Persatuan Pengguna Pulau Pinang
Consumers Association of Penang
槟城消费人协会 பினாங்கு பயனீட்டாளர் சங்கம்

10 Jalan Masjid Negeri, 11600 Pulau Pinang, Malaysia
Tel: 604-8299511 Fax: 604-8298109
email: consumerofpenang@gmail.com

Website: (English, BM, Chinese & Tamil)
https://consumer.org.my

facebook.com/ConsumerAssociationPenang
twitter.com/consumer_penang
instagram.com/consumer_penang

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Microorganisms: The Invisible Forces Sustaining Life and the Climate

Most people, apart from those in the scientific community, have very limited knowledge and understanding of the crucial role that microorganisms play in enabling life on Earth to exist. Unlike other living things that can be seen and heard, microorganisms are invisible to the naked eye. As the earliest forms of life, they are found everywhere on the planet, from the frozen reaches of the Arctic to the scorching hydrothermal vents deep beneath the ocean floor.

Undoubtedly, one of the greatest existential threats facing humanity in the twenty-first century is climate change. Microorganisms, the most abundant living entities on Earth, both significantly influence and are profoundly affected by climate change. Yet, despite the seriousness of the issue, discussions about the interaction between microbes and climate change remain uncommon outside the microbial research community.
Microbes, including viruses, bacteria, archaea, fungi, algae, and protozoa, inhabit every conceivable environment such as terrestrial, urban, atmospheric, subterranean, and aquatic habitats. Despite their minute size, microbes have a major impact on the planet's climate due to their vast abundance.
They play a vital role in global geochemical cycles, act as symbionts of major crops, and serve as both producers and consumers of greenhouse gases.

Microbes are also essential for maintaining ecological balance and improving soil health. They facilitate the decomposition of organic matter, breaking down dead plants and animals into nutrients vital for plant growth. This process enriches the soil and sustains a healthy environment.

However, the excessive use of pesticides can harm soil fertility, as such chemicals are toxic to soil microorganisms and can disrupt soil physiology. Depending on the type of pesticide and microbe involved, pesticides may have varying effects on microbial populations and can persist in soil for long periods, being absorbed by plants and leading to reduced microbial diversity. The decline of these vital populations, which are responsible for releasing macro, micro, and trace elements into the soil, disrupts the natural biogeochemical cycle.

Microbes also play a key role in biodegradation, the breakdown of pollutants and organic waste, and in the remediation of oil spills and other environmental toxins. This is achieved through the use of specific microorganisms that convert harmful compounds into less toxic forms.

Freshwater ecosystems such as lakes, rivers, ponds, streams, wetlands, and groundwater host diverse microbial communities that are vital for water purification, nutrient cycling, and overall ecosystem function. Yet, only about 3.9 per cent of Earth's water is non-saline, and just a fraction of that exists as the familiar streams, rivers, and wetlands that we identify as freshwater.

Climate change is a global phenomenon driven by greenhouse gases such as carbon dioxide, methane, and nitrous oxide. These gases cause rising temperatures, droughts, extreme frost, heatwaves, heavy rainfall, storms, and increased fire frequency. The impacts are far reaching, affecting sectors such as food, energy, transport, and livestock. Human activities and consumption have led to higher greenhouse gas concentrations, contributing to climate change, a major socio-scientific issue. According to *News Medical Life Sciences,* global temperatures are projected to rise by more than two degrees Celsius by 2050.

Given the gravity of the situation, understanding how a changing climate will affect microbes, and how these changes will in turn influence humans and the environment, is critical.

Every living organism, including humans, depends on microbes and their biological activities. Numerous studies have shown that microorganisms can protect humans from allergies and help prevent the spread of diseases through pathogen reduction. Their roles in the generation and consumption of greenhouse gases, in elemental cycles such as those involving carbon, nitrogen, and phosphorus, and in maintaining the health of humans, animals, and plants are central to understanding how our climate may evolve in the years ahead.

Many of the environmental transformations that have shaped the Earth were driven by microbes. As humanity strives to mitigate climate change, the Consumers' Association of Penang (CAP) calls on researchers in microbial sciences to recognise microorganisms as a vital part of the solution to global warming. These small, life-sustaining organisms have endured for billions of years. To truly understand how our climate will change in the future, we must first understand how a changing climate will affect microorganisms and how their delicate relationships with humans and the environment will in turn shape the planet's destiny.

Mohideen Abdul Kader
President
Consumers' Association of Penang