Connecting Microbiomes to Health

FROM SOIL TO HUMANS AND THE ECOSYSTEMS IN BETWEEN

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ENCEMA 2024 Conference
Bern, Switzerland

THE SONNENSCHEIN INSTITUTE

Introduction: What are microbiomes?

DEFINITION

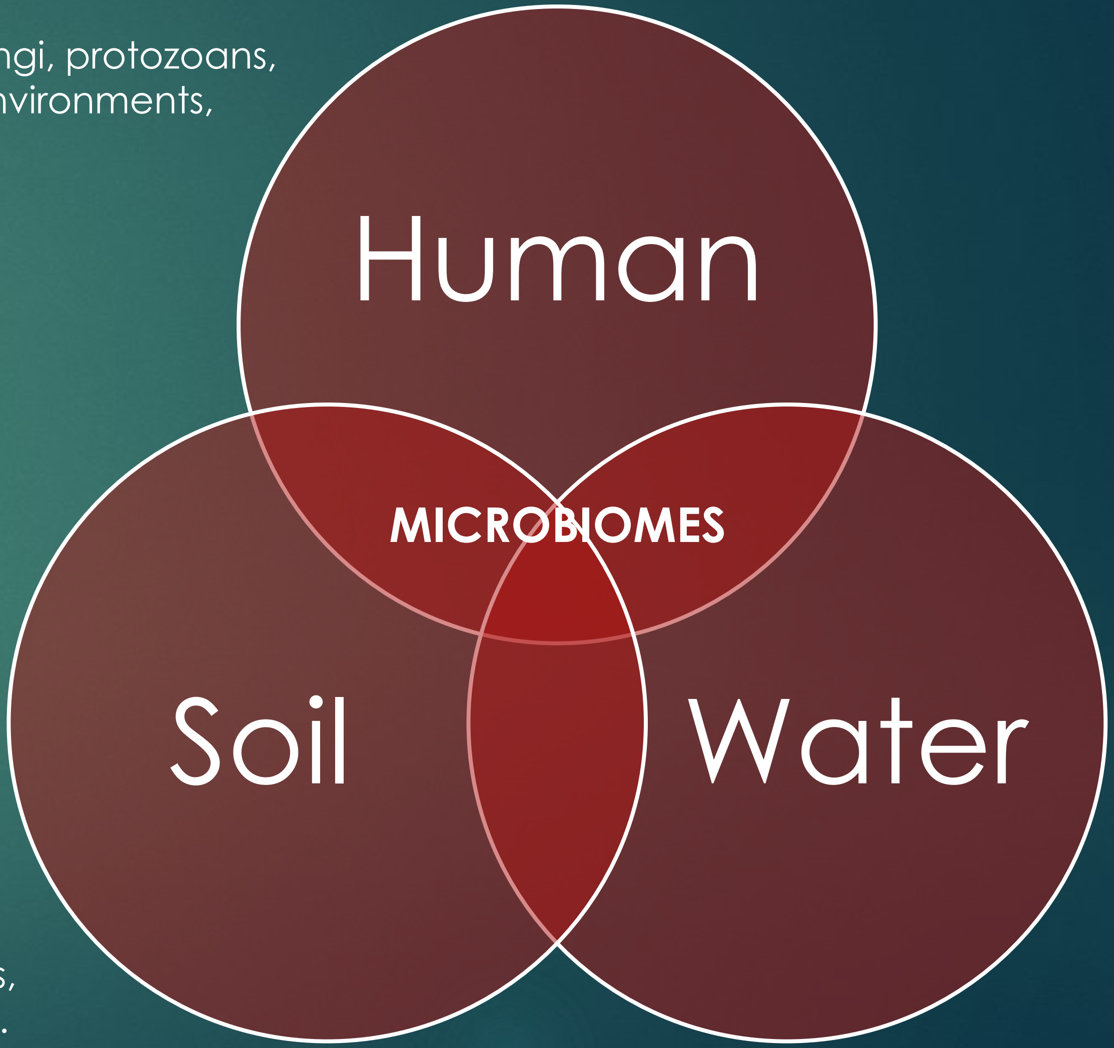
Microbiomes are communities of microorganisms—including bacteria, fungi, protozoans, archaea, viruses, and other microeukaryotes—that exist within specific environments, influencing both biotic (living) and abiotic (non-living) habitats.

PRESENCE & FUNCTIONALITY

- Found almost everywhere: marine, terrestrial, freshwater environments, and within living hosts like humans, plants, and animals.
- Microbiomes play critical roles in environmental processes (nutrient cycling, waste treatment) and biological systems (metabolism, immunity).

IMPORTANCE ACROSS ECOSYSTEMS

- **HUMANS:** Microbiomes in the gut aid digestion, immune defense and overall health.
- **SOIL:** Microbiomes support plant health, nutrient uptake and disease resistance.
- **WATER:** Microbiomes are pivotal to marine and freshwater ecosystems, contributing to biodiversity, carbon sequestration and nutrient cycling.



Microbiomes and Human Health

PATHOGENS & HUMAN MICROBIOMES

A healthy microbiome affects nutrient absorption and there is a direct functional relationship between the gut and brain health. Pathogens like bacteria, viruses and parasites can have significant health effects.

