materials can be very resistant and durable.

Polystyrene

This is a hard, solid plastic used to make many consumer products. It is generally used to make transparent packaging, such as food containers and laboratory equipment. When combined with various colorants, additives, and other plastics, polystyrene is used to make appliances, electronics, auto parts, toys, and more. This material is also manufactured in a foamed form, called expanded polystyrene (EPS), which is valued for its insulation and padding properties. It is used as household insulation and in appliances, automotive parts, and in many forms for food packaging and serving.

Physical properties of plastic

Plastics can be classified in different ways. How they behave in the heat is one of them. We thus distinguish three types:

- Thermoplastics
- Thermostable
- Elastomers

The main difference between ***thermoplastics*** and ***thermostable,*** is that the latter can only be melted and shaped once (at the time of manufacture). Once cooled, when heated again they burn instead of melting, making it impossible to work with that material again. This is because, when applying temperature to mold them the first time, the molecules become permanently linked. Therefore, thermostable plastics are rigid and highly resistant to heat. ***Bakelite*** belongs to this group!

Elastomers are characterized by their elasticity, which allows them to recover their initial shape after being altered. The elastomer molecules are called monomers, and they link together in a disorderly way, forming large chains. When the material is stretched, the molecules line up, and when released they quickly return to their original state. Elastomers can rarely dissolve or melt due to their tendency to return to their original state. Rubber (natural and synthetic), neoprene and silicone are examples of elastomers.

Homework Guide (Reflection Exercise)

MODULE #2: A WORLD of plastic

Oceans and plastics quiz questions

Instructions: Mark next to the statement if you think it is T or F

TRUE **T** FALSE **F**

T **F** 1. The oceans cover about 70% of the Earth's surface.

T **F** 2. Climate change and microplastics are threatening the life of the oceans.

T **F** 3. Each plastic bottle takes about 450 years to decompose. If that bottle is in a landfill, it takes about 1,000 years.

T **F** 4. In 2018, the global production of plastics was 359 million tons, a weight similar to the approximate weight of the world population.

T **F** 5. If plastic production continues at the same rate as right now, the oceans will have more plastic than fish by 2050.

T **F** 6. Most of the single-use plastic materials are recycled at the end of their use.

T **F** 7. Millions of birds, fish, whales, and turtles die each year from eating plastic found in the sea or on beaches.

T **F** 8. The main problem with plastic is that there are no other materials that can be used instead of plastic.

T **F** 9. Plastic items are good or bad depending on how we use them and how they are disposed of.

T **F** 10. Microplastics can get into our food and drinks without us realizing it.

1. true
2. true
3. true
4. true
5. true
6. false
7. true
8. false
9. true
10. true

"The world will not be destroyed by those who do evil,
but by those who watch them without doing anything".

Albert Einstein

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MODULE #2 A WORLD of plastic

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VISUAL SUPPORT

Contaminación por plástico: o cómo estamos convirtiendo el mundo en plástico.
https://www.youtube.com/watch?v=RTRxZvVcjfM
El plástico que te estás bebiendo.
https://www.youtube.com/watch?v=EyI-IFj0S_4