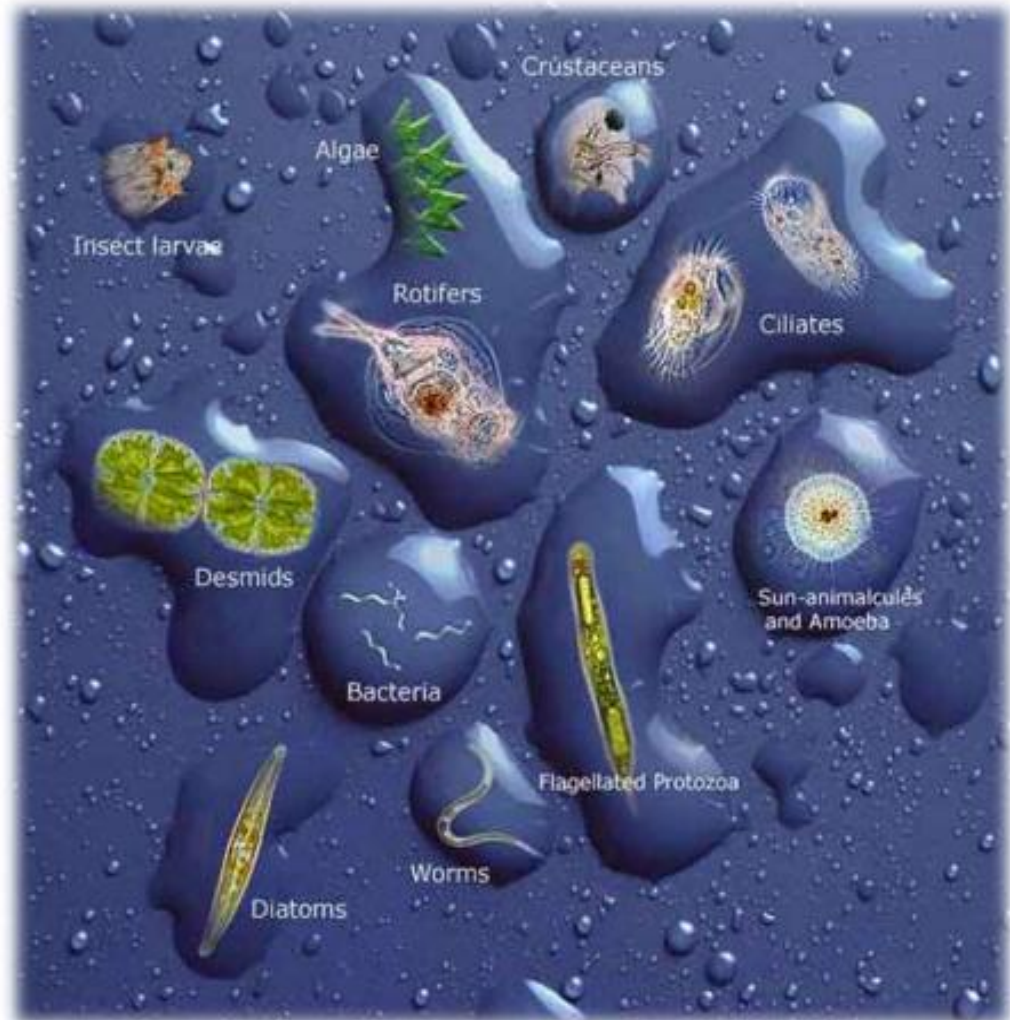
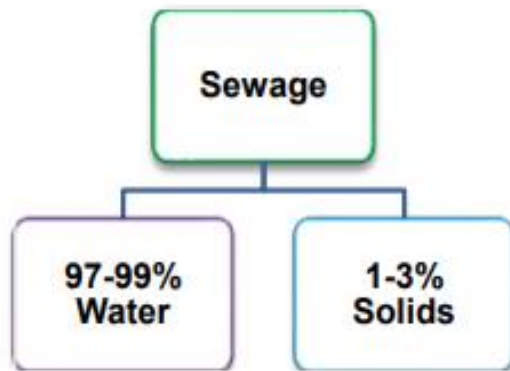


# Sewage microbiology

- Sewage is waste matter carried in sewers or drains.
- It is a “mixture of water and solids separated from various types of water as a result of natural or artificial processes”.
- Sewage could be sludge or wastewater from:
  - ✓ Domestic used water and toilet wastes
  - ✓ Rainwater (surface runoffs)
  - ✓ Industrial effluent
  - ✓ Agricultural wastes.

The composition of sewage mainly depends upon source from which it comes and varies from place to place and season to season.



- Biowaste of animal origin such as that contained in sewage and soiled animal bedding contains unabsorbed fats, proteins and carbohydrates, resulting from incomplete digestion of ingested food of animal and plant origin.
- In addition, abattoir waste would include all of the above and a substantial proportion of fats and protein, derived from the slaughtered animal.
- In addition, materials excreted by the animal include metabolic breakdown products such as urea and other small nitrogen-containing materials, for example partially degraded bile pigments.

- Live and dead bacteria, normally resident in animal gut are also present in the biowaste and so contribute their own fats, proteins, carbohydrates and nucleic acids.
- In addition to all the components listed above, biowaste of plant origin will contain cellulose, hemicelluloses and lignin.
- Cellulose is worthy of note given that estimates of over 50% of the total organic carbon in this biosphere is to be found in the form of cellulose.
- This is unsurprising, since wood is approximately 50% cellulose and cotton is almost 100% cellulose.
- The stabilization of wastewater is accomplished biologically using a variety of microorganisms.
- The microorganisms convert colloidal and dissolved carbonaceous organic matter into various gases and into protoplast.

