General Microbiology

Tishk International University-Nursing

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2022-2023

Reference:

Microbiology (Principle and Exploration)
Jacquelyn G.Black- 5th edition
2- Microbiology Experiments (fourth edition)
A health Science perspective John Kleyn- Mary Bicknell
3- Microbiology (A human perspective)
Fourth edition Nester, Anderson , PEARSALL.
4- text book of microbiology
P.C. Trivedi Sonali, Pandey Seema , Bhadauria
5- Antimicrobials
Mohammed Almarjani

Weekly course outline

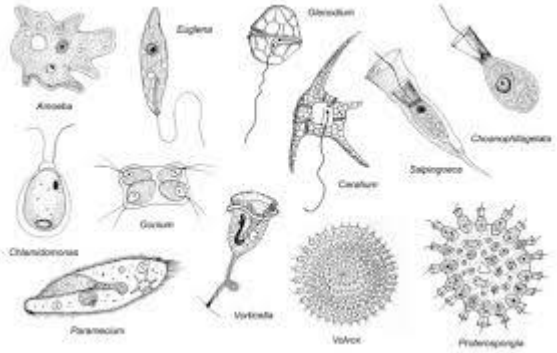
No	**Subject Title**
1-2	Introduction to microbiology , new concept in microbiology, virus
3	Microbial cell structure and functions –fungi, algae protozoa

4-5	Microbial growth and population, principle of gram stain and microbial metabolism
6-8	Antimicrobial activity ,Antibiotic, Classification of antibiotic , Antifungal
9	Food microbiology
10-11	Medical microbiology
12-13	fungal and protozoan diseases

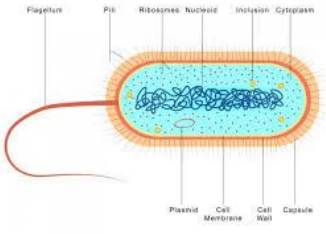
Aims

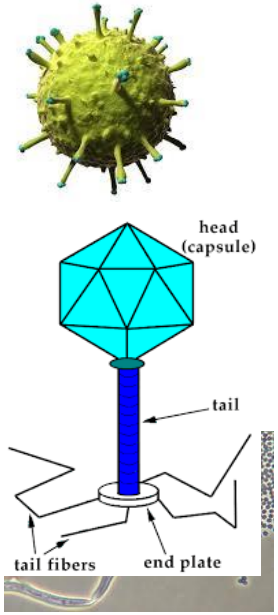
- What is microbiology?
- Why study microbiology?
- Some important concepts.
- Identify disease
- Useful microorganism

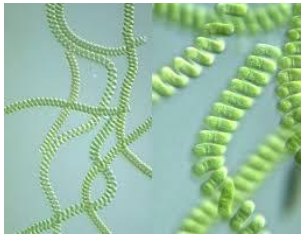
What is Microbiology?



Microbiology: - Is the science which study the living microorganism of microscopic size, which include the following: bacteria, fungi, viruses, algae and protozoa.







History of Microbiology

A. Anton van Leeuwenhoek (1632–1723): was the first microbiologist and the first person to observe bacteria using a single-lens microscope of his own design.

B. Louis Pasteur (1822–1895): Pasteur developed a process (today known as pasteurization) to kill microbes. pasteurization is accomplished by heating liquids to 63 to 65 C for 30 minutes or to 73 to 75 C for 15 seconds.

C. Robert Koch (1843–1910): was a pioneer in medical microbiology and worked in cholera, anthrax and tuberculosis. He was awarded a Nobel prize in 1905 (Koch's postulates) he set out criteria to test.

D. Alexander Fleming (1929): Discovered penicillin.

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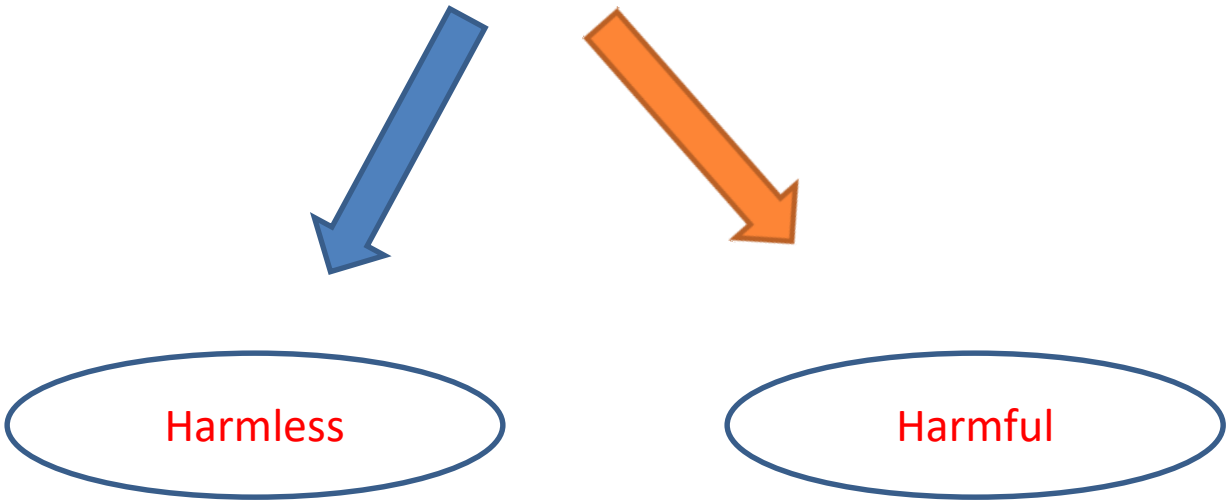
- **Microbes and microorganisms**

Both terms include all organisms that are too small to be seen without a microscope.

- Most of as think microorganisms are harmful, but it is not true. Most of the microorganisms are harmless.



Harmful Effects of microorganisms

1. Diseases to animal and plant
2. Spoilage of food
3. Food poisoning

Beneficial of microorganisms

Microorganisms are used in the production of beneficial material such as antibiotics, dairy products (yoghurt), ethanol, vitamins, and proteins.

- **Microbiology has many applied area:-**

1. Medical microbiology: Study the microorganism in the causative agent of disease and their diagnostic procedure, prevention and treatment.
2. Food microbiology: Study the microorganism which has a role in the spoilage of food, the method of preservation of food and food poisoning by microorganism.
3. Industrial microbiology: Study microorganism which has a role in the production of substance and economic value such as antibiotic, protein, hormone, vitamin

4. Agriculture and soil microbiology: Study microorganism that live In soil which concern soil fertility .

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6. Aquatic microbiology: Study the microorganism in the aquatic environment the water purification and microbiological degradation of waste ecology.

The study of microbiology includes:-

1. The distribution of microorganism in nature.
2. The relationship to each other and other living organisms.
3. The effect of microorganisms on animal, plant, and human being.
4. The ability of microorganism to make physical and chemical effects in their environment.
5. The reaction of microorganism to chemical and physical agents.

Normal Flora

What is normal flora?

Normal Flora: The term " Normal Flora " include the population of microorganisms that inhabit the skin or in specific areas of the body.

Normal flora microorganisms ::including bacteria, protozoa and fungi

- Human beings are not microbiologically sterile, we are all covered with bacteria, fungi and some parasites.

