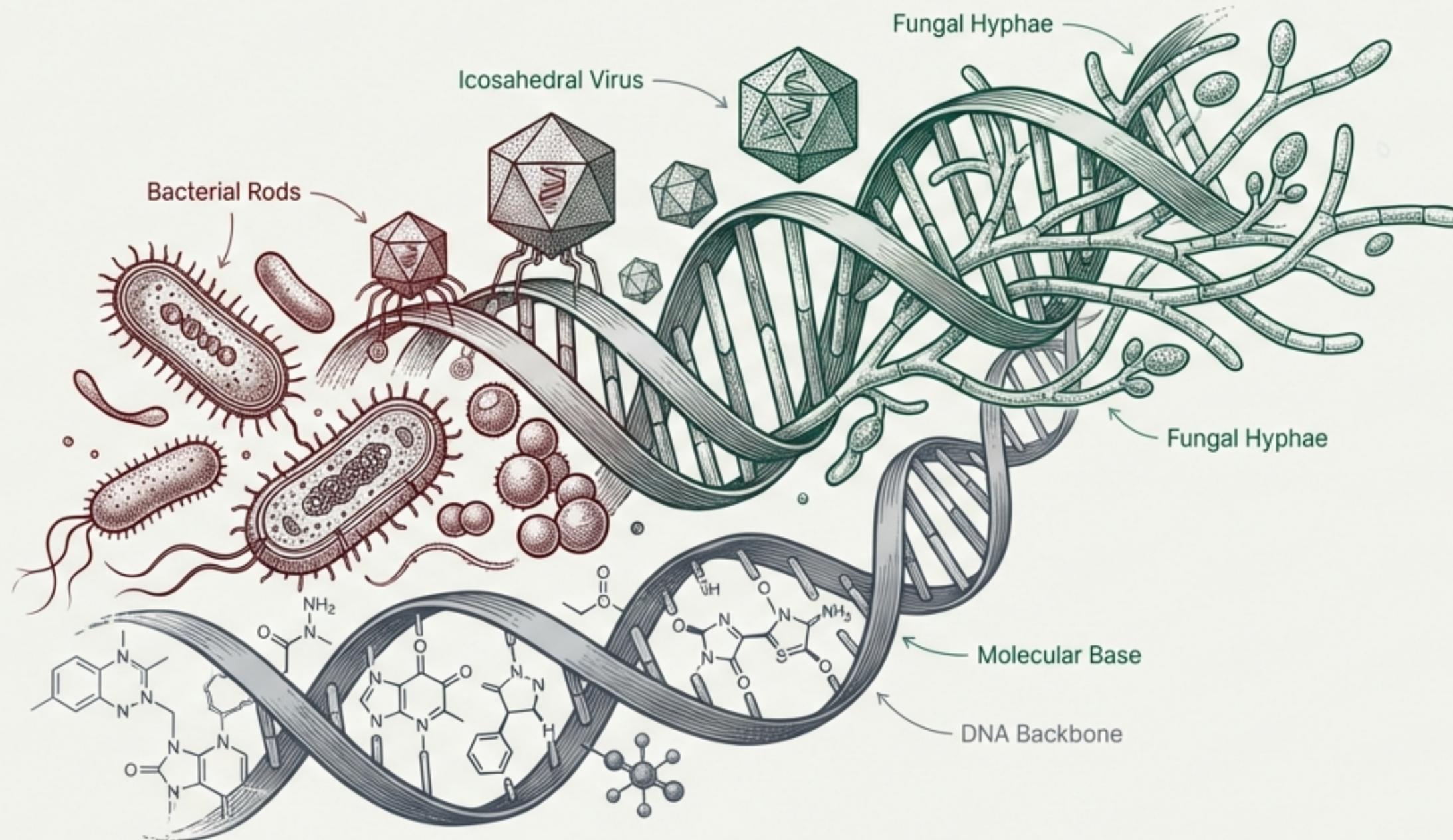


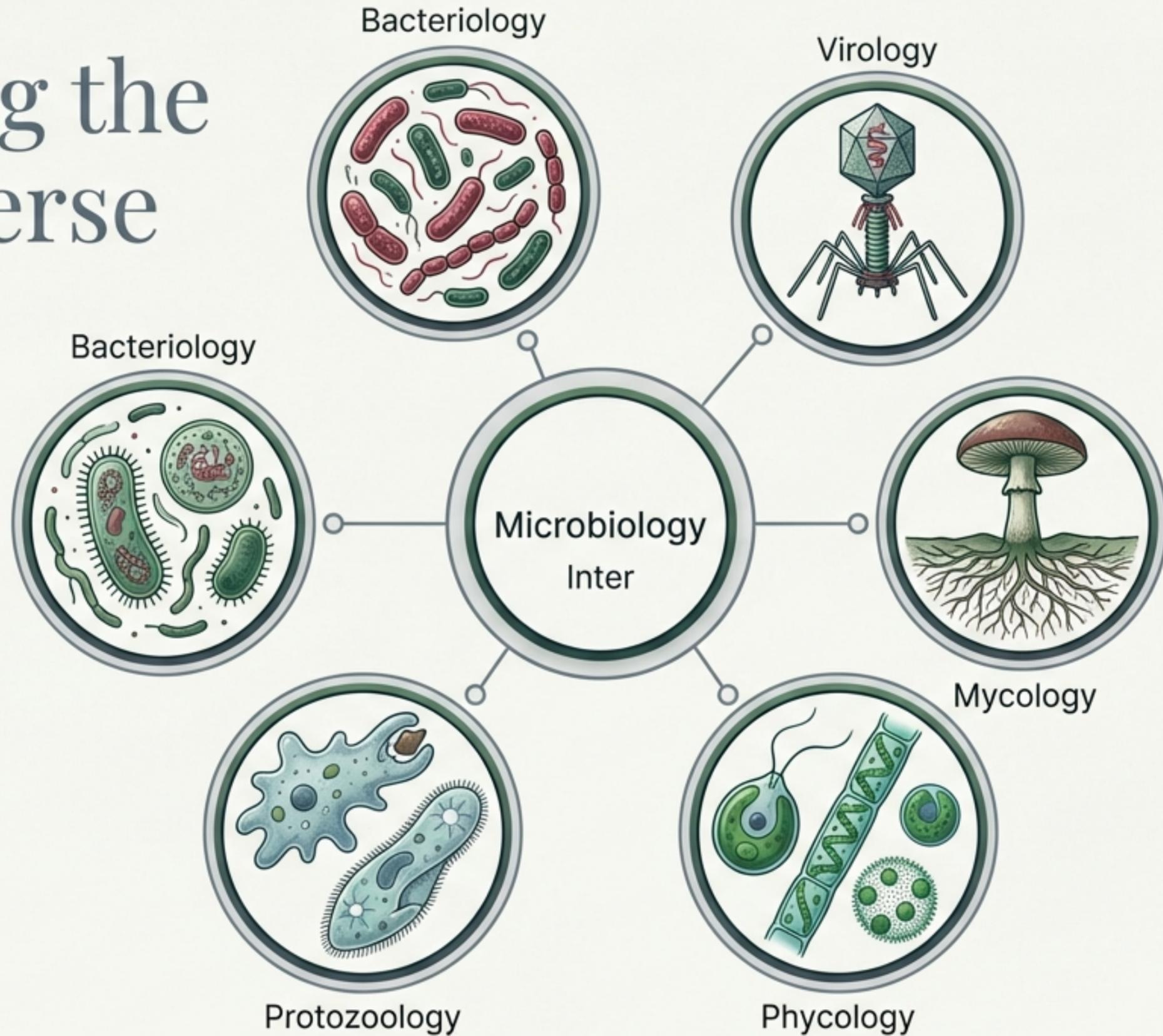
The Invisible Engine: An Introduction to Microbiology

Exploring the microscopic forces that shape our health, environment, and industry.



Etymology: Mikros (small) + Bios (life) + Logos (study).

Defining the Microverse



Microbiology is the study of life too small to be seen by the unaided eye. Despite their size, these organisms th the constitute abundant and adaptable forms of life on Earth.