- Most organisms in biological wastewater are -
- Microscopic
- Macroscopic in size.
- Greatest numerical importance !
- Vital role in conversion of organic matter present to less complex compounds.
- Size- 0.2- 2.0  $\mu\text{m}$  in diameter
- Large surface area in relation to their body volume and their associated high metabolic and reproductive rates.
- Not all are harmful,-but, a number of them cause water-related diseases in human and animals. eg; cholera, dysentery, typhoid fever, salmonellosis and gastroenteritis.
- Heterotrophic bacteria predominate (obtain their energy from the carbonaceous organic matter in wastewater effluent- biomass).
- Found entangled in flocs (activated sludge)-important role in biological treatment

- Some important bacteria genera that are found in WW treatment systems are *Achromobacter*, *Alcaligenes*, *Arthrobacter*, *Citromonas*, *Flavobacterium*, *Pseudomonas*, *Zooglea* and *Acinetobacter*.
- Some may be chemolithotrophic and oxidize  $\text{NH}_3$  (*Nitrosomonas*),  $\text{NO}_2^-$  (*Nitrobacter*), and  $\text{H}_2\text{S}$  (*Thiothrix*).
- Filamentous bacteria such as *Sphaerotilus* may be found to cause bulked sludges.
- Activated sludge flocs also harbor autotrophic bacteria such as nitrifiers (*Nitrosomonas*, *Nitrobacter*), which convert  $\text{NH}_4^+$  to  $\text{NO}_3^-$ , phototrophic bacteria such as the purple nonsulfur bacteria.
- Floc particles -clusters of bacteria that break down waste.

- Filamentous bacteria form, trichomes or filaments -provide a backbone for the floc particles, allowing particle growth and withstand the shearing action of various treatment process.
- Excessive numbers or length, -cause solid/liquid separation or settleability problems.
- Major genera in the flocs are Zooglea, Pseudomonas, Flavobacterium, Alcaligenes, Achromobacter, Corynebacterium, Brevibacterium, Acinetobacter, Bacillus spp., as well as filamentous microorganisms.
- Some examples of filamentous microorganisms are the sheathed bacteria (e.g., Sphaerotilus) and gliding bacteria (e.g., Beggiatoa, Vitreoscilla), which are responsible for sludge bulking.
- The floc particles, serve as sites on which waste can be absorbed and broken down.

- The term protozoa means “first animals,”
- Protozoa reproduce asexually by fission, budding, or schizogony.
- Schizogony is multiple fission; the nucleus undergoes multiple divisions before the cell divides.
- After many nuclei are formed, a small portion of cytoplasm concentrates around each nucleus, and then the single cell separates into daughter cells.
- Protozoa are mostly aerobic heterotrophs, although many intestinal protozoa are capable of anaerobic growth.
- Two chlorophyll- containing groups, dinoflagellates and euglenoids,
- All protozoa live in areas with a large supply of water.
- Some protozoa transport food across the plasma membrane. However, some have a protective covering, or pellicle, and thus require specialized structures to take in food.



- Ciliates take in food by waving their cilia toward a mouthlike opening called a cytostome.
- Amebae engulf food by surrounding it with pseudopods and phagocytizing it.
- In all protozoa, digestion takes place in membrane-enclosed vacuoles, and waste may be eliminated through the plasma membrane or through a specialized anal pore.
- Most are aerobic chemoheterotrophs.
- Advantage- prey on pathogenic bacteria- Hence, desirable in wastewater effluent.
- Excellent indicators of an aerobic environment & indicators of a toxic environment and are capable of exhibiting greater sensitivity to toxicity than bacteria.
- An indication of possible toxicity in a treatment system is the absence of or a lack of mobility of protozoa

- The primary role of protozoa is to clarify the effluent through predation on (Bacterivorous grazers).
- Add weight to floc particles and improve their settleability.
- Produce and release secretions that coat and remove fine solids (colloids, dispersed cells, and particulate material) from the bulk solution to the surface of floc particles.
- Excrete growth-stimulating compounds that can enhance bacterial activity.
- Recycle nutrients (nitrogen and phosphorus) through their excretions.
- Also cause flocculation resulting from secretion of a mucus like substance.
- Grazing on bacteria-remove senescent bacteria and maintain the population in a youthful physiological state.

- In WW treatment systems, algae grow on the nutrients in the water.
- Found in highest numbers on surfaces such as trickling filters or walls of clarifiers, where the biologically treated waters trickle over the top of the clarifiers.
- Algae are significant organisms for biological purification of wastewater because they can accumulate plant nutrients, heavy metals, and pesticides, organic and inorganic toxic substances.
- May cause problems in clogging or eutrophic blooms after discharge of treated wastewater to receiving waters .
- Chlorella, Scenedesmus, Euglena, Chlamydomonas, Oscillatoria etc.

- The most frequent fungi colonizing fixed film processes are *Subbaromyces splendens.*, *Ascoidea rubescens.*, *Fusarium aquaeductuum.*, *Geotrichum candidum* and *Trichosporon cutaneum.*
- Fungi take part in the removal of the carbonaceous matter- the conversion rate- much higher than bacteria ,encourages a significant production of biomass.
- To great proportion of fungi in the biomass favors the formation of a highly resistant biofilm that is difficult to slough.
- Clog the aerated filters.
- Yeast can degrade organic compounds to CO<sub>2</sub> and H<sub>2</sub>O.

- Yeast can degrade organic compounds to carbon dioxide and water with the use of free molecular oxygen ( $O_2$ ), or as facultative anaerobes.
- They can degrade organic compounds such as sugars to ethanol ( $CH_3CH_2OH$ ) in the absence of free molecular oxygen.