Mirror Biology & Environmental Health: Persistence and Governance

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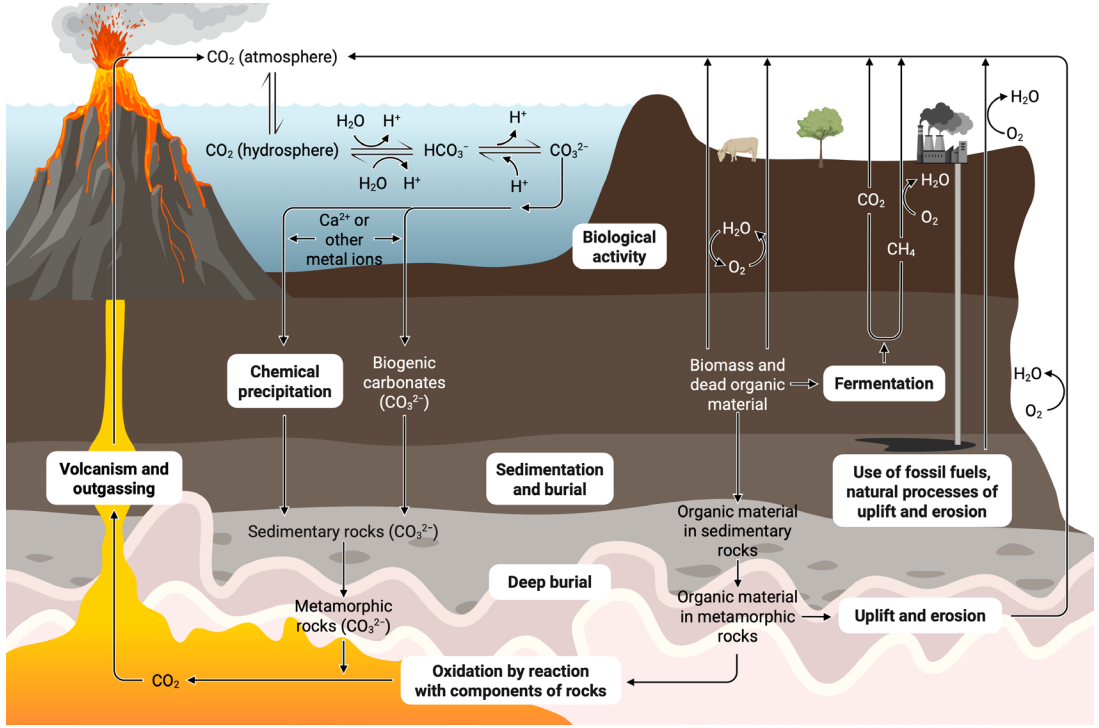
Environmental Microbes: Nature's Utility Players

- Roles in ecosystems
  - Decomposition: Breaking down organic matter and promote nutrient cycling
  - Predation / Trophic link: Food for protozoa, invertebrates, and higher trophic levels.
  - Symbiosis: Partner with plants and animals (mediate soil nitrogen fixation vertebrate and contribute to vertebrate gut microbiomes)