The Dawn of Observation: From Miasma to Animalcules

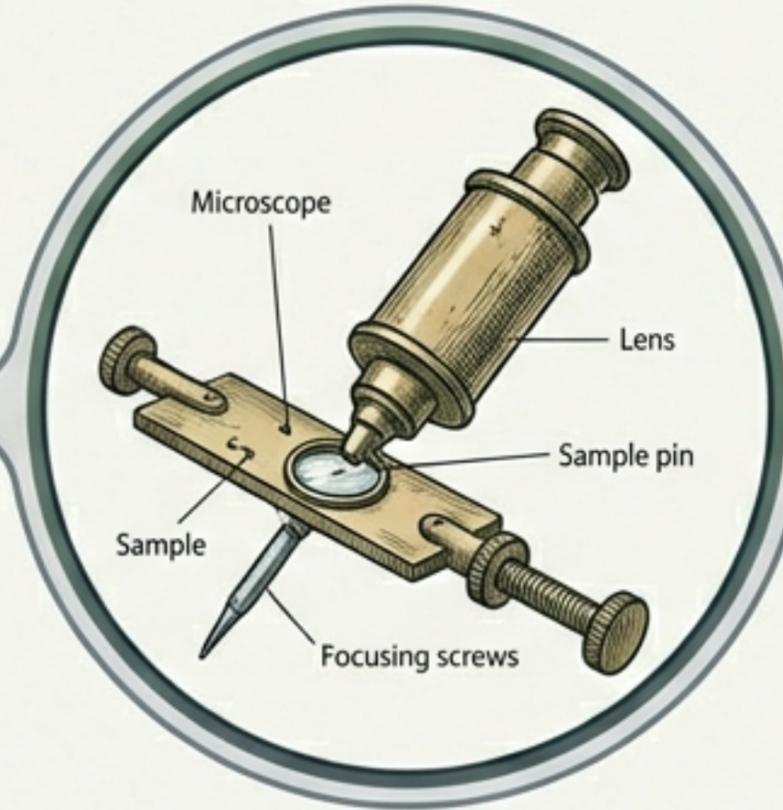
The Old World



Spontaneous Generation
(Disproven)

The ancient belief that life arises from non-living matter.

1670s



The First Lens

Leeuwenhoek observes
Animalcules in
"Animalcules" in pond water.

The Proof

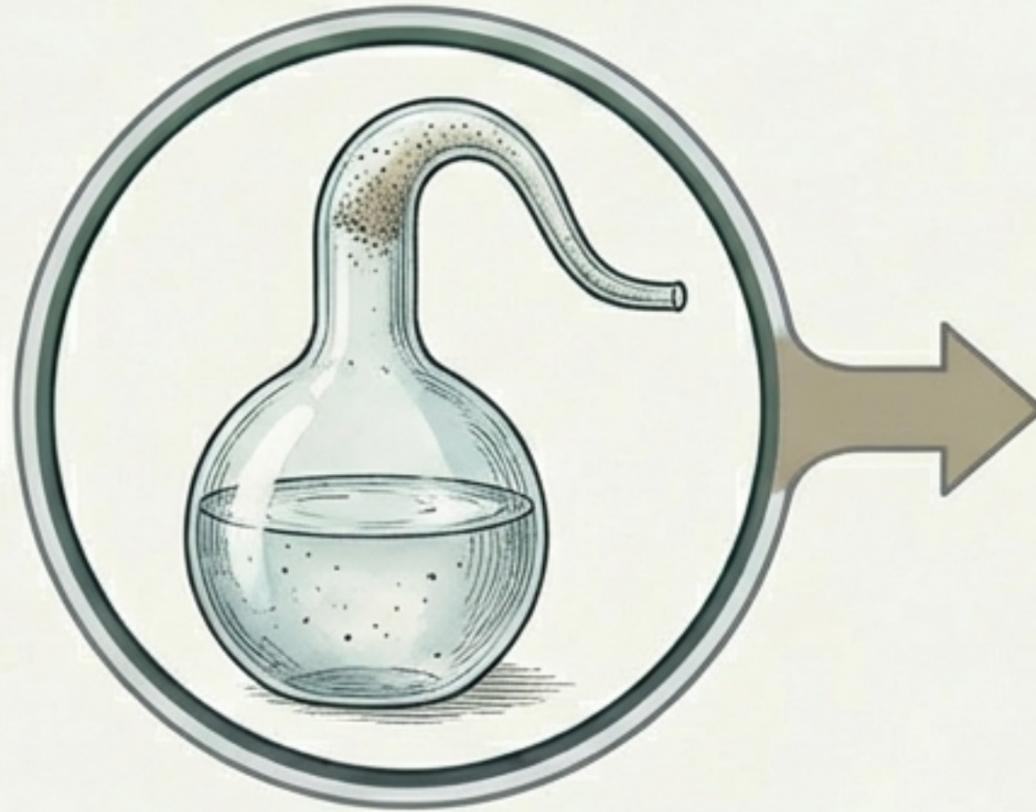


Spallanzani & Redi

Spallanzani & Redi
Experiments prove life
comes only from life.

The Golden Age: Germ Theory & Immunization

Louis Pasteur



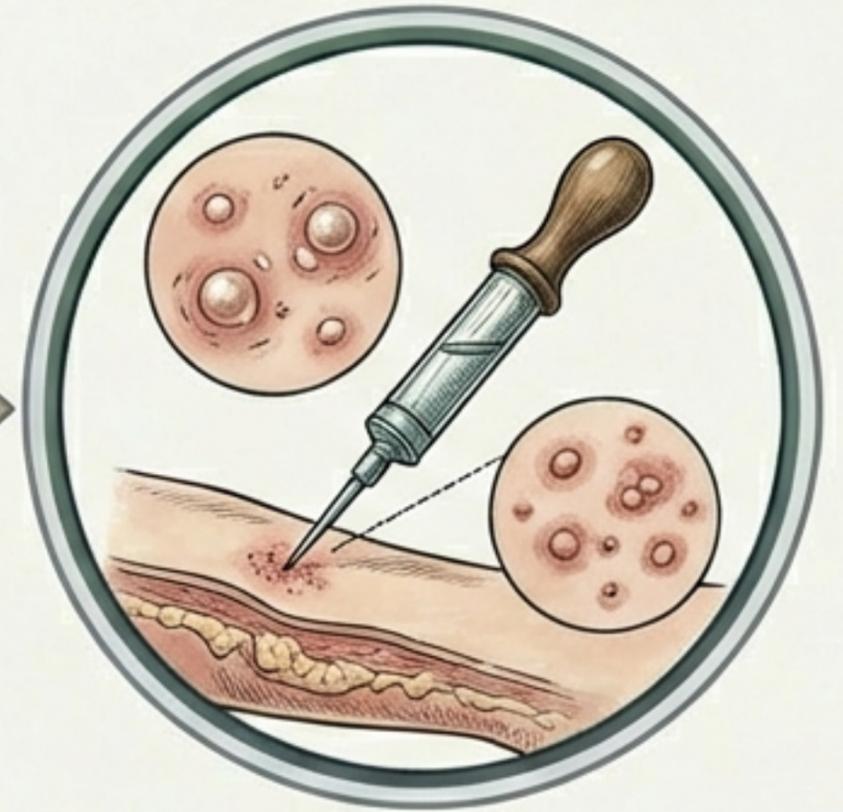
Disproved Spontaneous Generation. Established Biogenesis, Fermentation, and Pasteurization.

Robert Koch



Koch's Postulates: The logical framework linking specific microbes to specific diseases (e.g., Anthrax, TB).

