Hydroponic Telemetry

Mastering the Four Critical Thresholds

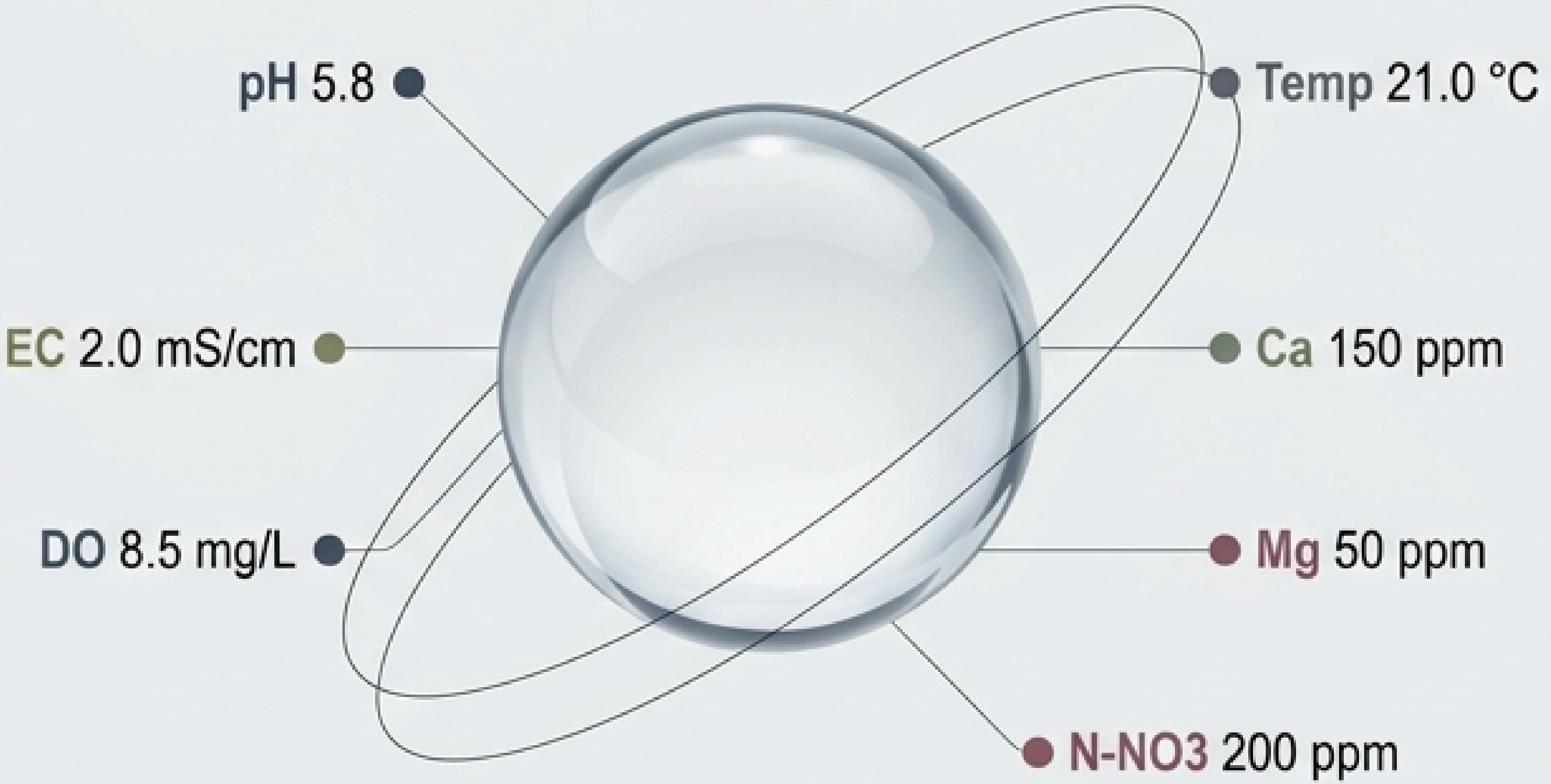
INITIALISE SYSTEM

Soilless Cultivation is Zero-Buffer Engineering

In traditional agriculture, native soil acts as a chemical and biological buffer. In hydroponic environments, you replace this buffer with controlled atmospheric vapour pressure and exact elemental chemistry.

The Native Buffer

Exact Fluid Engineering



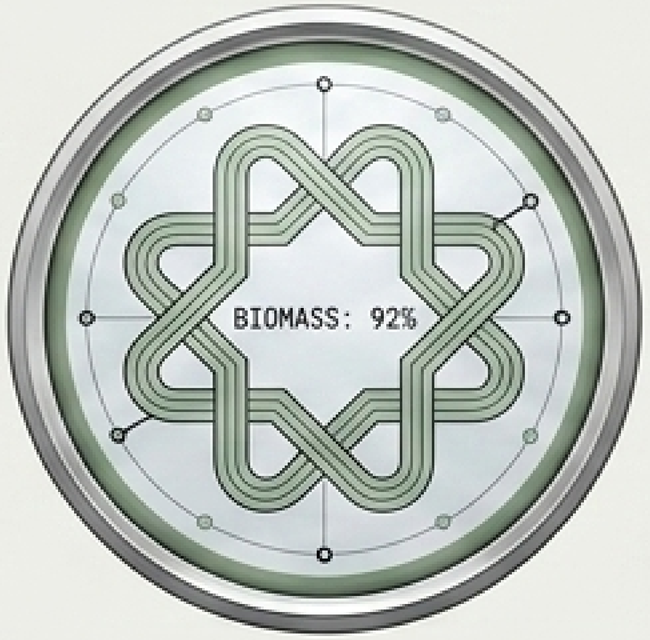
Zero Soil Buffer + Missed Threshold = Catastrophic Crop Loss