Normal Flora

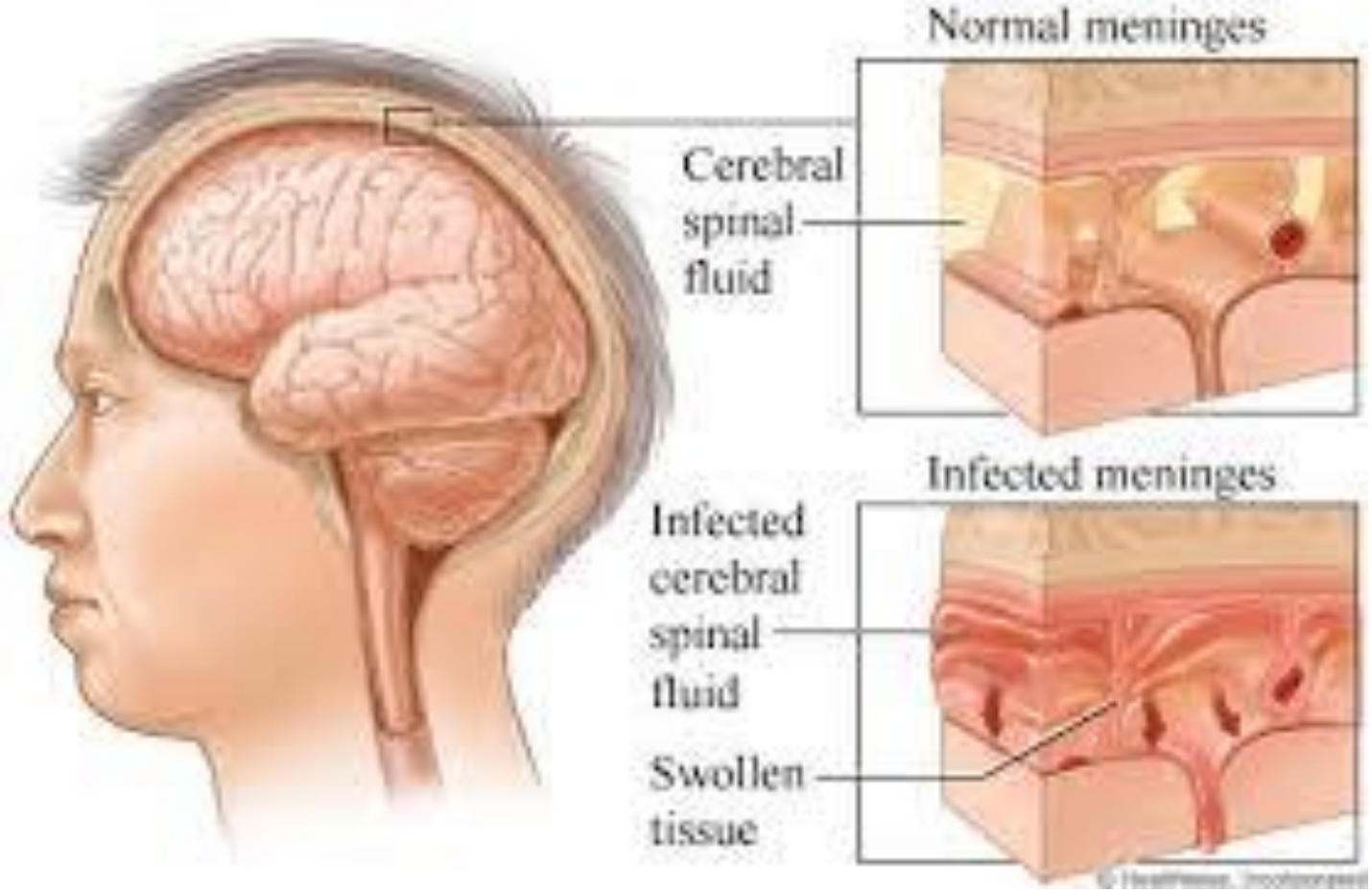
The normal flora is present :

- skin, upper respiratory tract, oral cavity, intestine, especially large intestine, vaginal tract.
- Very little normal flora in eyes and stomach.

The normal flora is absent in:

- Sterile tissue in a healthy human, the internal tissues such as blood, brain, muscle, cerebrospinal fluid, meninges and lower respiratory tract are normally free of microorganisms.

A human body contains around $\mathbf{10^{13}}$ cells. The human body is home to around $\mathbf{10^{14}}$ bacteria.
One fourth of fecal weight is made of bacteria.


Normal meninges
Cerebral spinal fluid
Infected meninges
Infected cerebral spinal fluid
Swollen tissue

Normal Flora

Beneficial effects of normal flora:

1- Competing with invaders for space and nutrients.
2- Producing compounds (bacteriocins) which kill other bacteria.
3- lowering the pH, so that other bacteria can not grow.
4-In addition; normal flora help us in other ways eg
Producing vitamins we are not able to produce such as vitamin **k** produced by *E. coli*
5-Help digest food
6-Help the development of the immune system.

Note: Antibiotic treatment of bacterial infection also killed beneficial bacteria

Infection

- **Infection:** the invasion and multiplication of microorganisms such as bacteria, viruses and parasites, that are not normally present within the body. An infection may cause no symptoms and it may be cause symptoms.

- Infection is caused by microorganism.
- The microorganisms may be a bacteria, a virus, a para fungus.
- Microorganisms that live naturally in the body are not considered infection.

Contamination

- Presence of an organism in a culture that was not in the sample when taken.
- E.g. a culture of blood contaminated with an organism from the skin.
- Sample contaminated in the lab.


Flow of Personnel
Material
Waste
HVAC
Facility
Assembly
Cleaning
Sterilization
Equipment
Open
Vs
Closed
Personnel
Microbial
Contamination
Sources
Process
Utilities
Materials
Raw material
Reusable resin &
Membrane filter
Water
Gases

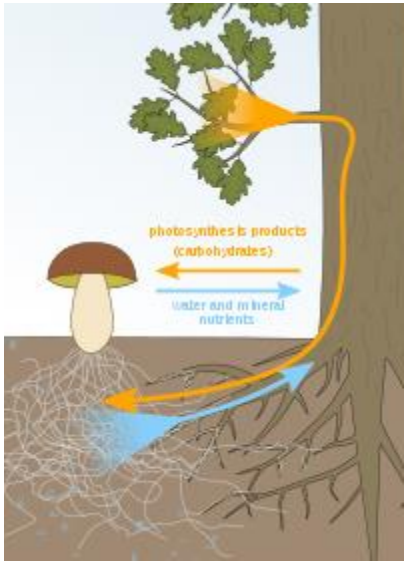
Relationship among microorganisms

There are many different types of relationship that the body can have with the microorganisms:

1- **Mutualism:** A symbiotic relationship in which both species benefits.
2- **Commensalism:** A symbiotic relationship in which one species benefits and the other species is neither helped nor harmed.
3- **Parasitism:** A symbiotic relationship in which one species benefits and the other species is harmed.

Example of microbial community

Mycorrhiza- Fungal symbiotic association with plants which helps plants to absorb phosphorus from soil.



Examples of commensalism are where the waste products of one organism is utilized by another.

Example of parasitism: all microorganism that cause disease.

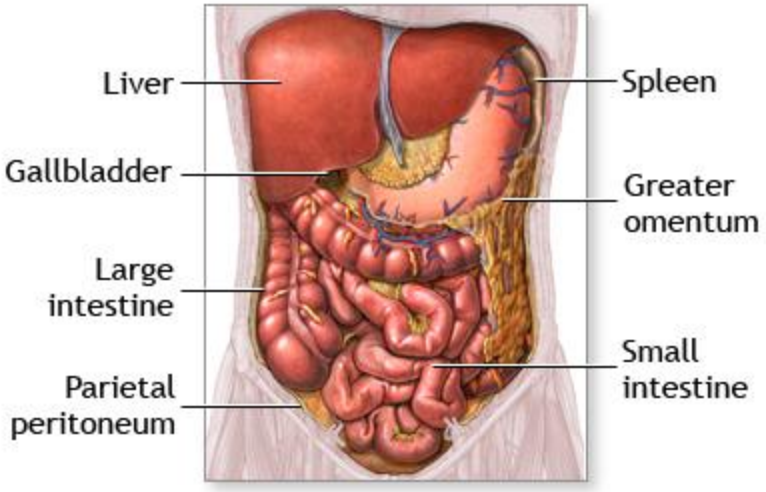
Importance of Microbiology in nursing:

1. Intensive Care Nurseries :-

As nurses have to work with Respirators, Exchange transfusions, Umbilical catheters, Gastrostomy feeds, they need to know hygienic use of these materials. They take care of incubators and maintain sterile atmospheric environment in this branch of health care.