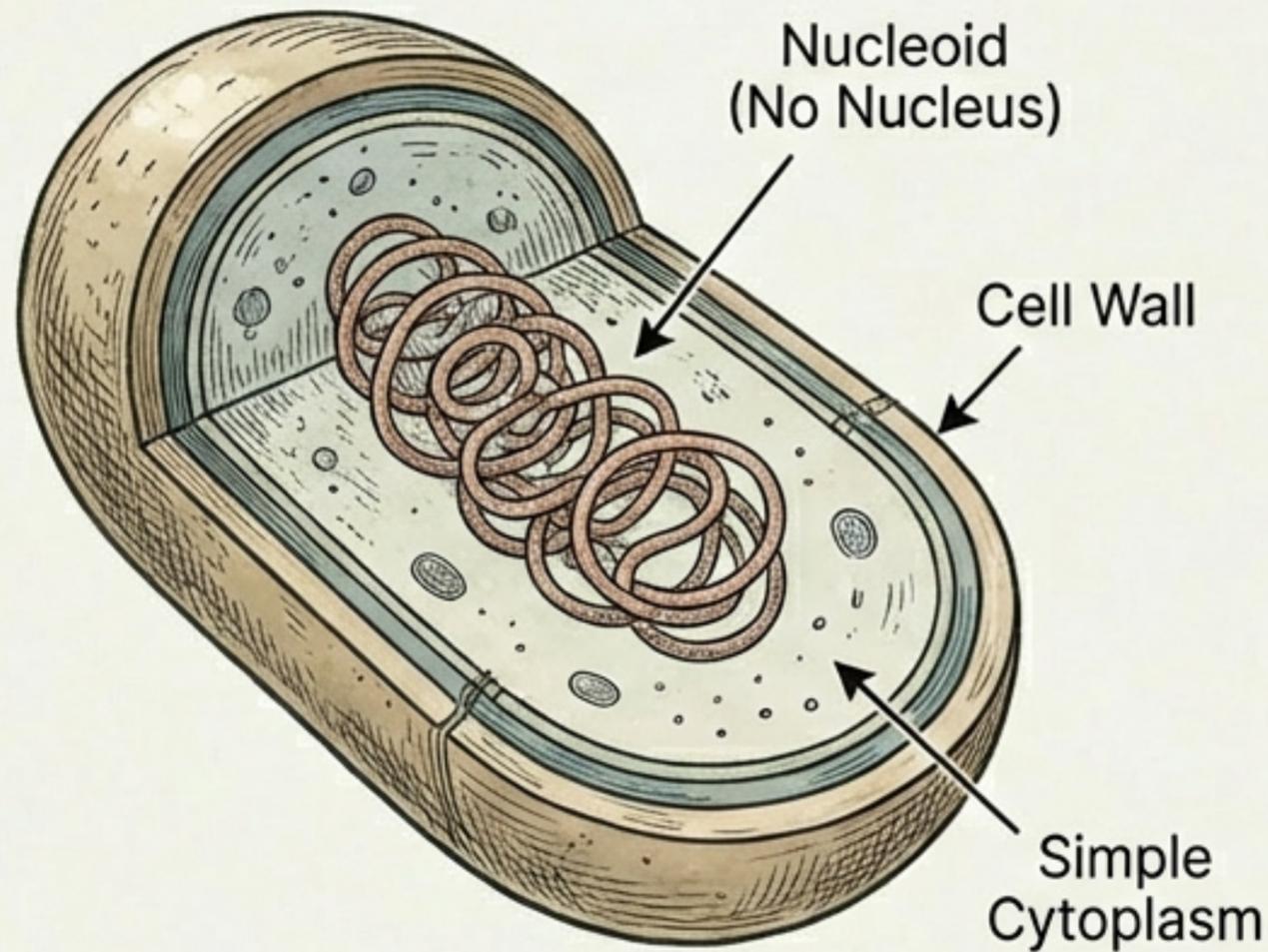
Edward Jenner



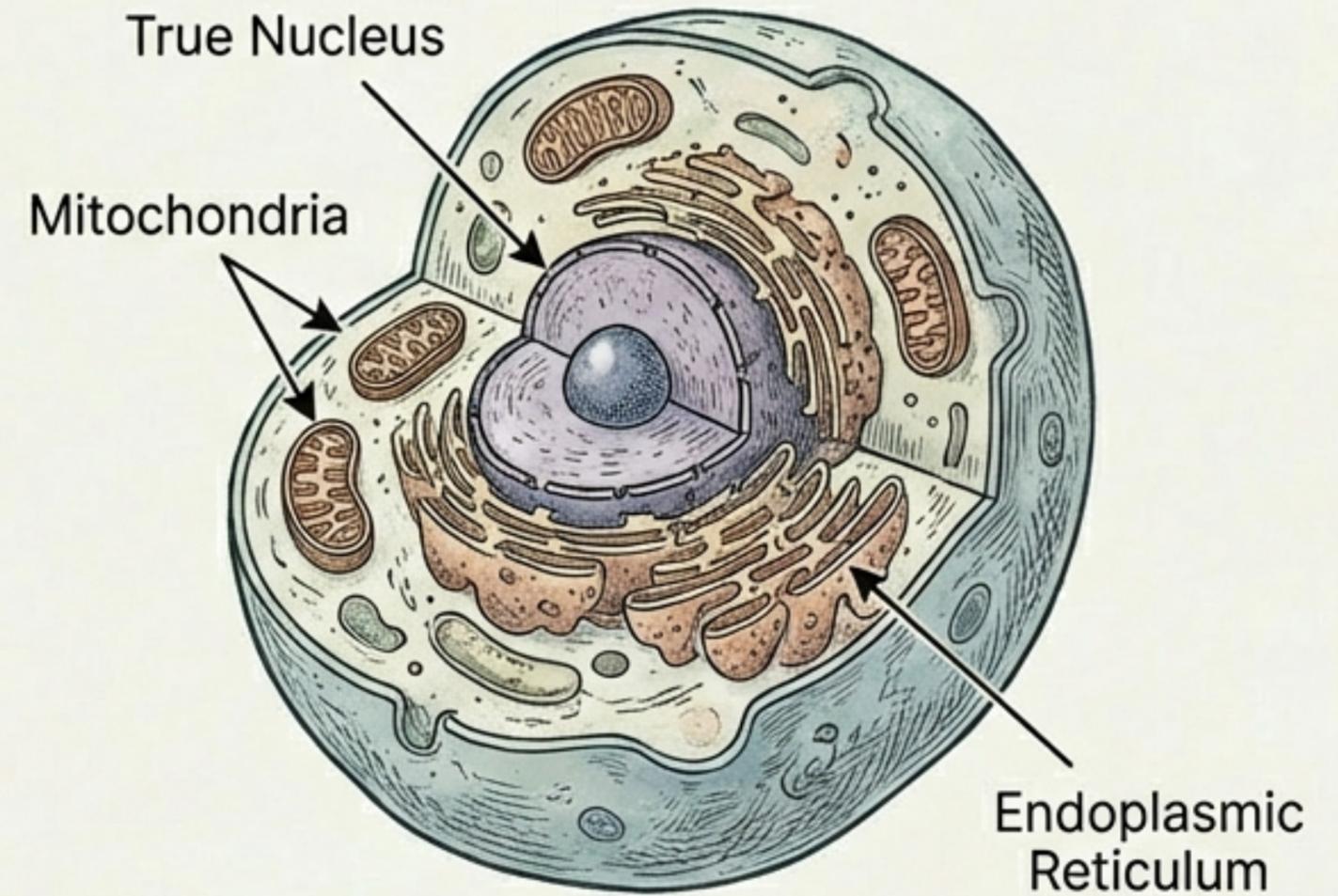
Immunization: Proved that exposure to weaker pathogens (Cowpox) protects against virulent ones (Smallpox).

Insight: This era transformed medicine from treating symptoms to targeting biological causes.

The Architecture of Life: Prokaryotes vs. Eukaryotes



Bacteria & Archaea.
Strategy: Rapid growth, simplicity, adaptability.



Fungi, Protozoa, Algae.
Strategy: Complexity, specialization, regulation.

Evolutionary Note: Prokaryotes ruled the Earth alone for billions of years.

Bacterial Anatomy: The Cell Wall Fortress

Gram-Positive

Gram-Negative

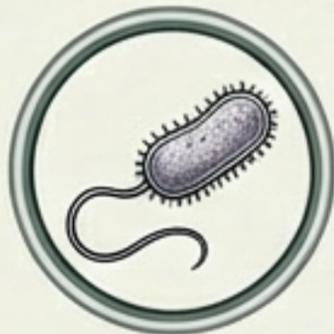
Thick Peptidoglycan Layer

Outer Membrane (LPS)

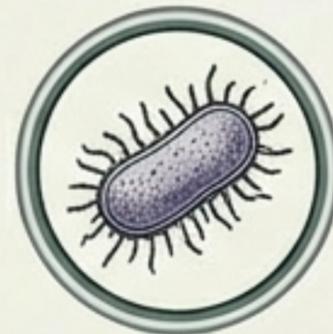
Thin Peptidoglycan

Gram-Positive:
Retains Crystal Violet stain.
Rigid and chemically simple.

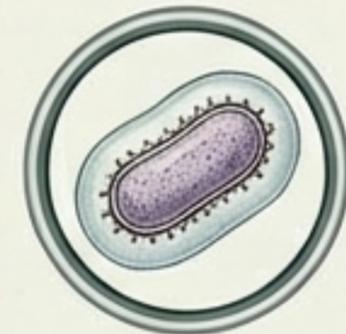
Gram-Negative:
Retains Counterstain (Pink).
Resistant to many antibiotics.