The Four Control Panels

Module 1: Atmospheric
& Fluid Respiration

Module 2:
The Conductivity Illusion

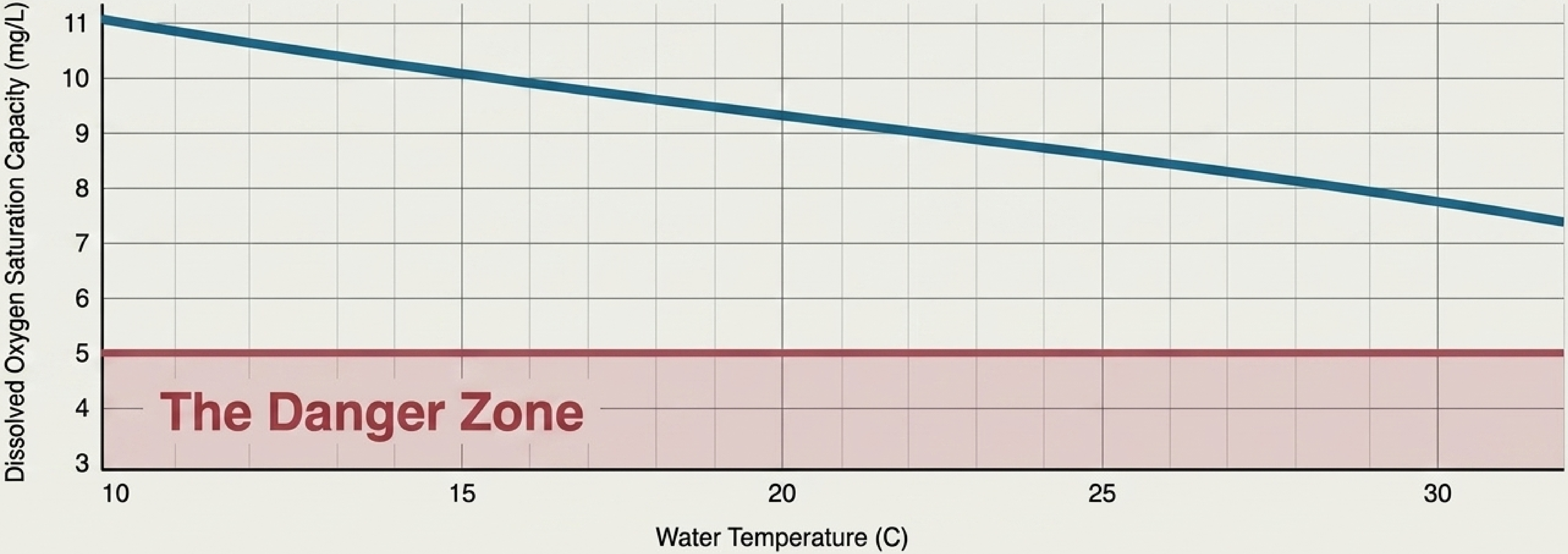
Module 3: Chemical
Antagonism & pH



Module 4: Reservoir
Biological Warfare

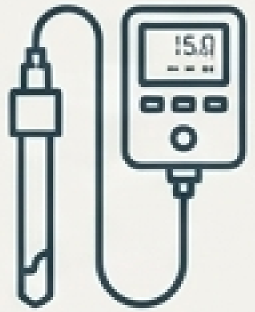
Warm Water Cannot Breathe

Optimal Target: 7.0 - 9.0 mg/L DO	**Takeaway:** Dissolved oxygen capacity is physically limited by temperature. Warmer reservoirs inherently hold less oxygen, creating immediate biological stress.
Critical Threshold: < 5.0 mg/L DO (Root Hypoxia)	



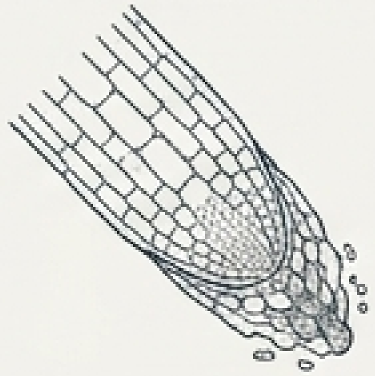
The Anoxia Cascade

When dissolved oxygen falls below the 5.0 mg/L threshold, the root environment becomes anoxic. Plant metabolic transport ceases, cell death occurs in the root tips, and fungal water moulds (Pythium, Phytophthora) rapidly consume the decaying tissue.



