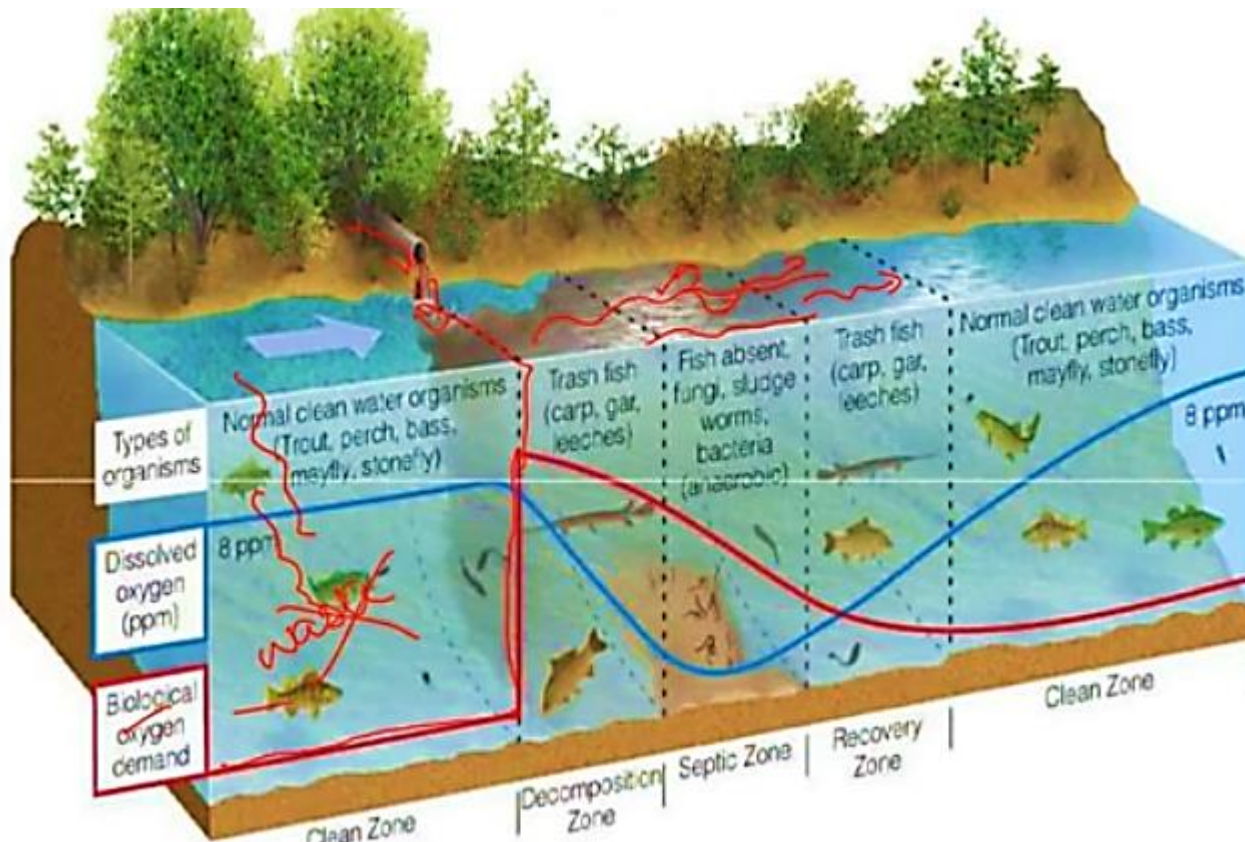




Water Microbiology

Self Purification of natural water

Water self-purification relies on three complementary mechanisms: physical, chemical, and biological processes. Together, they reduce pollutants, organic matter, nutrients, and pathogens. It is most effective under favorable environmental conditions such as high flow, good oxygenation, suitable temperature, and solar radiation.



