

CLEANING THE AIR WITH MICROBES AND MAGNETIC FIELDS

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ALESSANDRO

AGE: 12



HARRY

AGE: 15

Microbes are tiny organisms, but when it comes to eating, they have powerful appetites. They even have a taste for harmful stuff. While eating harmful substances, they can help us clean the environment. We can use these hungry microbes to get rid of man-made contaminants present in the air we breathe, such as the pollutants called volatile organic compounds released into the air by certain industries. We can give microbes a boost with a magnetic field, stimulating their appetite and their growth, and thus making them even greater cleaners. Such magnetic fields have lots of helpful applications in our daily lives.

CHEMICAL AIR POLLUTION

Humans must take a breath every few seconds, without interruption, from the first to the last minutes of their lives. Air quality is thus

POLLUTANTS

Substances present in the air that cause harm to people and to the environment.

VAPORS

Gaseous substances which also exist as liquids in the environment (as water), contrarily to gases which can only be found in gaseous state (as the oxygen we breathe).

VOLATILE ORGANIC COMPOUNDS

Carbon-containing chemicals that exist both as liquid and vapor in everyday life and are toxic when people breathe them in. Examples include methanol and toluene.

EVAPORATE

Action of turning from liquid into vapor.

Figure 1

The most common chemical air pollutants can be gases or vapors like volatile organic compounds. Volatile organic compounds are produced by some industries, during fuel evaporation from vehicles, and in our homes, when we use cleaning or personal care products.

MICROBES

Tiny living things, like bacteria and fungi, that cannot be seen by the naked eye. Like all living beings, they need food to stay alive and grow.

MAGNETIC FIELD

The area around a magnet, where the magnet creates attraction forces for some objects, like iron pieces.

of prime importance for all of us. Unfortunately, several chemical **pollutants** can be present in the air we breathe (Figure 1). In everyday conditions, some air pollutants are considered as gases, as they are always in gaseous form (ozone, sulfur dioxide, and nitrogen dioxide, for example), while others are considered as **vapors**, as they can also exist as liquids. **Volatile organic compounds** can be found both as liquids and as vapors. Have you ever been to a gas station? Sometimes you can smell the fuel. This is because it contains volatile organic compounds. Part of the liquid fuel turns into vapor and reaches your nose. Volatile organic compounds are common air pollutants that can damage human health. Most of them are known to cause damage to the respiratory system (lungs and airways). Some affect other organs, like the kidney, eyes, and liver, or can even increase the risk of cancer. Volatile organic compounds are released by many industries, such as the chemical industry (Figure 1). Transport, like cars and trucks, can also release volatile organic compounds when fuel evaporates or does not burn completely. Such compounds can also be found in our homes, as liquid components of cleaning and beauty products [1]. They help the ingredients in personal care products to spread evenly, they work as disinfectants, and they make it easier to remove stains. For example, a chemical compound called rubbing alcohol is widely present in window and sink cleaners. When such volatile organic compounds are sprayed or applied on a surface, they quickly **evaporate** and vanish into the air. Good ventilation can remove pollutants from our homes. However, it is crucial to find new ways to treat industrial emissions.

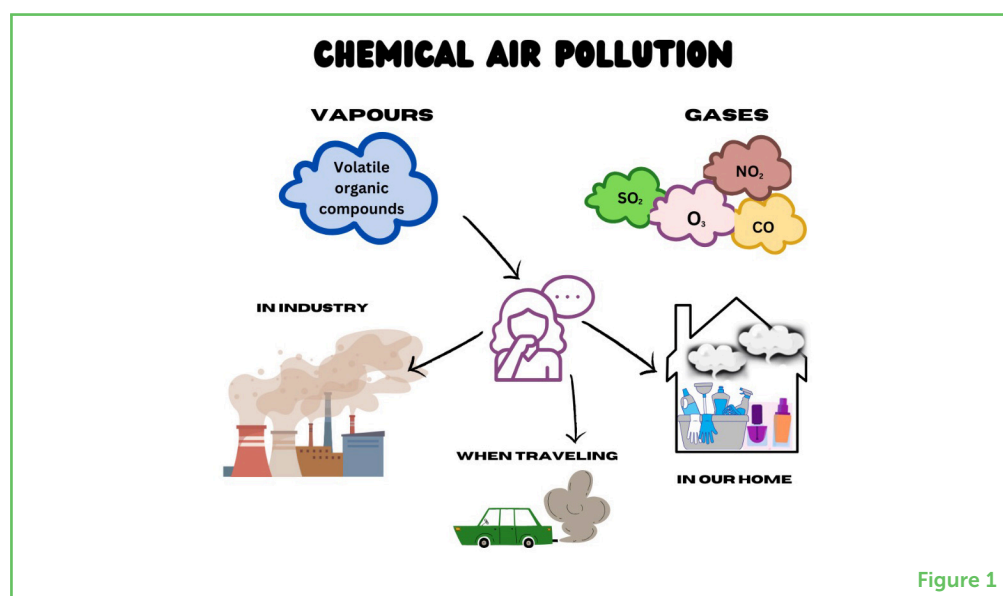


Figure 1

Luckily, physicists and biologists are combining their efforts to find new ways to clean the air we breathe. They have discovered that they can use **microbes**, like fungi or bacteria, that feed on volatile organic compounds. What is cool is that using a **magnetic field** can help the microbes do a better job.