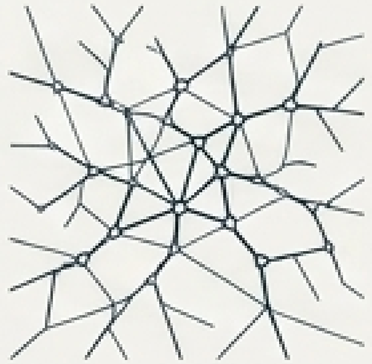
Sensor Reading:
< 5.0 mg/L DO

Hypoxia



Root Tip Cell Death

Metabolic transport ceases



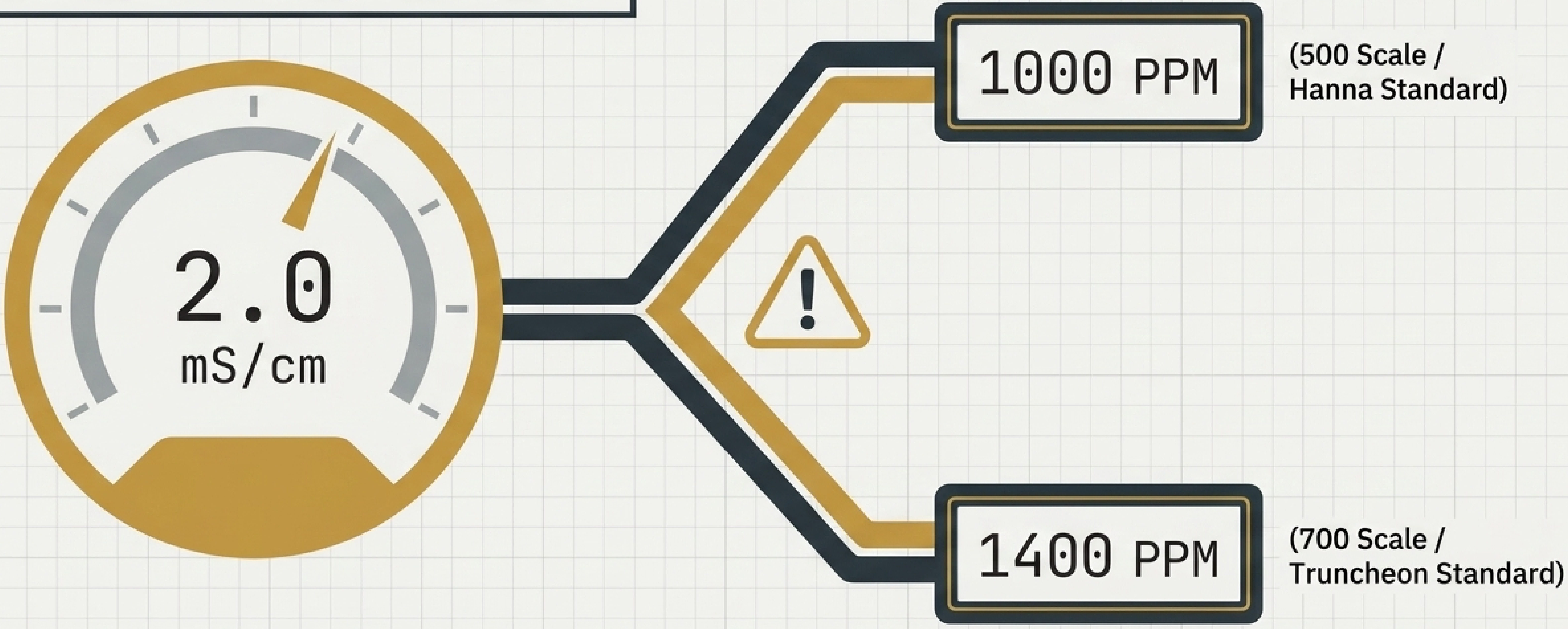
Pythium Proliferation

Opportunistic root rot pathogens colonise

The Conductivity Illusion

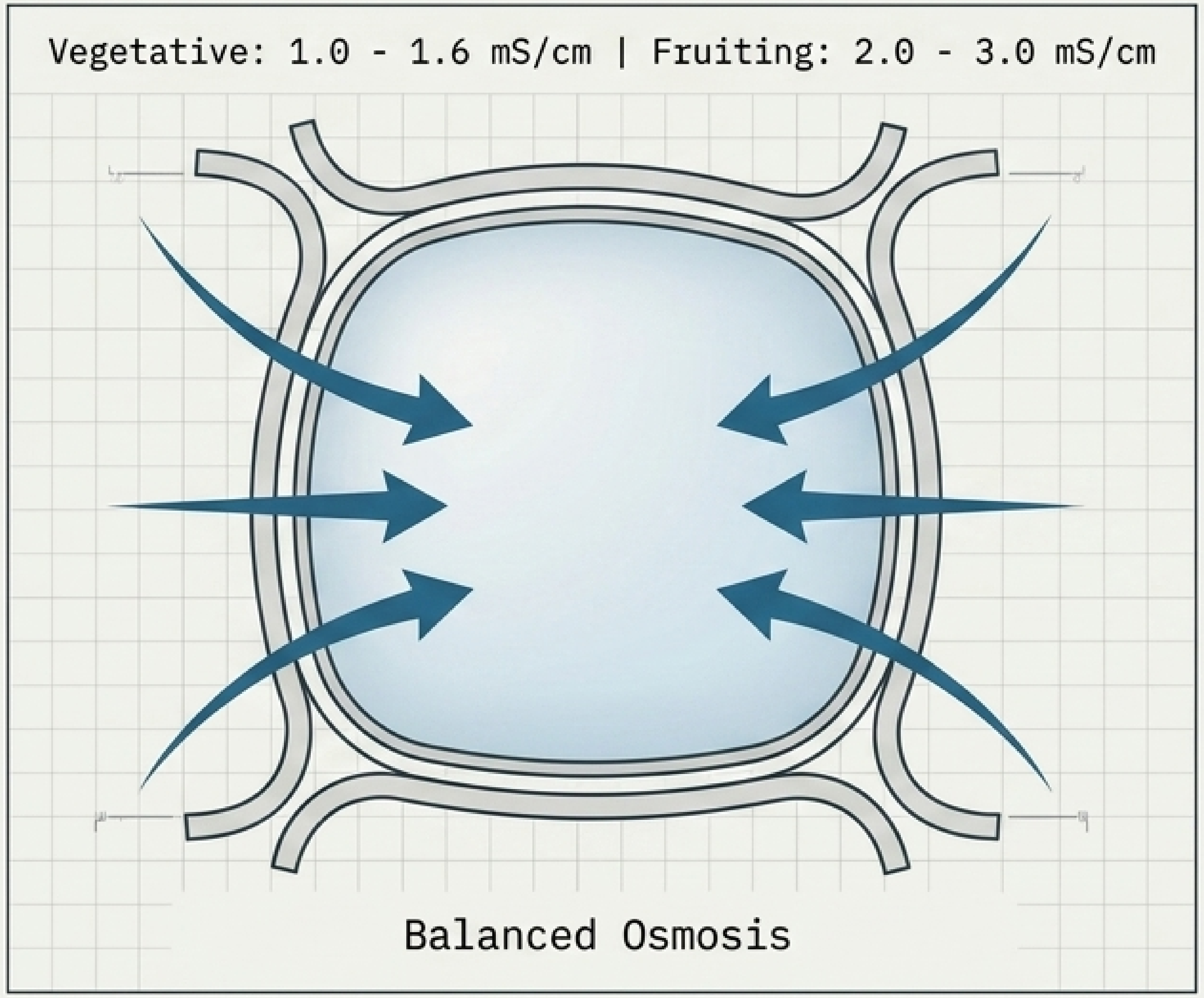
Rule: Never communicate target concentrations in PPM.

