

The Soil Microbiome

Introduction

My interest in the microscopic world began with the human microbiome, the bacteria and fungi that live inside and on our bodies. The microorganisms affect our overall physical and mental health. But that interest took a new turn when I learned about the soil microbiome. Beneath our feet and within the soil is a complex, lively world of tiny organisms like bacteria, fungi, and other microbes that keep our planet alive. This invisible community in the soil plays a key role in growing our food, fighting climate change, and even supporting human health.

Considering the content of the course, I also found that artists are engaging with microbes, including soil life, in creative ways that challenge how we see the natural world. The soil microbiome plays a role in ecology, is connected to climate and farming, it has a surprising relationship to human health, and it is present in art. I would argue that soil is not just dirt but a living system that deserves our attention, respect, and protection.

I. Living within Soil

What Is the Soil Microbiome?

Soil is home to billions of tiny living organisms. In just a single teaspoon of dirt, there can be more living things than there are people on Earth. This includes bacteria, fungi, viruses, and small animals like “nematodes” and “protozoa.” All of them work together to keep the soil healthy. They break down dead plants and animals, recycle nutrients, and help plants grow strong

(Thotakuri et al, 2024). Bacteria and fungi are especially important. Fungi can partner with the roots of plants and help them absorb water and nutrients. This is a mutually beneficial relationship since in return, the plants share sugars they made through photosynthesis. This teamwork is one reason forests and farms can thrive without chemical fertilizers.

What's especially fascinating is that the diversity of these microbes is what makes soil so important. The richer the microbial life, the stronger the soil is and more resilient it becomes to changes in weather, pollution, or other environmental stressors. These microbial communities also create complex networks that can communicate chemically. They can suppress harmful pathogens by producing antibiotics or outcompeting them for resources. This natural defense system means that the soil is constantly healing itself and adjusting to maintain balance



Image generated using ChatGPT, "Create an image that displays the soil microbiome" by Kyla, 2025

Why It Matters

The soil microbiome affects everything. Anything we eat and all that we breathe. When these microbes break down plant material, they help store carbon in the ground. That's important

because it keeps carbon dioxide, which is a major greenhouse gas, out of the atmosphere.

Healthy soil can also hold more water, allowing it to be more resilient during droughts and heavy rains (Mason et al, 2023). This is especially important as climate patterns become more unpredictable due to global warming.

Unfortunately, modern industrial practices often destroy this delicate ecosystem. Disturbing the soil through pesticides or pollution can result in hurting the microbes. When this happens, it leads to erosion, poor crops, and higher carbon emissions. Tilling the soil, for instance, exposes microbial communities to oxygen and sunlight, disrupting their balance and reducing their ability to store carbon. Pesticides can wipe out beneficial microbes along with harmful ones. Over time, this damage accumulates and weakens the entire system. We need to see our soil as the gut of the planet, one that needs balance, diversity, and care. As a society, becoming more aware of how vital soil life is can help us protect it.

II. Regenerative Farming and Effect on the Environment

Farming Naturally

Regenerative agriculture is a type of farming that focuses on improving soil health. Instead of spraying chemicals, farmers use cover crops, compost, reduced tilling, and crop rotation. These practices help soil microbes thrive (Hermans et al, 2023). Rather than fighting against nature with artificial solutions, like pesticides, regenerative farming works with it, mimicking natural processes that have evolved over time.

When soil life is healthy, plants grow healthier, pests are less of a problem, and farmers can use fewer synthetic chemicals. Cover crops, for example, prevent erosion, provide habitats for

beneficial insects, and enrich the soil with organic matter. Compost adds beneficial microbes and nutrients back into the ground. Crop rotation prevents the buildup of disease and keeps soil nutrients balanced. The result is not just better yields but more sustainable farming.

In fact, regenerative farming also helps trap more carbon in the soil, which can in turn reduce the effects of climate change (Thotakuri et al, 2024). This process is called “Carbon Sequestration.”

According to studies on Climate Change, soil holds more carbon than the atmosphere and all plant life combined. By increasing the organic matter in soil through regenerative practices, we can lock away more carbon and reduce the greenhouse gases that are heating the planet. (Lal, 2004)

Solutions

Scientists and farmers are working together to improve these techniques. Some are testing natural “microbial boosters,” adding helpful bacteria and fungi to the soil. Others are studying how certain farming methods, like using compost or applying “biochar,” can increase the amount of carbon soil can store (Mason et al, 2023). Biochar is a charcoal-like substance made from plant material. It holds carbon and also improves soil structure, water retention, and microbial habitats.

In addition, new technologies like satellite imaging and AI-driven sensors are helping farmers monitor soil health in real-time, allowing them to make informed decisions. This blending of ancient wisdom with modern science is showing real promise. These practices aren’t just good for the planet they also benefit people. Healthier soil means better food, cleaner air and water, and more stable farming communities. This leads to a cleaner planet and a more sustainable future for everyone.

III. Soil's connection to Human Health

Contribution to a Healthy Body

It might be surprising, but spending time around dirt can be good for us. Scientists are discovering that exposure to diverse soil microbes helps build stronger immune systems, especially in children (Engemann et al, 2019). This is particularly relevant in urban environments where kids are increasingly disconnected from nature. Some research also suggests that these microbes might reduce allergies and autoimmune diseases. Researchers believe this might be because interacting with nature exposes us to helpful bacteria that can balance our body's own microbial community within the gut microbiome.

