**الجامعة المستنصرية**

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**المرحلة الثالثة /فرع الاحياء المجهرية/**

# Environmental Microbiology

In the 1970s a new area of microbiology emerged and developed into the field of environmental microbiology because several events occurred

1. The first of these events was the emergence of series of new waterborne and foodborne pathogens that posed a threat to both human and animal health.
2. A result of past waste disposal practices, both surface water and groundwater supplies are frequently contaminated with organic and inorganic chemicals.
3. The discovery of the structure of DNA in 1953 by Watson and Crick engendered the development of new technologies, the polymerase chain reaction (PCR) based on nucleic acids for measuring and analysing microbes.

The roots of **environmental microbiology (E.M )** are widespread but are perhaps most closely related to the field of **microbial ecology,** which comprise the study of interaction of microorganisms within an environment ,be it air, water ,or soil.The primary difference between these two fields is that **E.M** is an applied field in which how can we use our understanding of microorganisms in the environment to benefit the society? Because environmental microbes can affect so many of aspects of life, and easily transported between environments.

**E.M.** interfaces with a number of different subspecialties ,including soil, aquatic and aeromicrobiology, as well as bioremediation, water quality ,occupational health and infection control , food safety ,and industrial microbiology .

**Microorganisms:** are organism too small to be seen with the naked eye , include bacteria, fungi ,protozoa, algae and viruses. The associated structures and metabolic capabilities of a microorganism determine where it can be found and ecological influence it has on the surrounding environment.M.O., due to their unique ability to adapt to extreme conditions imposed by oligotrophy (low nutrients),temperature ,pH, pressure and radiation ,among others ,have so far been found in every environment imaginable .Until the 1970s ,classification of microorganisms was passed primary on physiological differences ,later. Molecular phylogeny based on ribosomal RNA genes has shown that there are three domains of living organisms: Bacteria , Archaea and Eucarya .of these domains ,the Bacteria and the Arhaea are single celled prokaryotic organisms, whereas the Eukarya are more complex single and multicelled organisms that are eukaryotic in nature.

The two prokaryotic domains can be further classified on the basis of their cell wall properties into four type: Gram negative,Gram positive,lacking a cell wall-the mycoplasmas ,cell wall lacking peptidoglycan-the Archaea.

