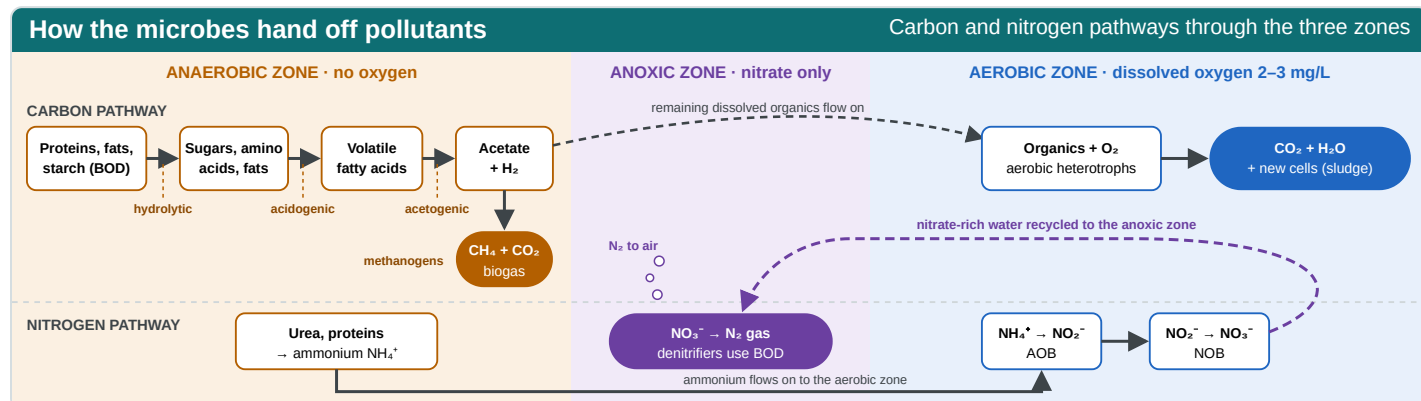
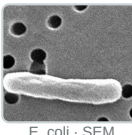
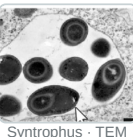
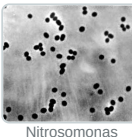
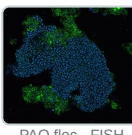
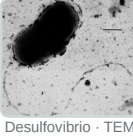
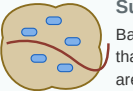


Biological treatment relies on **naturally occurring bacteria** from sewage, soil and water, each given the zone it needs: **anaerobic** (no oxygen, no nitrate), **anoxic** (nitrate but no dissolved oxygen) or **aerobic** (dissolved oxygen). Together they turn organics, ammonia and phosphate into gases, water and sludge.



Aerobic heterotrophs AEROBIC  <i>Bacillus, Pseudomonas, Zoogloea</i> The main workforce: eat dissolved organics (BOD) with oxygen; Zoogloea slime binds flocs. Organics + O₂ → CO₂ + H₂O	Hydrolytic bacteria ALL ZONES  <i>Clostridium, Bacteroides</i> Release enzymes that cut proteins, fats and starch into soluble molecules. Polymers → monomers	Acid formers ANAEROBIC  <i>Clostridium, Escherichia</i> Ferment sugars and amino acids into fatty acids, alcohols and H ₂ ; overload drops pH. Sugars → VFAs + H₂ + CO₂
Acetogenic bacteria ANAEROBIC  <i>Syntrophomonas, Syntrophus</i> Turn propionate and butyrate into acetate and H ₂ , in partnership with methanogens. VFAs → acetate + H₂ + CO₂	Methanogens (archaea) ANAEROBIC  <i>Methanosarcina, Methanosaeta</i> Archaea, not bacteria: turn acetate or H ₂ + CO ₂ into biogas; killed by oxygen. Acetate → CH₄ + CO₂	Ammonia oxidisers (AOB) AEROBIC  <i>Nitrosomonas, Nitrospira</i> Autotrophs living on ammonia; slow growing, sensitive to low oxygen, pH and cold. NH₄⁺ + O₂ → NO₂⁻
Nitrite oxidisers (NOB) AEROBIC  <i>Nitrospira, Nitrobacter</i> Oxidise toxic nitrite to nitrate; some Nitrospira do both steps (comammox). Slow growing. NO₂⁻ + O₂ → NO₃⁻	Denitrifying bacteria ANOXIC  <i>Pseudomonas, Paracoccus</i> Without oxygen they “breathe” nitrate, using sewage organics; nitrogen leaves as N ₂ . NO₃⁻ + BOD → N₂ + CO₂	Phosphate accumulators ANA → AER  <i>Accumulibacter, Tetrasphaera</i> Store food without oxygen, then take up extra phosphate in air; removed with sludge. PO₄³⁻ → stored poly-P
Filamentous bacteria BALANCE  <i>Microthrix, Nostocoida</i> Backbone of flocs; overgrowth from low oxygen or grease causes bulking and foam. Balance → firm floc	Sulphate reducers (SRB) NUISANCE  <i>Desulfovibrio, Desulfobacter</i> Use sulphate instead of oxygen, releasing H ₂ S odour and corrosion; controlled by sealing and venting. SO₄²⁻ + organics → H₂S	Protozoa & rotifers AEROBIC  <i>Vorticella, ciliates, rotifers</i> Not bacteria: graze free bacteria and fine particles, clarifying the effluent. Sign of healthy sludge

Two ways to keep bacteria in the tank  Suspended floc Bacteria clump into flocs that settle in a clarifier and are pumped back to the tank.  Attached biofilm Bacteria grow on MBBR carriers or media and stay; slow nitrifiers are protected.	What keeps the bacteria working <ul style="list-style-type: none"> Oxygen: 2–3 mg/L aerobic; none in anaerobic and anoxic zones pH 6.5–8.5, about 20–35 °C; nitrifiers slow below 15 °C Nutrients near BOD : N : P = 100 : 5 : 1 (normal in sewage) Sludge age long enough to keep slow nitrifiers and methanogens No shock toxins: excess bleach, acids, solvents or oil
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Educational overview. Genera are typical examples; communities vary by plant. Micrographs are representative and not to a common scale.

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