EWC 333
Wastewater Engineering and Sanitation

Lecture 11

Instructor

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Lecture Outline

Topics	Reference
• Secondary treatment – purpose, biological treatment mechanism • Important organisms involved in biological treatment	Water Supply and Sanitation - Feroz Ahmed and Mujibur Rahman ITN -BUET

Purpose of Secondary Treatment

- The effluent from primary treatment still contains 40 to 50 percent of the original suspended solids and virtually all of the dissolved organic and inorganic matters. To remove these, further treatment is required.

- Organic matters are removed through secondary treatment processes.

Biological Treatment Mechanism

- In biological treatment, microorganisms use the organics in wastewater as a food supply and convert them into biological cells or *biomass*.

- Because wastewater contains a wide variety of organics, a wide variety of organisms, or a mixed culture, is required for complete treatment.

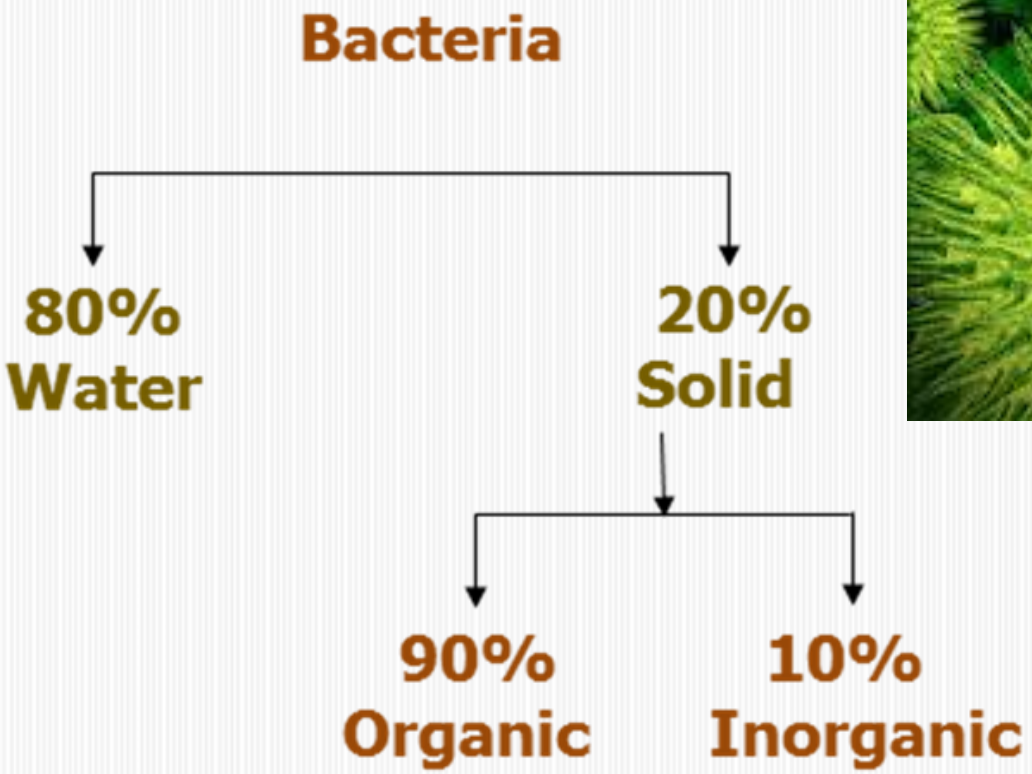
Biological Treatment Mechanism

- Each type of organism in the mixed culture utilizes the food source suitable to its metabolism.
- Most mixed cultures will also contain grazers, or organisms that prey on other species.
- The newly created biomass must be removed from the wastewater to complete the treatment process

Important Organisms - Bacteria

- Single cell protists.
- They use soluble food and in general will found whenever moisture and a food source are available.
- Their usual mode of reproduction is by binary fission.
- Bacteria are capable of storing food particles outside the cell by means of extracellular enzymes and hence can remove soluble, colloidal and solid organic matter from waste water.