Self Purification of natural water

Physical Processes

- Dilution
- Sedimentation
- Solar UV radiation
- Temperature

Chemical Processes

- Redox reactions
- Precipitation and adsorption
- pH and salinity

Biological Processes

- Biodegradation of Organic Matter
- Nitrogen Cycle
- Other Biogeochemical Cycles (Carbon, Phosphorus, sulfur)
- Reduce of bacterial abundance by protozoa and phages

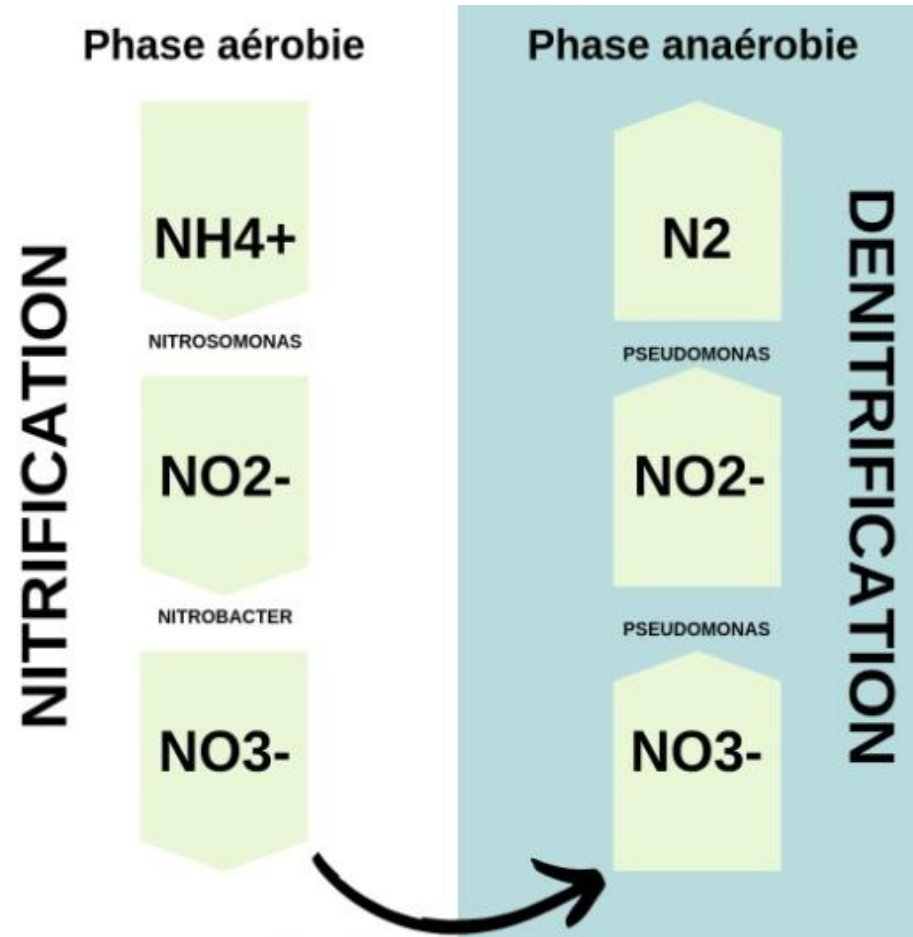
Nitrogen occurs in water mainly as **NH₄⁺, NO₂⁻, and NO₃⁻**.

•**Nitrification:** $\text{NH}_4^+ \rightarrow \text{NO}_2^- \rightarrow \text{NO}_3^-$ under aerobic conditions, mainly by *Nitrosomonas*, *Nitrobacter*, and *Nitrospira*.

•**Denitrification:** $\text{NO}_3^- \rightarrow \text{NO}_2^- \rightarrow \text{NO} \rightarrow \text{N}_2\text{O} \rightarrow \text{N}_2$ under anoxic conditions.

•**Anammox:** $\text{NH}_4^+ + \text{NO}_2^- \rightarrow \text{N}_2$ under anaerobic/anoxic conditions.

The final objective of these processes is to convert reactive nitrogen forms into **nitrogen gas (N₂)**, which is released into the atmosphere.



Water pollution

Parameters for measuring water pollution

TSS

- **Total Suspended Solids:** it measures the dry weight of suspended particles in water.