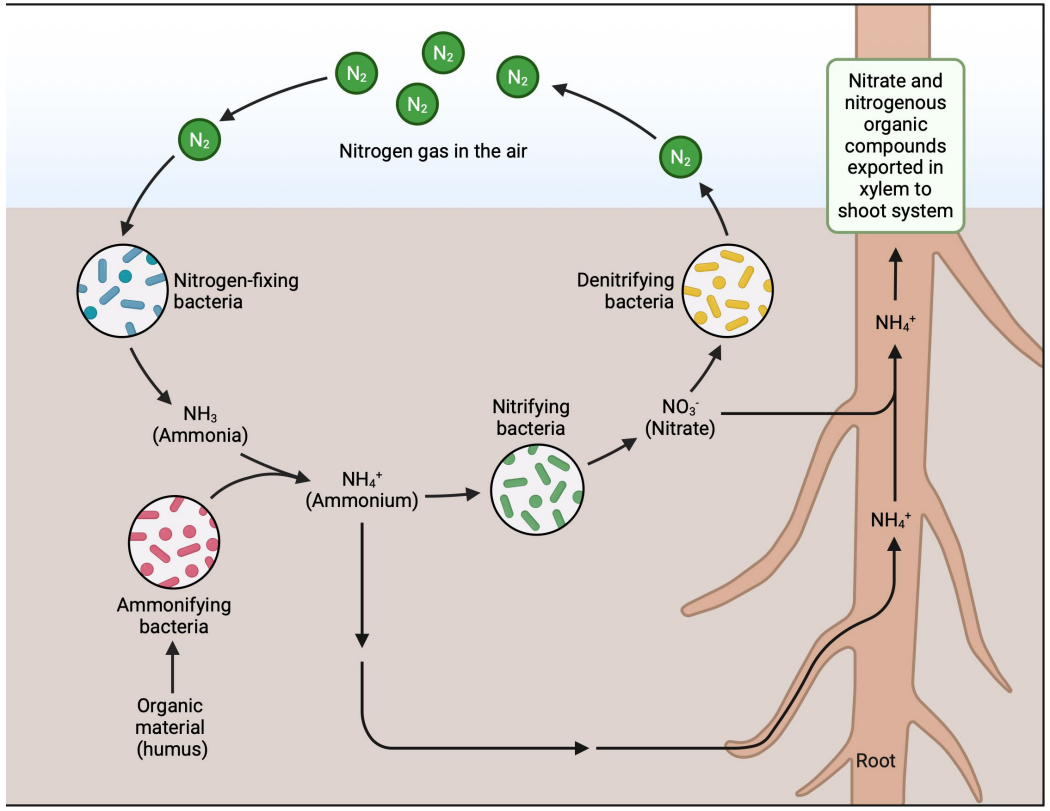
Carbon Cycling – Microbial Engines of Ecosystems

- Microbes decompose organic matter and release CO_2 and recycle energy.
- Stabilize soil carbon (humus) to build fertility and structure.
- Regulate the balance between **carbon storage vs release to** directly impact on climate.
- Coupled tightly with nitrogen cycling as productivity depends on both.

