

Biological Processes in Wastewater Treatment

Pre – Course Material



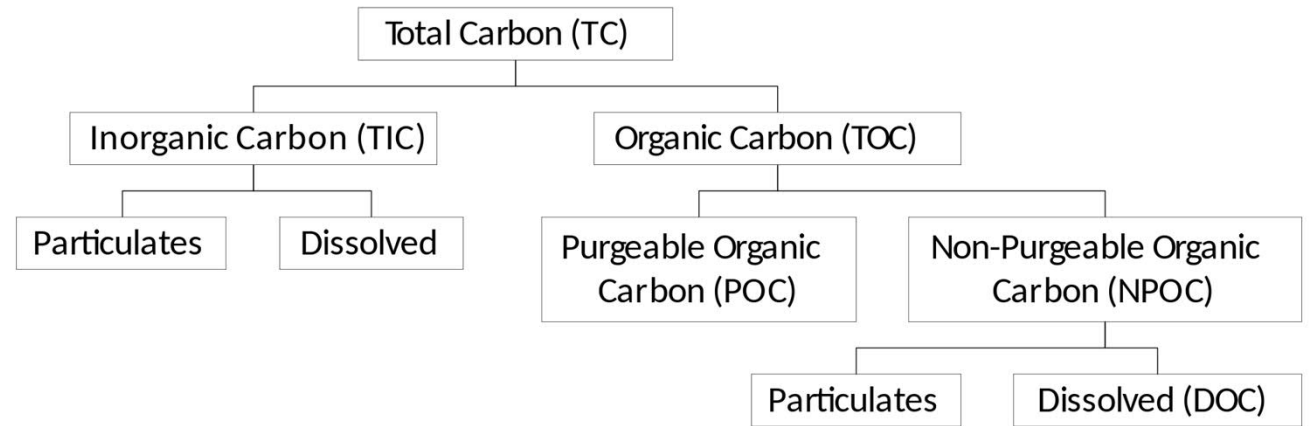
Biochemistry

Total Organic Carbon (TOC)

Total organic carbon is the amount of carbon present in an organic compound.

It is measured in two ways.

1. Total carbon is measured and the amount of inorganic carbon (dissolved carbon dioxide and carbonic acid salts) is subtracted from it.
2. The second method is to remove all the inorganic carbon and the remaining carbon is called non – purgeable organic carbon (NPOC).



Biological Oxygen Demand (BOD)

Biochemical Oxygen Demand (BOD, also called Biological Oxygen Demand) is the amount of dissolved oxygen needed (i.e. demanded) by aerobic biological organisms to break down organic material present in a given water sample at certain temperature over a specific time period.

The BOD value is most commonly expressed in milligrams of oxygen consumed per litre of sample during 5 days of incubation at 20 °C.

Chemical Oxygen Demand (COD)

Chemical oxygen demand is the amount of oxygen needed to decompose the organic matter present in water and oxidize inorganic chemicals such as Ammonia and nitrite.

Extra information:

<https://camblab.info/wp/index.php/272/>

Measurement of COD:

<https://www.camlab.co.uk/cod-chemical-oxygen-demand-c2865.aspx>

Theoretical Oxygen Demand (ThOD)

Theoretical oxygen demand (ThOD) is the calculated amount of oxygen required to oxidize a compound to its final oxidation products.

Example: Pages 23 – 27

<http://www.ecs.umass.edu/cee/reckhow/courses/370/slides/370l04.pdf>

Bioplastics VS Biodegradable Plastics

Bioplastics

IUPAC definition: Bio based polymer derived from the biomass or issued from monomers derived from the biomass and which, at some stage in its processing into finished products, can be shaped by flow.

Bioplastics are plastics derived from renewable biomass sources, such as vegetable fats and oils, corn starch, straw, woodchips, food waste, etc. Bioplastic can be made from agricultural by-products and also from used plastic bottles and other containers using microorganisms.

Biodegradable Plastics

Biodegradable plastics are plastics that can be decomposed by the action of living organisms, usually bacteria.

Microbiology

Cells

- The cell (from Latin cella, meaning "small room") is the basic structural, functional, and biological unit of all known organisms. A cell is the smallest unit of life. Cells are often called the "building blocks of life".
- Broad classification - Eukaryotic and Prokaryotic cells
<https://www.youtube.com/watch?v=zZtcMBTQaS4&index=3&list=PLTH8ahUlcwvRCscNWDRcD2ZrzBjbrPLt9>

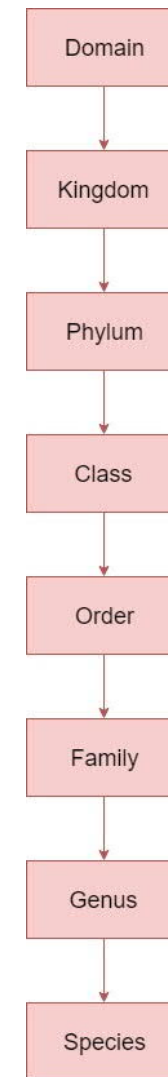
Classification of living Organisms

All living organisms are classified into groups based on very basic, shared characteristics. Organisms within each group are then further divided into smaller groups.

