



## DO ALL PLASTICS DAMAGE THE ENVIRONMENT?

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### YOUNG REVIEWER:



REBECA

AGE: 10

Many of the objects we use every day are made from plastics that are created from petroleum. Not only is petroleum a limited resource that will run out 1 day, but petroleum-derived plastics break down very slowly in the environment, so they cause pollution. This is a critical problem because these plastics have been building up ever since humans first made them. This article will describe what plastics are and what we can do to tackle plastic pollution. One solution may be the use of bioplastics, which are a promising alternative to petroleum-derived plastics and can be used to create many of the same objects. Bioplastics do not cause pollution because they can be naturally broken down by microorganisms in the environment. What is plastic pollution and why is it unhealthy for our planet? Have you ever wondered why we should worry about plastic pollution? Is it already too late to help protect our planet from plastics? In this article, we will answer these questions and provide some suggestions to decrease the problem of plastic pollution.

## WHAT ARE PLASTICS?

### POLYMERS

These are materials composed of similar units "monomers" bonded together and repeated a large number of times.

#### Figure 1

(A) Plastic toys and other plastic items are made from long chains called carbon polymers. (B) Carbon polymers are composed of chains of building blocks called monomers. (C,D) There are various kinds of monomers that can form plastic polymers.

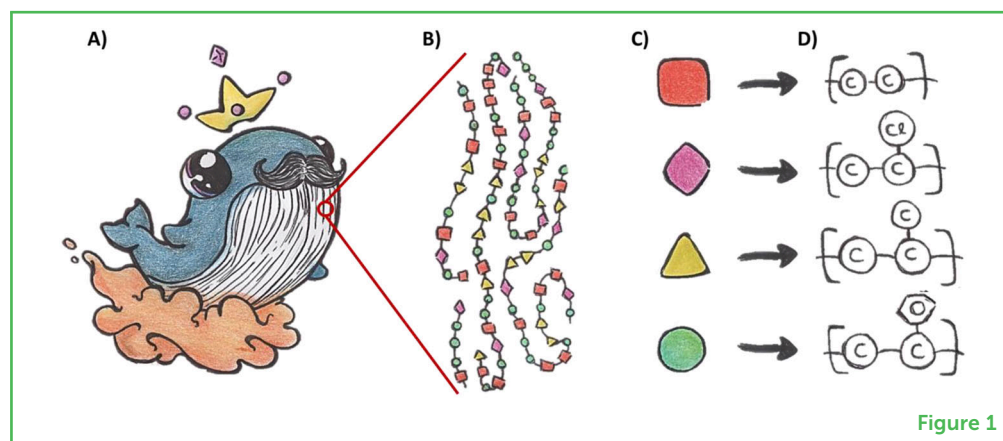


Figure 1

### MONOMERS

They are the building blocks or units that form a polymer. They have a specific chemical structure mostly composed of carbon.

### HOMOPOLYMERS

These are the polymers that only contain a single monomer unit repeated.

### COPOLYMERS

These are the polymer that contains more than one repeated monomer.

### PETROLEUM-DERIVED PLASTICS

Those are the plastics created from polymers derive from petroleum compounds.

Polymers can be classified into two types based on the kinds of monomers they contain. **Homopolymers** contain only one type of monomer. Plastics like polyethylene, polypropylene, and polystyrene are homopolymers. In contrast, **copolymers** are made of more than one type of monomer. Plastics like polyethylene terephthalate, and polybutylene succinate are copolymers. Homopolymer plastics have set properties such as hardness, flexibility, and heat resistance. However, the properties of copolymers are determined by the types of monomers that make them up, which allows us to create plastics with properties that suit our needs, by modifying the types of monomers they contain. This is great because it means we can produce various types of plastics to make toys, water bottles, food packaging, and grocery bags, to name a few common plastic items. We currently use plastics for so many purposes in everyday life that it is almost impossible to imagine life without them!

## IS IT HARMFUL TO USE PLASTICS MADE FROM PETROLEUM?

**Petroleum-derived plastics** are made using chemical processes that create carbon polymers from petroleum, which is a liquid mixture of oils and carbon compounds originated from fossils buried underneath. Petroleum-derived plastics are mainly used for packaging and protection, but they can also be used to create a variety of objects that are virtually everywhere around us, cellphones, computers, refrigerators, cars, televisions, pens, and toys are just a few examples. It is crucial to remember that petroleum is a non-renewable resource,

meaning that petroleum has a finite quantity on earth. Since petroleum is also used to manufacture other products like gasoline, diesel, and kerosene, we will only be able to make petroleum-derived plastics until this natural resource runs out. Since petroleum-derived plastics are man-made products, nature has a very difficult time breaking them down.

The high demand for plastic products results in the production of tons of petroleum-derived plastics. Many petroleum-derived plastics are designed to be used once and discarded, so they accumulate in almost all of the world's ecosystems. This results in plastic pollution, which is often called white pollution [1, 2] and it negatively affects the environment. For instance, plastics that have been improperly disposed of in natural areas such as forests, fields, rivers, and the ocean can remain in those ecosystems for years because neither nature nor animals can degrade them. Unfortunately, animals can eat plastics, but they are not able to degrade them, which sometimes causes them to get sick and die.