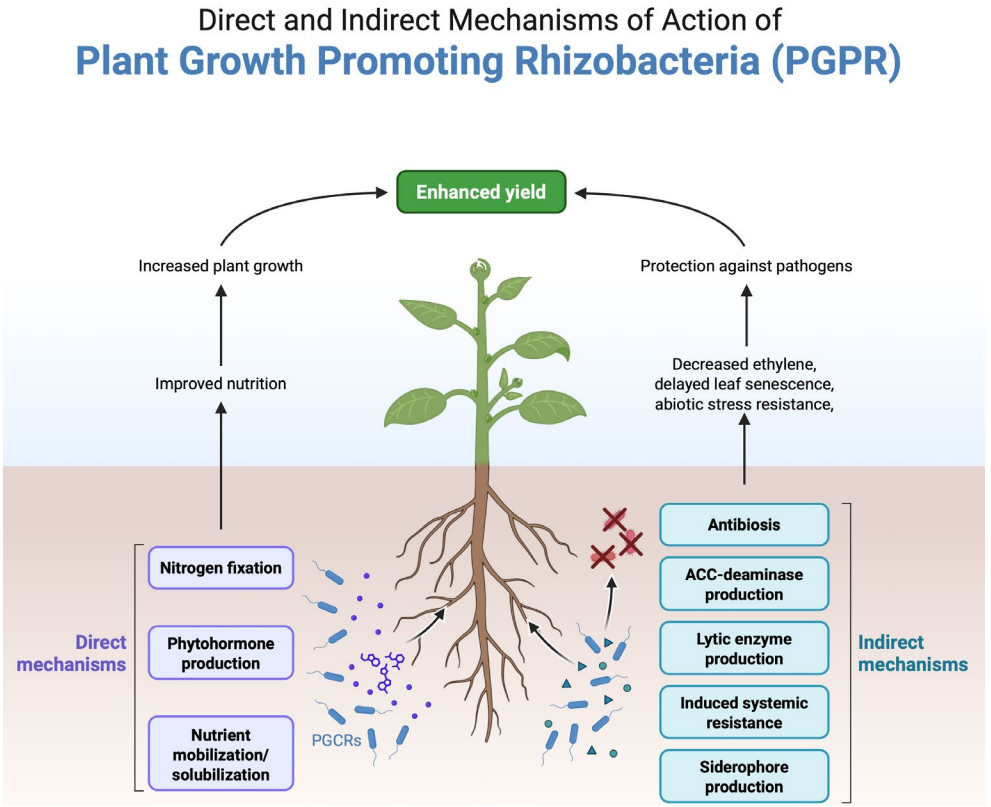


Nitrogen Cycling – Microbial Gatekeepers of Growth

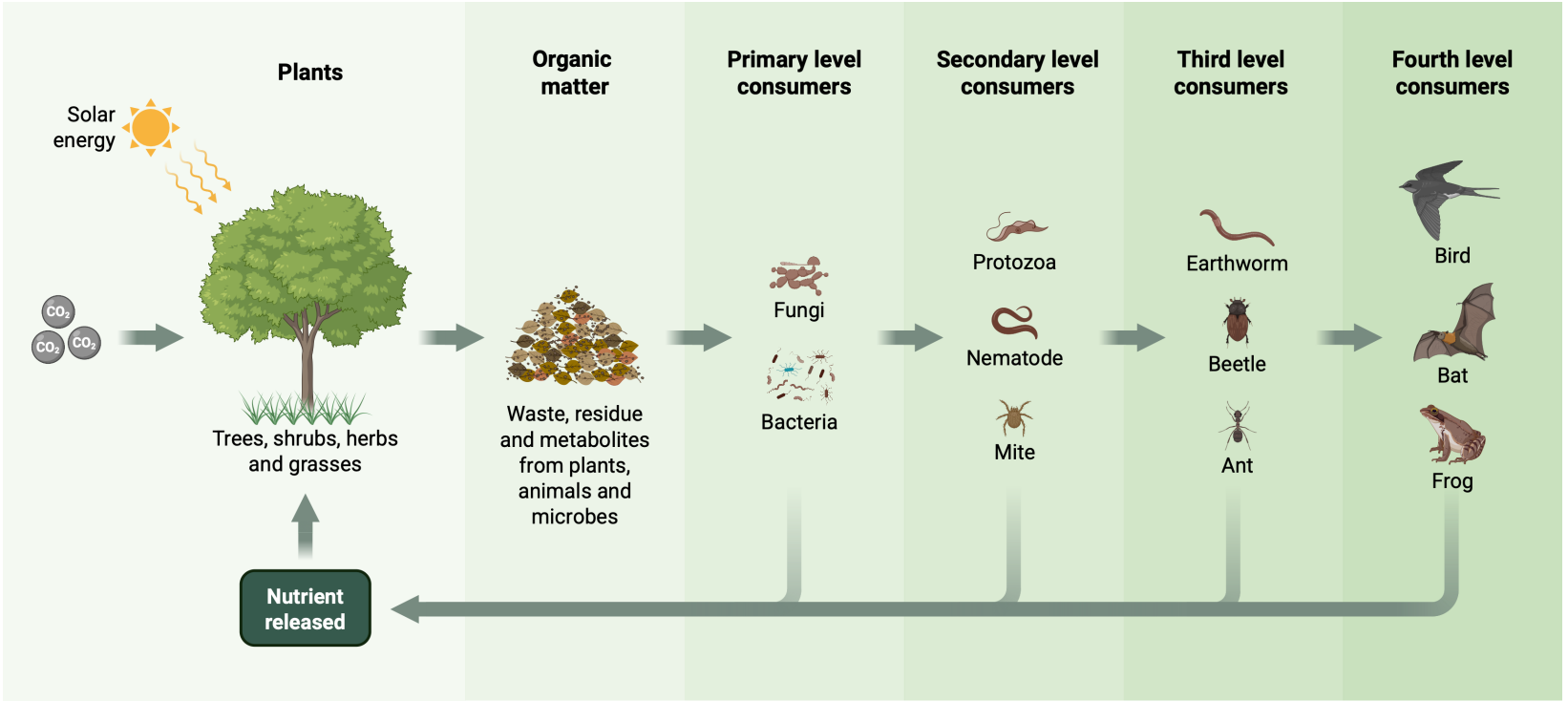
Nitrogen cycling “Nitrogen Fixation” – 78% of Earth’s atmosphere is nitrogen gas, but most organisms cant use it directly.