These smaller groups are based on more detailed similarities within each larger group. This grouping system makes it easier for scientists to study certain groups of organisms.

Characteristics such as appearance, reproduction, mobility, and functionality are just a few ways in which living organisms are grouped together. These specialized groups are collectively called the classification of living things.

The classification of living things includes 8 levels: domain, kingdom, phylum, classes, order, families, genus, and species .



Extra information about taxonomic classification

- <https://courses.lumenlearning.com/wm-biology1/chapter/reading-the-taxonomic-classification-system/>
- <https://www.learner.org/courses/essential/life/session2/closer4.html>



Binomial Nomenclature

- Binomial nomenclature, also called binominal nomenclature or binary nomenclature, is a formal system of naming species of living things by giving each a name composed of two parts, both of which use Latin grammatical forms, although they can be based on words from other languages.
- First name is Genus and starts with a capital letter.
- Second name is species and is written in lower case.
- Both words are written in Italics

Extra information –

<https://www.youtube.com/watch?v=DsuAULTILsY>

Phylogenetics and Phylogenetic Tree

- Phylogenetics is the study of evolutionary history and relationships among individuals or groups of organisms.
- A phylogenetic tree or evolutionary tree is a branching diagram or "tree" showing the evolutionary relationships among various biological species or other entities based upon similarities and differences in their physical or genetic characteristics.

Extra Information:

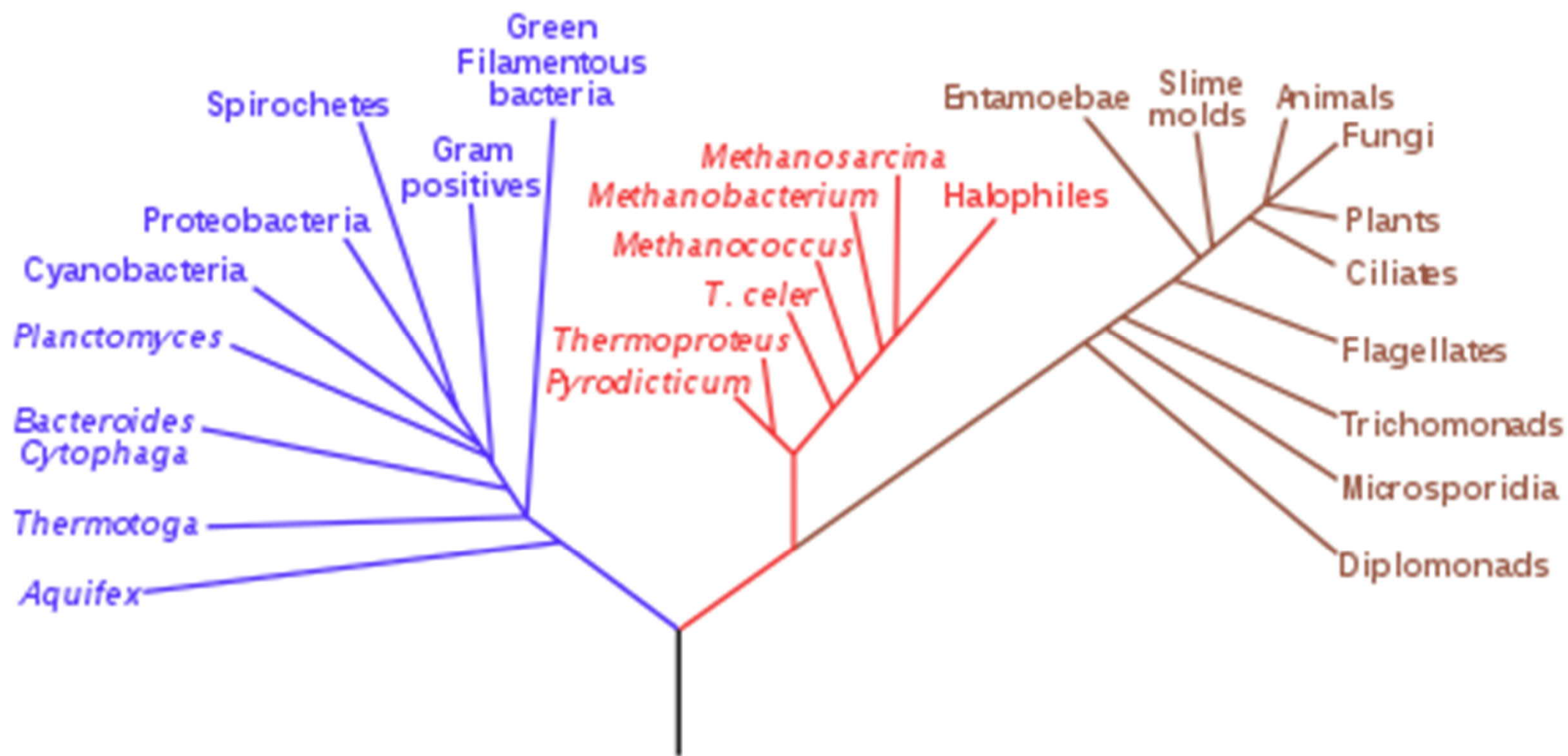
<https://www.khanacademy.org/science/high-school-biology/hs-evolution/hs-phylogeny/v/taxonomy-and-the-tree-of-life>