Flagella
(Motility)



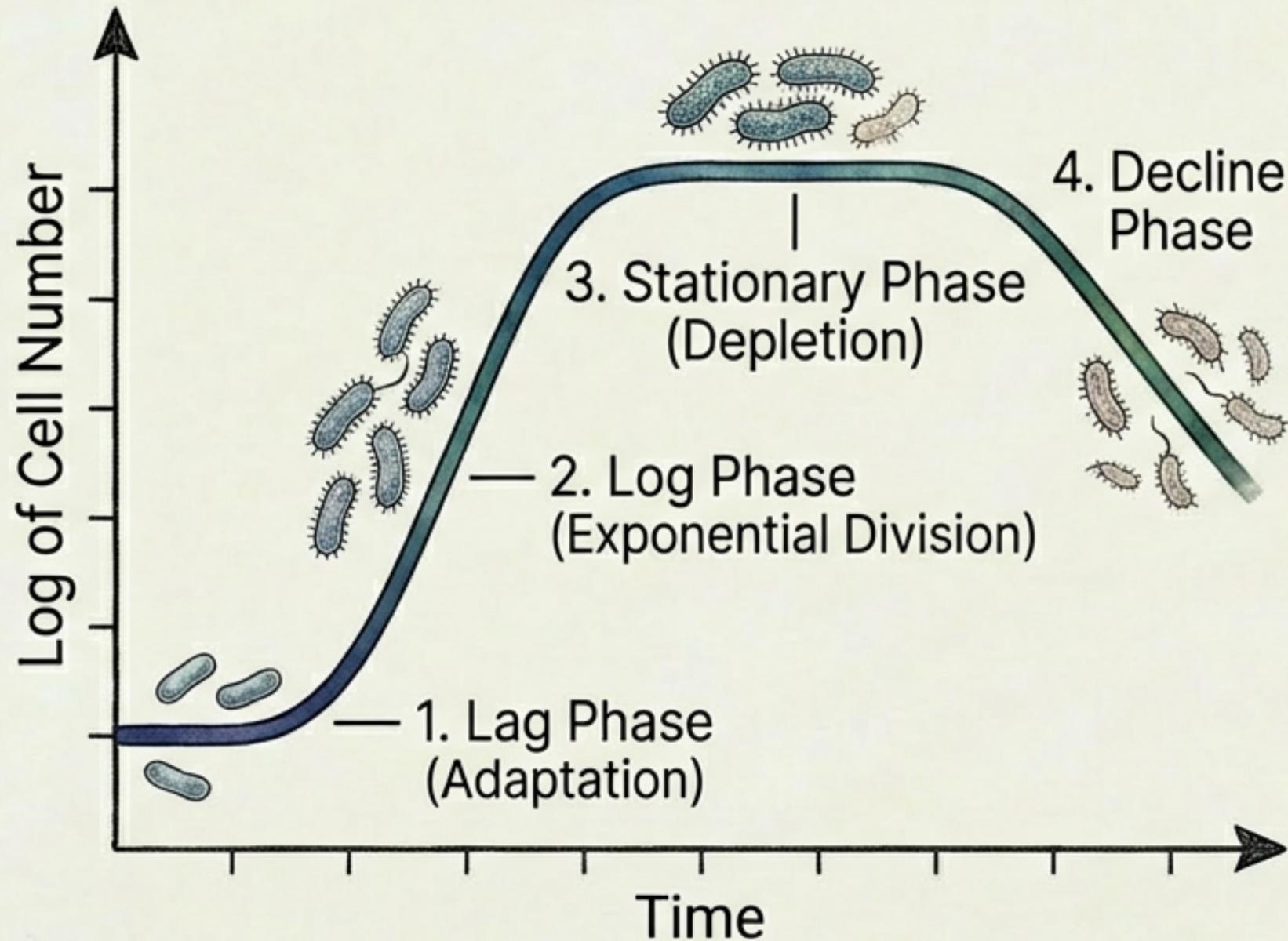
Pili
(Attachment)



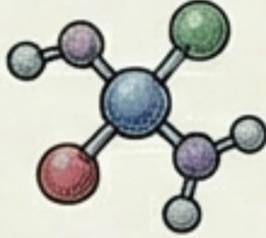
Capsule
(Defense)

Growth & Nutrition: The Engine of Expansion

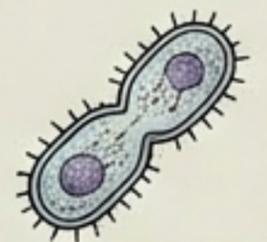
Bacterial Growth Curve



Nutritional Types

	Chemoautotrophs Energy source: Inorganic Chemicals (Ammonia/Sulfur).
	Photoautotrophs Energy source: Light (Photosynthesis).

Binary Fission allows one cell to become a colony of millions in mere hours.



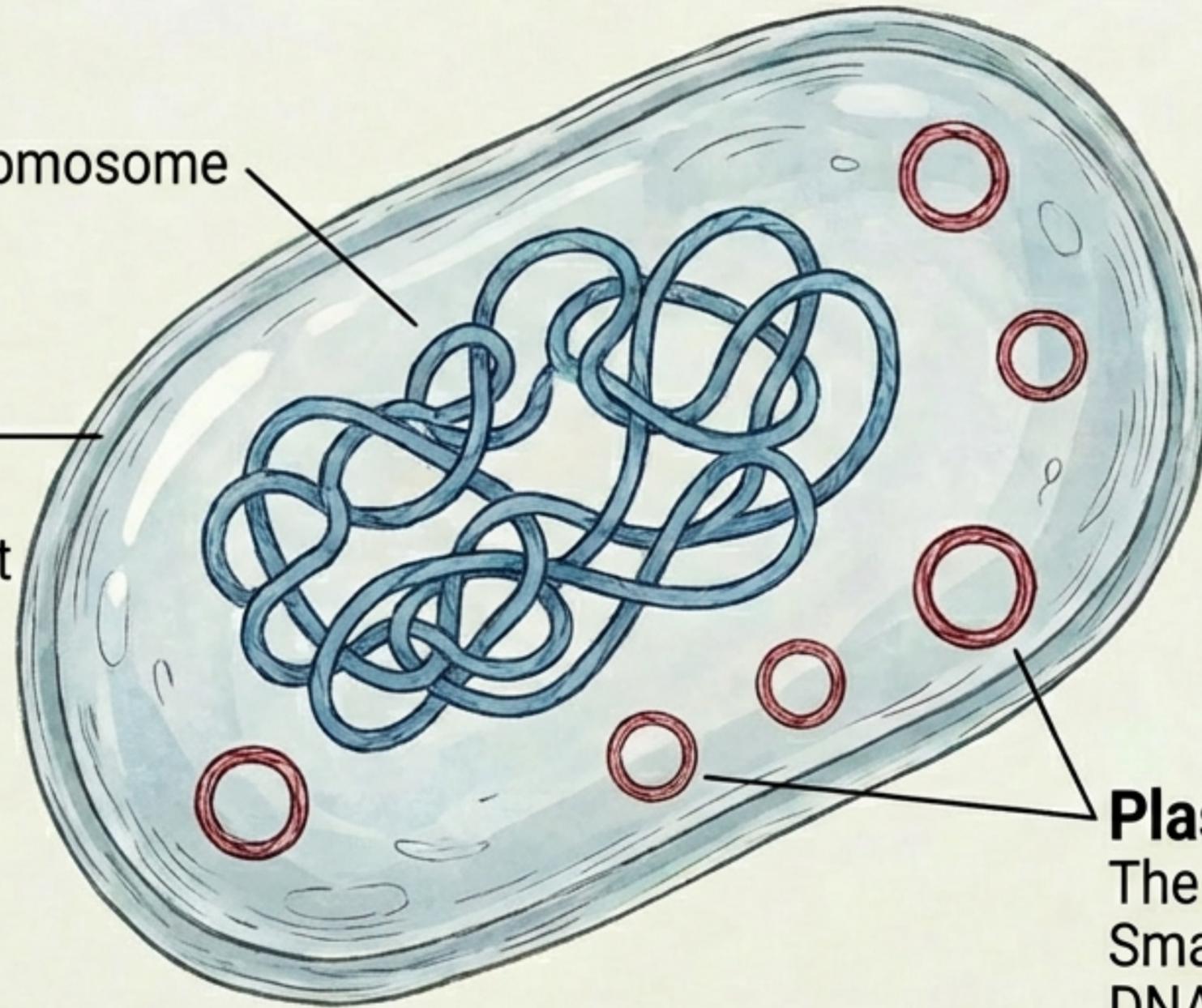
The Bacterial Genome: Efficiency & Flexibility

The Nucleoid:

The Master Plan.
Single circular chromosome
essential for life.