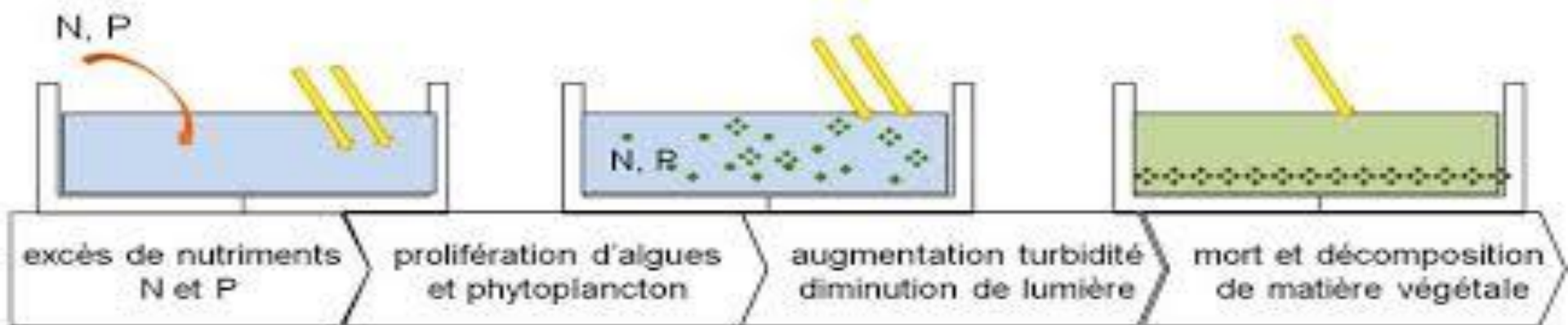
BOD5

- **Biochemical Oxygen Demand over 5 Days:** it measures the amount of oxygen consumed by aerobic microorganisms to degrade biodegradable organic matter.

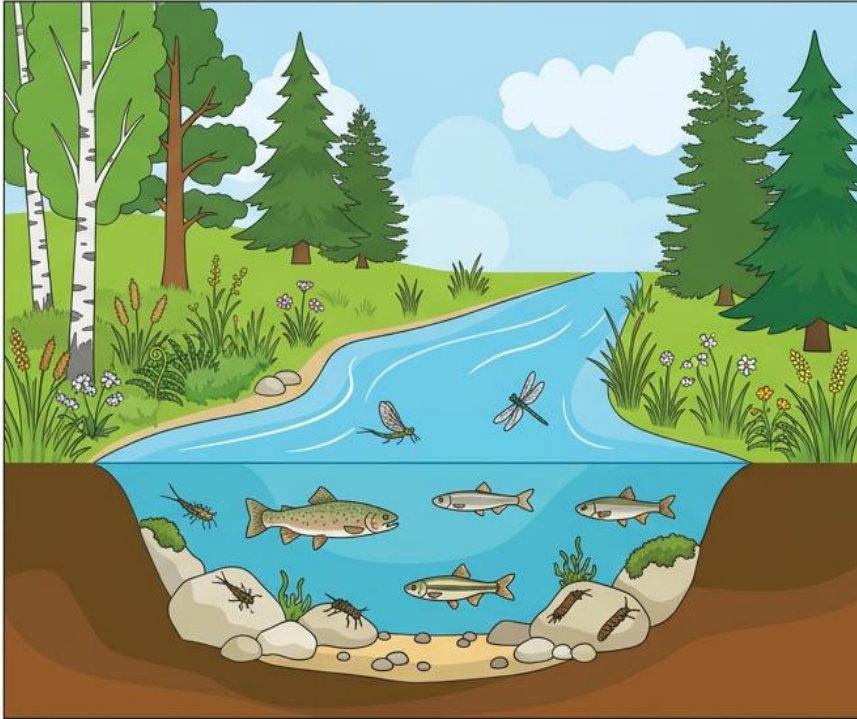
COD

- **Chemical Oxygen Demand:** it measures the total amount of oxygen required to chemically oxidize organic and inorganic matter.