2. Obstetric Units :-

In hospital or clinic, puerperal and post abortal infections cause a significant number of death.
It is a microbial infection of the birth canal after abortion or childbirth that finally results in phlebitis and peritonitis. The microbiological knowledge of the nurses help the nurse prevent these infections.


Liver
Gallbladder
Large intestine
Parietal peritoneum
Spleen
Greater omentum
Small intestine

3. Communicable disease wards :

Patients infected with microbial disease are admitted in communicable disease wards and are taken care. The nurses have to care for these patients by using aseptic to prevent transmission of the infection to other patients.

4. Operation Theaters :

Operation theaters must be an sterile environment. The Nurse in the operation theater plays an important role in keeping the atmosphere sterile by frequent fumigation procedures. They also have to sterile various surgical instruments regularly.

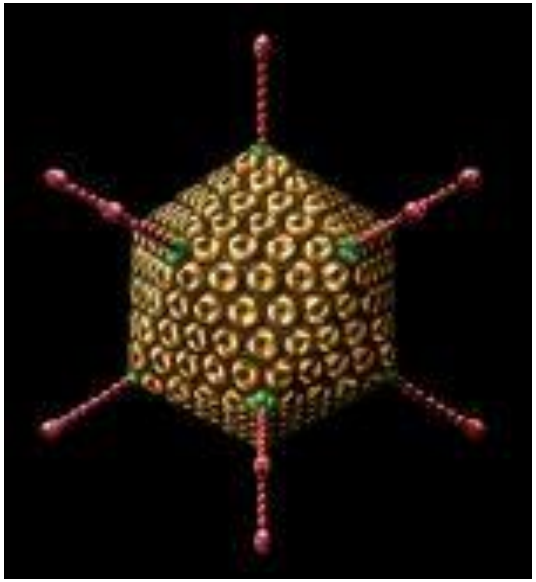
5. Burns Units :

The wound can easily get infected by harmful bacteria. The nurse can prevent bacterial infection from burned patients in the hospital by using aseptic technique.

6. C S U :

The central sterilization unit in the hospital is an important section to prevent microbial infections in the hospital. Sterilization technique is an important topic of microbiology. The knowledge of sterilization technique help the nurse improve the quality of work in this unit.

Member of Microorganisms-
A-Virus



- A virus is a non-cellular particle made up of genetic material and protein that can invade living cells.

•Beijerinck (1897) coined the Latin name “virus” meaning poison

•He studied filtered plant juices & found they caused healthy plants to become sick

Characteristics

1. Small size:

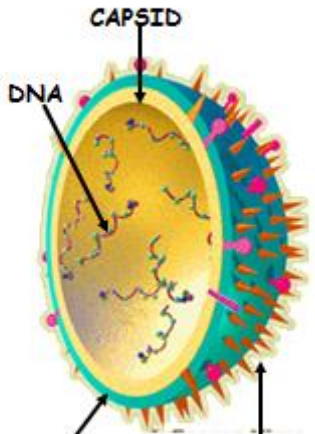
- The smallest infectious agents (20-300 nm in diameter)
- Bacteria (300-1000nm); RBC (7500nm)

2. Genome:

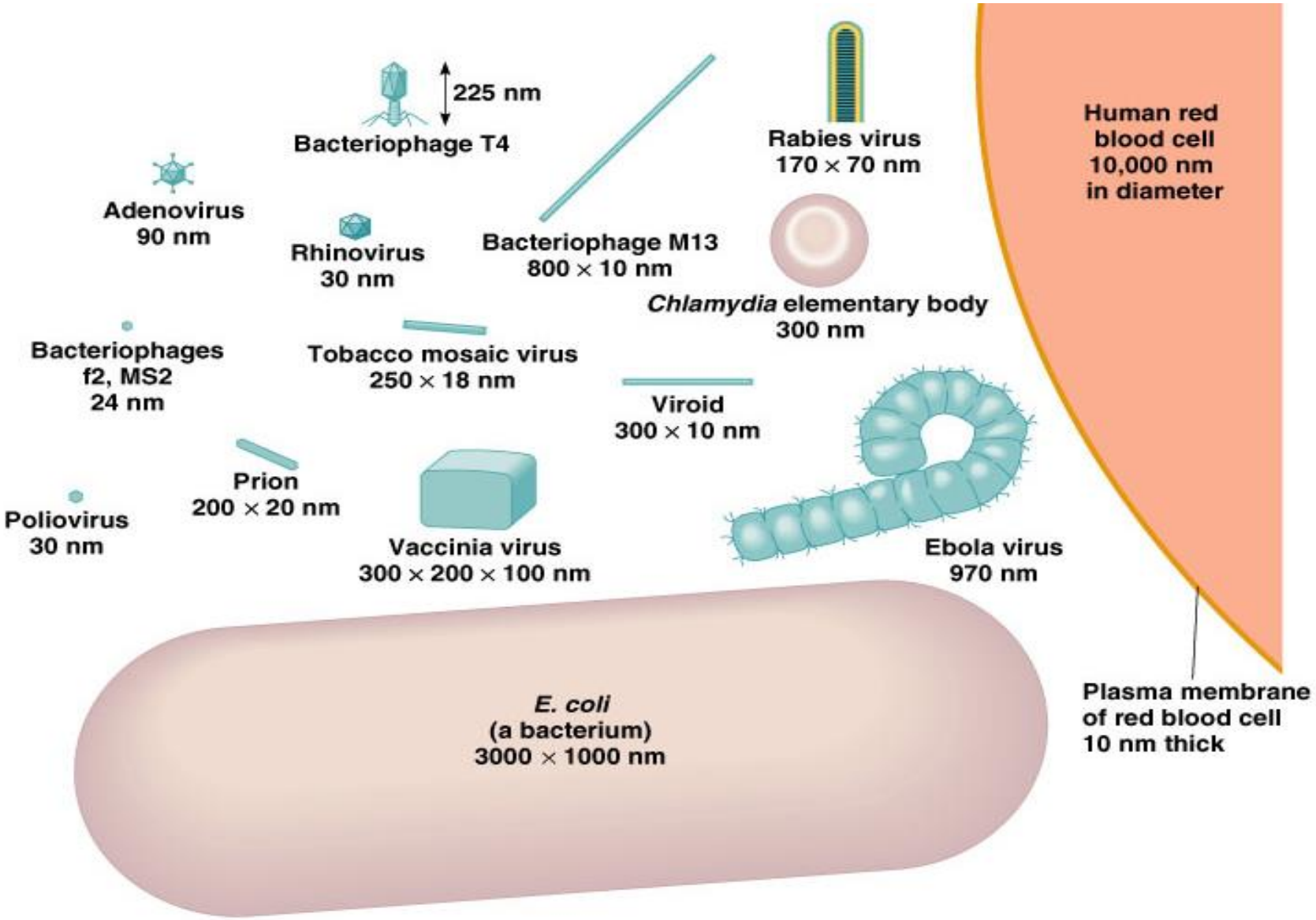
- Either DNA or RNA

3. Metabolically inert:

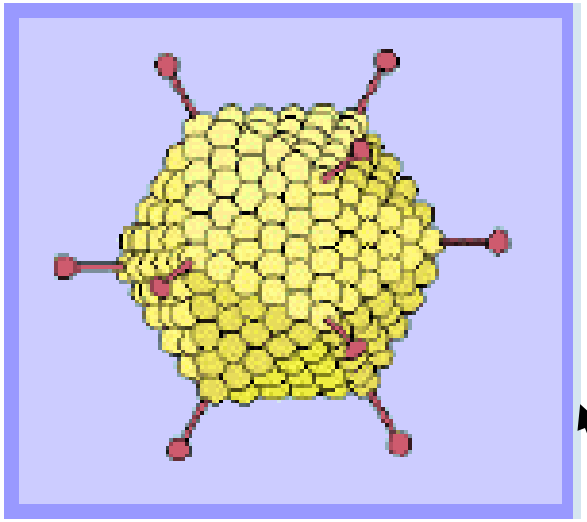
- Do not posses active protein synthesizing apparatus
- Do not have a nucleus, cytoplasm, mitochondria or ribosomes
- No metabolic activity outside host: obligate intracellular parasites
- Can replicate only inside living cells; NOT on inanimate media