Plasmids:

The Add-ons.
Small, independent
DNA circles.



Plasmid Capabilities (The 'Superpowers'):

- Antibiotic Resistance
- Toxin Production
- Metabolic Versatility

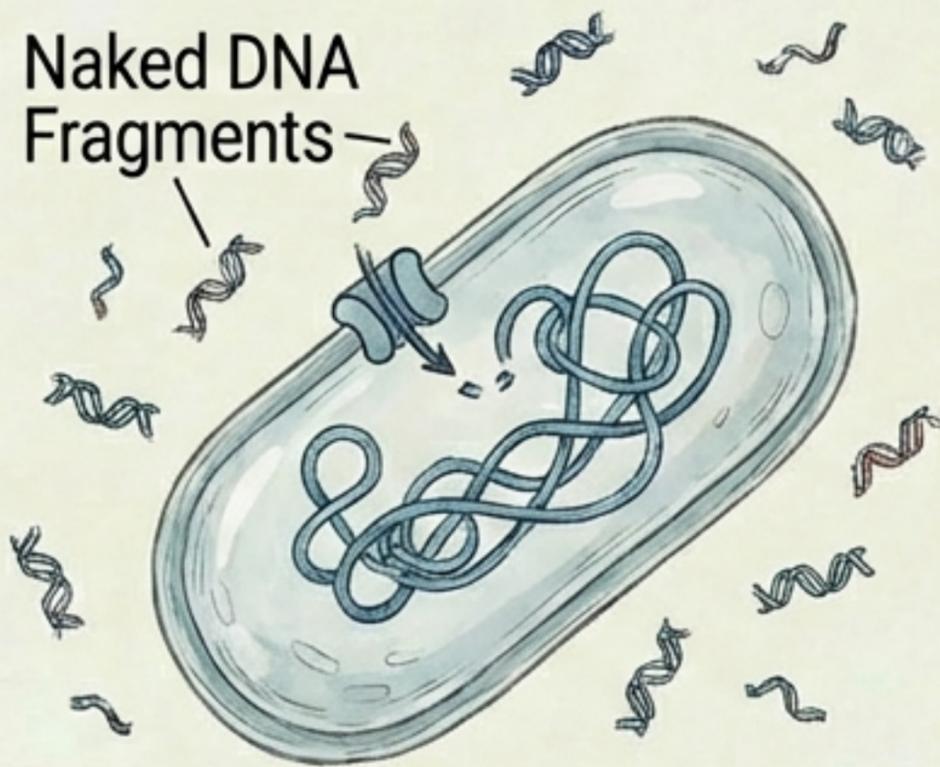
Plasmids:

The Add-ons.
Small, independent
DNA circles.

Genetic Recombination: Horizontal Gene Transfer

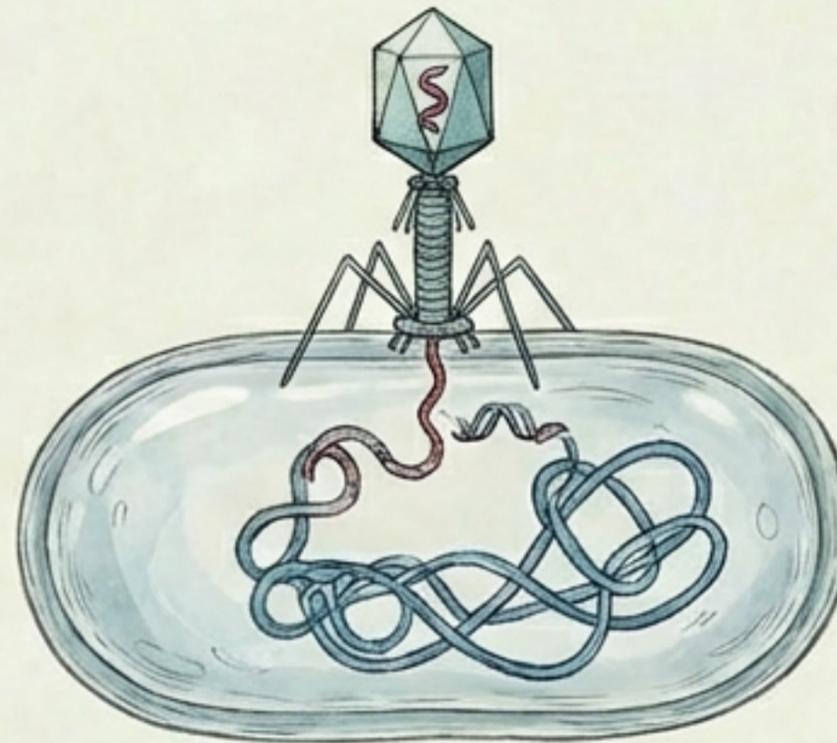
How bacteria evolve without sexual reproduction.

Transformation



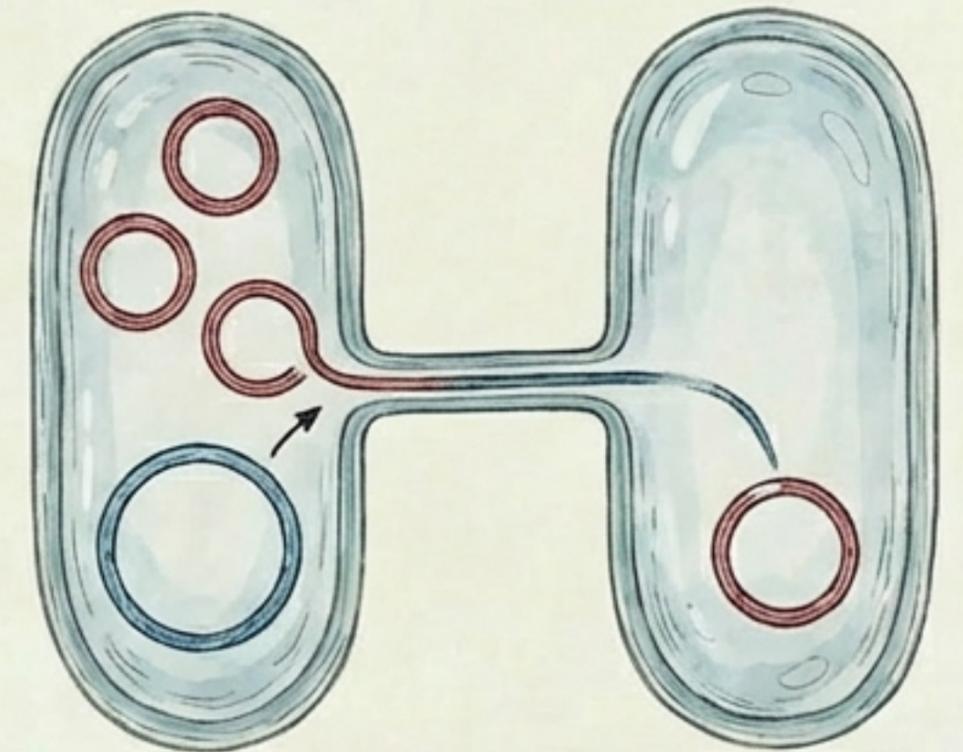
Uptake of 'naked' DNA.

Transduction



Viral delivery via Bacteriophage.