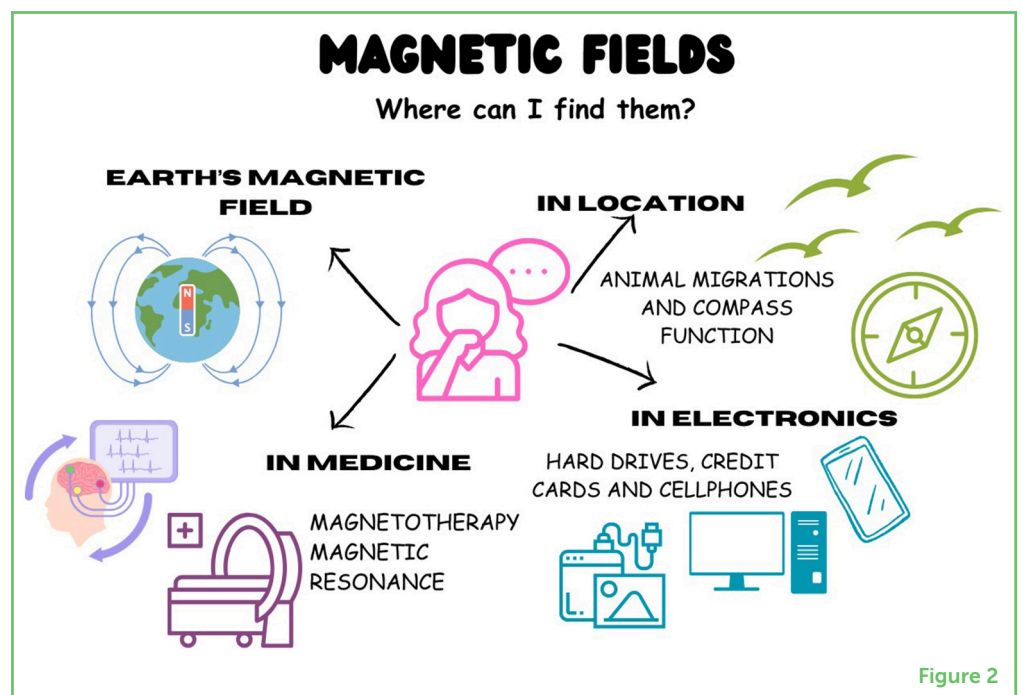
We will first tell you about magnetic fields, and where we can find them in our lives. Second, we will give more details about how microbes can clean the air. Finally, the advantages of combining magnetic fields with microbial air treatment will be explained.

MAGNETIC FIELDS IN DAILY LIFE

Have you ever wondered how we stay safe from the dangerous, highly energetic particles emitted from the Sun? It is because we are surrounded by a gigantic magnetic field. The Earth's magnetic field acts like an invisible shield that allows life as we know it to exist. This magnetic force protects us from some of the charged particles emitted by the sun, which are known as the solar wind. The Earth's magnetic field also interacts with living beings. It allows many animals, like birds and turtles, to move across the planet, as if they have an inner compass. Thanks to Earth's magnetic field, they can go in the right direction during their migrations. Interestingly, magnetic fields are also applied as a type of "alternative" medicine, in what is known as magnetotherapy. Magnetic fields are non-invasive techniques believed to stimulate areas of the brain to treat depression. They are also thought to relieve chronic pain. Magnetic fields are also used to obtain a full inside view of a person and to pinpoint problems in the body, through a technique called magnetic resonance imaging. We can also find magnetic fields in electronic devices. They are used to make components like sensors, hard drives, credit cards, and data storage units, including some parts of your cell phone. As you can see, magnetic fields have many uses in our daily lives (Figure 2).

Figure 2

Magnetic fields are common in our daily lives.



But what is a magnetic field? It is an area where a magnetic force is present. A magnetic force is invisible, but you can feel the attraction or repulsion when holding a magnet close to another magnet, or close to some kind of metal like a piece of iron.

HOW IS THE AIR CLEANED BY MICROBES?

Microbes are microscopic organisms, meaning they are not visible to the human eye. Although small, they play key roles. Microbes have been used for centuries in human food, to produce yogurt, cheese, and wine, for example. They are needed in ecosystems, where they break down organic matter like dead leaves and fruits on the ground. The same type of microbes can be used to clean up pollutants. To clean up air pollutants, and more particularly volatile organic compounds, microbes like fungi or bacteria are frequently used. They are placed inside a container where they are fed with the polluted air. The higher the flow of polluted air, the larger the size of the microbial container. Microbes use the pollutants for their growth and survival, releasing only non-toxic products, such as carbon dioxide and water [2].