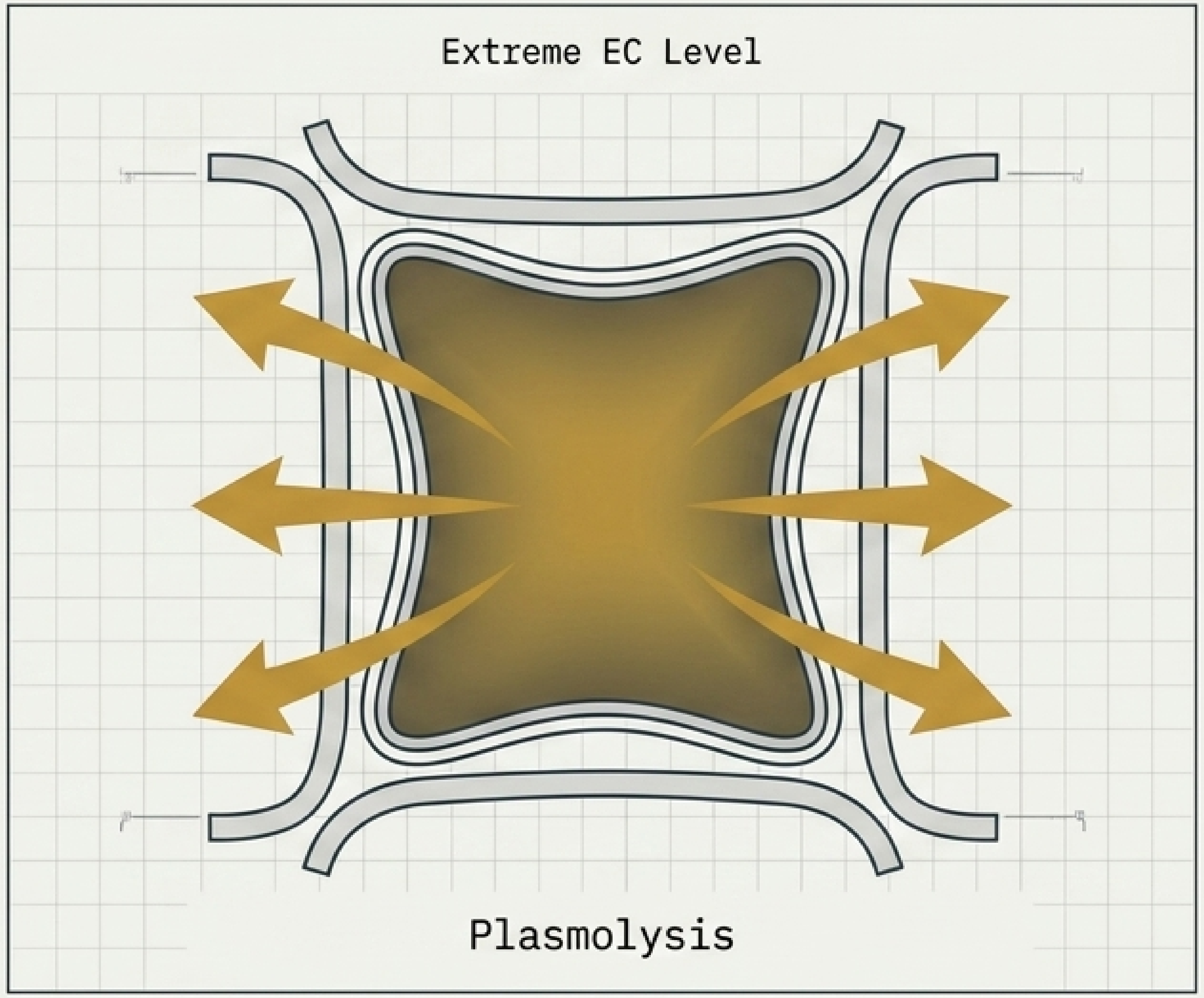
Explanation: PPM meters do not count particles; they measure Electrical Conductivity (EC) and multiply it by an assumed conversion factor. A perfect 2.0 EC solution reads as two wildly different PPM numbers depending on the manufacturer's algorithm. Always target mS/cm or µS/cm.