IMPACT ON BLOOD FLOW

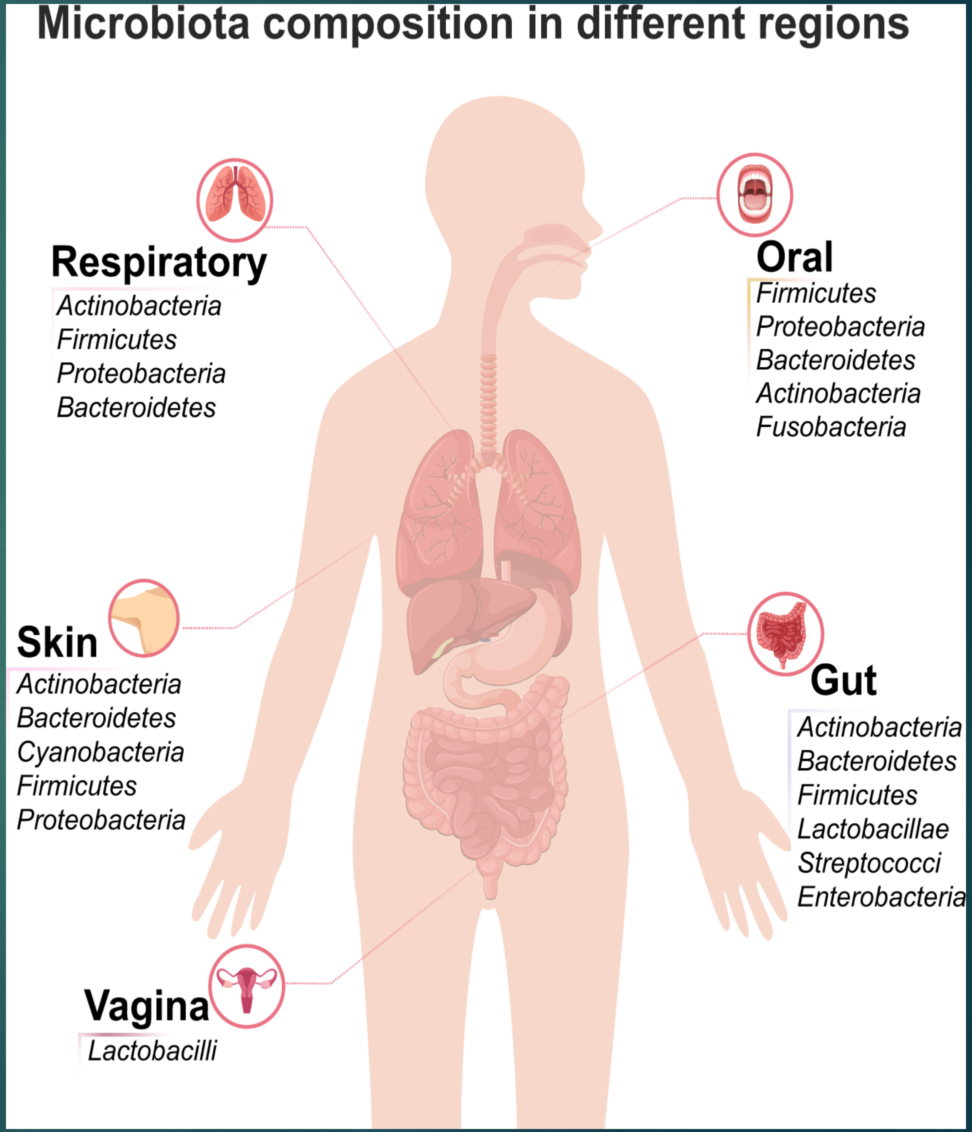
- Pathogens can significantly disrupt blood flow by causing inflammation, blood clots (thrombosis) and vascular damage.
- Inflammation increases blood vessel permeability and dilation, allowing immune cells to fight infection but potentially leading to complications.