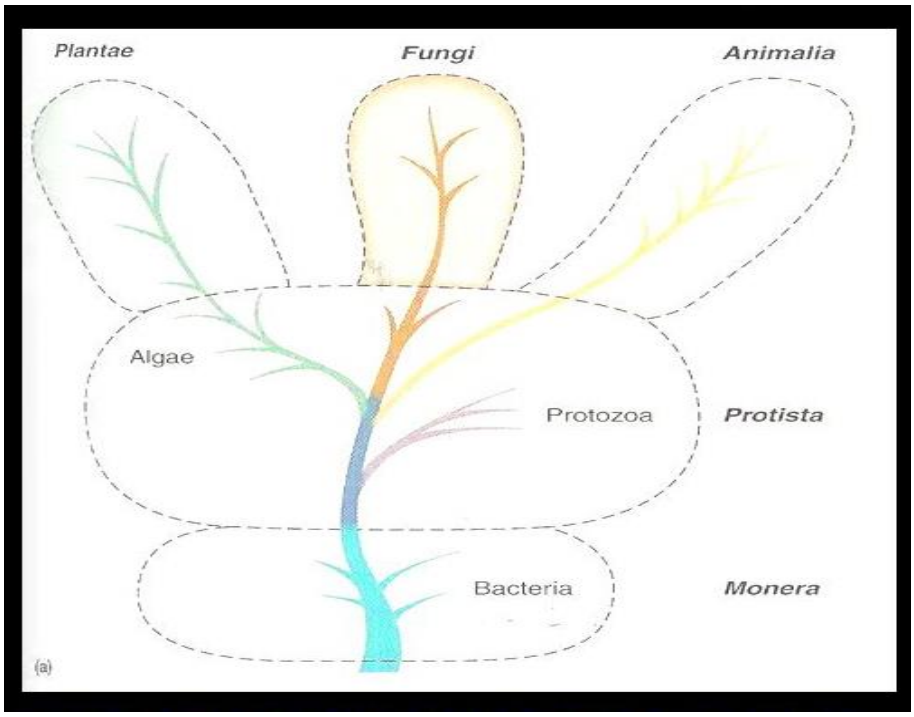
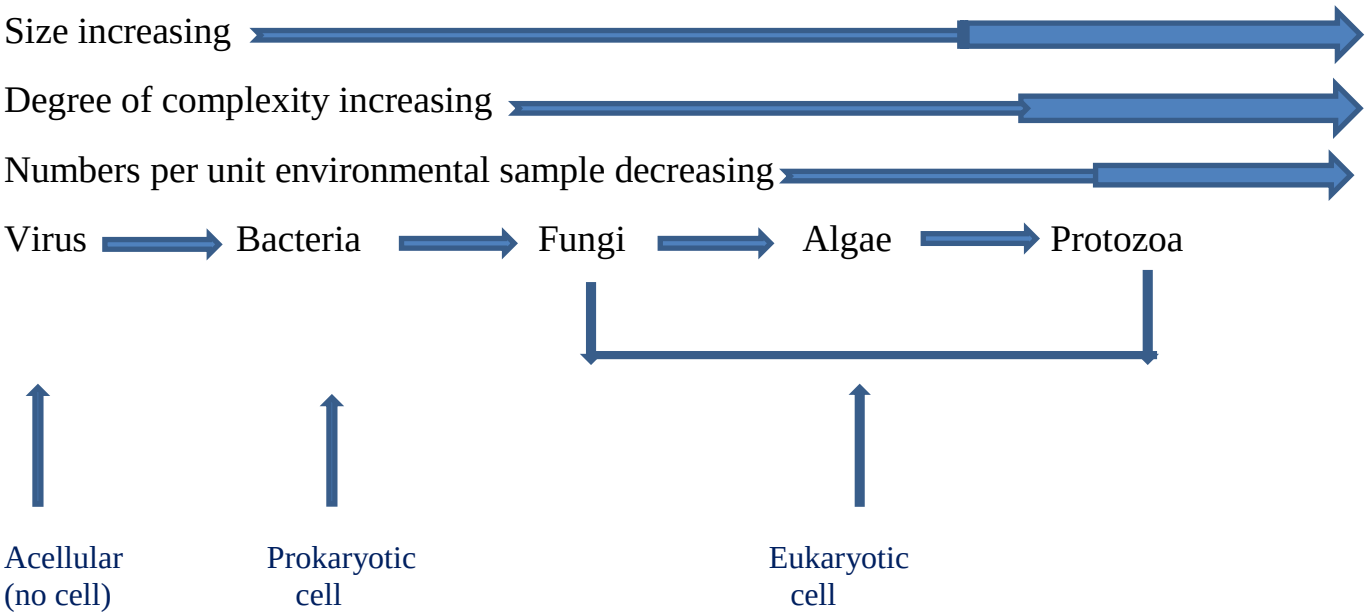



Figure ( 1): The five kingdoms system proposed by whittaker

## ❖ Microorganisms in the Environment (Scope and Diversity of Microbes Found in Environmental Microbiology




## ❖ Recently Discovered Microbes that have had a Significant Impact on Human Health

| Agent | Type of Microorganisms | Mode of transmission | Disease/symptoms |
|---|---|---|---|
| **Rotavirus** | Virus | Waterborne | Diarrhea |
| **SARS(a coronavirus)** | Virus | Fomites | Respiratory ` |
| ***Escherichia coli* 0157:H7** | bacterium | Foodborne,Waterborne | Enterohemorrhagic fever , kidney failure |
| **Hepatitis E virus** | Virus | Waterborne,Foodborne | Hepatitis |
| **Bird flu virus (avian influenza A(H5N1))** | Virus | Aerosol,fomites, Foodborne | Respiratory |
| **Norovirus** | Virus | Waterborne,Foodborne | Diarrhea |
| ***Helicobacter pylori*** | bacterium | Foodborne,Waterborne | Stomach ulcers |
| ***Cyclospora*** | protozoan | Foodborne,Waterborne | Diarrhea |
| **MRSA(antibiotic-resistant *Staphylococcus aureus*)** | bacterium | Fomites | Severe skin infections |

**Bacteria:** are prokaryotic cells and as such are the simplest of microbial cells.They are among the most common and ubiquitous organism found on earth, gram of soil can contain up to $10^{10}$ bacteria ,they can also found in diverse and extreme environments .the activities and importance effects of bacteria are : Biogeochemical processes, nutrient cycling in soils,bioremediation, human and plant diseases ,plant-microbe interactions, municipal waste treatment, and the production of important drug agents including antibiotics . Gram- negative and Gram- positive bacteria are prevalent in soil,water and subsurface zone materials, with the archaebacteria.