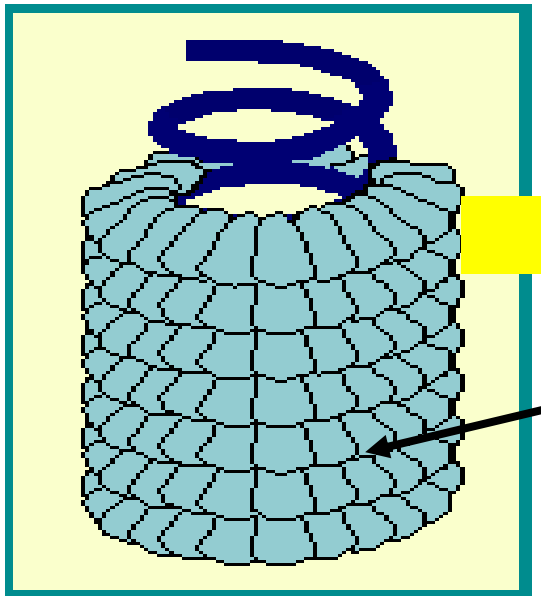


Size of Viruses



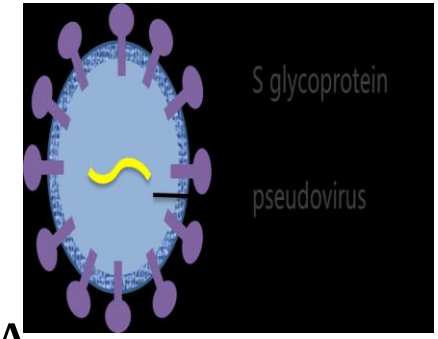
- **Capsid:** protein coat surrounding the genome
  - Provides structural symmetry
  - Participates in attachment to susceptible host
  - Facilitates transfer of viral nucleic acid in to host cell
  - Protects the viral genome from nucleases in blood stream
- **Capsomeres:** the structural units making up capsid: consist of one or several proteins





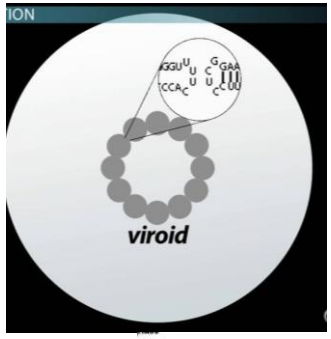
Pseudovirions

- Contain host cell DNA instead of viral DNA within the capsid
- Can infect cells but do not replicate.



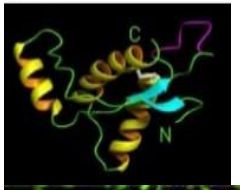
Viroids

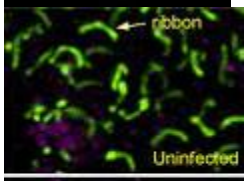
- Are infectious agents that consist only of naked RNA without any protective layer such as a protein coat.
- Cause several plant diseases but are not implicated in human diseases (Potato spindle tuber viroid)

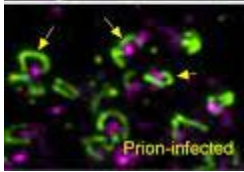


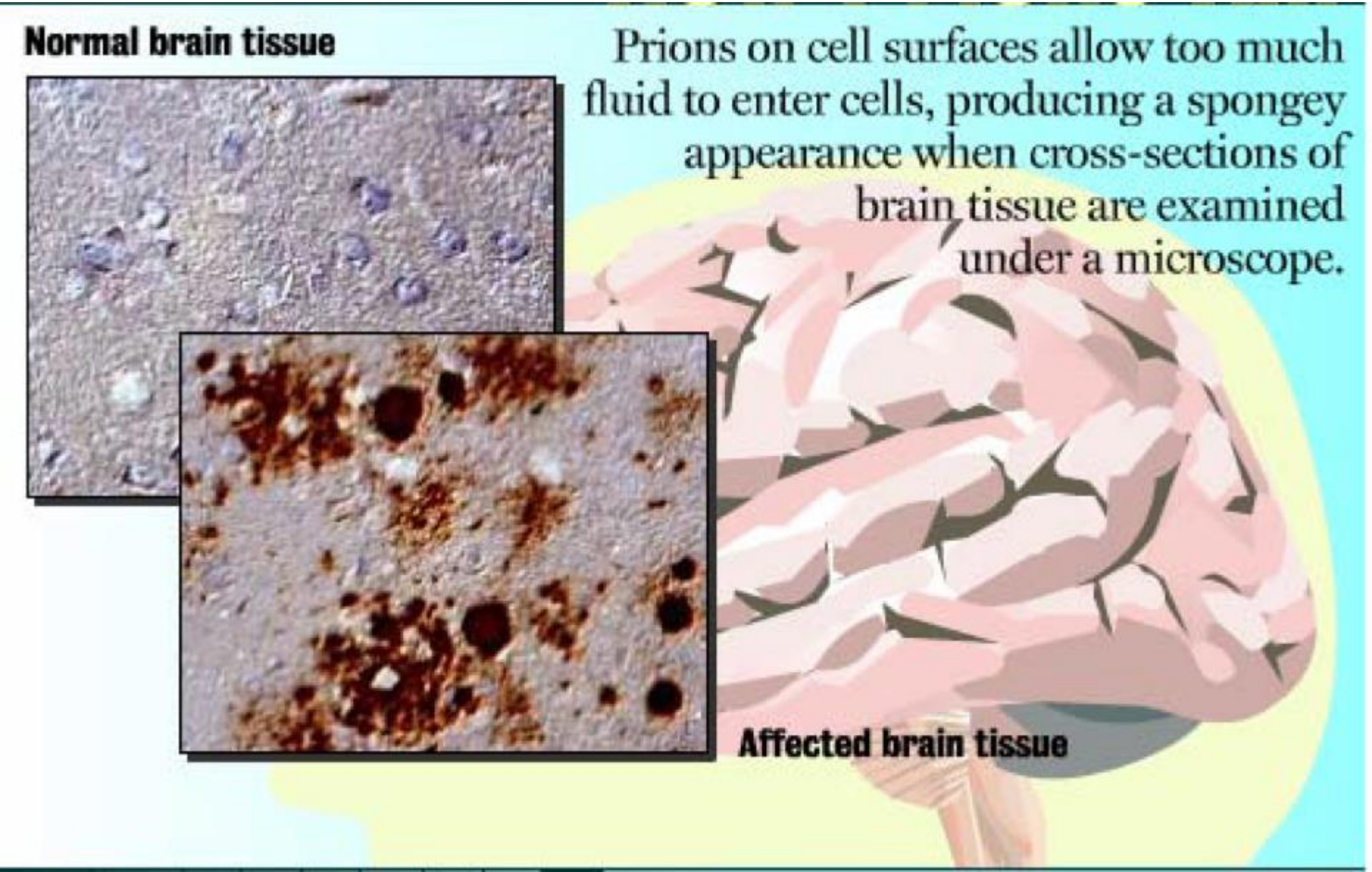
Prions

- A prion is a type of protein that can trigger normal proteins in the brain to fold abnormally. Prion diseases can affect both humans and animals and are sometimes spread to humans by infected meat products.
- The most common form of prion disease that affects humans is Creutzfeldt-Jakob disease (CJD).