MECHANISMS OF PATHOGEN-INDUCED DISRUPTION

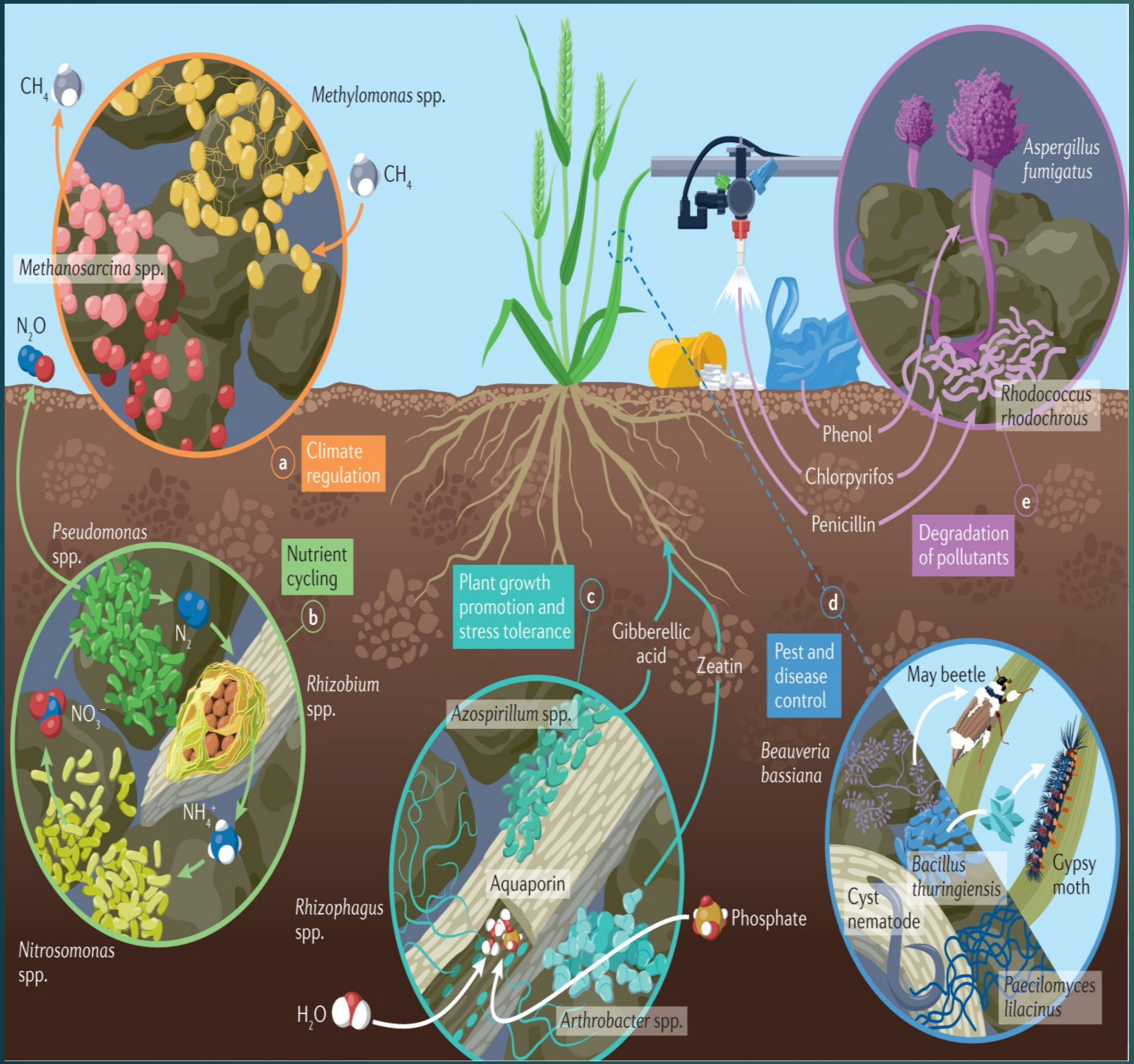
- Clot Formation: Some pathogens create a hypercoagulable state, forming clots that block blood flow, leading to tissue damage or organ failure.
- Vascular Damage: Pathogens directly harm blood vessels, weakening their structure and function, increasing risks like hemorrhage or ischemia.

SEVERE INFECTIONS AND SEPSIS

- Systemic inflammatory responses, such as sepsis, cause widespread vasodilation, reduced vascular tone, and abnormal clotting.
- These conditions can lead to multiorgan failure and impaired tissue perfusion, which are life-threatening without prompt intervention.



Microbiomes and Soil Health



SOIL MICROBIOMES

Soil microbiomes are complex communities of microorganisms that interact closely with plants, influencing soil fertility, plant health, and agricultural productivity.

ROLE OF SOIL MICROBIOMES

- Microbiomes in soil act as reservoirs of beneficial, neutral, and pathogenic microorganisms that regulate plant growth, nutrient cycling, and stress resistance.
- Symbiotic relationships, such as those with mycorrhizal fungi or nitrogen-fixing rhizobia, enhance plant nutrient uptake and resilience.

IMPACT OF SOIL MANAGEMENT PRACTICES

- Practices like heavy tillage, excessive pesticide use, and nutrient depletion degrade soil microbiome diversity, reducing natural disease resistance and crop productivity.
- Sustainable soil management practices, such as reduced tillage and organic amendments, enhance soil fertility and microbiome health.
- Integrated strategies combining biological, cultural, and chemical controls are essential for managing soilborne pathogens.

Microbiomes and Aquatic Ecosystems

AQUATIC MICROBIOMES

Aquatic microbiomes maintain the health, balance and functionality of aquatic ecosystems by supporting nutrient cycling, biodiversity, and ecological resilience.