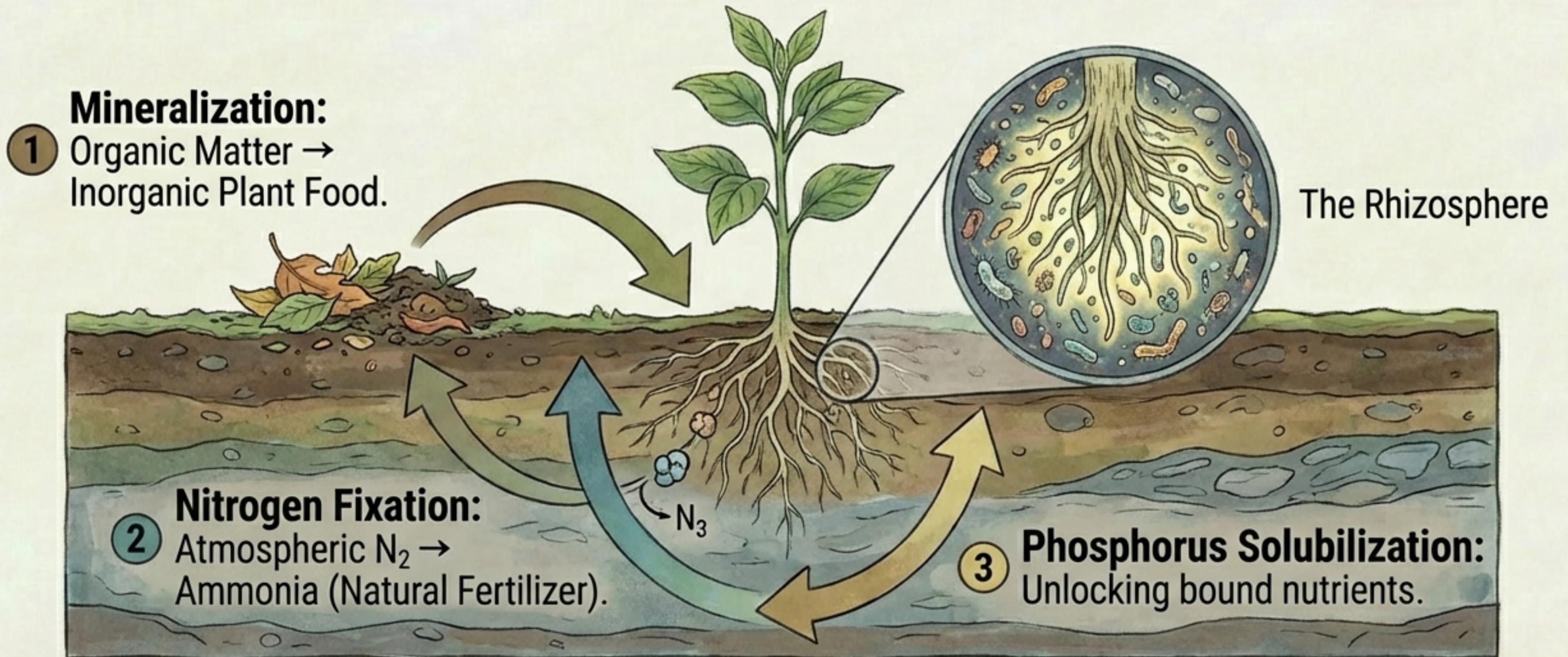
Conjugation



Direct 'mating' bridge.

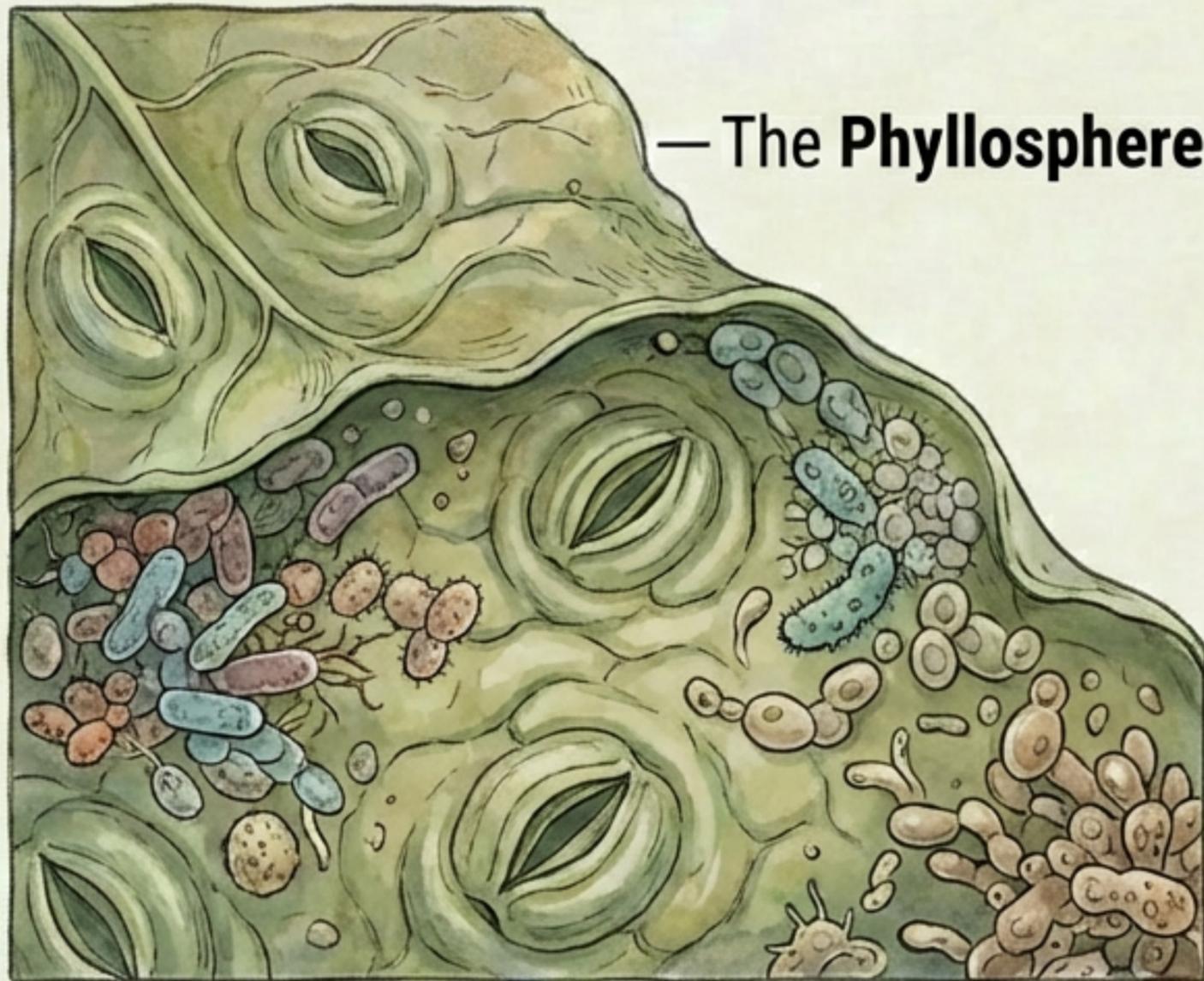
These mechanisms drive the rapid spread of antibiotic resistance (Superbugs).