There is also growing concern that being "too clean" can actually harm our immune systems. The "hygiene hypothesis" suggests that early exposure to microbes, including those found in soil, helps the immune system learn what is and isn't harmful. Without this exposure, the immune system may overreact to harmless things, leading to allergies, asthma, or autoimmune conditions. (Strachan, 1989)

Connecting with soil could also potentially improve mental health. One fascinating area that bridges the gap between soil, health, and human experience is the practice of "Grounding." Grounding involves making direct physical contact with the Earth's surface such as walking barefoot on grass or soil or using products designed to transfer the Earth's electrical charge to the body.



Image generated using ChatGPT, "Could you create an image of grounding and connection to mental wellness from laying in dirt" by Kyla, 2025

The Earth is rich in electrons, and some research suggests that when we connect with the ground, these electrons can be absorbed into our bodies. This transfer may help neutralize free radicals, reduce inflammation, and promote better sleep, improved circulation, and reduced stress levels. In our modern lives, we are often disconnected from the Earth by buildings, pavement, and rubber shoes. Through these studies physiological changes have been observed to improve heart rate variability, and lower nighttime cortisol levels in individuals who regularly practice grounding. This emerging field illustrates a remarkable way in which the soil traditionally seen as gross may be important to human wellness. (Fischer, 2024)

Awareness

Of course, not all soil microbes are friendly. While many of them play essential roles in supporting plant growth, recycling nutrients, and even boosting our immune systems, others can

pose health risks especially when the soil itself is contaminated. Some microbes can cause disease, particularly if the soil has been polluted with chemicals, pesticides, or human and animal waste. In urban areas, lead contamination is a serious and ongoing issue. Soil near old buildings, factories, or high-traffic roads may contain dangerously high levels of lead, which can be especially harmful to children if they accidentally ingest dirt while playing or if the particles become airborne and are breathed in. (Filippelli and Laidlaw, 2010)

That's why safe soil management is incredibly important. We need to be aware of what's in our soil before we engage with it, whether for gardening, agriculture, or recreation. Raising awareness about both the risks and benefits of soil exposure can empower communities to make informed choices. Public education campaigns, school programs, and local workshops can teach people how to identify contaminated soil, test it when necessary, and take precautions like wearing gloves or using raised beds with clean soil. One positive solution is the creation of community gardens in safe, monitored environments. These spaces not only provide access to fresh food and a sense of connection to nature but also offer a way to interact with healthy soil in a controlled setting. When managed properly, they allow people to reconnect with the land while minimizing health risks, turning soil into a source of nourishment, learning, and community.

IV. Soil in Art: Tarsh Bates and Microbial Beauty

Art Connection

Tarsh Bates is an Australian artist who uses microbes in her art. She works with yeast and bacteria, including species that live on and in our bodies, to explore themes of identity, intimacy,

and what it means to be alive. Her work brings microbes into galleries, making the typically invisible visible (Bates; Art Laboratory Berlin, 2025).

In one piece, she used her own blood and “*Candida albicans*”, which is a type of yeast, to grow living patterns on agar plates. As the microbes grew, they formed delicate designs that were both beautiful and somewhat unsettling. The work asked viewers to think differently about the organisms we often fear but typically ignore.

Bates doesn't just show that microbes exist but she invites us to have a relationship with them. Her art makes us consider how humans and microbes are connected, and how we might treat these tiny life forms with more care. In a world where many people see bacteria as dirty or dangerous, her work opens a door to curiosity and even compassion. Her art reminds me that microbes aren't just data points but they're living beings with stories of their own.

Her pieces also raise philosophical and ethical questions. In blending the scientific with the emotional, Bates expands how we understand both art and biology. By collaborating with microbes as co-creators, she transforms petri dishes into canvases of life, decay, and regeneration.

Conclusion

The soil microbiome is one of the most important ecosystems on Earth, yet it often goes unnoticed. These tiny creatures make our lives possible, from growing our food to cleaning our air and supporting our health. When we farm with nature instead of against it, we protect these invisible allies. And through art, we can reconnect with the microbial world in ways that science alone cannot offer.

As I've learned more about the soil microbiome, I've started to notice how disconnected many people, including myself, have been from the ground beneath us. Soil is often seen as something dirty or unimportant, something we walk on without a second thought. But when we begin to understand soil as a living, breathing ecosystem full of interdependent organisms, that perspective starts to shift. This growing awareness has made me think differently about environmental issues and sustainability, understanding what is right under our feet. There is so much potential in reconnecting with soil. It offers us a chance to rethink how we live on this planet and what kind of future we want to build. A future where we value and care for the systems that quietly sustain life every day.

Looking forward, I believe the soil microbiome can shape how we think about sustainability, wellness, and even creativity. Through regenerative agriculture, public health, or bio-art, paying attention to what's beneath our feet can help us build a better future. Soil is not just dirt, it is a living system, a tiny hidden universe that bridges science, humanity, and the natural world. By seeing soil through a new lens, we can appreciate its complexity and advocate for its protection not just for its sake, but for ours as well.

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