MICROBIOMES AND ECOSYSTEM FUNCTION

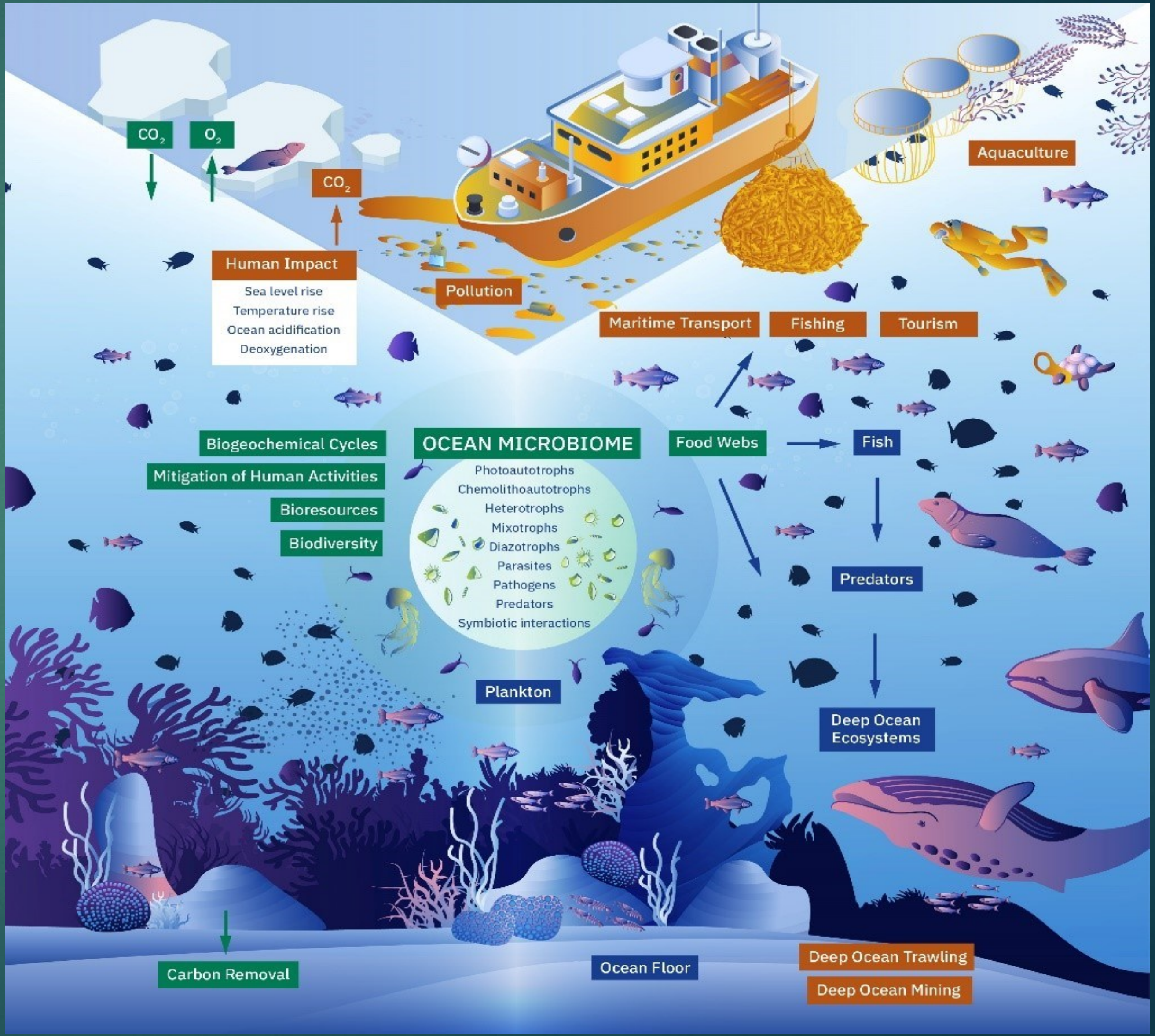
- Microbiomes in aquatic systems regulate nutrient cycling, support primary production, and maintain biodiversity.
- Keystone ecosystems like estuaries, coral reefs, and salt marshes rely on microbial communities to filter pollutants, sequester carbon, and sustain habitats for diverse species.

PATHOGEN INTERACTIONS

- Aquatic ecosystems are susceptible to pathogens that disrupt balance and biodiversity.
- Examples include harmful algal blooms (HABs), Vibrio spp. in estuaries, and coral diseases like Stony Coral Tissue Loss Disease (SCTLD).

HUMAN IMPACTS AND POLLUTION

- Agricultural runoff, industrial waste, and urban pollution alter aquatic microbiomes, decreasing resilience and increasing vulnerability to pathogens.