Soil Microbiology: The Foundation of Agriculture

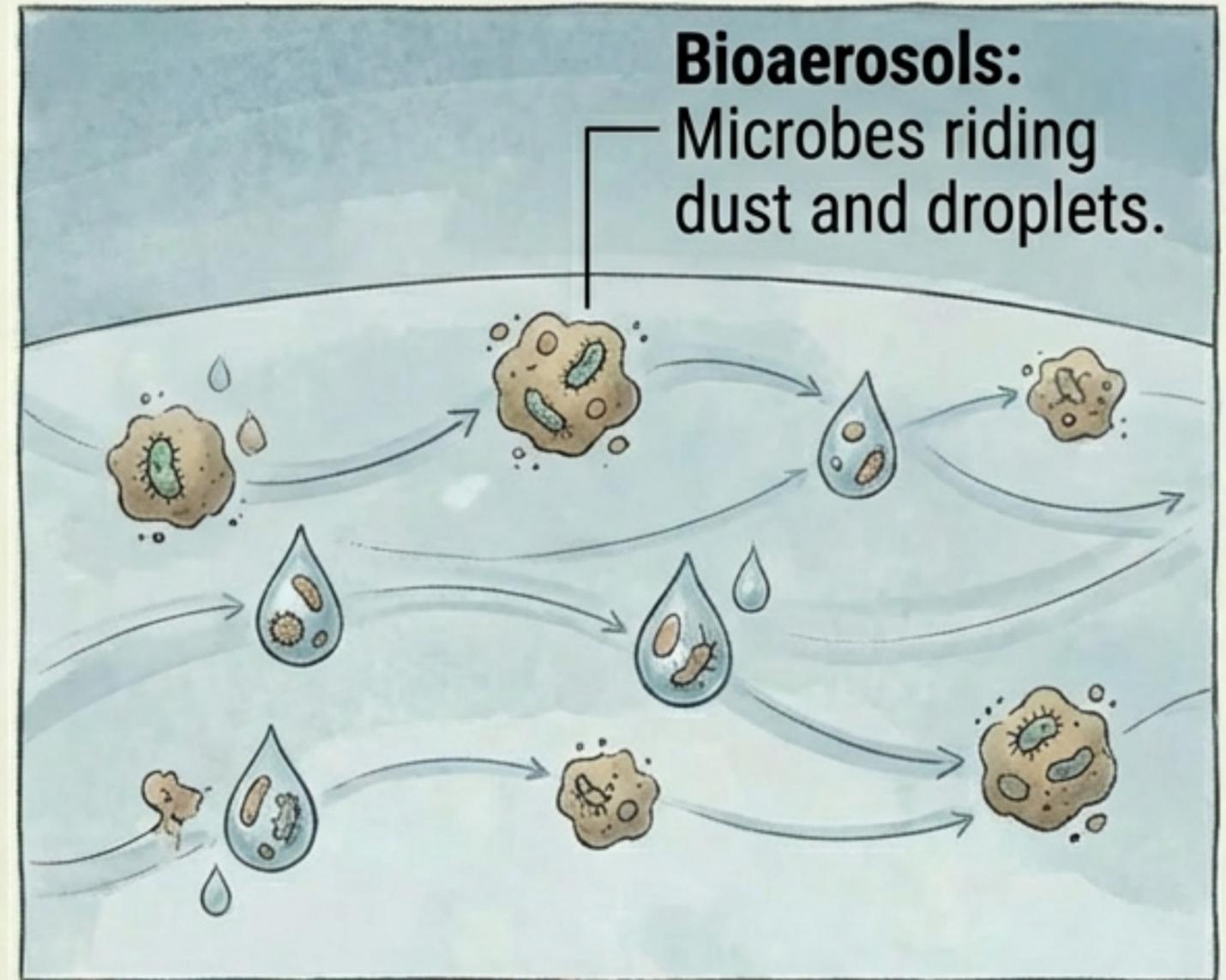


Soil is not inert dirt. It is a dynamic biological digestive system.

Air Microbiology: The Transport Network



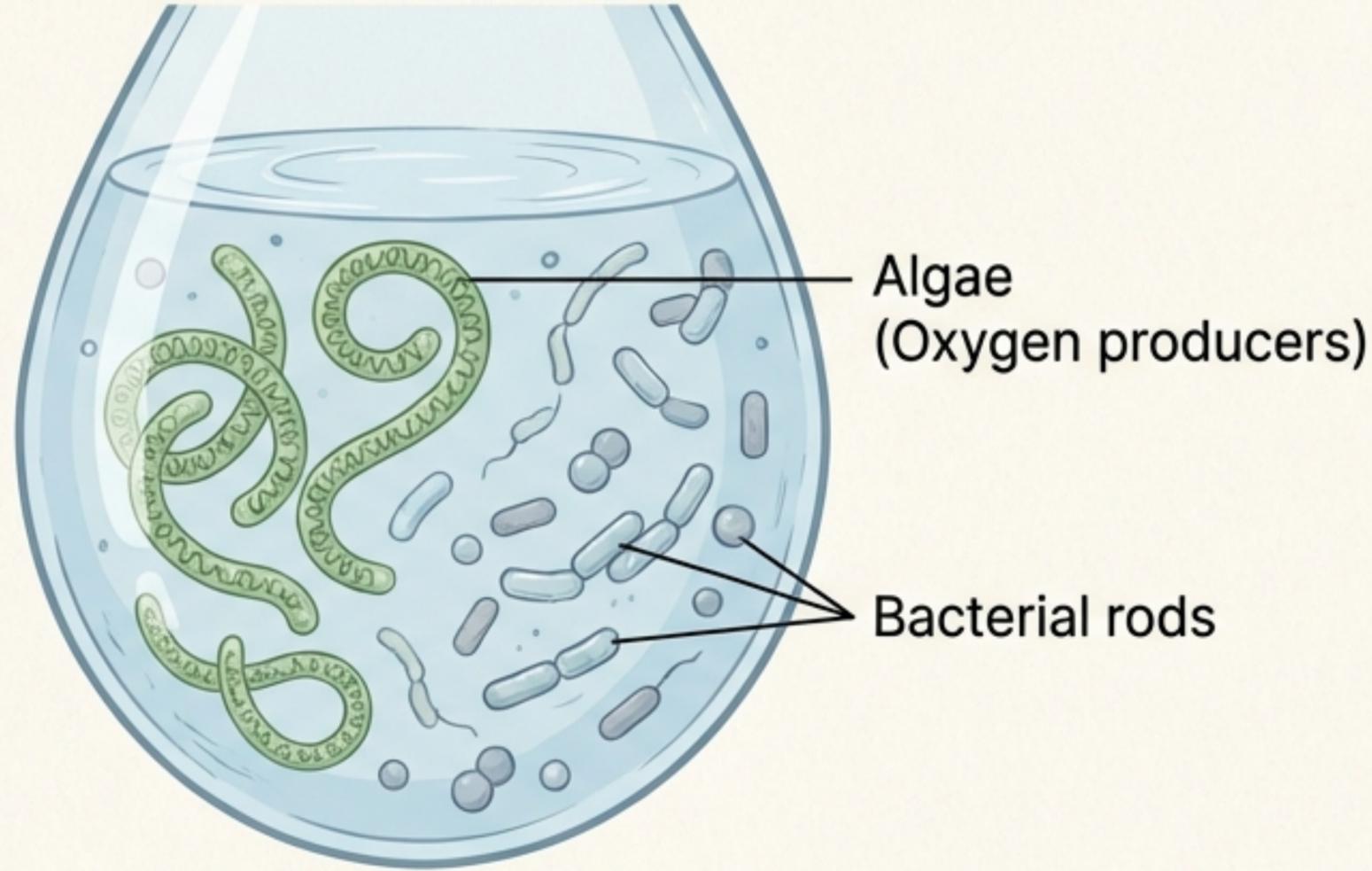
- **The Phylloplane:** A harsh habitat exposed to UV and desiccation.



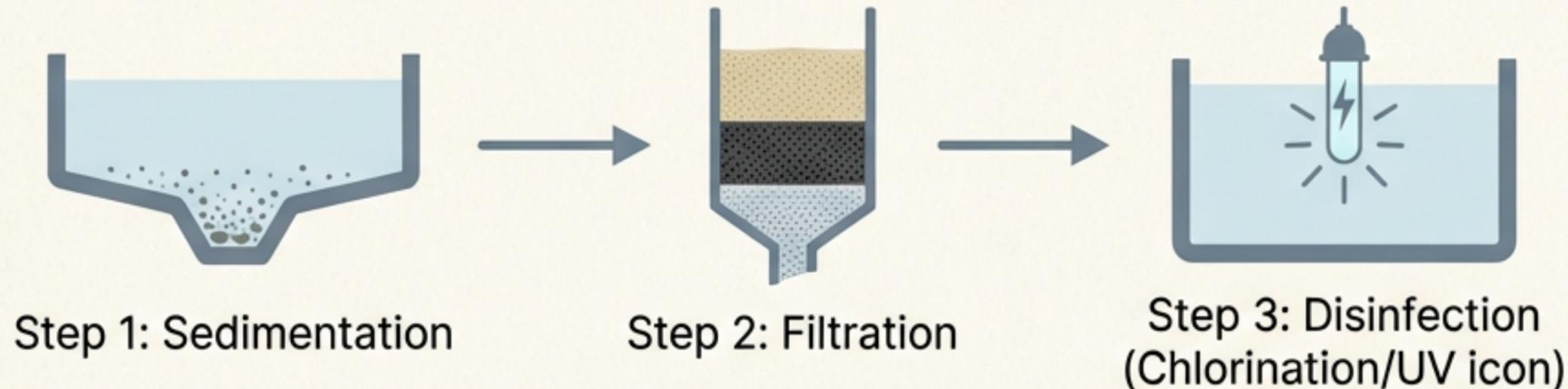
- **Impact:** Transport for pathogens causing blights and leaf spots.

Water Microbiology: Ecosystems & Public Health

The Ecosystem



The Treatment



****Indicator Organisms (Coliforms)**:** Presence signals fecal contamination and risk of Cholera/Typhoid.

Food Microbiology: Spoilage vs. Preservation

Spoilage - The Enemy



- Degradation, Texture loss,
- Food-borne illness (Salmonella).