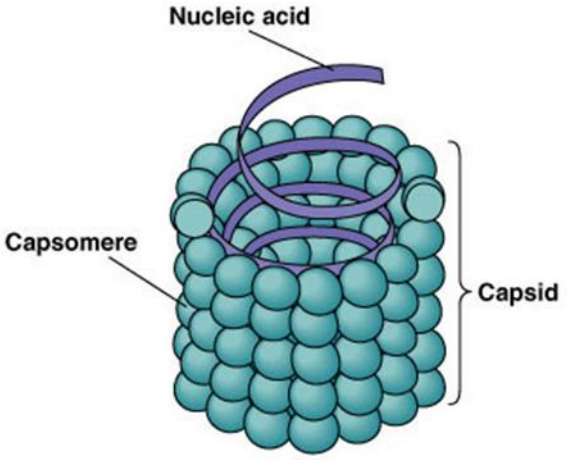





Normal brain tissue
Prions on cell surfaces allow too much fluid to enter cells, producing a spongey appearance when cross-sections of brain tissue are examined under a microscope.
Affected brain tissue

Viral Shapes

- Viruses come in a variety of shapes
- Some may be helical shape like the Ebola virus

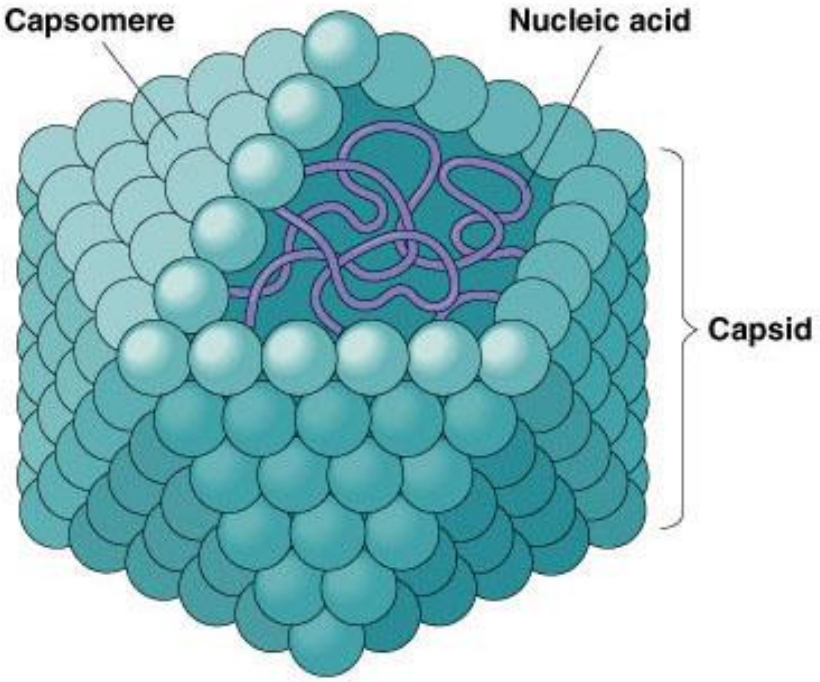


(a) A helical virus

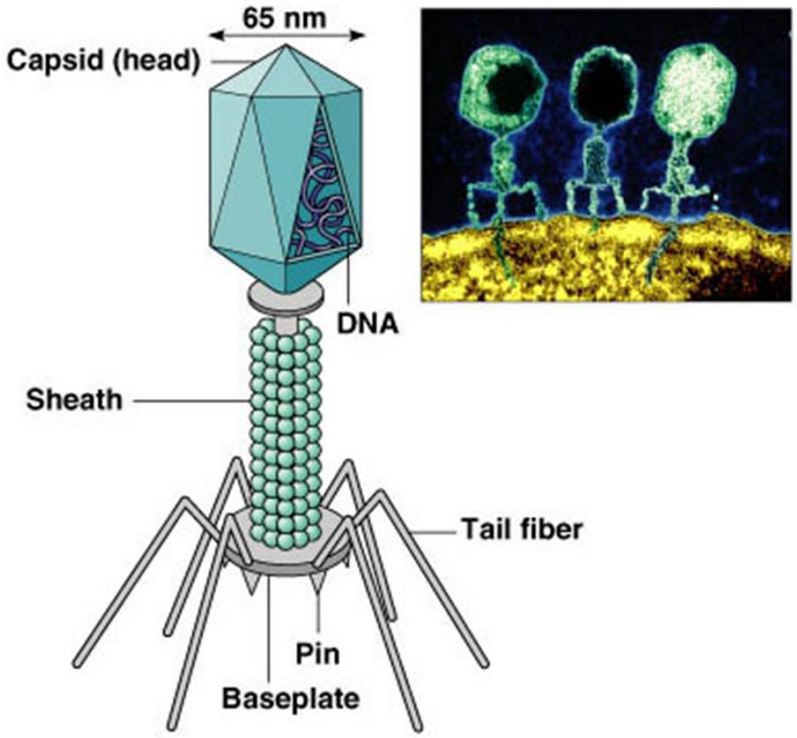
(b) Ebola virus

•Some may be polyhedral shapes like the influenza virus

•Others have more complex shapes like bacteriophages



(a) A polyhedral virus



(a) A T-even bacteriophage

Cultivation of viruses:

need living cells, living hosts, Tissue cultures, embryonated eggs,

Some question and Answers about Viruses:

Q/ Are viruses cellular organisms?

A/ Viruses are considered living organisms but they do not have a cellular structure.

Q/ What is the basic structure of a virus?

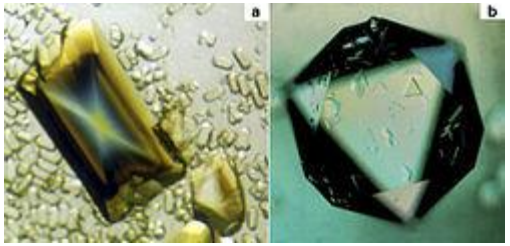
A/Viruses are made up of genetic material (DNA or RNA) covered by a protein capsule also known as a capsid. Some viruses, like HIV, also have an external envelope produced from the plasma membrane of the host cell from which it came.

Q/ Are there non-parasitic viruses?

A/All viruses are obligate intracellular parasites, meaning that they depend on a host cell to complete their life cycle. A virus does not have its own metabolism.

Q/ What is the crystallization of a virus? What is the importance of this process?

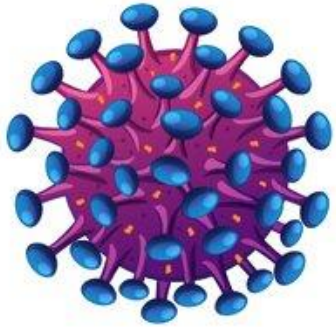
A/ Crystallization is the process of the transformation of viral components into organized solid particles.
The crystallization of biological macromolecules, including viral components, is used to study structural characteristics, through X-rays or laser beams.



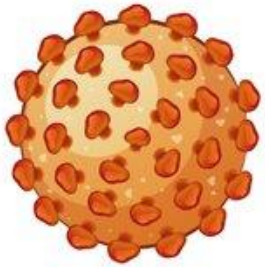
Q/What are the main human diseases caused by viruses?

A/ Among diseases caused by viruses are the common cold, the flu, mumps, smallpox (considered eradicated nowadays), rubella, measles, AIDS, viral hepatitis, papillomatosis (HPV infection), rabies, dengue fever, yellow fever, poliomyelitis (a disease almost eradicated in developed countries), hemorrhagic fever from the Ebola virus and SARS (severe acute respiratory syndrome).

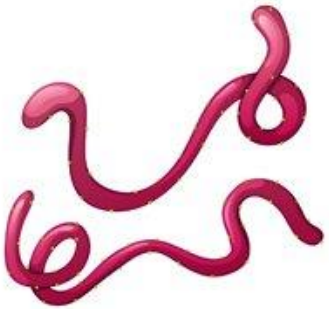
Viruses also cause many other diseases in animals and plants.



