

A microscopic view of numerous green, rod-shaped bacteria, likely Bacillus or Clostridium species, arranged in various orientations against a dark blue background. The bacteria are illuminated from the side, creating a strong 3D effect with highlights and shadows.

# Classification of Microorganism

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Assistant Professor,

# MICROORGANISM.....?

Micro and Macro

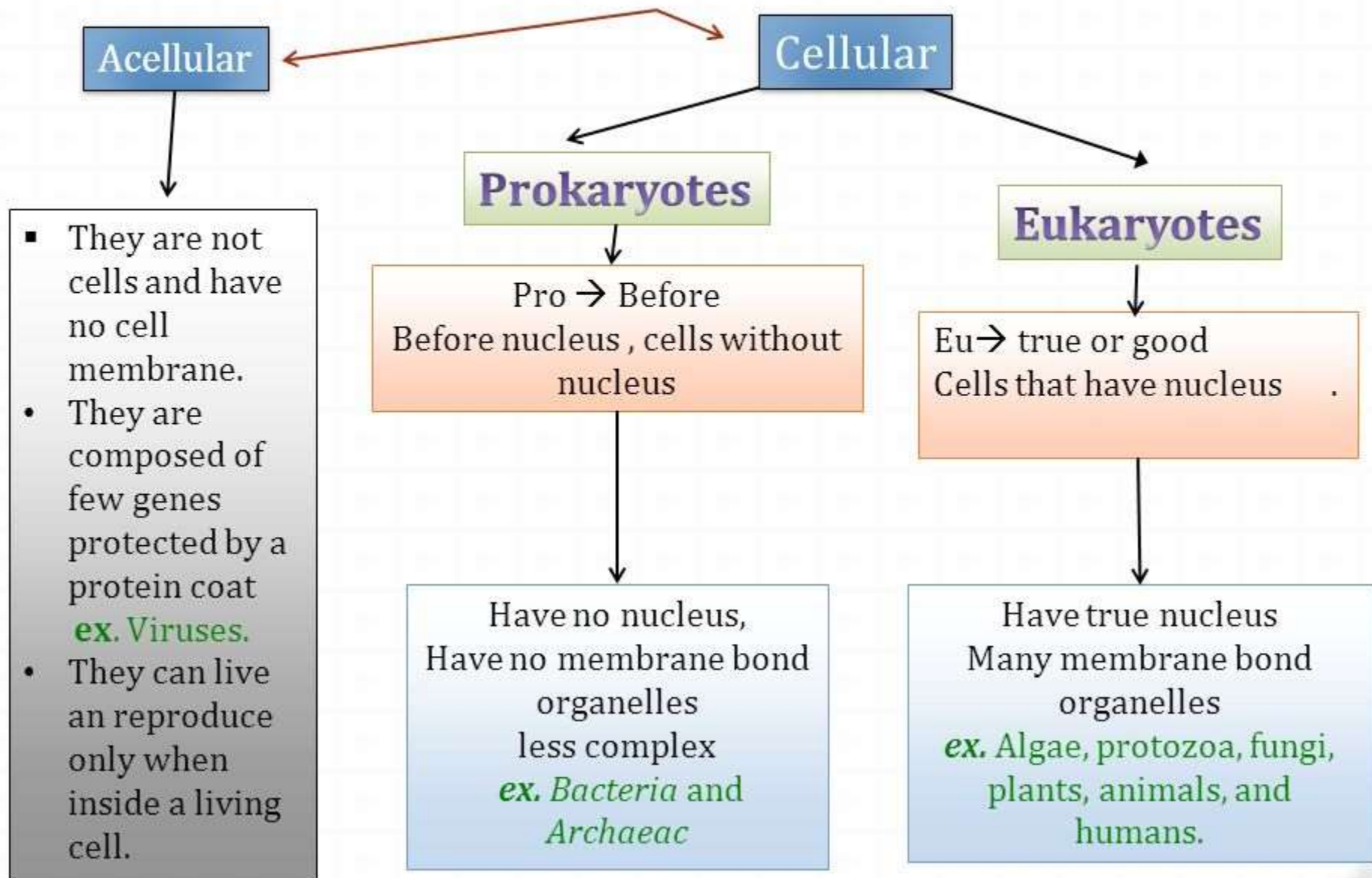
Micro mean.....small, very small,  
can't see by naked eyes.