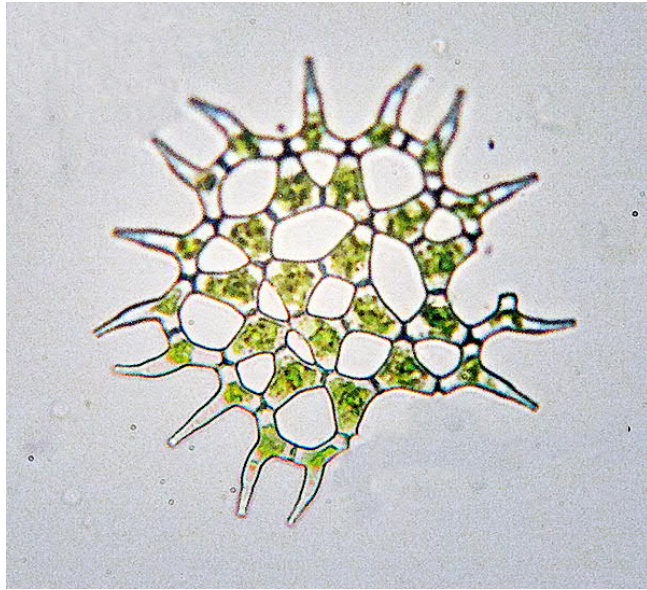
<https://www.khanacademy.org/science/high-school-biology/hs-evolution/hs-phylogeny/a/phylogenetic-trees>

Bacteria

Archaea

Eukaryota



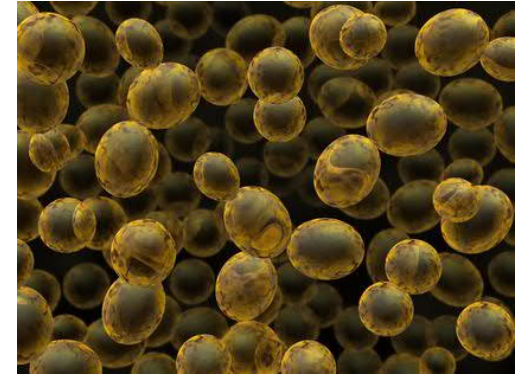


Algae

- Diverse group of photosynthetic eukaryotic organisms
- Can be unicellular microalgae or multicellular
- Produce oxygen and consume carbon dioxide
- Remove nutrients and pollutants from water and stabilize sediments
- Used as fertilizers, algae – based wastewater treatment and biofuel production