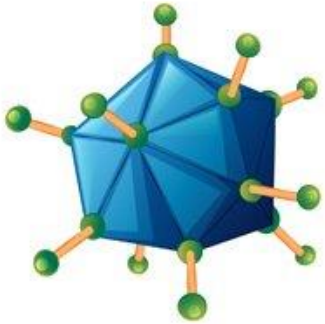
HIV



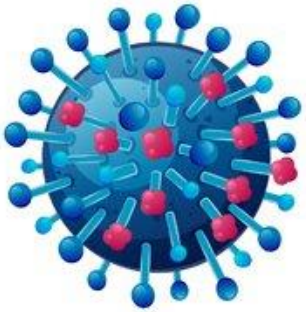
Hepatitis B



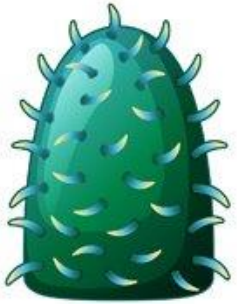
Ebola Virus



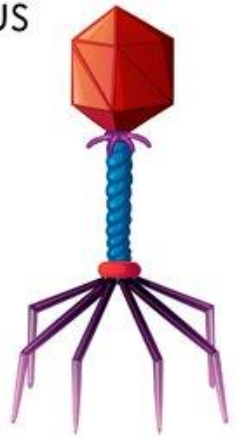
Adenovirus



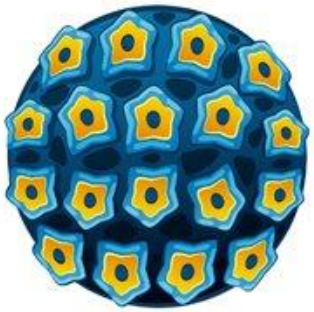
Influenza



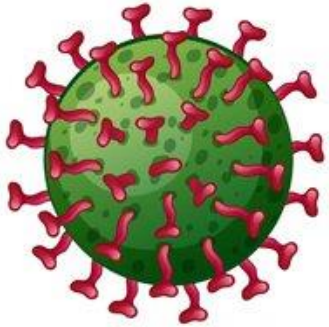
Rabies Virus



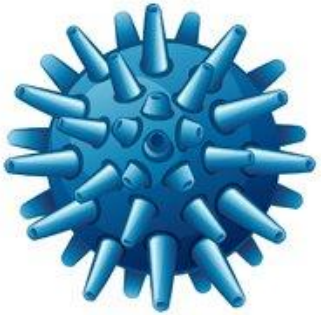
Bacteriophage



Papillomavirus



Rotavirus



Herpes Virus

	Virus	Living Cell
Structure	RNA or DNA core (center), protein coat (capsid)	Cell membrane, cytoplasm, genetic material, organelles
Reproduction	Copies itself only inside host cell--REPLICATION	Asexual or Sexual
Genetic Material	DNA or RNA	DNA and RNA
Growth and Development	-	YES—Multicellular Organisms
Obtain and Use Energy	-	YES
Response to Environment	-	YES

Prokaryotic cell structure

- Prokaryotic cells are about 10 times smaller than eukaryotic cells.

- Prokaryotes are very simple cells when compare with eukaryotic cells and yet they are able to perform the necessary processes of life.
- Reproduction of prokaryotic cells is by **binary fission** (the simple division of one cell into two cells, after DNA replication and the formation of separating membrane and cell wall)

- Prokaryotic cells: **bacteria** and **archae**

- Do **not have true nucleus** or other **membrane-bound organelles** (Mitochondria, Golgi apparatus …)

Bacteria

Important characteristics:

- Prokaryotic
- Unicellular
- Simple internal structure
- Grow on artificial laboratory media
- Reproduction by binary fission

Practical significance:

- Some cause diseases
- Some perform role in natural cycling of elements and increase soil fertility.
- Manufacture of valuable compounds in industry.

Structures common to all bacterial cells

- Cell membrane
- Cytoplasm
- Ribosomes
- One (or a few) chromosomes

Structures found in most bacterial cells

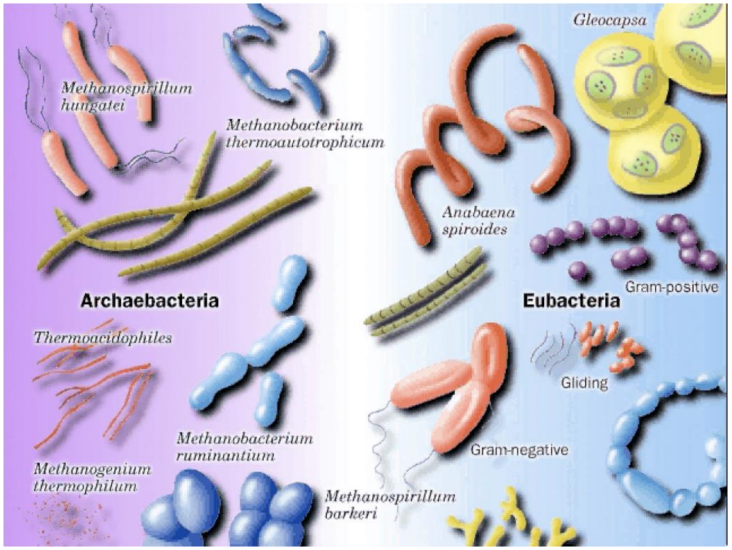
- Cell wall
- Surface coating or glycocalyx

Structures found in some bacterial cells

- Flagella
- Pili
- Fimbriae
- Capsules
- Slime layers
- Inclusions
- Actin cytoskeleton
- Endospores

Archaebacteria

- These can easily survive under very harsh conditions such as, The cell membranes of the Archaebacteria are composed of lipids.
- **Unicellular**
- Autotrophic and heterotrophic
- Prokaryotes
- Live in harsh environments



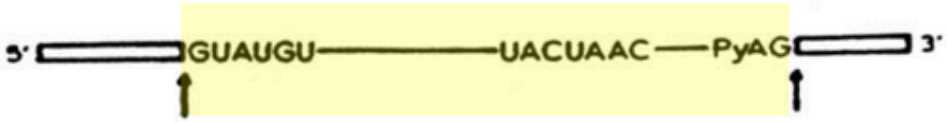
Bacteria	Archaea
Cell wall structure contains peptidoglycan	Cell wall structures do not contain peptidoglycan. They have : Polysaccharide Protein, or no cell wall
Introns absent	Introns present
Ribosomal protein (58)	Ribosomal protein (64)
Can be parasitic and cause infectious disease	None are parasitic

Archaea:
-methanogens
-thermoacidophiles
-halophiles

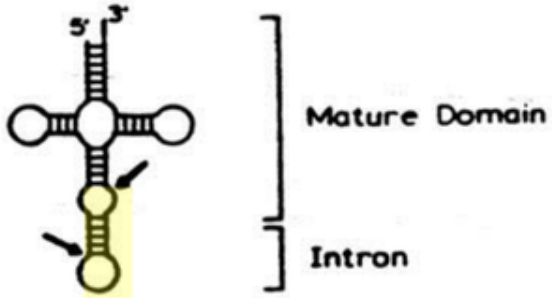
Bacteria:
-Cyanobacteria
-enterobacteria
-gliding and bubbling bacteria

Five Classes of Introns

■ Nuclear mRNA

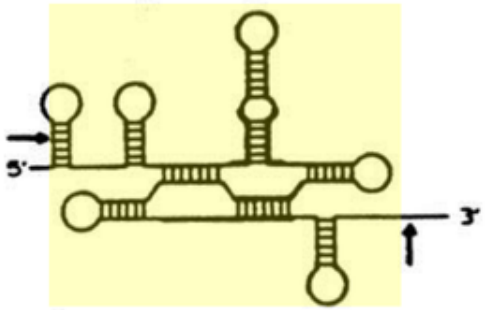


■ tRNA

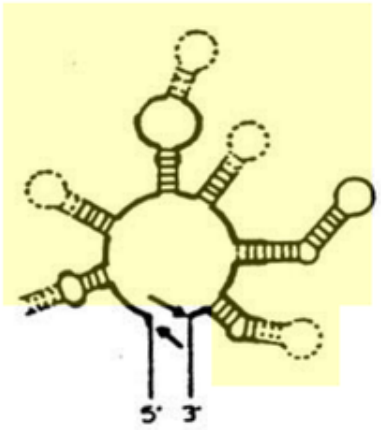


Archaeal introns
(tRNAs and rRNAs)

■ Self-Splicing



Group I



Group II

Fungi:

- The study of fungi is called **mycology**
- Fungi are diverse and widespread
- They are essential for well-being of most terrestrial ecosystems because the **break down organic material** and **recycle vital nutrients**

Fungi include:

Yeast, mold, mushroom and toadstools, puffballs,

etc.