Important Organisms - Bacteria



Composition of bacteria





Important Organisms - Bacteria

- Each type of bacteria lives and multiplies under specific environmental conditions. Of the various environmental conditions, light, air, water, food, temperature, pH and dissolved oxygen play a very important part.

- Temperature and pH play a vital role in the life and death of bacteria.

- Rate of reaction will be doubled with about every 10° C of rise in temperature.

Important Organisms - Bacteria

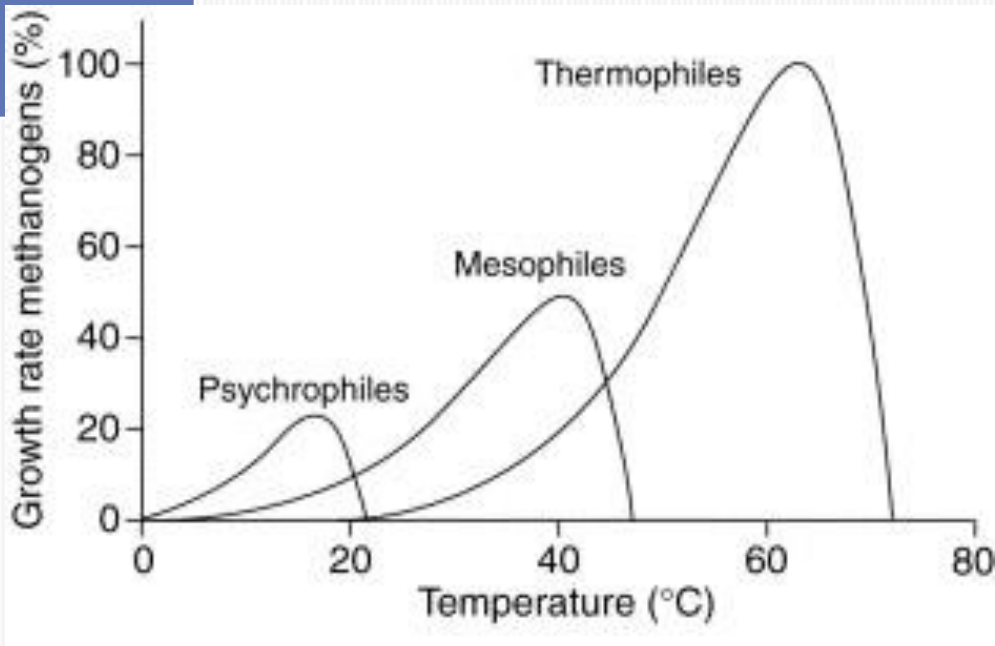
- Few bacteria can tolerate acid or alkaline conditions and most organisms (bacteria) cannot tolerate pH levels above 9.5 or below 4.0.

- Generally the optimum pH for growth lies between 6.5 and 7.5.

Types of Bacteria

1. Depending on temperature -

Type	Temperature (ºC)	
	Range	Optimum
Psychrophilic	-2 to 30	12 to 18
Mesophilic	20 to 45	25 to 40
Thermophilic	45 to 75	55 to 65