The Osmotic Pressure Threshold

Mechanism: Plasmolysis. If reservoir EC is driven too high, the osmotic pressure of the nutrient solution exceeds the internal pressure of the root cells. Water leaches out of the roots, resulting in severe tissue desiccation known as "fertiliser burn".

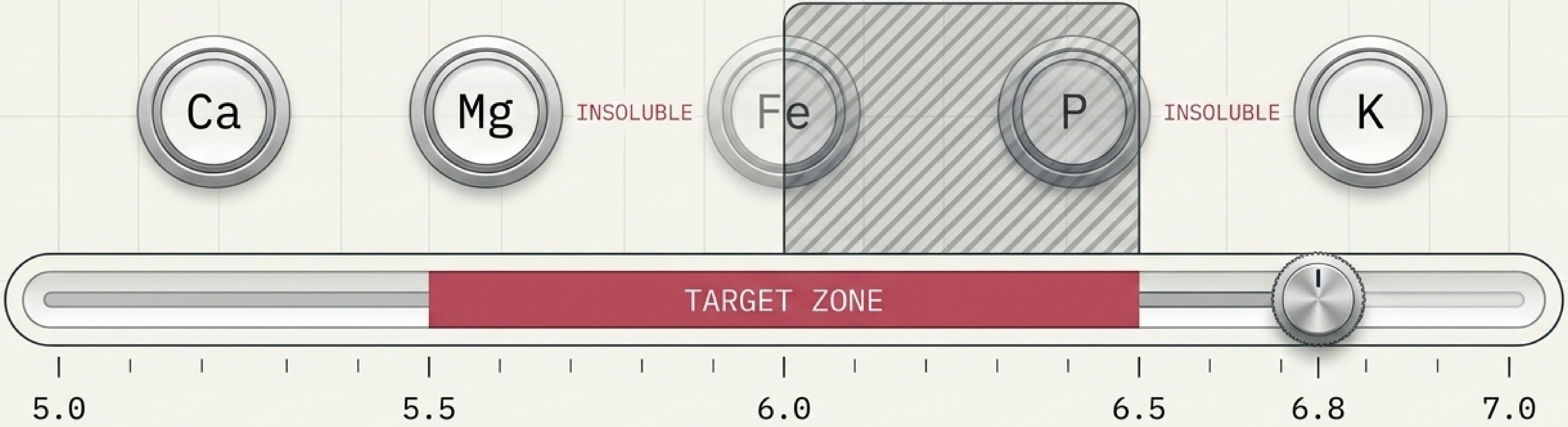




The Antagonism Window

Rule: Target pH 5.5 - 6.5 for optimal solubility.

Explanation: Extreme pH levels or excessive single-ion concentrations cause chemical antagonism. The ions remain in the water, but they are "locked out"—structurally unavailable for transport across root cell membranes.



Real-Time Root Diagnostics

Diagnostic Rule: Mobile elements are physically translocated by the plant from older leaves to save new growth during a shortage. Immobile elements cannot be moved once deposited. Therefore, the physical location of the symptom instantly identifies the missing elemental category.

Incident Report: The Rapid pH Spike

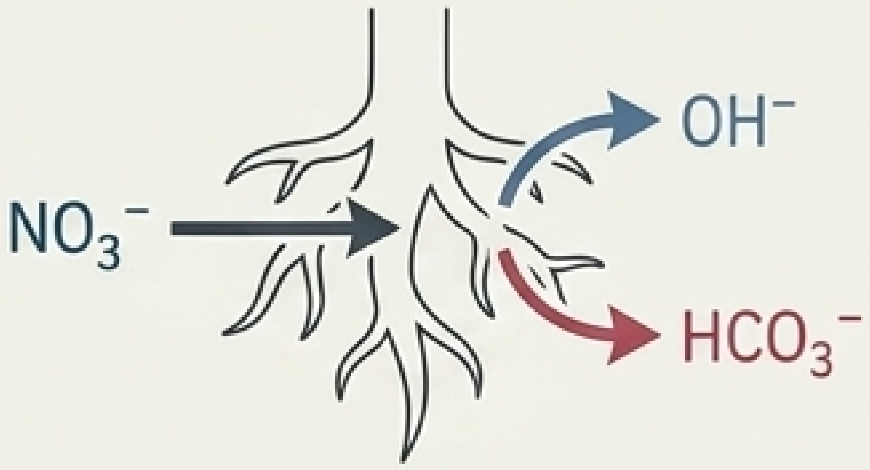
Observation

Reservoir pH jumps from 5.8 to 6.8 within a 24-hour window.