Soil microbes fix nitrogen and make it usable for plants, promoting soil fertility and plant health

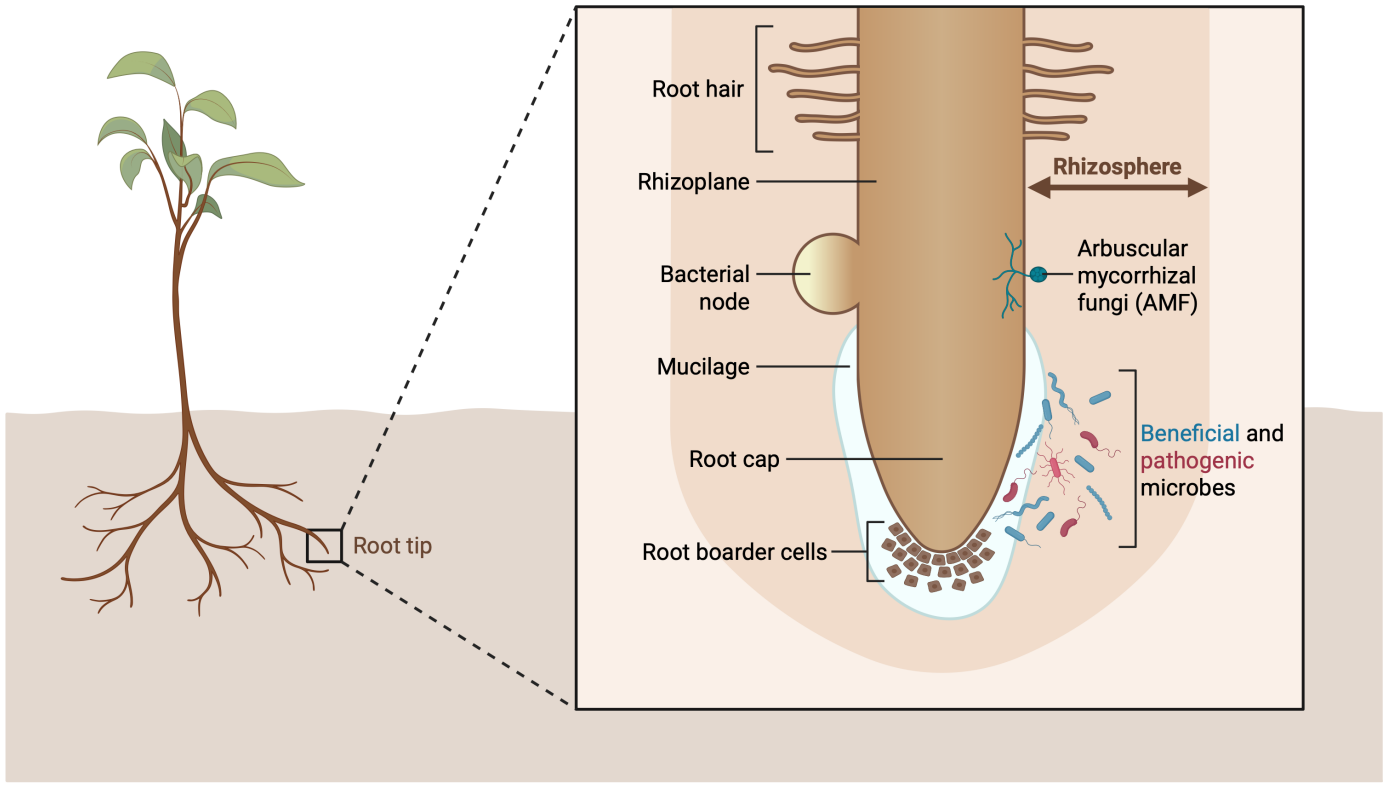


Microbes in the Predation Chain



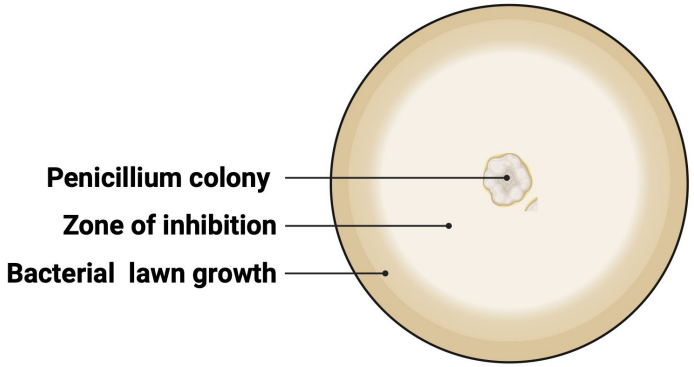
Environmental Microbes and Symbiosis

Components of the Rhizosphere



Competition & Balance – Hidden link to health

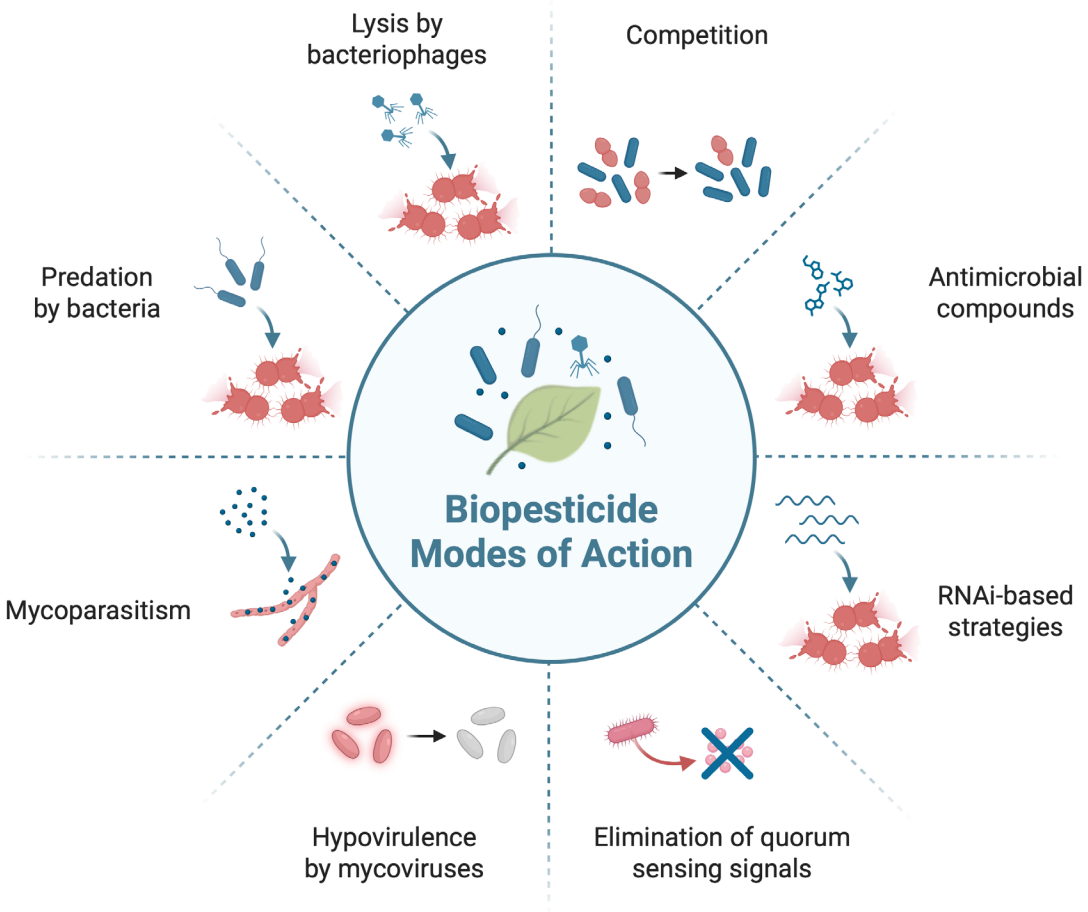
- Microbial warfare and diplomacy
- Microbial competition is often about borders and limited resources – who controls the nutrient space.
- Penicillin was just one weapon in this ongoing border war.
- What started as cross domain microbial competiions in the soil became the foundation for modern medicine



Mirror Microbes: Breaking the Utility Roles

- Limited molecular degradation
- No predators: Not eaten or eradicated – outside of food web
- No symbiosis: No recognition by hosts – no ecological services
- Resource siphoning: Still compete for nutrients – imbalance without recycling

Mirror Biology applied to the environment?



Potential Sources and Sinks of Engineered Mirror Organism in the Environment