ADDING MAGNETIC FIELDS WHEN CLEANING THE AIR

The success of air cleaning depends on the number of microscopic cleaners, and on how fast they can eat pollutants. These microbes need to stay healthy and strong! One way to support them is with the help of a magnetic field, which can be created with magnets. Magnets are placed near the container containing the microbes, promoting their appetites.

In air treatment, pollutants are the only food given to the microbes, so they have no choice but to eat them. However, they need more than pollutants to survive. Like us, they need water and nutrients (such as vitamins and minerals), which must be periodically delivered. Like all cells, microbes have **cell membranes** that separate the cell contents from the outside world. To be consumed, the pollutant present in the air must first go into the water surrounding the microbe. It then gets inside the microbe by crossing through its cell membrane. The first advantage of using a magnetic field is that it makes the microbes' cell membranes more permeable, making it easier for the pollutant to move across. This improves microbes' intake of both pollutants and nutrients, making it easier for microbes to use the pollutants and improving air cleaning [2, 3].

The second advantage of using a magnetic field is that it can boost the growth of microbes. With extra mouths to feed, there is greater consumption of the pollutant and therefore better air cleaning.

CELL MEMBRANE

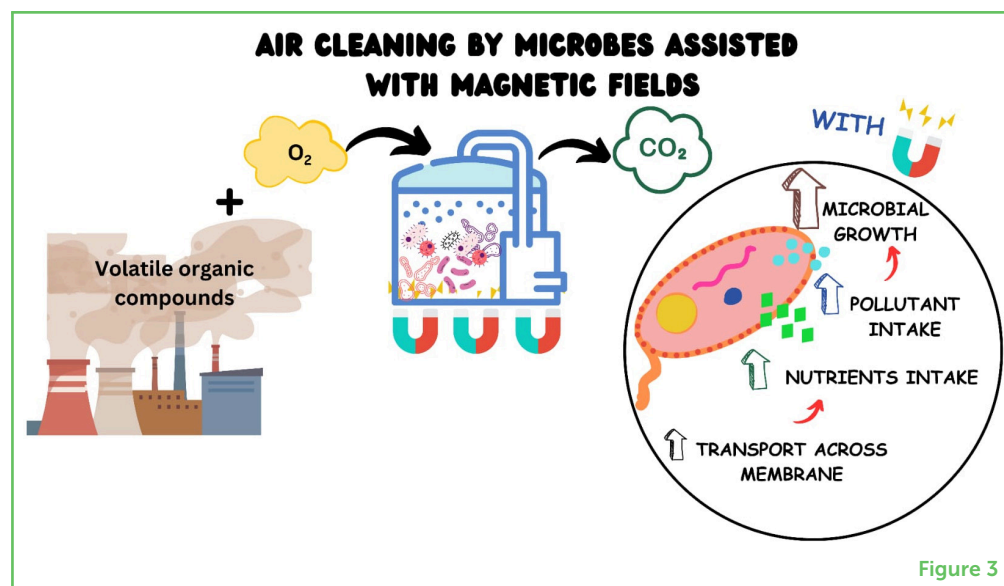
Thin wall separating the microbe from its surroundings.

NATURAL SELECTION

Process where the best fitted organisms replace the less fitted ones, promoting the more likely to survive under certain conditions.

Figure 3

Certain microbes can “eat” the volatile organic compounds and produce carbon dioxide. These microbes can be boosted by magnetic fields, which help nutrients and pollutants cross the cell membrane more quickly, increasing microbe growth and their ability to clean the air.



NEW AIR CLEANING TECHNOLOGIES ARE ALWAYS WELCOME

Human beings should be responsible for cleaning up pollution they release. Many invisible pollutants are present around us, even floating in the air we breathe. Among such pollutants, volatile organic compounds can be generated when using the cleaning and beauty products in our homes, when traveling in vehicles, and by many industries. You now know that microbes can eat pollutants and clean the air. This cleaning is a nature-based solution that can make our environment a better place. Magnetic fields can impact the activity of living beings, including microbes. To sum up, using magnets helps air-cleaning microbes to reproduce, increase their population size, and eat more pollutants. The exact way magnetism acts on microbial cells is not yet fully understood by scientists. However, magnetic fields somehow slightly change the shape of the microbes and make their cell membranes easier to cross, which helps them take in more nutrients [4]. Much more research should be done to shed light on new ways to clean pollution and to protect Earth from human activities.

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YOUNG REVIEWERS

ALESSANDRO, AGE: 12

Alessandro is a 12 years old student from Italy. He started to get interested in science when he was a kid. He wanted to become a scientific researcher, so his parents bought him the “Kit of the little scientist”. With that he made the first experiment being really proud of himself. His passion continued till now, and he is studying to follow his dream.

HARRY, AGE: 15

I am Harry, currently 15 years old. I enjoy a wide range of sports and games, and I am extremely interested in the different fields of science, especially biology and the biomedical sector, where I can see how applications of biochemistry and genetics are able to effectively solve real world problems!



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Aitor Aizpuru is a French expatriate working on the Mexican Pacific coast as a full professor of chemistry at the Universidad del Mar. He studies how to clean contaminated air, focusing on natural biological solutions. He likes gardening and plants.



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