Land-to-Sea Ecosystems and Pathogens

Ecosystem	Pathogen Impacts	Common Pathogens	Impacts
Estuaries	Estuaries are often affected by a range of pathogens, including bacteria, viruses, and protozoa, primarily due to nutrient runoff and human activities.	Vibrio spp.: These bacteria can be pathogenic to humans and aquatic organisms, particularly during warmer temperatures, and can lead to illnesses such as vibriosis. Enterococcus spp.: Often used as indicators of fecal contamination, elevated levels can indicate the presence of pathogens affecting human health. Pfiesteria piscicida: A dinoflagellate that causes fish kills and can lead to harmful algal blooms (HABs).	Pathogens can lead to disease outbreaks in fish and shellfish, impacting both ecological balance and fisheries.
Mangroves	Mangroves are affected by pathogens that can weaken trees, making them more susceptible to environmental stress	Phytophthora spp.: This water mold can cause root rot and affect mangrove health. Ceratocystis manginecans: A fungus that causes wilting and dieback of mangrove trees. Bacterial pathogens: Various bacteria can infect mangrove species and contribute to decline.	Infected mangrove trees may have reduced growth and reproductive success, leading to habitat loss and diminished ecosystem services.
Coral Reefs	Coral reefs are particularly vulnerable to pathogens, which can lead to coral diseases that threaten entire reef communities	Stony Coral Tissue Loss Disease (SCTLD): Affects various coral species, leading to widespread tissue loss and mortality. Vibrio corallilyticus: A bacterium that can lead to bleaching and disease in corals. White Band Disease: Caused by a combination of microbial pathogens, affecting key coral species like Acropora.	Coral diseases lead to coral bleaching, loss of biodiversity, and decreased reef resilience. This, in turn, affects fish populations and other marine life that depend on coral habitats.
Salt Marshes	Salt marshes can suffer from pathogens that affect the vegetation and the fauna relying on these habitats.	Necrotic Ring Spot Fungus: Affects salt marsh plants like Spartina alterniflora. Bacterial pathogens: Such as Pseudomonas spp., which can infect marsh plants and lead to reduced growth and health. Nematodes: Parasitic nematodes can impact plant roots, causing stress and reducing marsh resilience.	Pathogens can cause declines in key plant species, which can lead to erosion and loss of habitat for various species, thus disrupting the ecosystem's functionality.
Riparian Zones	Riparian zones face threats from pathogens that can affect both plant health and water quality.	Phytophthora spp.: Can cause root rot in riparian vegetation. Hyaloperonospora spp.: A downy mildew that can affect various plant species in riparian zones. Coliform bacteria: Indicator organisms that can signify faecal contamination, affecting water quality and aquatic life.	Disease in riparian vegetation can reduce bank stability and habitat complexity, affecting water quality and contributing to erosion.

Electrocide™ and Microbiome Health

Electrocide
"You Can Feel It Working"

Electrocide™ is a nature-based supplement with potential to improve microbiome health, combat pathogens and support both agricultural and human health outcomes.

Electrocide™ uses charged minerals to selectively degrade harmful pathogens like *Staphylococcus aureus* and *Escherichia coli.*

Applications in Human Health

- Electrocide™ supports immune function, promotes metabolism, and combats fatigue.
- It shows promise in treating diseases by reducing pathogen loads and improving overall health outcomes, including during recovery from conditions like sepsis and COVID-19.

Applications in Soil Health

- In agricultural settings, Electrocide™ reduces pathogenic bacteria without harming beneficial microorganisms critical for nutrient cycling and plant health.
- It has been tested across various soil types (moist, semi-arid, and arid), demonstrating its ability to suppress pathogens effectively while maintaining microbiome diversity.

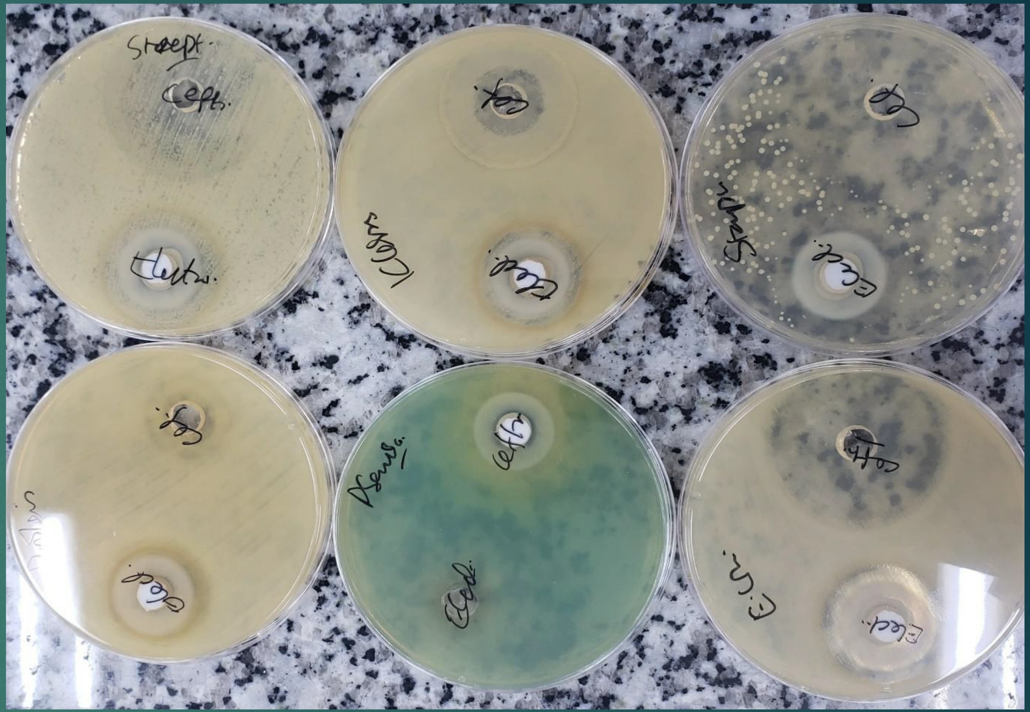
Applications in Aquatic Ecosystem Health

- Electrocide™ targets and degrades harmful bacteria like *Vibrio spp. and Pfiesteria piscicida* which cause fish kills and harmful algal blooms.
- It has shown to combat pathogens that cause Stony Coral Tissue Loss Disease, which causes coral bleaching, biodiversity loss and decreased reef resilience.