## WHAT CAN WE DO TO REDUCE PLASTIC POLLUTION?

We can do a lot of things to protect our planet. There are two main strategies to protect the environment from plastic pollution. The first is to follow the 3-R rule (reduce, reuse, and recycle). Reduce the amount of plastic you buy and use daily. Reuse by using plastic products more than once or giving them a new purpose. Recycle plastic products so they can be melted down and remolded into new products. The 3-R rule can be practiced in our homes, schools, and businesses. It is a simple and easy-to-adopt first step that everyone can use to reduce plastic pollution. The second strategy is to use a kind of plastics called **bioplastics**, which could replace all petroleum-derived plastics. Keep reading to find out more!

## WHAT IS A BIOPLASTIC?

Bioplastics are not as new as you might think. They have existed in nature for longer than petroleum-derived plastics have. Like petroleum-derived plastics, bioplastics are also carbon polymers, but they are synthesized by microorganisms in the environment, using **organic materials** (carbon materials done by nature) instead of petroleum. Since bioplastics are made from organic materials, we will not run out of their building blocks the way we eventually will for petroleum-derived plastics. In nature, microorganisms produce bioplastics as a way to store energy, and those microorganisms can then consume the microplastics through a process known as **biodegradation**. Biodegradation is similar to digestion [3, 4]. Biodegradation of bioplastics creates the energy microorganisms need

### BIOPLASTIC

A biodegradable plastic produced by microorganisms using organic materials.

### ORGANIC MATERIALS

Those materials mainly possess carbon, are done by nature, and also biodegrade by them.

### BIODEGRADATION

The biological process performed by microorganisms to break down organic materials into energy and carbon that can be used for other purposes.

to grow and breathe, and it produces carbon that they can use for other processes.

Bioplastics have properties similar to those of the petroleum-derived plastic products that are currently manufactured. Just like petroleum-derived plastics, the properties of bioplastics can be modified by changing the monomers they are made from. Bioplastics have one more big advantage: they are ecologically friendly and do not pollute the environment, even though bioplastics and petroleum-derived plastics look alike and can be used in the same ways. When bioplastics are discarded, microorganisms in the environment can biodegrade them [3, 4]. As a result, bioplastics do not contribute to plastic pollution. This makes bioplastics a great alternative, both for companies and for people like you who use plastic products. Bioplastics are being used today to produce packaging, artificial body parts, drug coating to medicine delivery, artificial skin and organs, and even clothing [3, 4].

Remember that in nature, bioplastics are easily recognized and biodegraded by microorganisms. Unfortunately, we cannot distinguish bioplastics from petroleum-derived plastics like microorganisms do. We have to use laboratory tests to identify them. So, we usually tag the products made from bioplastics to easily recognize them, making us easier to choose and use them over petroleum plastics.

## CONCLUSION

Now you know that bioplastics are an environmentally friendly alternative to petroleum-derived plastics. With this knowledge, we can add an R to the 3-Rs: reduce, reuse, recycle, and replace. Replacing petroleum-derived plastics with bioplastics may be the key to preventing even more plastic pollution. Science is advancing and uncovering a wide variety of bioplastics. Soon it will be up to all of us to preserve and protect the environment by using more bioplastics in place of petroleum-derived plastics.

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## REFERENCES

1. Ali, S. S., Elsamahy, T., Koutra, E., Kornaros, M., El-Sheekh, M., Abdelkarim, E. A., et al. 2021. Degradation of conventional plastic wastes in the environment: a review on current status of knowledge and future perspectives of disposal. *Sci. Total Environ.* 771:144719. doi: 10.1016/j.scitotenv.2020.144719
2. Raddadi, N., and Fava, F. 2019. Biodegradation of oil-based plastics in the environment: existing knowledge and needs of research and innovation. *Sci. Total. Environ.* 679:148–58. doi: 10.1016/j.scitotenv.2019.04.419
3. Kalia, V. C., Singh Patel, S. K., Shanmugam, R., and Lee, J. K. 2021. Polyhydroxyalkanoates: trends and advances toward biotechnological applications. *Bioresour. Technol.* 326:124737. doi: 10.1016/j.biortech.2021.124737
4. Shahid, S., Razzaq, S., Farooq, R., and Nazli, Z. H. 2021. Polyhydroxyalkanoates: next generation natural biomolecules and a solution for the world's future economy. *Int. J. Biol. Macromol.* 166:297–321. doi: 10.1016/j.ijbiomac.2020.10.187

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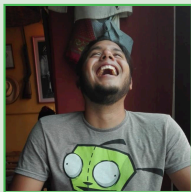
## YOUNG REVIEWER

**REBECA, AGE: 10**

Hello, my name is Rebeca and I am 10 years old girl. I enjoy science and mangá. Since I was very young I liked to mixture things to see if I can find a magical formula. My favorite character is Naruto.



## AUTHORS



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Hi, I am a Mexican student who enjoys drawing, painting, playing the piano, trying new foods, and traveling. I love photographing architecture, wildlife, plants, and animals when traveling across the world. I believe that humans are responsible for protecting nature. In addition, I have bachelor's and master's degrees in biotechnology and bioengineering. As a biotechnologist, I believe that bioplastics should be used in everyday life since they are one method to heal our planet. \*lottmar.palmag@cinvestav.mx



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I have been research assistant at the biotechnology and bioengineering department at Centro de Investigación y de Estudios Avanzados since 1982. I am part of a research group studying the production of biodegradable plastics using microorganisms such as bacteria and yeasts. Since I was a child, I have been interested in science, and my dream was to do everything possible to create a better planet in the future. I am sure that part of that dream is coming true. \*jalba@cinvestav.mx