Chemical Mechanism

Rapid absorption of Nitrate anions (NO3-) by fast-growing crops.

To maintain electrochemical balance, roots excrete hydroxyl (OH-) or bicarbonate (HCO3-) ions ions into the solution, driving alkalinity upward.



Correction Protocol

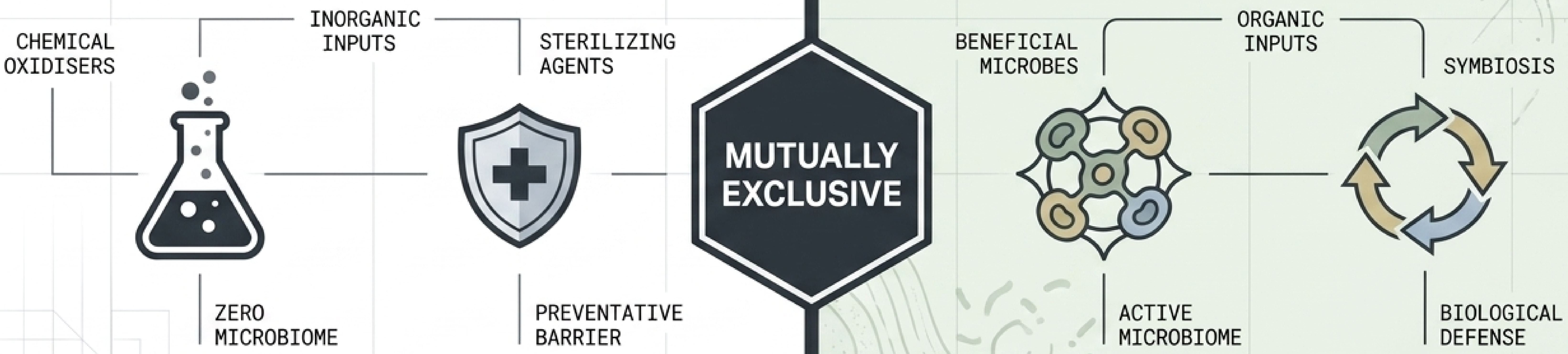
1. Shade reservoir to prevent algae (which consumes carbonic acid).
2. Dose dilute Phosphoric Acid (vegetative) or Nitric Acid.
3. Check tap water for high carbonate hardness (dKH) buffering.

The Biological Fork in the Road

The Rule: You must choose one architecture. Mixing them is **catastrophic.** Adding chemical **oxidisers to an inoculated reservoir** instantly kills the beneficial microbes you paid to cultivate.