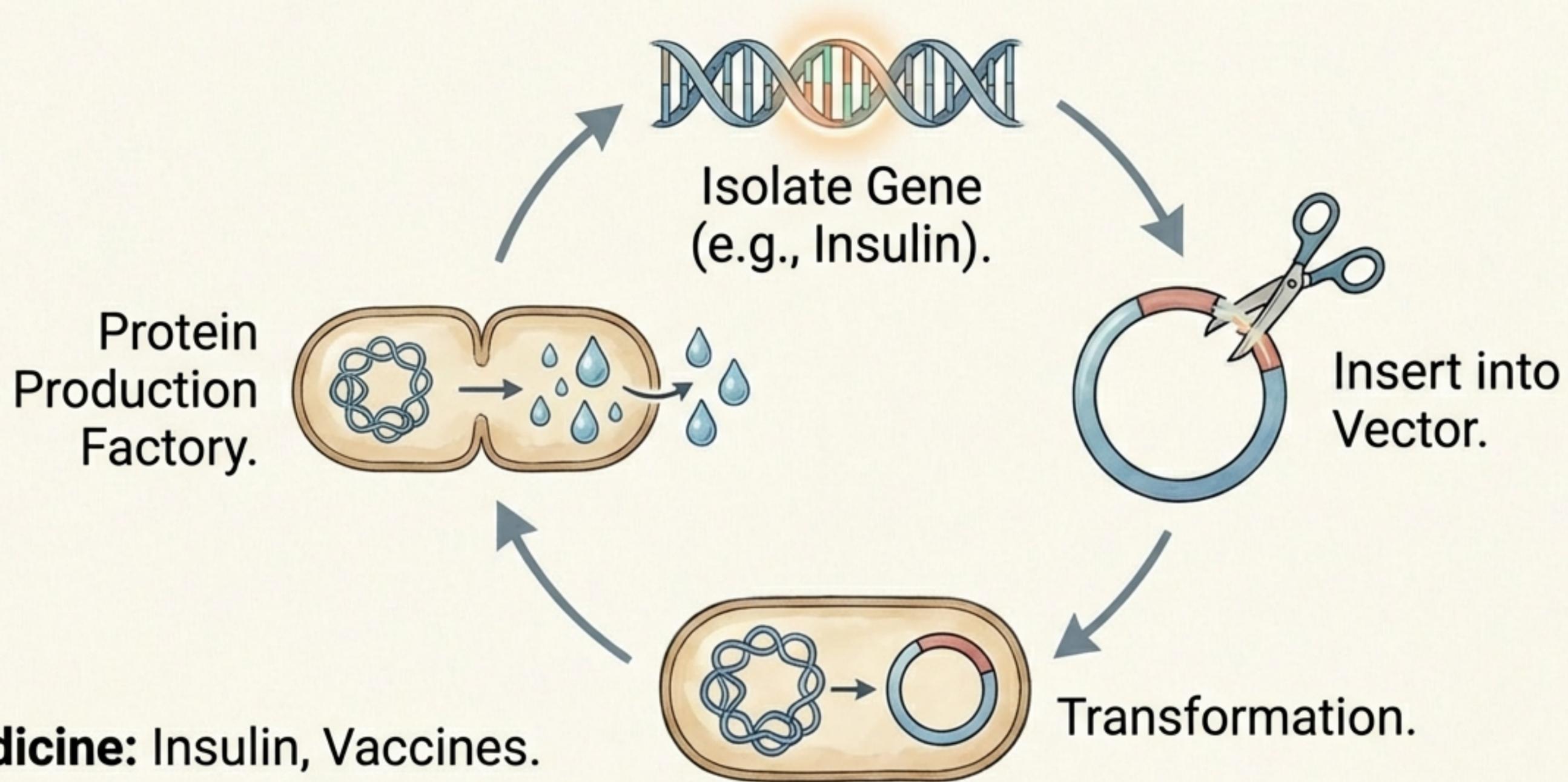
Fermentation - The Ally



- Controlled Growth: Preservation,
- Flavor enhancement, Probiotics.

Preservation Techniques: Heat (Pasteurization) | Cold | Drying | Chemical

Biotechnology: Reprogramming the Engine

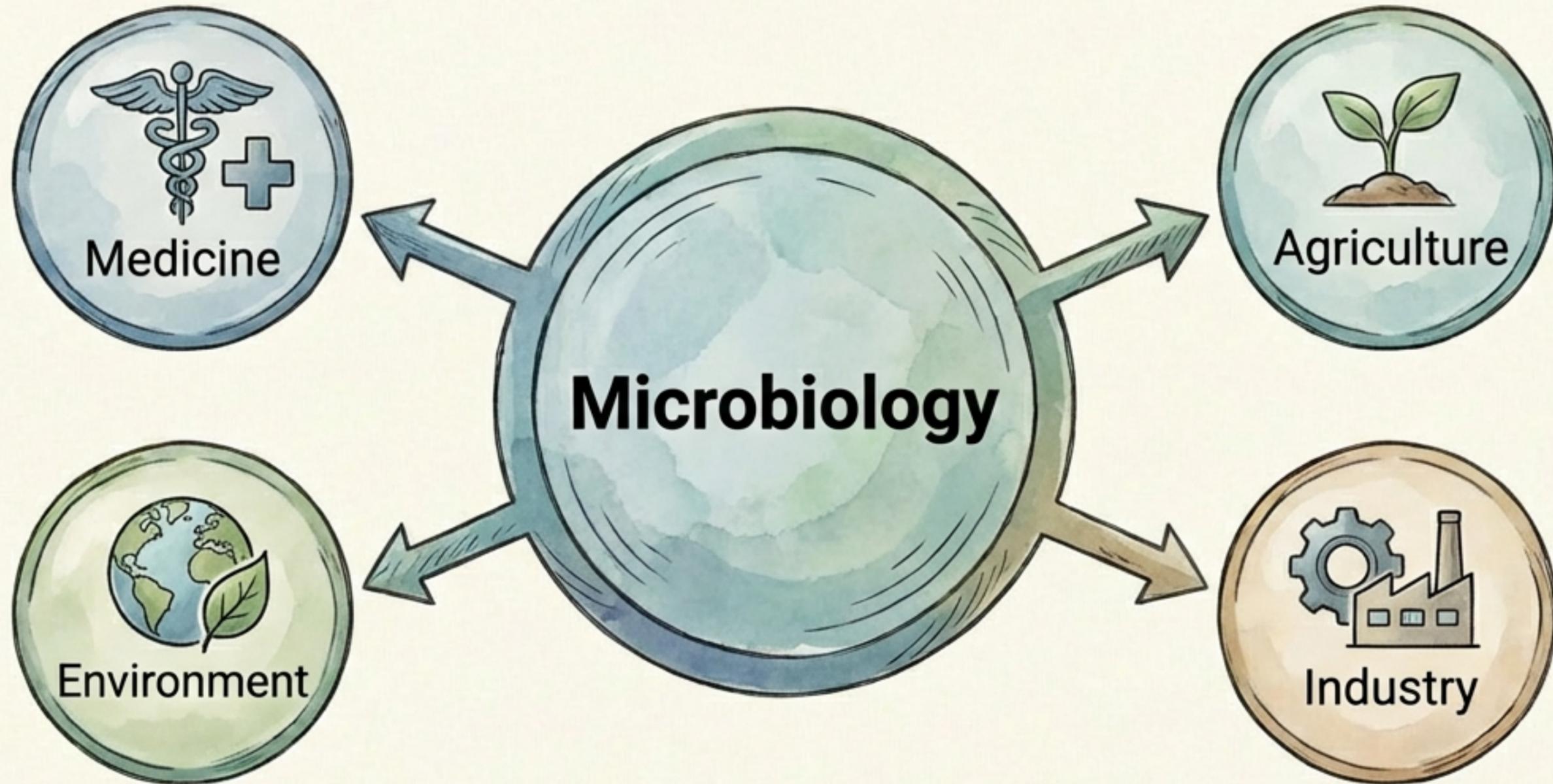


Medicine: Insulin, Vaccines.

Agriculture: Biofertilizers.

Environment: Bioremediation (Oil spill cleanup).

Conclusion: The Invisible Architect



“Microbiology challenges the anthropocentric view of life—demonstrating that the smallest entities often exert the largest influence.”