Types of Bacteria

2. Depending on need for oxygen –

- Aerobic – Oxygen is essential for oxidizing organic matter

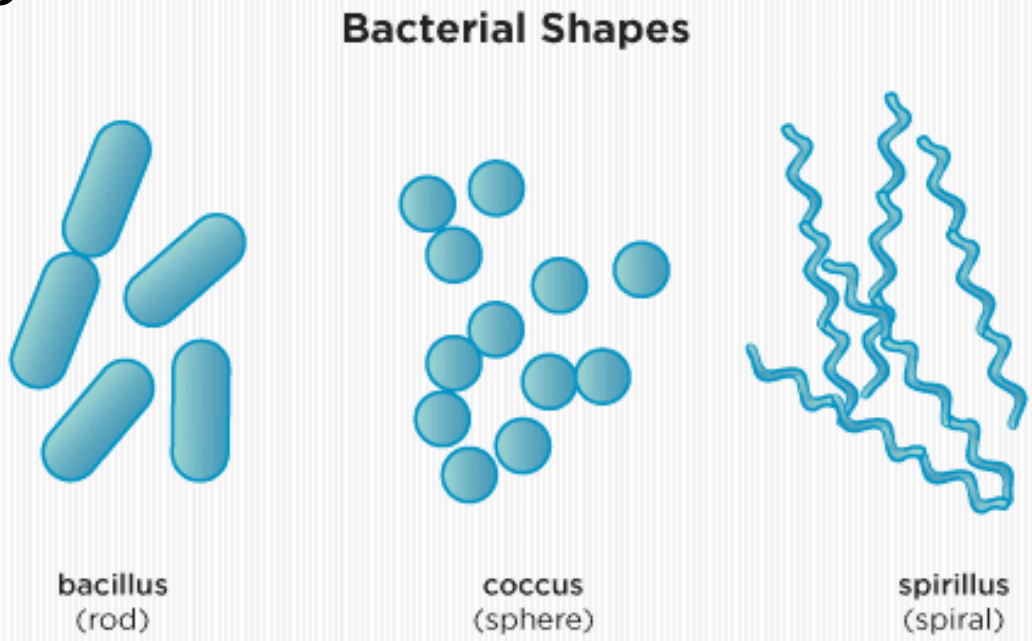
- Anaerobic – Oxidation of organic matter occur in absence of oxygen

- Facultative – Can grow aerobically in presence of air as well as anaerobically in absence of air.

Types of Bacteria

3. Depending on shape –

- Rod shaped – width 0.5 μ to 1.0 μ and length 1 μ to 3 μ
- Spherical – diameter 0.5 μ to 1.0 μ
- Spiral – width 0.5 μ to 5 μ and length 6 μ to 15 μ



Types of Bacteria

5. Depending on metabolism -

- According to metabolism (i.e. bacteria's ability to grow in any environment), bacteria are divided into two distinct groups, (a) Autotrophic and (b) Heterotrophic.

Type of Bacteria		Source of carbon	Source of energy
Autotrophic	Photosynthetic	CO_2	Sunlight
	Chemosynthetic	CO_2	Inorganic matter
Heterotrophic		Organic matter	Organic matter

Heterotropic organisms are important, 'cause their source of energy is organic matter, thus reduce load of OM.

Metabolism of Bacteria

Bacterial metabolism has two component parts:

Catabolism for energy

Anabolism for synthesis.

(1) Catabolism

$$C_XH_YO_ZN + O_2 \xrightarrow{\text{bacteria}} CO_2 + H_2O + NH_3 + \text{energy}$$

(organic matter)

(2) Anabolism

$$C_XH_YO_ZN + \text{energy} \xrightarrow{\text{bacteria}} C_5H_7NO_2$$

(organic matter) (bacteria cell)

(3) Autolysis

$$C_5H_7NO_2 + 5O_2 \xrightarrow{\text{bacteria}} 5CO_2 + NH_3 + 2H_2O + \text{energy}$$

(bacteria cell)