Eutrophication



Eutrophication

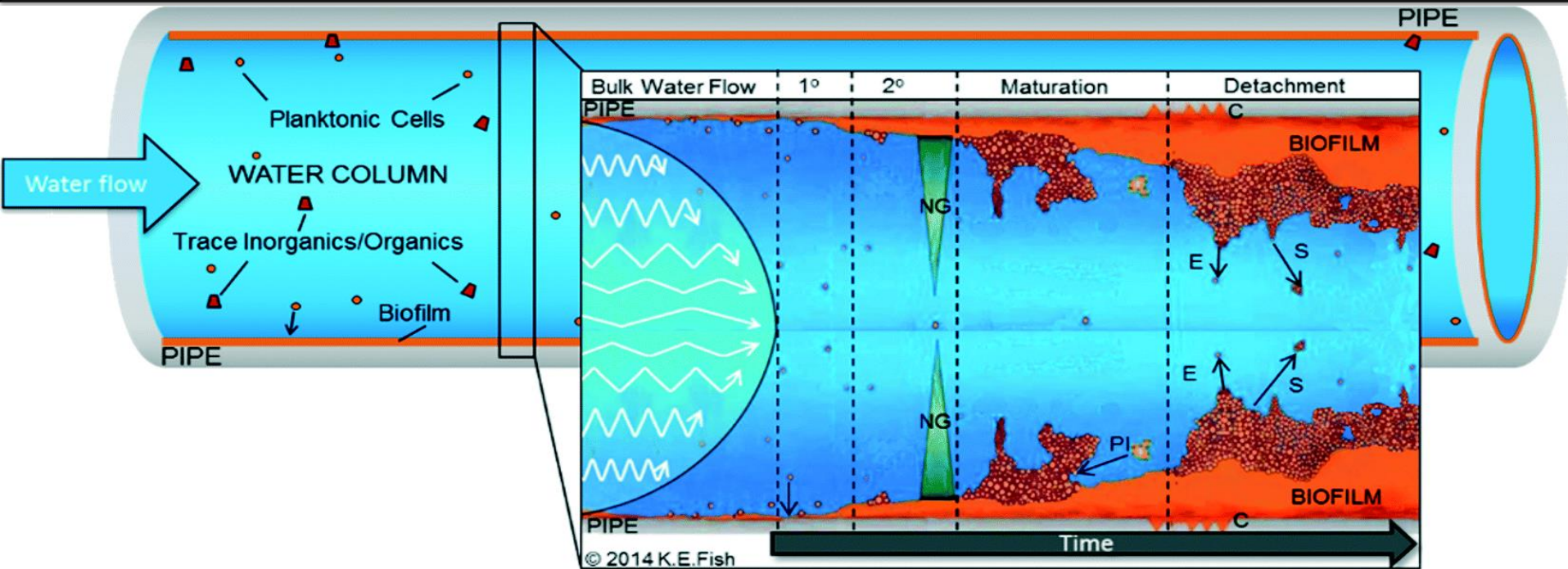


- Clear, cool water
- Little aquatic vegetation
- Well-oxygenated water
- Rocky, gravel or sandy bottom
- High biodiversity



- Turbid, warm water
- Abundant aquatic vegetation
- Poorly oxygenated water
- Muddy bottom
- Low biodiversity

Biofilm



Development of a biofilm in a drinking water distribution system

1° Primary adhesion

2° Secondary adhesion

NG Nutrient gradient, concentrated within the biofilm

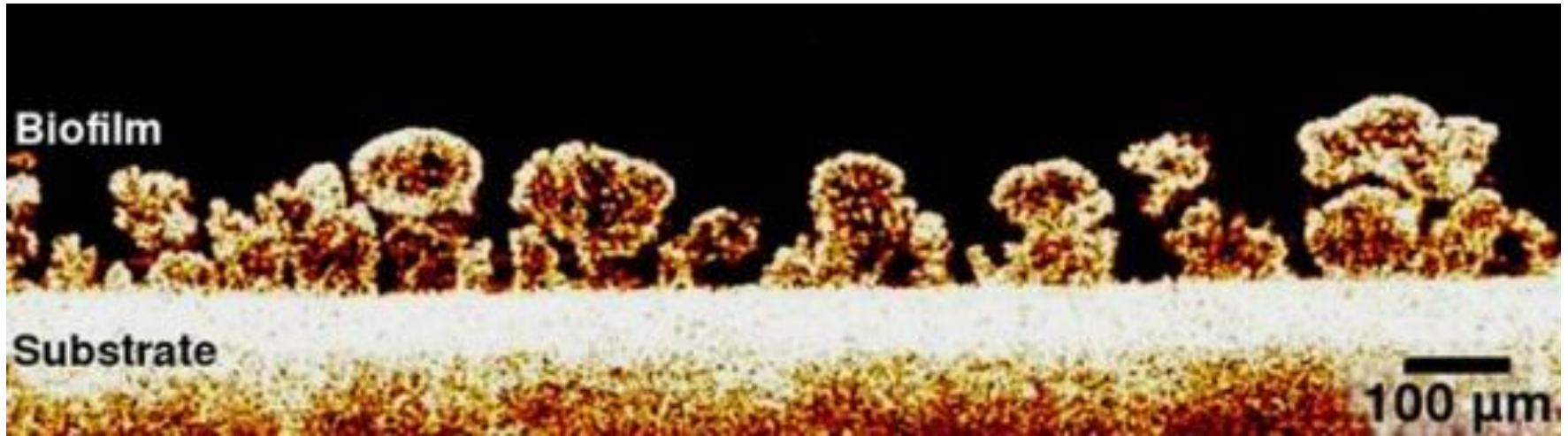
PI Protozoan interactions

C Corrosion of the pipe surface

E Erosion

S Sedimentation / silt deposition

Biofilm



Mushroom-like biofilm structures in a drinking water system (Fischer et al., 2016)