Electrocide™: Human Health

PATHOGEN SUPPRESSION

- Effectively targets pathogens like *Staphylococcus aureus* and *Escherichia coli*.
- Outperformed Ceftriaxone in laboratory tests.
- Inhibition zone: 452.6 mm² (Electrocide™) vs. 95.1 mm² (Ceftriaxone).
- Significant CFU/ml reductions observed within 48-72 hours.



Comparing areas of inhibition of the Electrocide versus Ceftriaxone against select pathogens

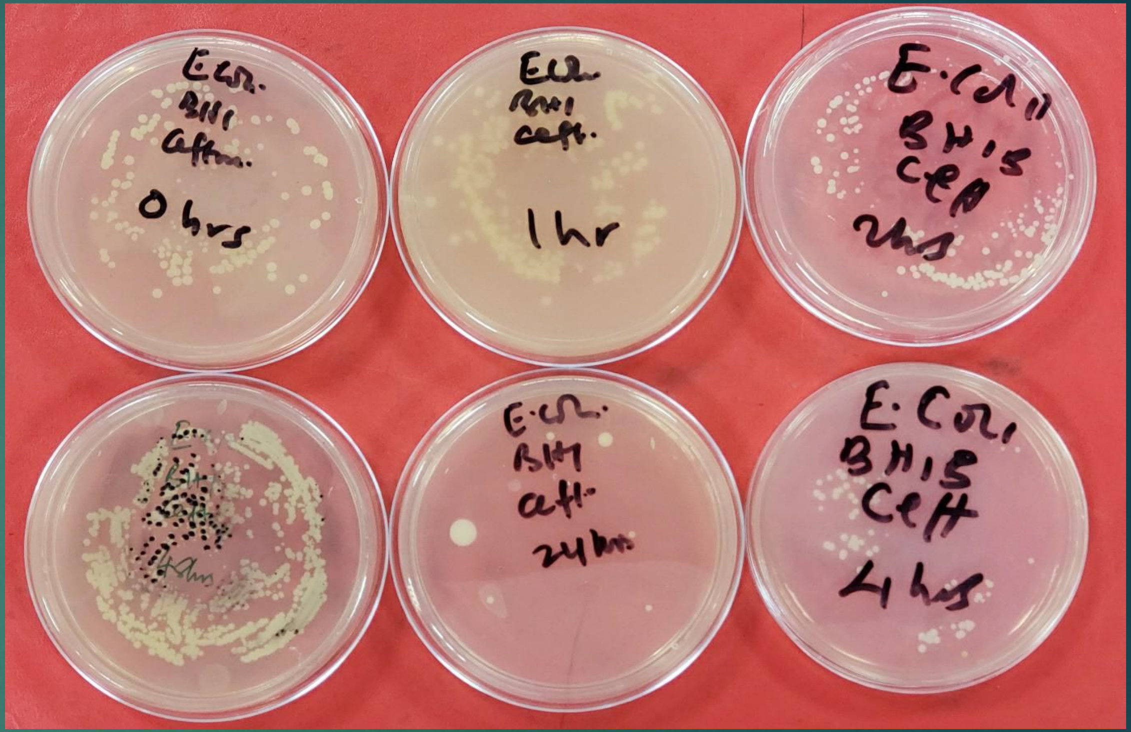
Pathogen	Area of inhibition (mm^2)	
	Ceftriaxone	Electrocide™
Staphylococcus aureus	95.1	452.6
Streptococcus pyogenes	616	531.1
Escherichia coli	804.6	452.6
Klebsiella pneumoniae	531.1	380.3
Pseudomonas aeruginosa	314.3	201.1
Proteus mirabilis/vulgaris	201.1	314.3

Electrocide™: Human Health

IMMUNE SYSTEM SUPPORT

- Promotes metabolism, strengthens immune responses and combats fatigue.

- Shown potential for therapeutic applications in recovering from infections, including COVID-19.



E. Coli in BHI + Ceftriaxone population comparison over time

Timelines (hrs)	E. Coli BHI +Electrocide population (CFU/ml)	E. Coli BHI +Ceftriaxone population (CFU/ml)
0	29100	Uncountable
1	Uncountable	Uncountable
2	28200	Uncountable
4	15800	Uncountable
24	2300	1100
48	2200	35800

Electrocide™: Human Health

RESISTANCE MITIGATION

- Reduces reliance on broad-spectrum antibiotics, addressing antimicrobial resistance (AMR).
- Preserves natural microbiome balance while degrading harmful pathogens.
- Supports global health initiatives to reduce dependency on chemical-based treatments.