Micro fungi include **Yeast and mold**

Characteristics of fungi:

1- Fungi are eukaryotic microorganisms, heterotrophic, they do not have chlorophyll.

2-Most are multicellular except unicellular yeast.

3- They are surround by a true **cell wall** except for slime mold. Cell wall are made of **chitin**.

5- The fungal colony may be a mass of yeast cell or it may be a filamentous as mold

6- Reproduce sexually and asexually

Asexually by spores, Sexually by mating of hyphae filaments

Yeast:

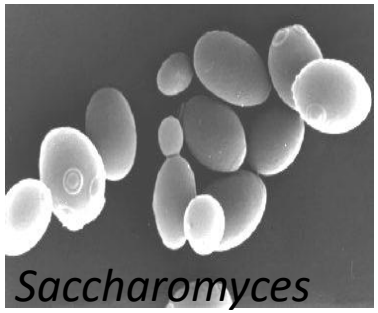
-Yeast are unicellular organisms about 5 to 10 times larger than bacteria.

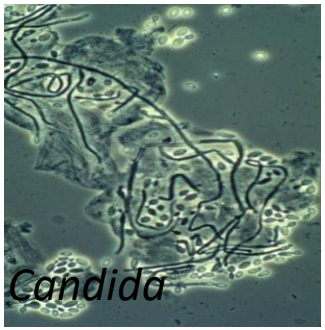
-The shape is commonly egg shaped, but some are elongated and some are spherical.

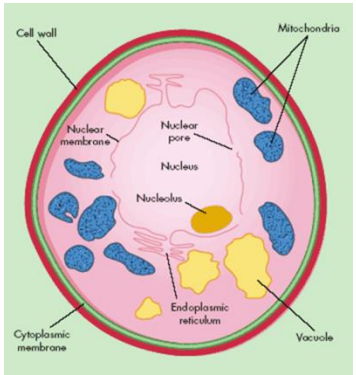
-The yeast cell have no flagellum or other organelles of locomotion.

-Most yeast reproduce asexually by a process called budding.

-Some yeasts may also undergo sexual reproduction


Saccharomyces


Candida



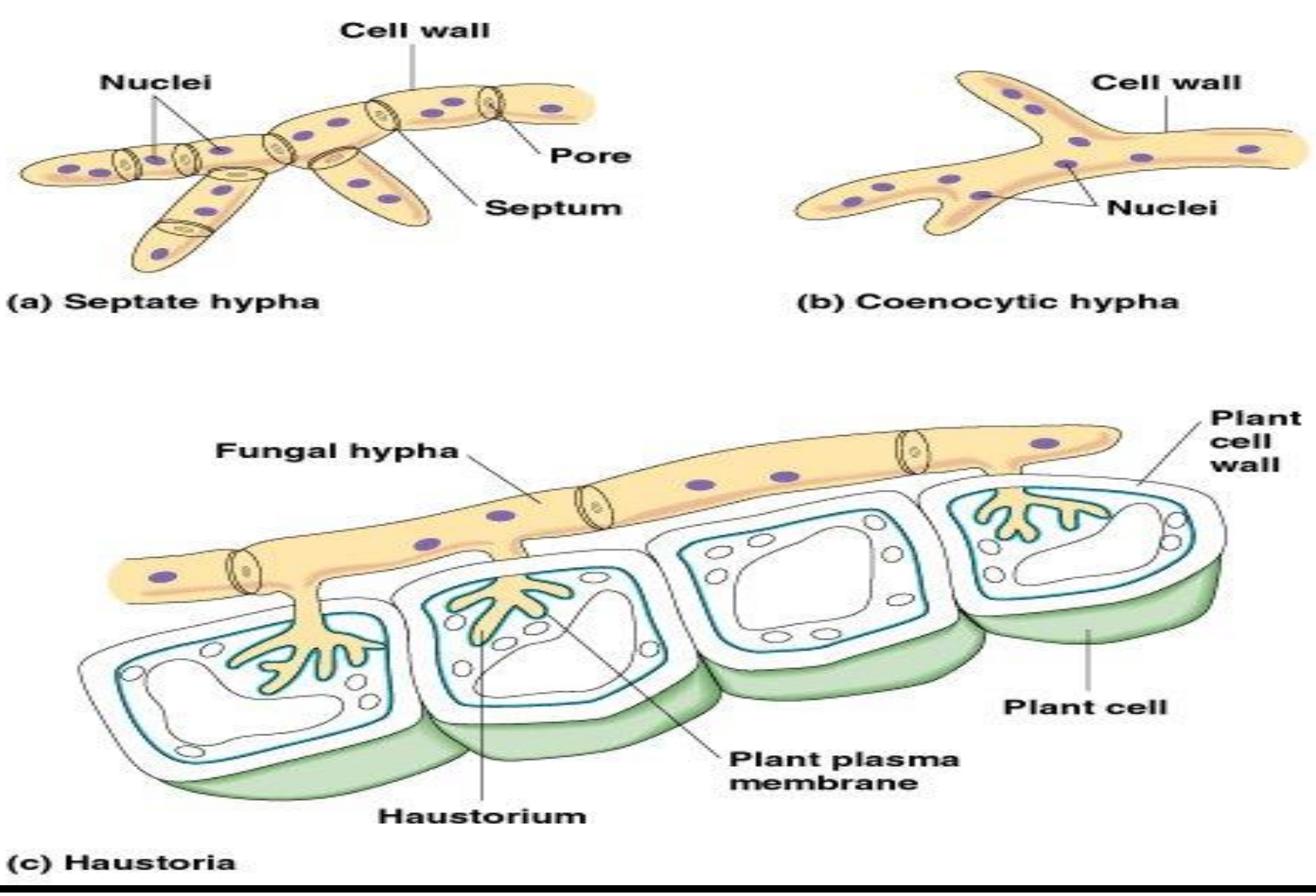
Mold:

- Molds are the major fungal organisms that can be seen by the naked eye.
- Thallus (body) of a mold or fleshy fungus consist of long filaments of cells joined together, these filaments are called **hyphae**
- Many hyphae together form a thick mass called a mycelium

Fungal hyphae may be septate or aseptate

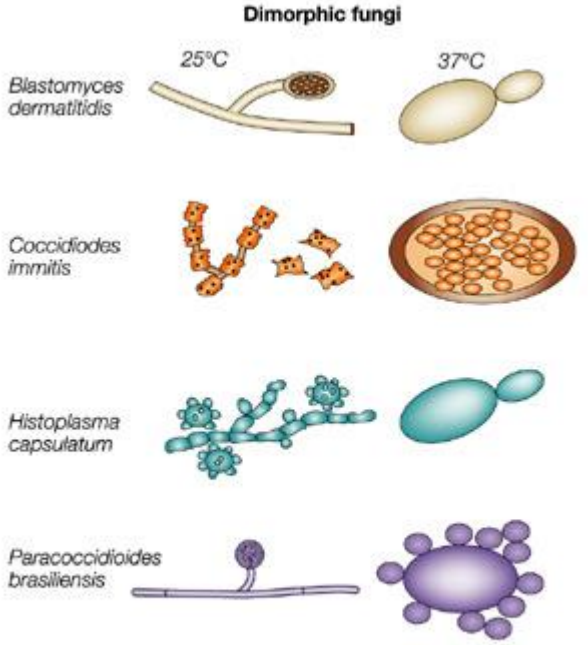
- Hyphae of septate fungi are divided into cells by cross walls called **septa**
- Hyphae of **aseptate** fungi lack cross walls (**coenocytic**)
- Parasitic fungi have modified hyphae called **haustoria**, which penetrate the host tissue but remain outside cell membrane