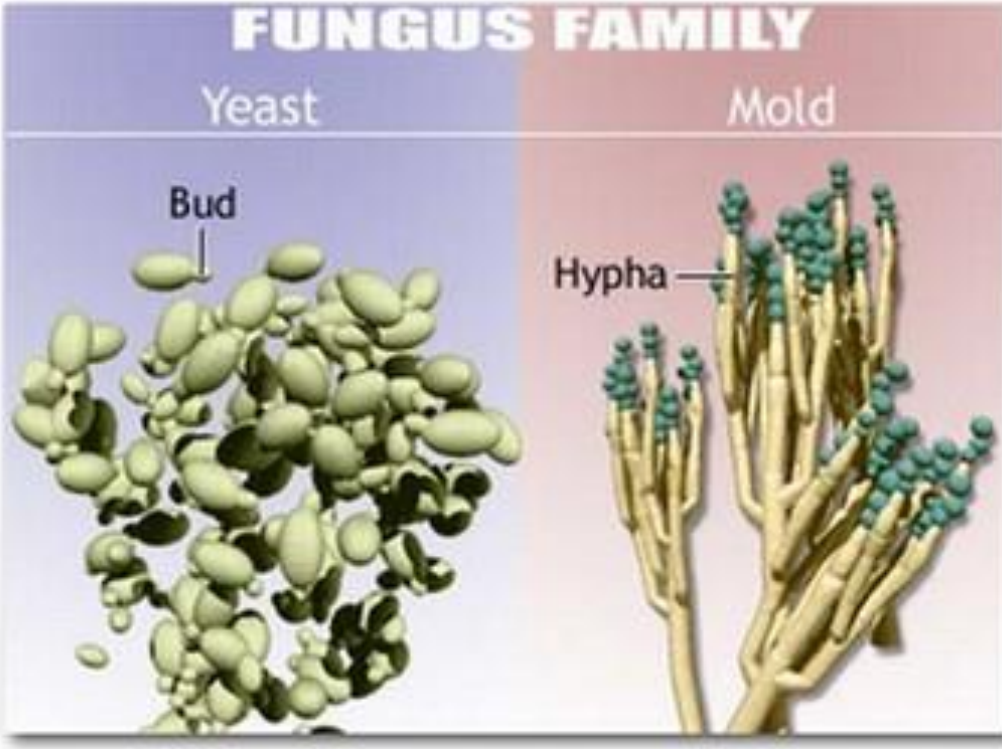
Metabolism of Bacteria

- As a general guide one-third of the available BOD is used in catabolic reactions and two-thirds in anabolic reactions.

- The process for autolysis does not proceed to completion since approximately 20-25 % of the cell mass is resistant to aerobic degradation.

Important Organisms - Fungi

- Multicellular, nonphotosynthetic, heterotrophic protists.
- Most fungi are strict aerobes.
- Ability to grow under low moisture condition.



Important Organisms - Fungi

- Can tolerate a relatively low pH range of 2 to 9, optimum is 5 to 6.
- Survive in nitrogen limiting condition.
- Important in biological treatment of some industrial waste.
- Being relatively large and filamentous shape, fungi tends to settle poorly and undesirable in biological treatment process.

Important Organisms - Algae

- Algae are unicellular or multicellular, autotrophic photosyntehtic protists.

- Undesirable in water supply for bad taste, odour and shorten filter run.



red alga



brown alga



green alga

Important Organisms - Algae

- Aesthetically objectionable.

- In waste stabilization ponds, algae are valuable to produce oxygen.





Important Organisms - Algae

Reaction:

(1) Photosynthesis

$$CO_2 + 2H_2O \xrightarrow{\text{light}} \mathbf{CH_2O} + O_2 + H_2O$$

(new algae cell)