Staphylococcus Aureus in BHI + Ceftriaxone population comparison over time

Timelines (hrs)	Staphylococcus Aureus in BHI +Electrocide population (CFU/ml)	Staphylococcus Aureus in BHI +Ceftriaxone population (CFU/ml)
0	Uncountable	Uncountable
1	38600	Uncountable
2	Uncountable	24400
4	24600	24700
24	700	Uncountable
48	400	32400

Electrocide™: Soil Health

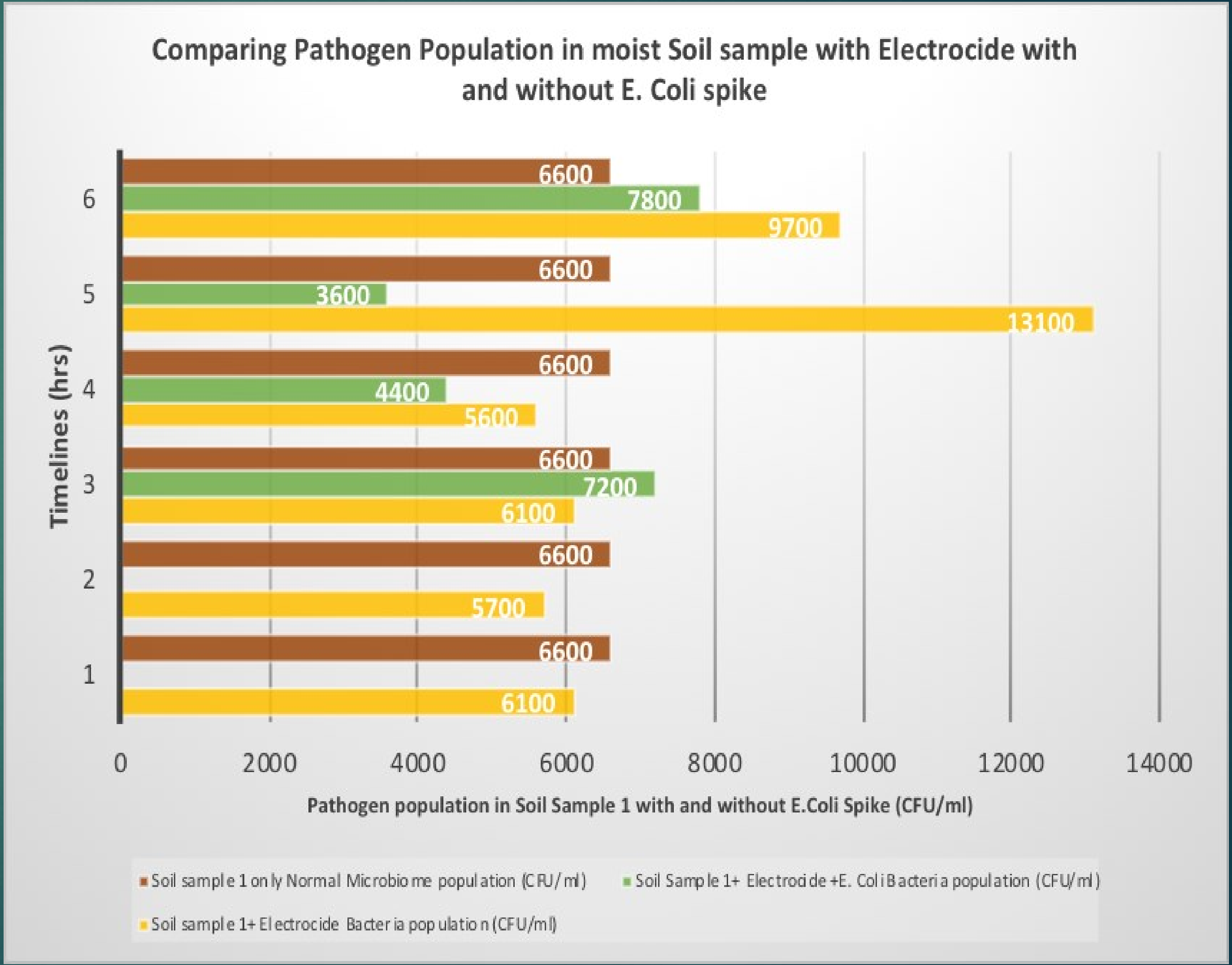
PATHOGEN CONTROL

- Demonstrated suppression of harmful bacteria while maintaining beneficial soil microorganisms.

- Tested across soil types (moist, semi-arid, and arid), ensuring broad applicability.

MICROBIOME PRESERVATION

- Maintains soil biodiversity critical for nutrient cycling and plant resilience.



Electrocide™: Soil Health

IMPROVED SOIL RESILIENCE

- Reduces the risk of crop diseases caused by pathogenic microorganisms.
- Supports sustainable agriculture practices by minimizing chemical inputs.

Moist soil sample with E. Coli spike + Electrocide™ pathogen population over time

Timelines (hrs)	Soil sample 1+ Electrocide Bacteria population (CFU/ml)	Soil Sample 1+ Electrocide +E. Coli Bacteria population	Soil sample 1 Normal Microbiome population (CFU/ml)
0	6100	Uncountable	6600
1	5700	Uncountable	6600
4	6100	7200	6600
24	5600	4400	6600
48	13100	3600	6600
72	9700	7800	6600

Electrocide™: Aquatic Ecosystems

PATHOGEN SUPPRESSION IN AQUEOUS ENVIRONMENT

- Targets pathogens like Vibrio spp., Enterococcus spp., and coral-specific bacteria (Vibrio corallilyticus).
- Reduces harmful algal blooms and mitigates risks to aquatic biodiversity.