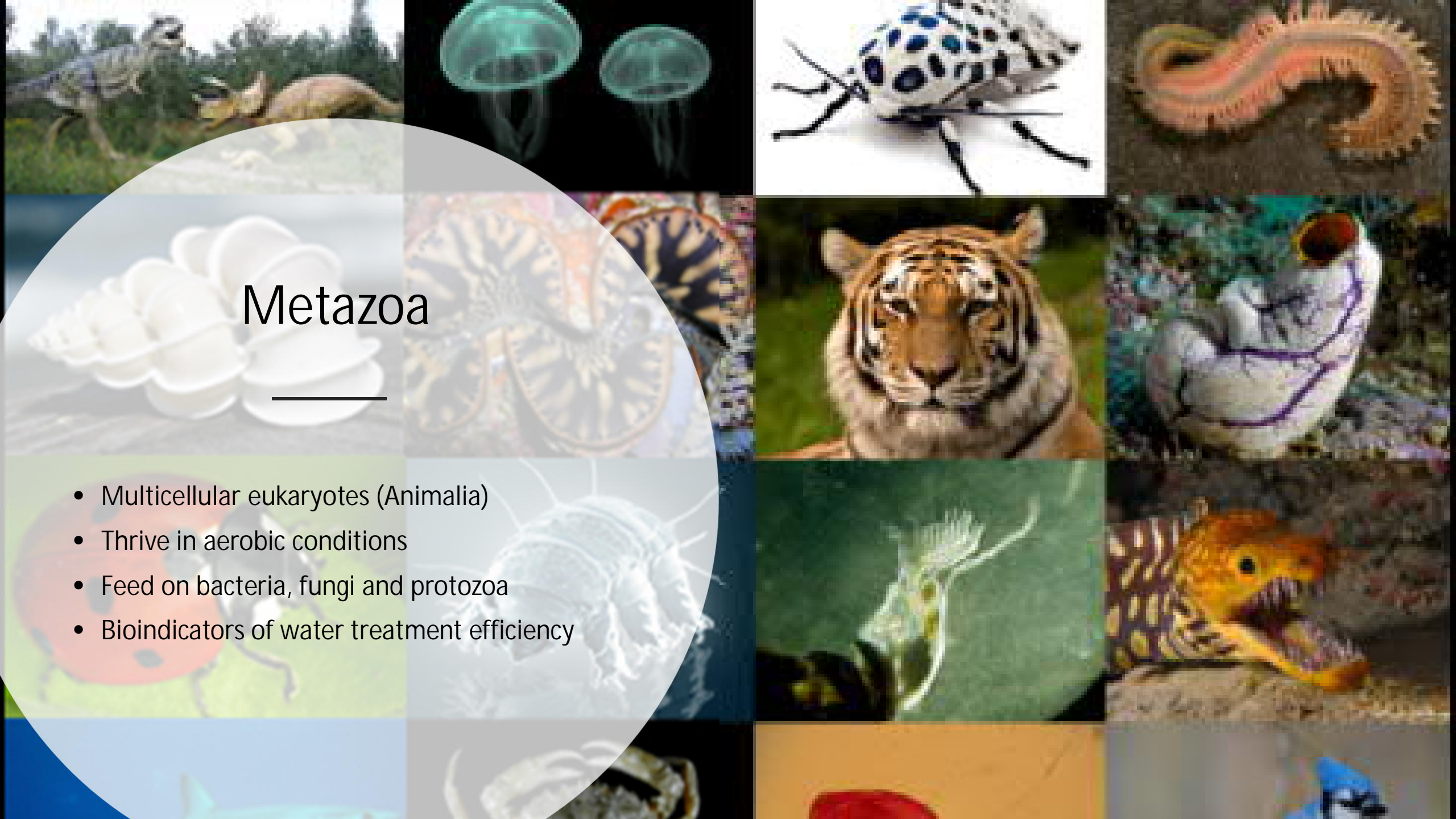
Fungi

- Eukaryotic
- Millions of species present
- Various habitats : water, soil, air, bodies of animals
- Use organic compounds are a source of carbon and energy
- Used in agriculture, medicine, environmental biology and biotechnology.