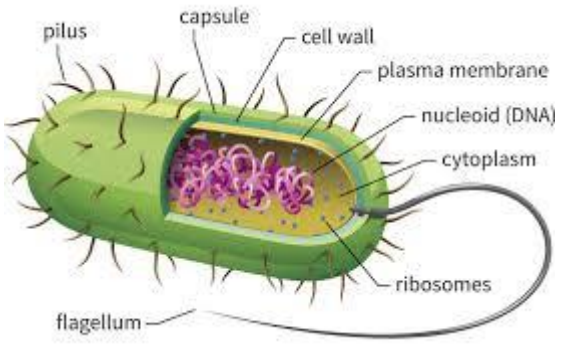



Figure ( 2): Show example of some bacterial structure

**the Archaea**: are m.o. similar to bacteria in size and shape under the light microscope but they are actually genetically and biochemically different,they appear to be a simpler form of life and may in fact be the oldest form of life on Earth. normally being found in harsh environments, Examples of archaeabacteria are the acidophiles ,which tolerate low-pH environments by exporting $H^+$ ions from the cell. Archaea tolerant of high salt are known as halophiles, and those that tolerate dry habitats are called xerophiles.

**Fungi:**In contrast to bacteria ,fungi are eukaryotic organisms.which are a physically larger group of eukaryotic organisms ,have the greatest biomass.they are ubiquitous in the environment and affect human health .For example,

1. fungi can beneficially affect plants through mycorrhizal associations.

2. or adversely affect plants via fungal plant pathogens.
3. they are also important in the cycling of organics and bioremediation.
4. fungal pathogens adversely affect human health,
5. and other fungi known as yeasts are utilized in the fermentation of sugars to alcohol in the brewing and wine industries.

Overall, fungi are found in fresh water, marine water or terrestrial habitats including soil and associated dead plant matter . metabolically, fungi are chemoheterotrophs, in addition to their primary metabolism that supports biosynthesis and energy production,fungi are known for producing **secondary metabolites** (compound produced during the stationary phase of growth),these secondary metabolites have role in medicine, biotechnology and agriculture.for example fungi are responsible for such antimicrobials as

1. penicillin produced by *penicillium notatum*,
2. cephalosporin produced by *cephalosporium acremonium.*

fungi can be divided into three general group based on morphological descriptions: molds, mushrooms and yeast.

**Molds** ,such as Aspergillus ,Penicillium ,Rhizopus, are filamentous fungi which are found in many fungal phyla. Each filamentous fungal cell is called a hypha. **Mushrooms** are part of the Basidiomycota , which are filamentous fungi that form the large fruiting bodies referred to as mushrooms. **Yeast** are unicellular fungi that are able to ferment under anaerobic conditions, most important are Saccharomyces and Candida, which are member of the Ascomycota.

(A) (B) (C)

Figure ( 3): Show examples of fungal diversity
(A) **Molds** (B) **Mushrooms** (C) **Yeast**

**Algae:**there are agroup of photosynthetic organisms that can be macroscopic, as in the case of seaweeds and kelps,or microscopic. the blue-green algae are actually classified as bacteria known as the cyanobacteria. The cyanobacteria not only are photosynthetic but can also fix atmospheric nitrogen in a free-living state or in a symbiosis with plants known as Azolla.

In terms of their impact in environmental microbiology

1. the algae are mostly significant in aqueous environments ,where they can cause eutrophication.
2. some algae produce toxins,which can causes death in fish and invertebrates and may cause food poisoning in human who eat these animals.

Large floating communities of microscopic algae are known **phytoplankton**. other algal habitats include the surface of soil,rocks and plants where one finds the diatoms.

Overall, the algae are known by common names such as **green algae, brown algae,**or **red algae** based on their predominant color. Amore technical classification is based on??