MANGROVE AND CORAL RESILIENCE

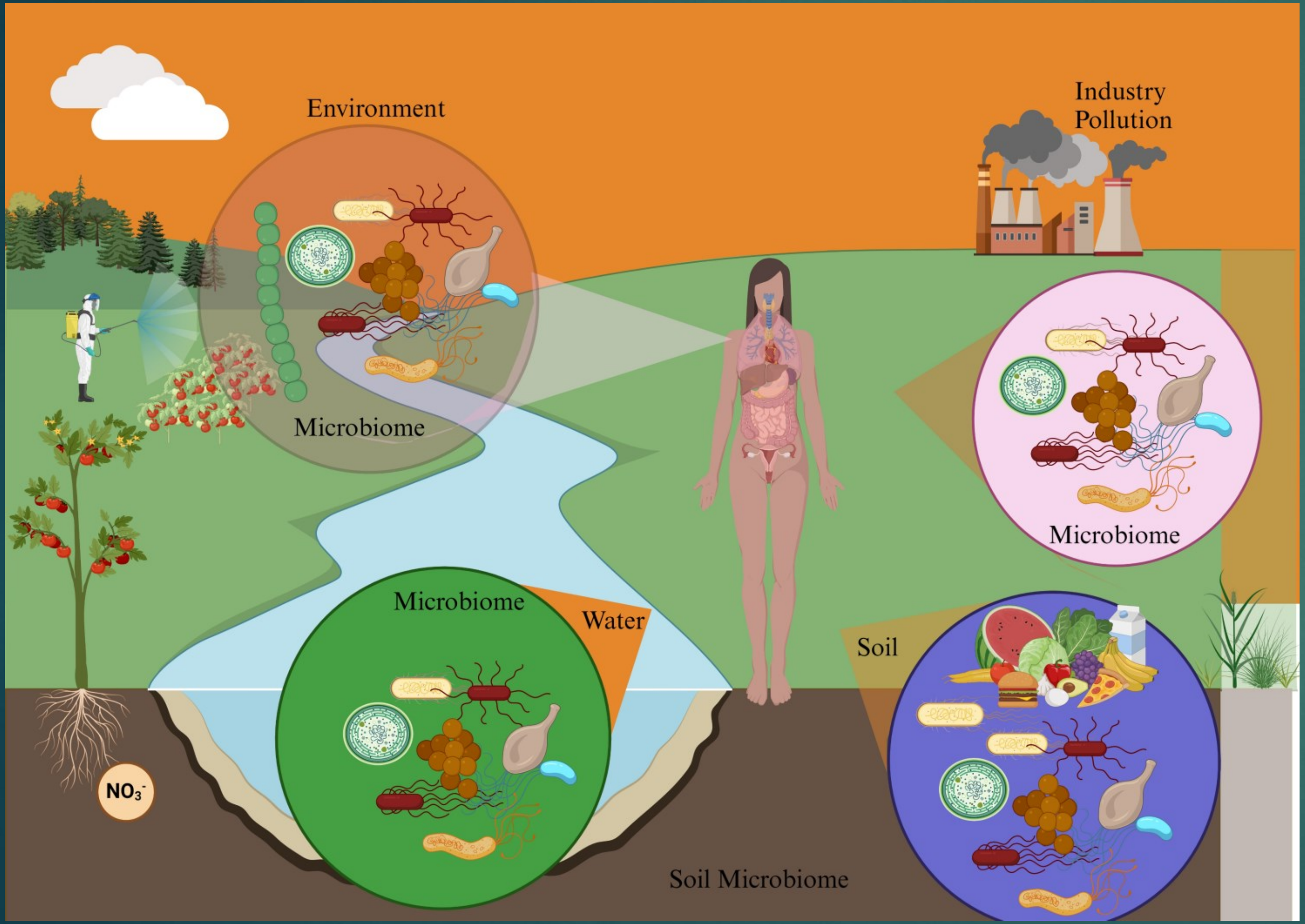
- Suppresses root rot pathogens (Phytophthora spp.) and coral pathogens (Stony Coral Tissue Loss Disease).
- Supports mangrove growth and coral reef recovery by preserving microbiome balance.

BROADER ECOSYSTEM BENEFITS

- Enhances resilience of estuaries, salt marshes, and riparian zones by mitigating microbial disruptions.
- Improves water quality and habitat stability through reduced pathogen loads.

E. Coli in Aqueous Applied Solution

Conclusions



MICROBIOMES ARE CRITICAL TO HEALTH

- Microbial communities play vital roles across ecosystems, influencing soil fertility, plant growth, aquatic balance, and human health.

ECOSYSTEMS ARE INTERCONNECTED

- The health of soil, aquatic ecosystems, and humans are deeply interconnected through microbiome exchanges and shared environmental impacts.

PATHOGEN CHALLENGES

- Pathogens disrupt microbiome balance, causing diseases in humans, plants and ecosystems. This is exacerbated by pollution, antimicrobial resistance and poor management.
- Electrocide™ technology can play a role in predictive pathogen analysis in waste water treatment systems with the goal of improving public health safety measures.

SUSTAINABLE INTERVENTIONS ARE ESSENTIAL

- Strategies like sustainable soil management, pollution mitigation, and microbiome-inspired technologies (e.g., Electrocide™) are vital for resilience and health restoration.

FOR MORE INFORMATION

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THE SONNENSCHEIN INSTITUTE

Electrocide
"You Can Feel It Working"

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