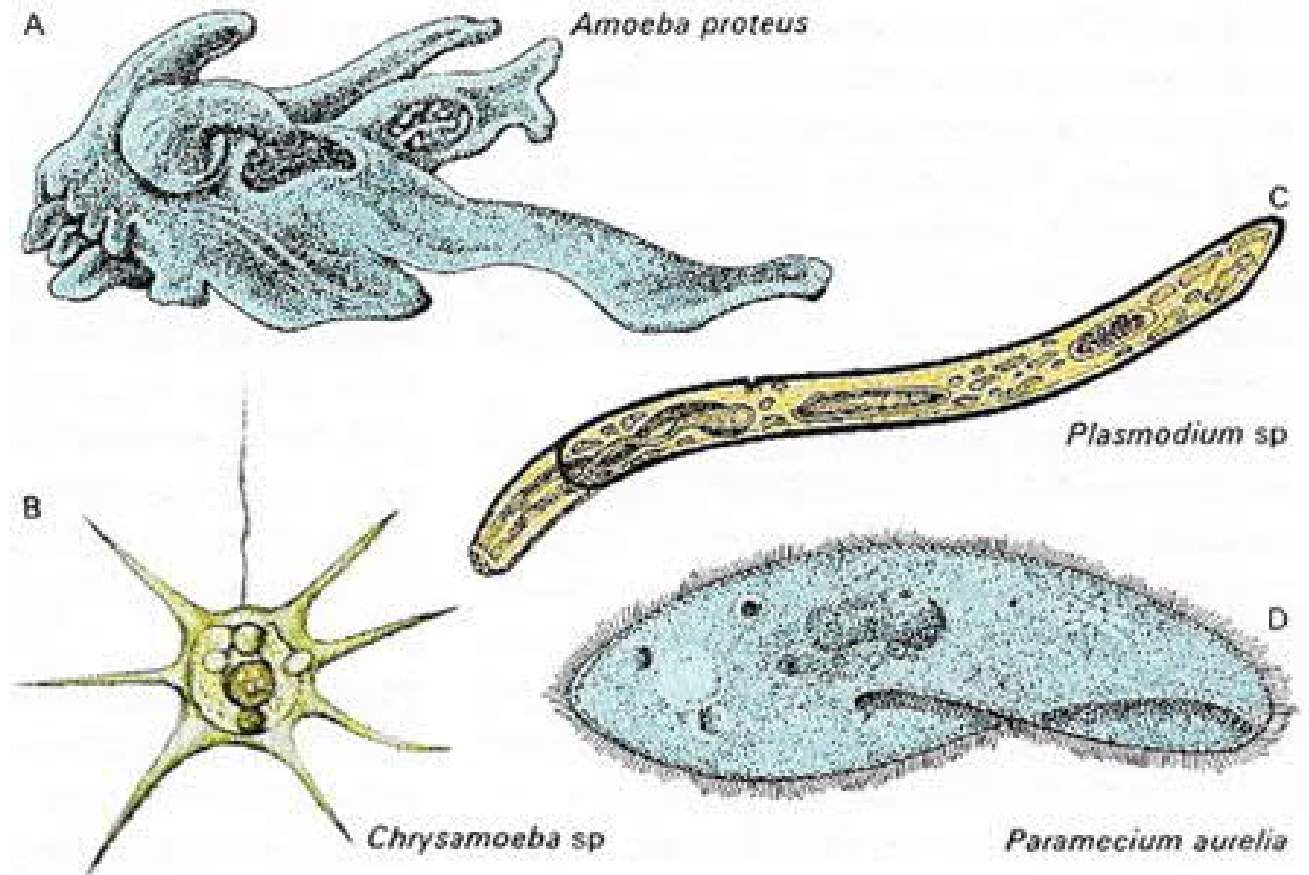
Metazoa

- Multicellular eukaryotes (Animalia)
- Thrive in aerobic conditions
- Feed on bacteria, fungi and protozoa
- Bioindicators of water treatment efficiency



Protozoa

- Animal – like protists
- Unicellular eukaryotes
- Free – living (feed on bacteria and other microorganisms) or parasitic
- Motile, i.e., capable of motion
- Bioindicators of water treatment efficiency



Flagellates or Mastigophora

- One or more flagella (hair – like structures)
- Free living species are indicators of young activated sludge
- Several dangerous parasites
- *Giardia lamblia* is an important contaminant of drinking water, resistant to the disinfectant action of chlorine



Ciliates or Ciliophora

- Phylum Ciliophora – approx. 8000 species
- Move by cilia (multiple short hair – like structures)
- Feeding mechanisms involve a mouth and cilia
- Dominant in the presence of mature flocs and low BOD in mixed liquor.

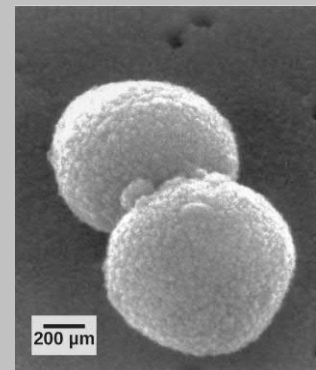
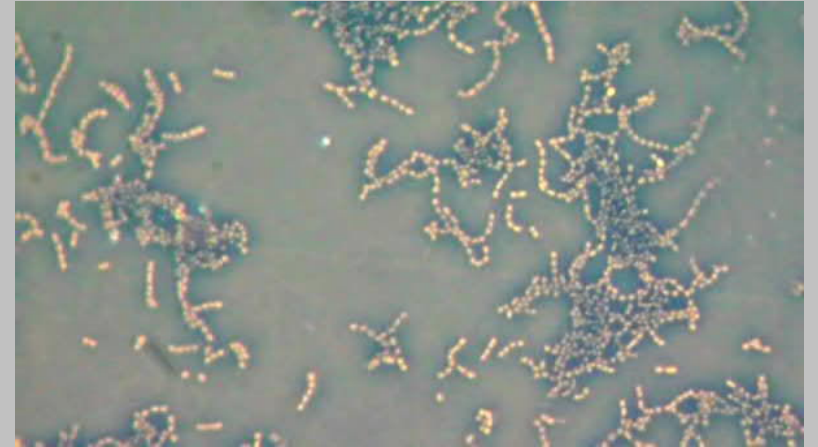


Bacteria and Archaea

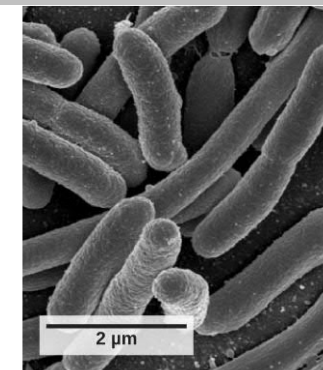
- Simplest celled organisms with lack of a membrane – enclosed nucleus
- Size: 0.02 – 400 μm
- Remove organic materials by microbial respiration and synthesis.