Fungal hyphae may be septate or aseptate



Morphological classification

1. Yeasts
2. Yeast-like fungi
3. Filamentous fungi (molds)
4. Dimorphic fungi

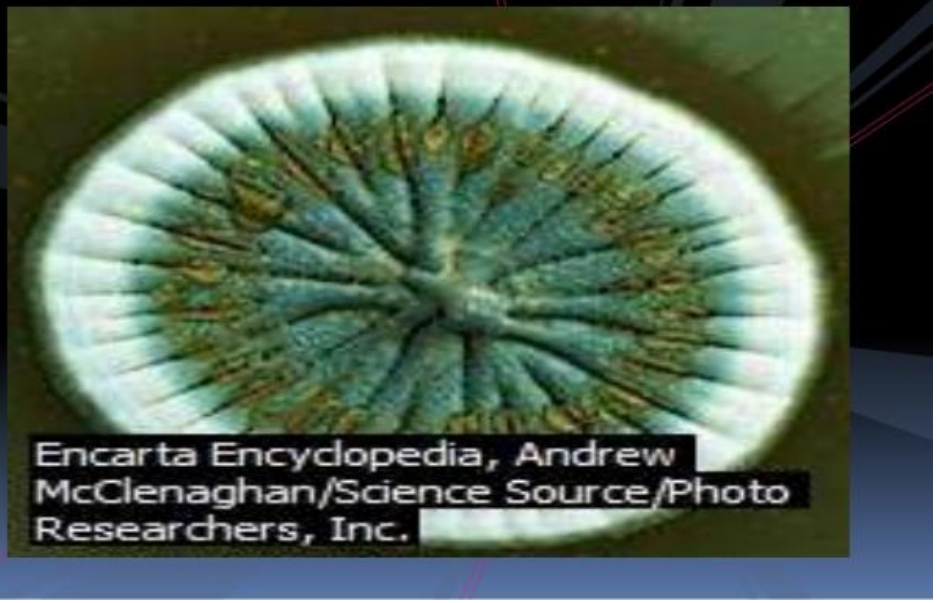


Systematic classification

Based on sexual spores formation: 4 classes

1. Zygomycetes
2. Ascomycetes
3. Basidiomycetes
4. Deuteromycetes

Deuteromycetes



Fungi Nutrition

-Heterotrophs depend on other organisms for food
-Unlike animals, fungi do not ingest their food
Instead they digest food outside their bodies and then absorb it
-Many feed by absorbing nutrients from decaying matter in the soil (decomposers)
-Others live as parasites, absorbing nutrients from their hosts

Beneficial Effects of Fungi

* Decomposition - nutrient and carbon recycling.
* Biosynthetic factories. Can be used to produce drugs, antibiotics, alcohol, acids, food (e.g., fermented products, mushrooms).
* Model organisms for biochemical and genetic studies.

Harmful Effects of Fungi

* Destruction of food, lumber, paper, and cloth.
* Animal and human diseases, including allergies.
* Toxins produced by poisonous mushrooms and within food (e.g., grain, cheese, etc.).
* Plant diseases.

-Algae

- Algae are autotrophic, diverse group of eukaryotic organisms, ranging from unicellular to multicellular forms.exept Cyanobacteria(Blue green algae) are Prokayotic

- Aquatic (fresh water and marine) and terrestrial environment.

- They also occur in moist stones, soils, wood, on snow and on ice.

Marine Algae

Algae on wood

The Form of Algae

Algae exhibit great diversity in organization of plant body.

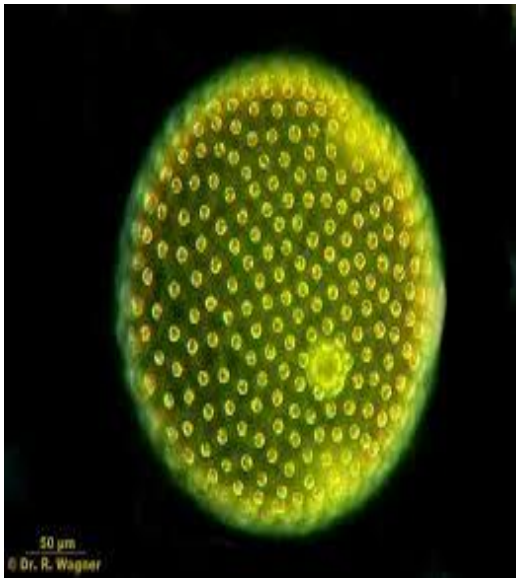
- Unicellular — Motile e.g. *Chlamydomonas*
  Non-motile e.g. *Chlorella*

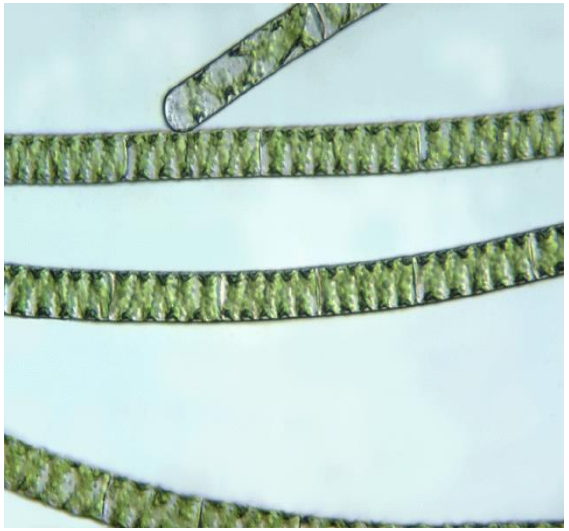
- Colonial e.g. *Volvox*

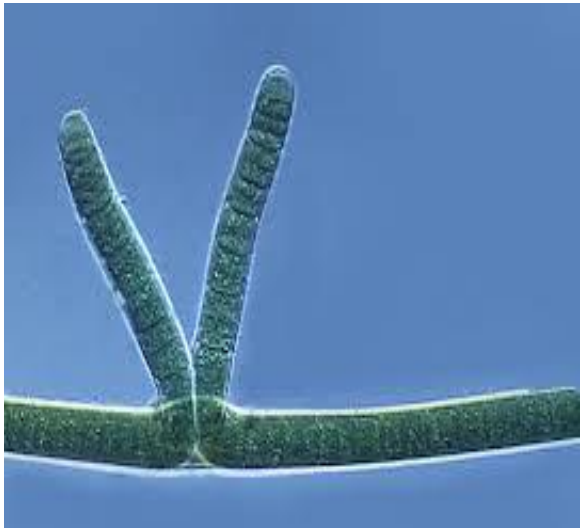
- Filamentous — Simple or un branched e.g. *Ulothrix*
  Branched e.g. *Sytonema*

- Dendroid means tree like. e.g. *Prasinocladus*

Shapes of Algae







Reproduction in Algae

1. Vegetative reproduction is by fragmentation.
2. Asexual reproduction is by the production of different types of spores, the most common being the **zoospores.**
3. Sexual reproduction takes place through fusion of two gametes. Gametes may be isogamy or anisogamy or oogamy.

Classification of Algae based on

- Color
- Type of chlorophyll
- Food storage substance
- Cell wall composition

Advantages of Algae

- Source of food
- Used as biofertilizer
- Sewage treatment
- Alternative to chemical dyes and colouring agents
- Commercial uses Agar

- **Protozoa**
- **Characteristics of Protozoan Phyla**

1.They are unicellular with some colonial and multicellular stages.

2.Most are microscopic.

3.All symmetries are present within members of the group.

4.No germ layers are present.

5.No organs or tissues are formed, but specialized organelles serve many of these functions.

6.They include free-living, mutualistic, commensal and parasitic forms.

7.They move by pseudopodia, flagella, cilia and they can direct cell movements.

8.Most are naked, but some have a simple endoskeleton or exoskeleton.

All types of nutrition are present: autotrophic, heterotrophic and saprozoic.

10. They can be aquatic or terrestrial.

11. Reproduction is asexual by fission, budding or cysts; or sexual by conjugation or syngamy of gametes.

The Protozoa

- **Trophozoite - the motile vegetative stage; multiplies via binary fission; colonizes host.**
- **Cyst - the inactive, non-motile, infective stage; survives the environment or is a dormant stage of a protozoan that helps to survive in unfavorable environmental conditions.**
- **due to the presence of a cyst wall. Cysts do not multiply, however, some organisms divide within the cyst wall.**

Transmission:

- **mostly person-to-person,**
- **fecal-oral route; fecally contaminated food or water; other means include sexual transmission, insect bites or insect feces.**