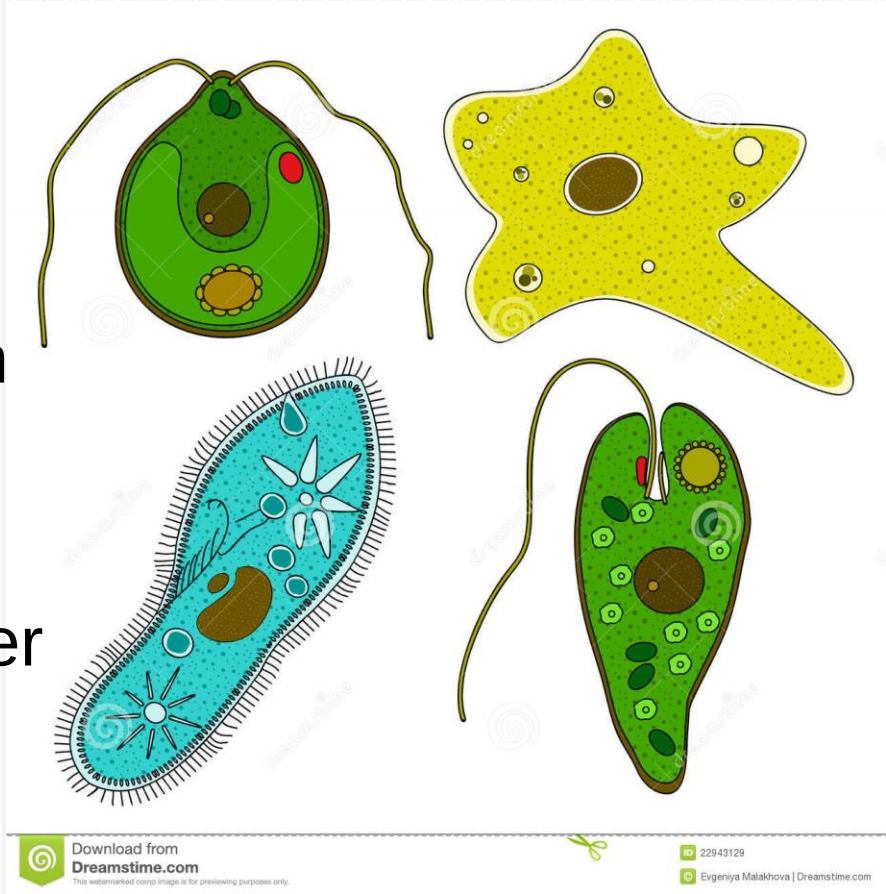
(2) Respiration

$$CH_2O + O_2 \rightarrow CO_2 + H_2O$$

- Because algae use CO_2 in photosynthetic activity, high pH conditional can result.