The Sterile Reservoir

The Living Reservoir

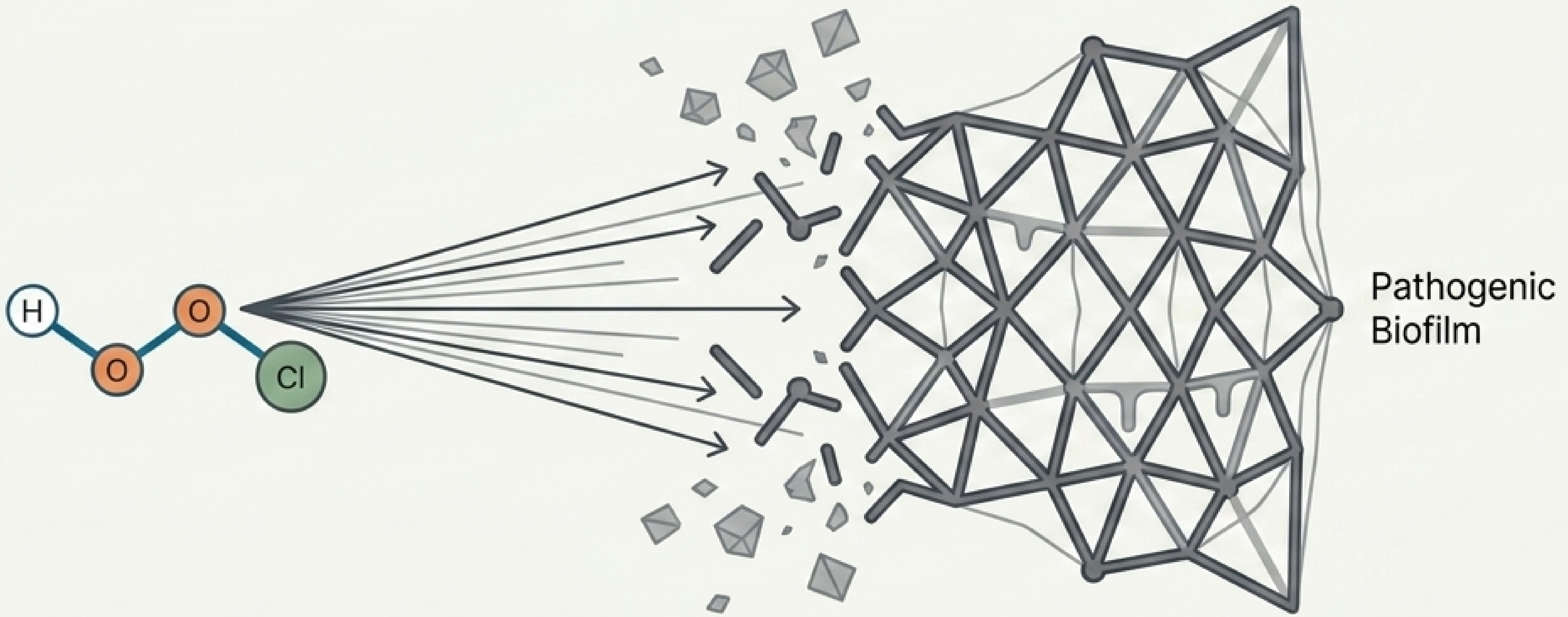


Protocol 1: Chemical Oxidation

Mechanism: Continuous low-level oxidisers (HOCl, H2O2, UV-C) keep water entirely free of bacteria, fungi, and algae.

The HOCl Advantage: Hypochlorous Acid (0.05% active) clears mineral deposits and suppresses Pythium without stripping delicate root tissue or leaving toxic salt build-up.

Primary Use Case: Mandatory for High-Pressure Aeroponics (HPA), where living biofilm will instantly clog 30- to 80-micron atomising nozzles, causing crop death in 15 minutes.



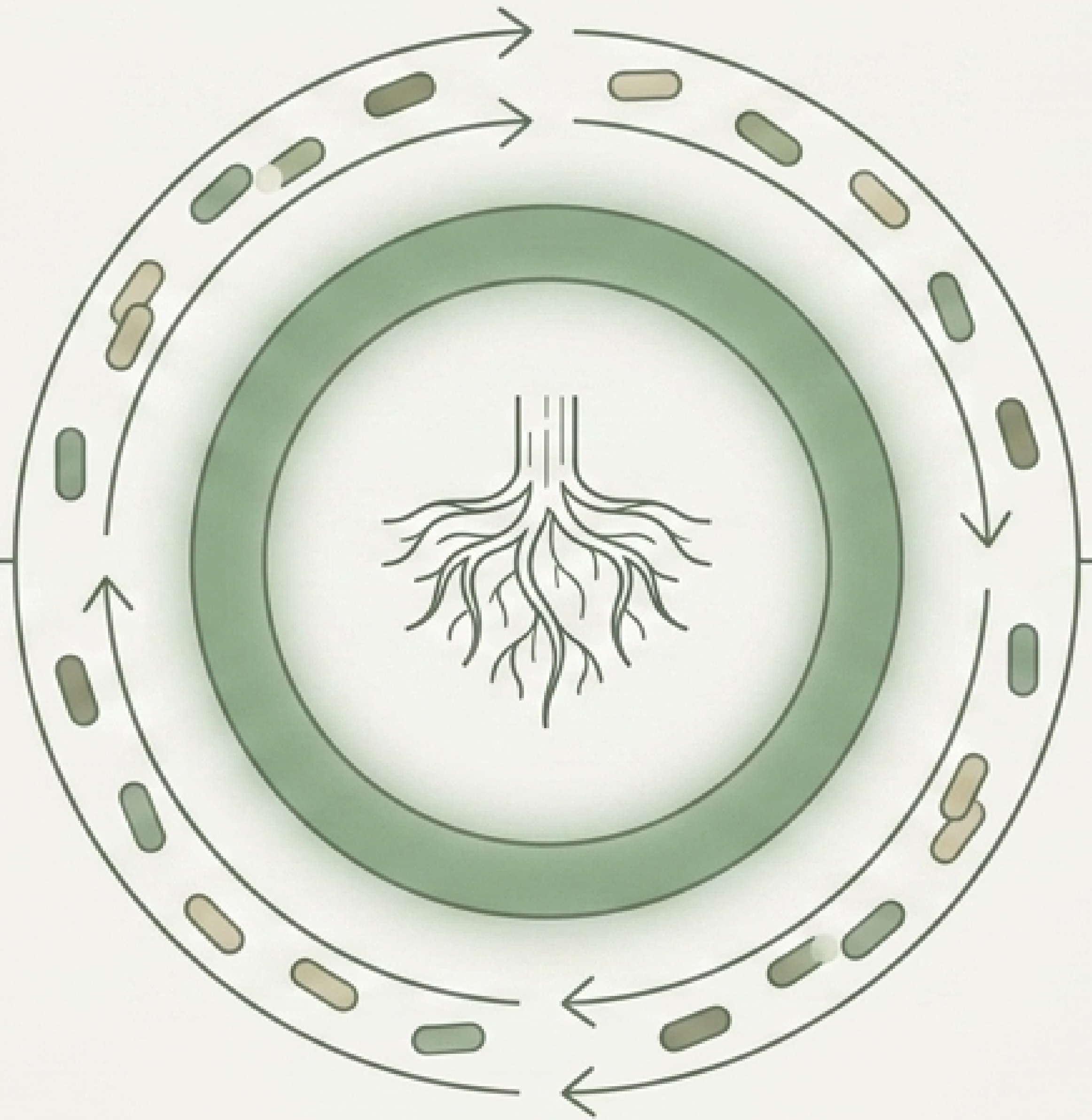
Protocol 2: The Engineered Ecosystem

Mechanism: Intentional inoculation of the water column with beneficial bacteria, fungi, and biological enzymes.