Extra information :

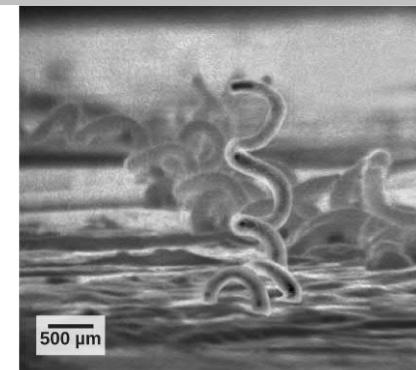
<https://www.khanacademy.org/science/biology/bacteria-archaea/prokaryote-structure/v/bacteria>



(a)



(b)



(c)

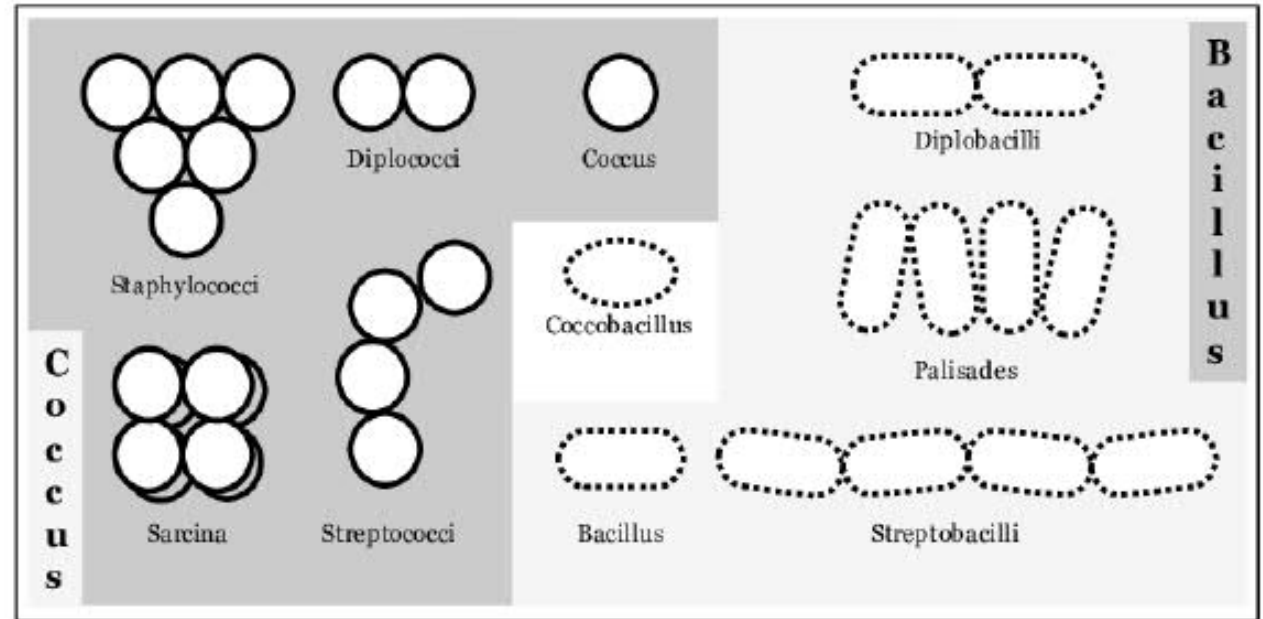
Bacteria Identification

- Generally grouped into species according to their morphological, physical and metabolic characteristics.
- Typically, identification starts with morphological observation, colony appearance and gram staining.

Colony - A visible mass of microorganisms on solid media all originating from a single mother cell

Microbiological culture - A method of multiplying microorganisms on selective media in laboratory conditions