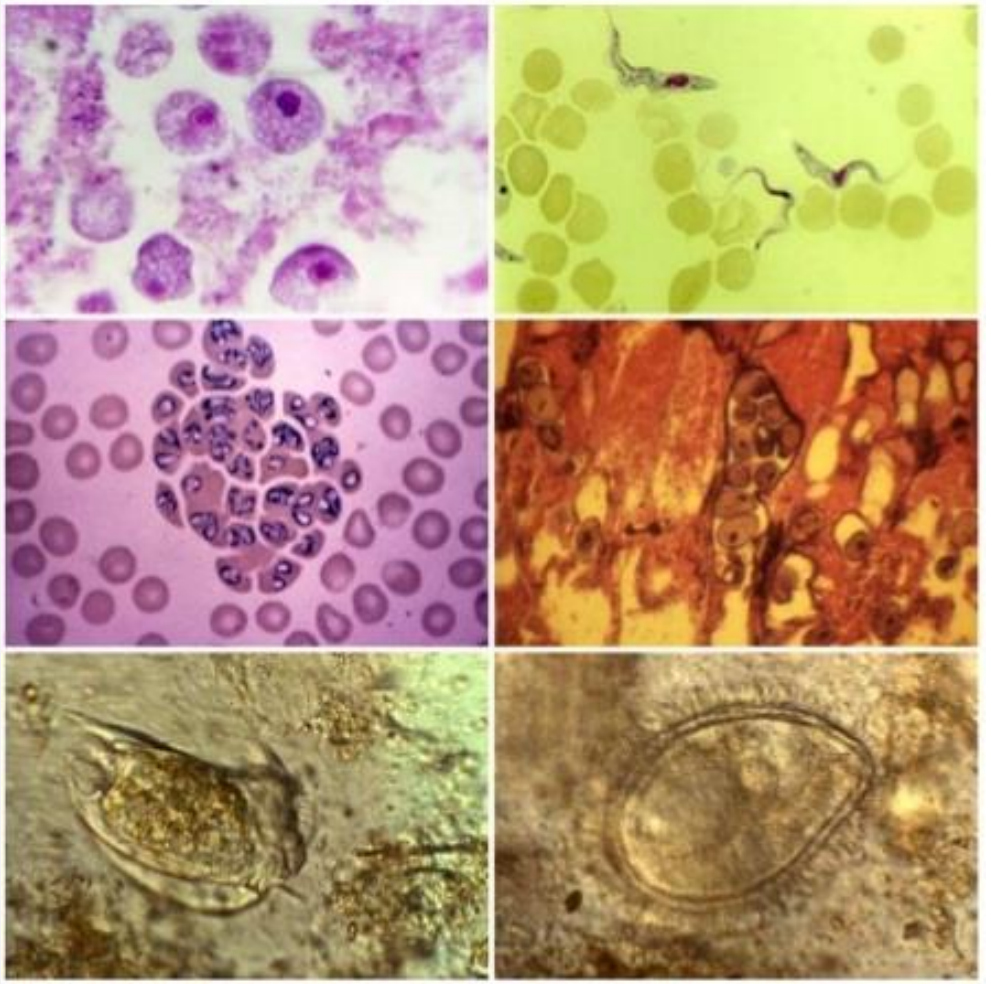
Important Organisms - Protozoa

- Protozoa are motile, microscopic protists that are usually single cells.
- The majority of protozoa are aerobic heterotrophs, although a few are anaerobic.
- Protozoa are generally an order of magnitude larger than bacteria and often consume bacteria as an energy source.



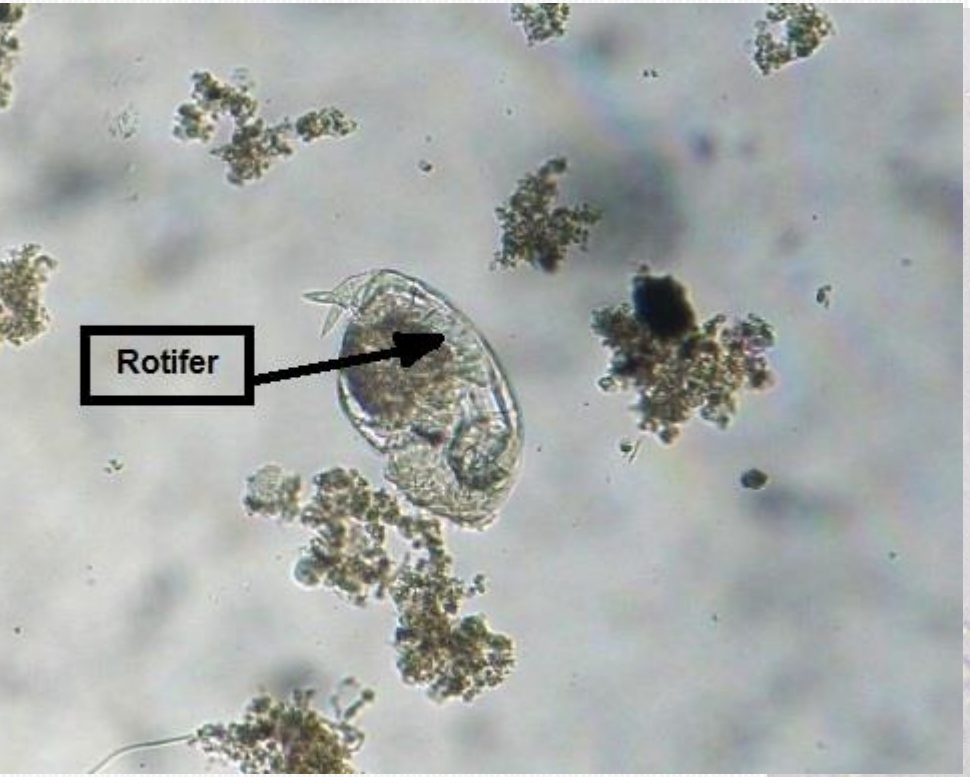
Important Organisms - Protozoa

- The protozoa act as polishers of the effluents from biological waste-treatment processes by consuming bacteria and particulate organic matter.
- The reproduce by binary fission.



Important Organisms - Rotifers

- Rotifers are aerobic, heterotrophic and multicellular animal.
- Rotifers are very effective in consuming dispersed and flocculated bacteria, protozoa and small particles of organic matter.





Important Organisms - Viruses

- Obligate parasites and requires a host to live in.
- Causes various diseases.
- During wastewater treatment, these are controlled by chlorination and proper disposal of the plant effluent.