Waste water treatment

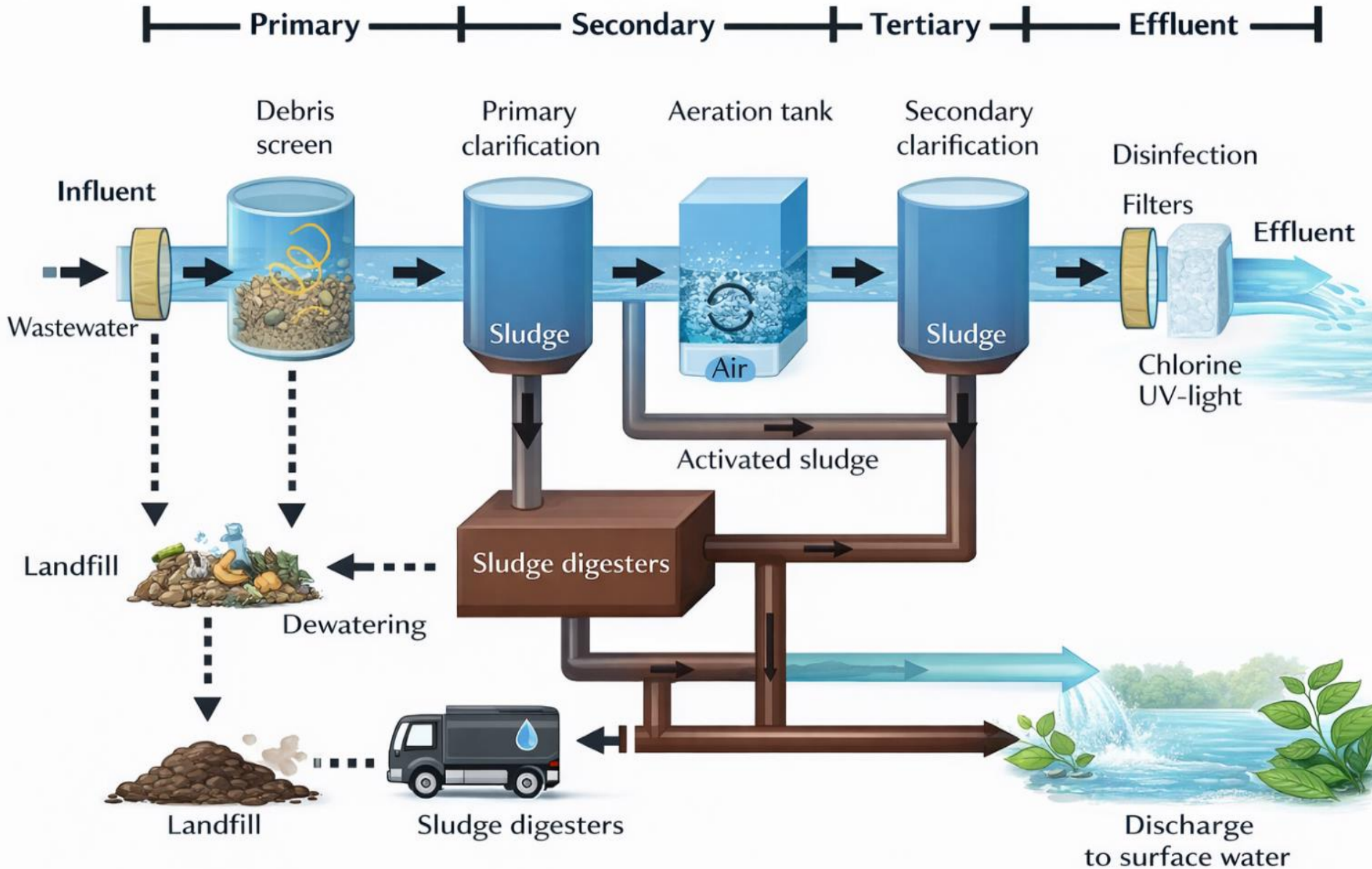
Physical pretreatment

*Primary treatment
sedimentation*

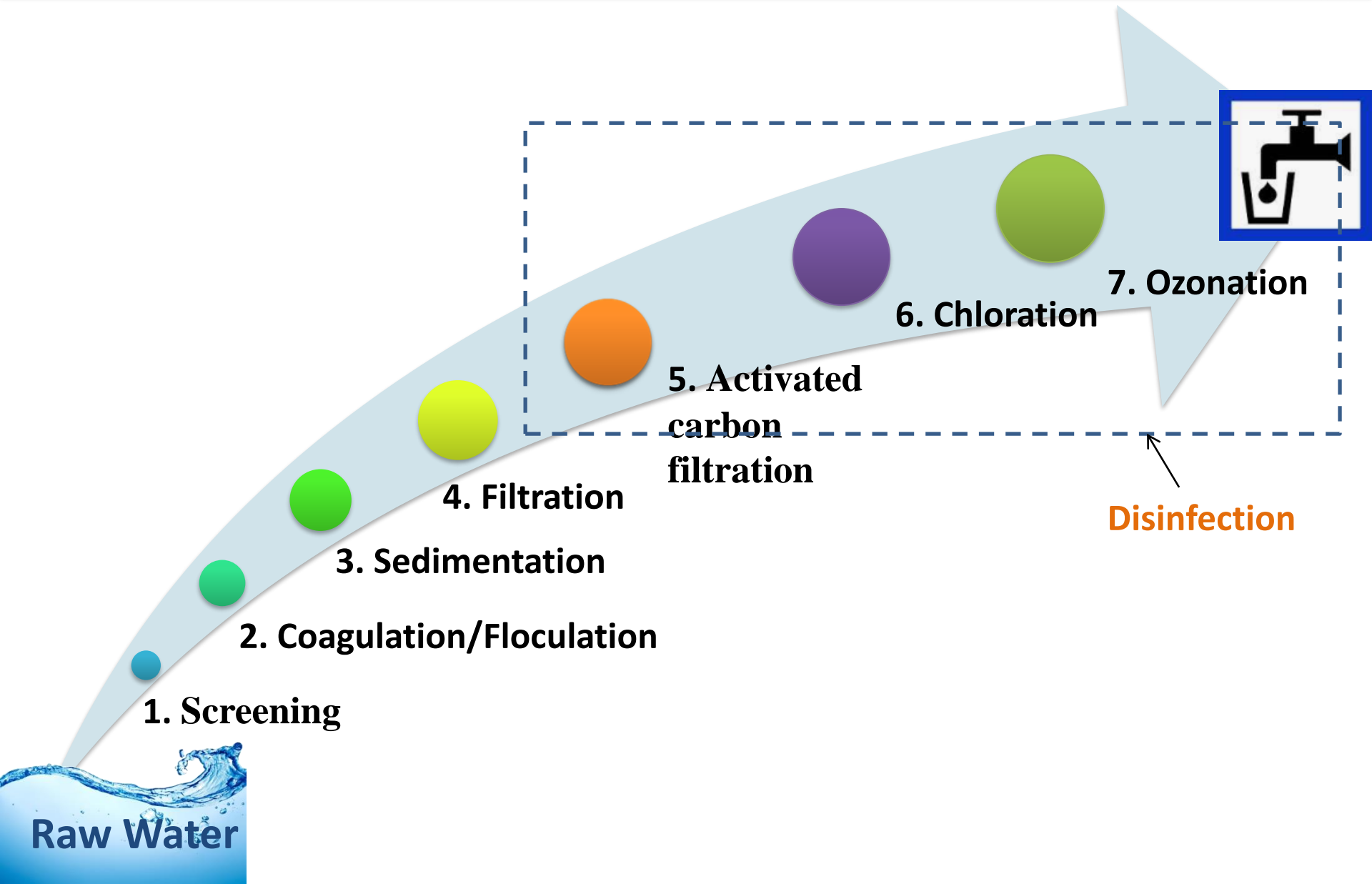
*Secondary treatment:
biological treatment*

*Tertiary treatment:
advanced treatment
or polishing*

Waste water treatment



Drinking water treatment



Drinking water treatment