1. The type of chlorophyll
2. The type of cell covering
3. The nature of their stored foods

**Protozoa:** are unicellular eukaryotes, meaning that they have characteristic organelles and are large (some are visible with the naked eye).protozoa characteristically lack cell walls. Although they are single-celled organisms, they are by no means simple in structure and many diverse forms can be observed among the more than 65,000 named species. Such morphological variability evolved over hundreds of millions of years, has enabled protozoan adaptation to a wide variety of environments. most protozoa are motile and are divided into taxonomic group based on mechanism of motility for example, some use flagella , use cilia and use ameboid motility and other nonmotile.

Because differentiation of protozoa with multiple feeding habits (mixotrophy) is difficult, protozoa are now classified with algae and other unicellular eukaryotes in the same kingdom ,**Protista**.

During feeding, protozoa help to control bacterial biomass in the environment.,**phagotrophic and heterotrophic protozoa** act as both predator and prey, aiding in the availability of elements, energy and nutrients for other members of the microbial community. **Parasitic protozoa** may cause significant disease or actually help the invaded host,I,e,, flagellates, found in the intestines of wood- eating termites, digest cellulose material to an acceptable nutrient for the insect,without which the decomposer would starve to death. This wide range of

adoptive traits enables long – term survival and replication of protozoa in a number of different environments. Many parasitic protozoa are of obvious public health concern , causing such diseases as malaria ,sleeping sickness, chagas disease, leishmaniasis , giardiasis and cryptosporidiosis.

**Viruses:** are a group of biological entities consisting of nucleic acid encapsulated within a protein coat known as the capsid in various different size and morphologies, viral nucleic acids can consist of single- or double – stranded DNA or RNA. They are obligate parasites that have no metabolic capability and rely on host metabolism to produce viral parts. **procaryotic viruses** is interact with prokaryotic host like bacteriophage is bacterial viruses, while **Eucaryotic viruses** was infected humans and other animals ,plants and Eucaryotic M.0. including algae and fungi

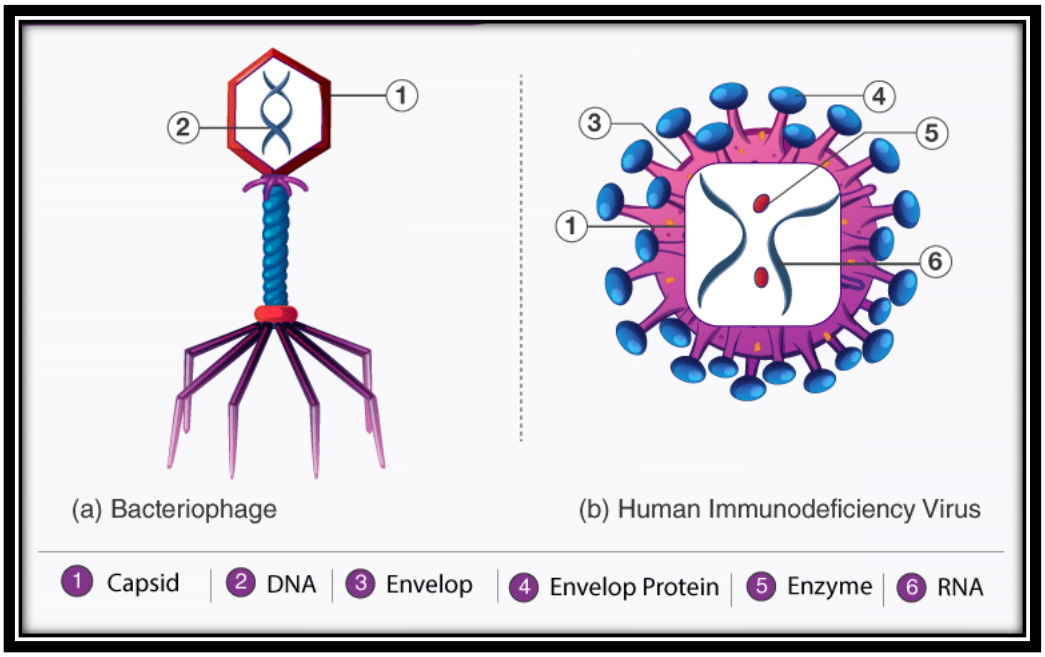



Figure ( 4): Show example of some viral structure