The Symbiotic Advantage: These microbes colonise the root surface, suppress plant pathogens, and enhance nutrient availability.

Primary Use Case: Ideal for Deep Water Culture (DWC) and Dutch Buckets, where massive root systems are continuously submerged and possess high thermal mass.

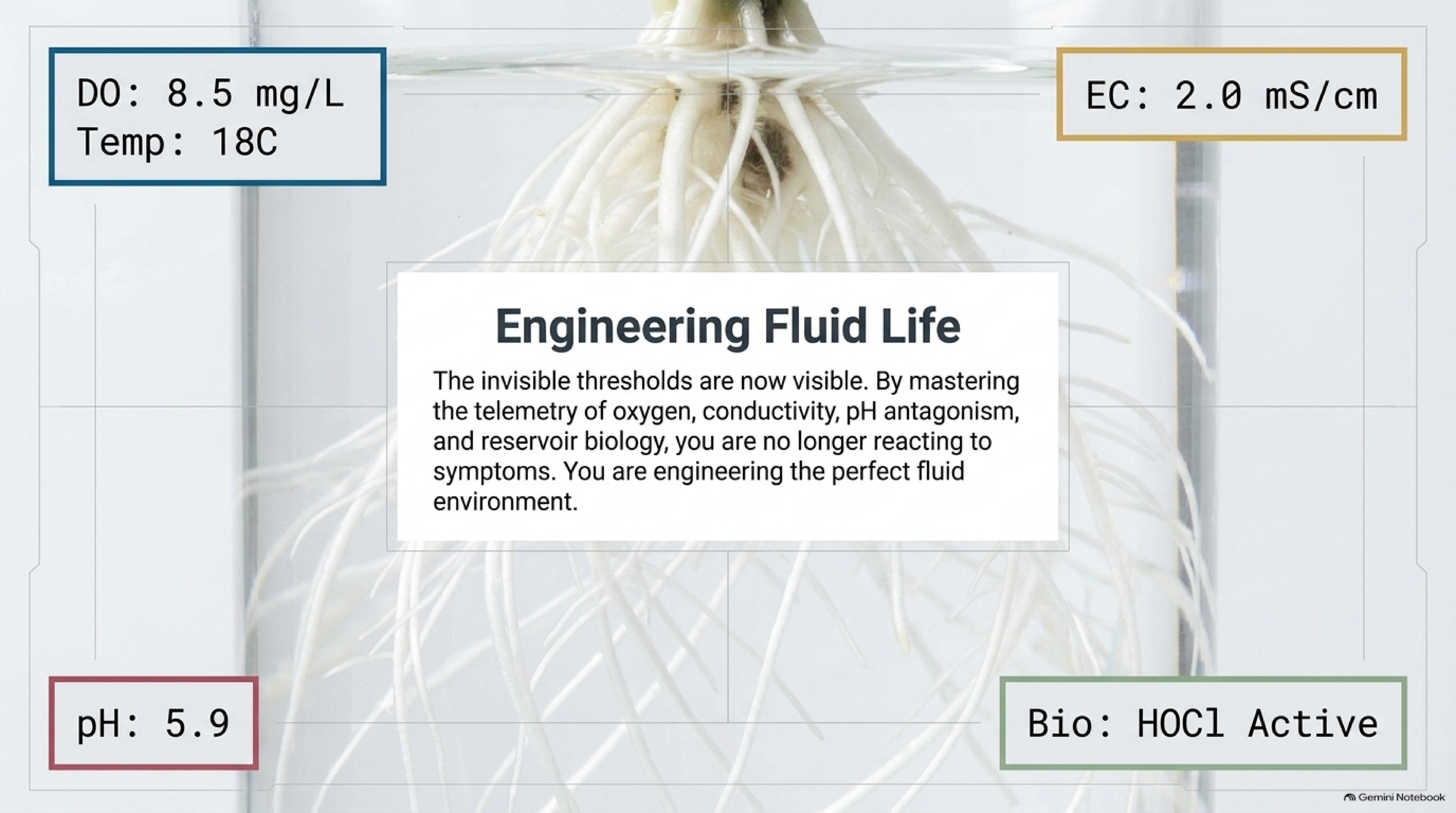
Autotrophic & Heterotrophic Bacteria (*Bacillus*, *Trichoderma*)



Converts organic waste into plant-available nutrients

System Architecture & Threshold Matrix

System Architecture	DO Level Required	Mechanical Failure Risk	Ideal Bio-Strategy
Deep Water Culture (DWC)	Medium (Air-stone reliant)	Low (High water buffer)	Living Ecosystem
Nutrient Film Technique (NFT)	High (Air exposure)	High (Rapid dry-out)	Sterile or Living
High-Pressure Aeroponics (HPA)	Extreme (Atomised mist)	Critical (Nozzle clogs)	Strictly Sterile (HOCl)
Kratky Method	Low (Passive air gap)	None (Zero moving parts)	Passive / Living



Engineering Fluid Life

The invisible thresholds are now visible. By mastering the telemetry of oxygen, conductivity, pH antagonism, and reservoir biology, you are no longer reacting to symptoms. You are engineering the perfect fluid environment.