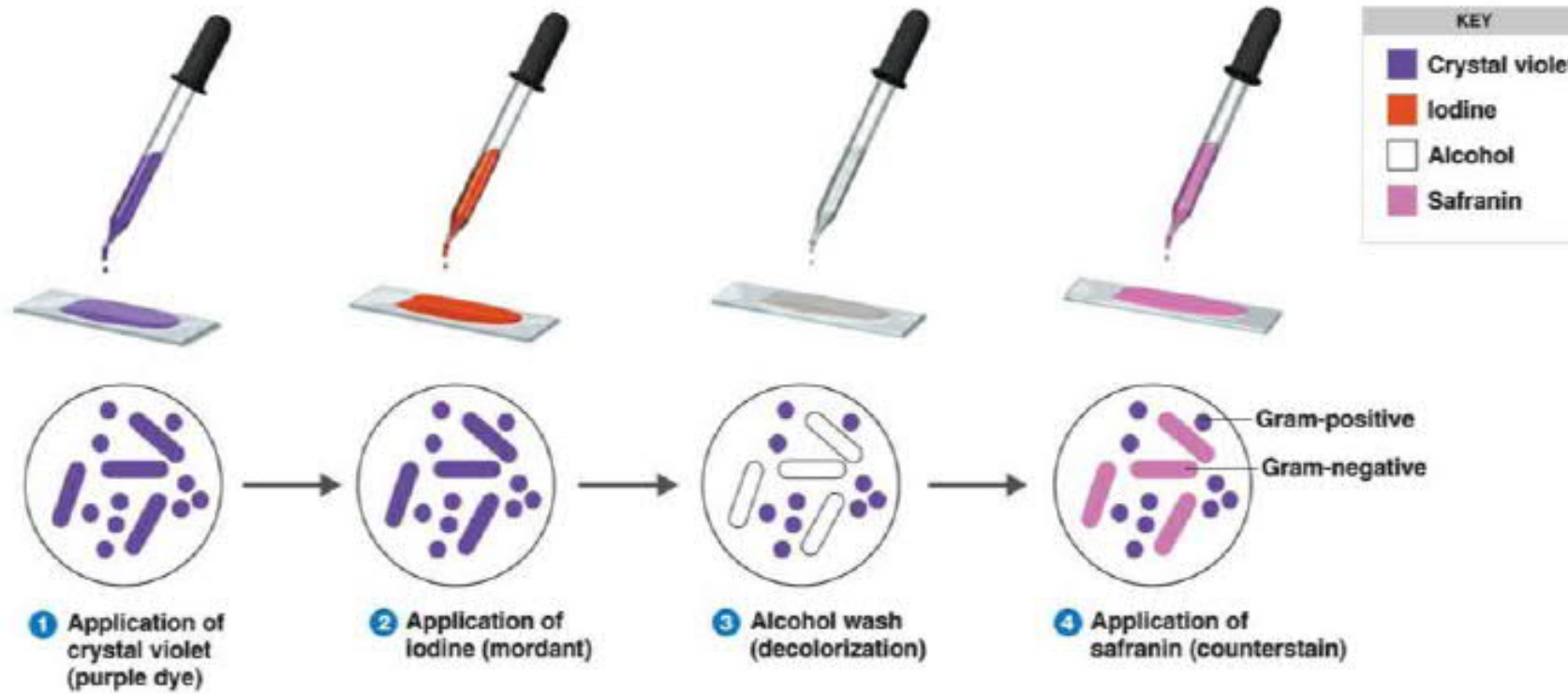
Shapes and arrangements



Colonies on Petri dishes/ culture plates



Cell Wall Structure

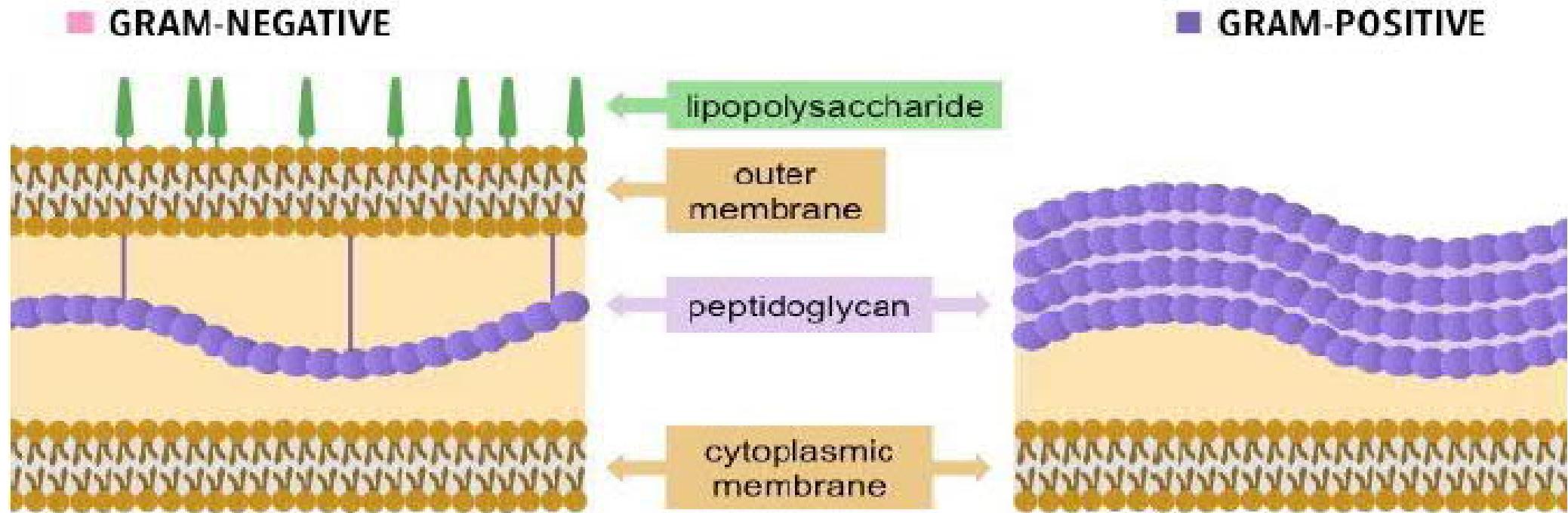


Identification Tests:

<http://www.microrao.com/identify.htm>

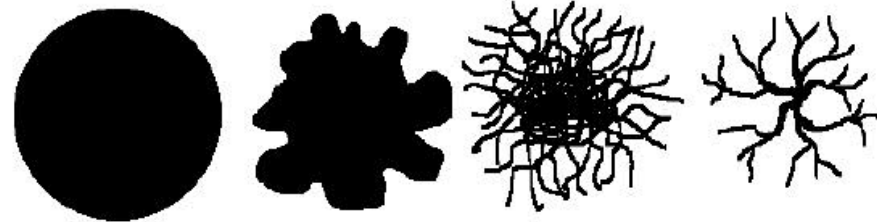
Gram Positive and Gram Negative Bacteria

https://www.diffen.com/difference/Gram-negative_Bacteria_vs_Gram-positive_Bacteria



Examination of Bacterial Colonies

Form



Circular

Irregular

Filamentous

Rhizoid

Elevation



Raised

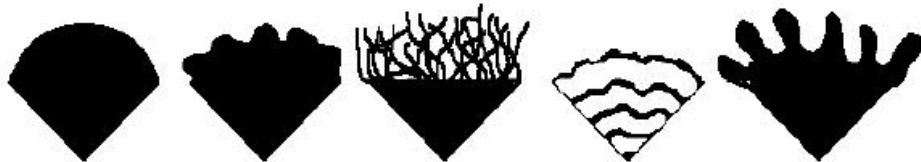
Convex

Flat

Umbonate

Crateriform

Margin



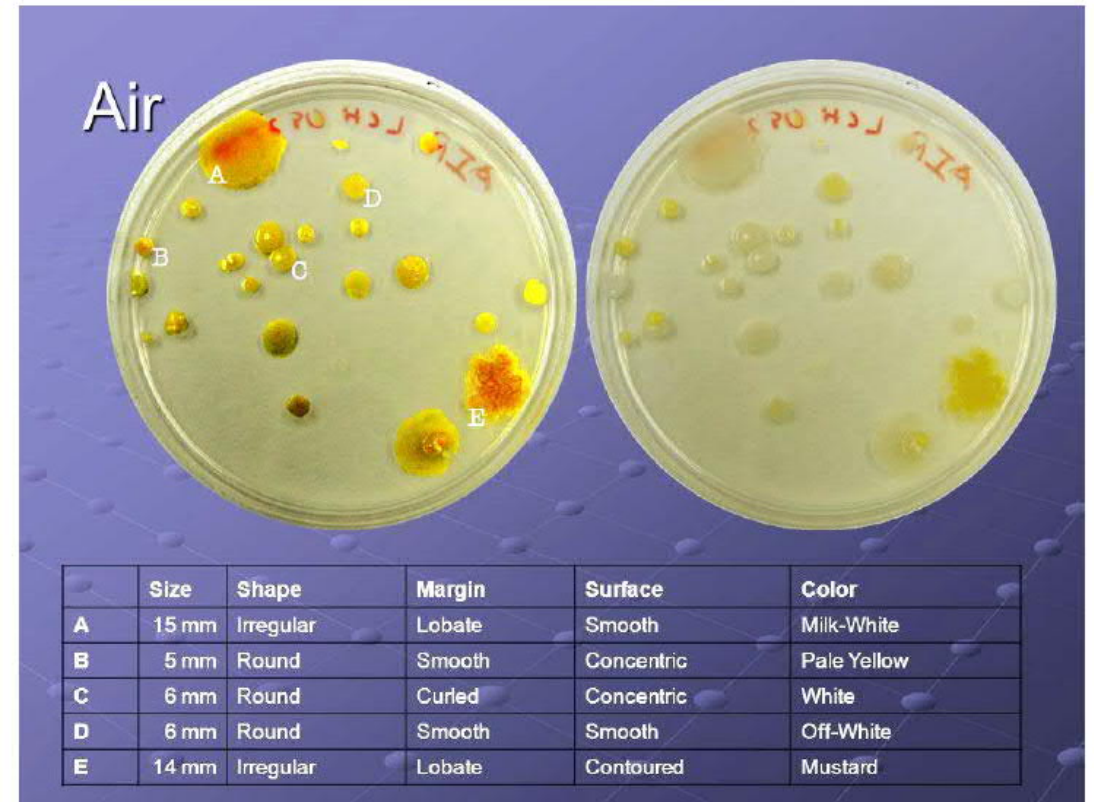
Entire

Undulate

Filiform

Curled

Lobate



Metabolism

Cellular metabolism is the set of chemical reactions that occur in living organisms in order to maintain life. Cellular metabolism involves complex sequences of controlled biochemical reactions, better known as metabolic pathways. These processes allow organisms to grow and reproduce, maintain their structures, and respond to environmental changes.

Basics – Catabolism, Anabolism and ATP

<https://www.khanacademy.org/science/high-school-biology/hs-energy-and-transport#hs-introduction-to-metabolism>