Macro mean.....  
big,can see by naked eyes

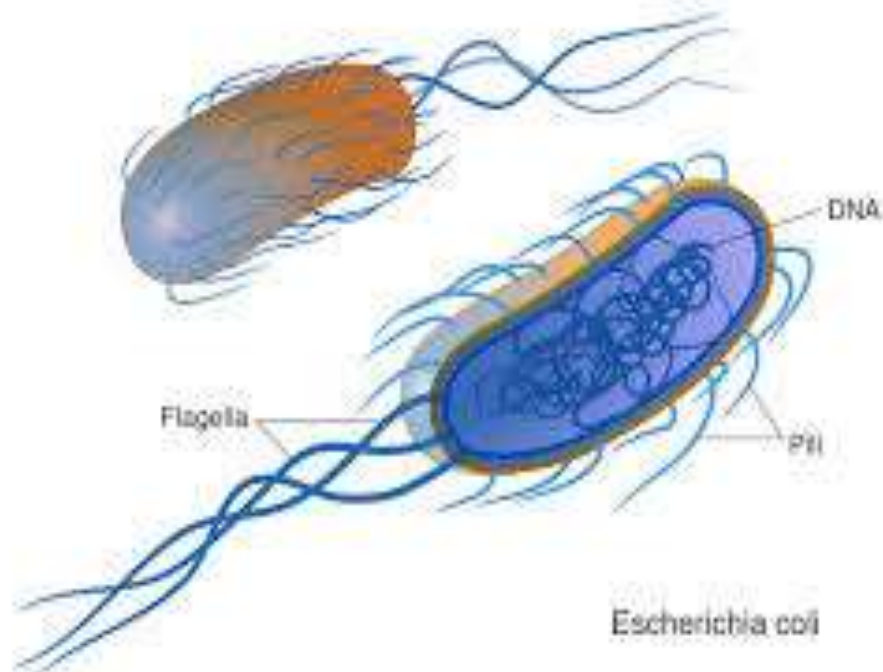
How to see the tiny particle such as  
microorganism.....

- ▶ It can be seen by using electron  
microscope..

# Classification of Microorganism



**Bacteria** are microscopic, single-celled organisms that thrive in diverse environments. These organisms can live in soil, the ocean and inside the human gut. Humans'





# Basis of classification

- ⊗ **Morphological**
- ⊗ **Anatomical**
- ⊗ **Staining**
- ⊗ **Cultural characteristics**
- ⊗ **Pathogenecity**
- ⊗ **Nutrition**
- ⊗ **Environmental factors**
- ⊗ **Relationship with host and organism**

# Morphological classification

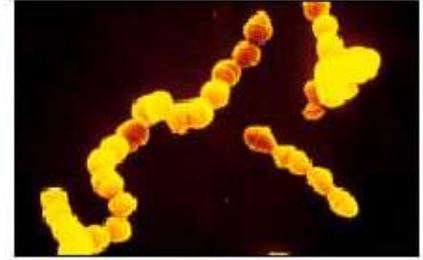
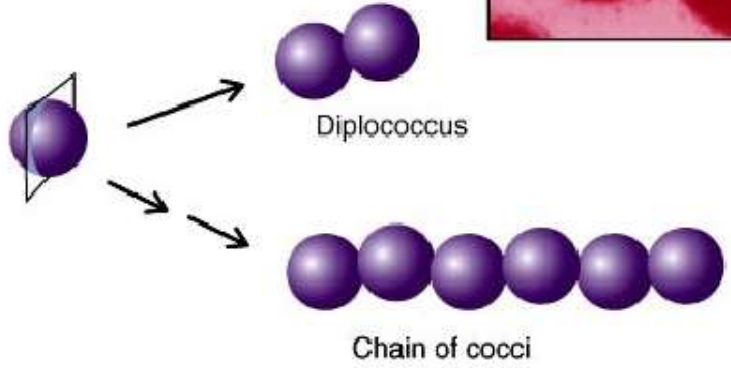
- Bacteria can be classified into **six** major groups on morphological basis.

## 1. TRUE BACTERIA

- **Cocci** – These are spherical or oval cells. On the basis of arrangement of individual organisms they can be described as
  - **Monococci** (Cocci in singles) – *Monococcus* spp.
  - **Diplococci** (Cocci in pairs) – *Streptococcus pneumoniae*
  - **Staphylococci** (Cocci in grape-like clusters) – *Staphylococcus aureus*
  - **Streptococci** (Cocci in chains) – *Streptococcus pyogenes*
  - **Tetrad** (Cocci in group of four) - *Micrococcus* spp.
  - **Sarcina** (Cocci in group of eight)

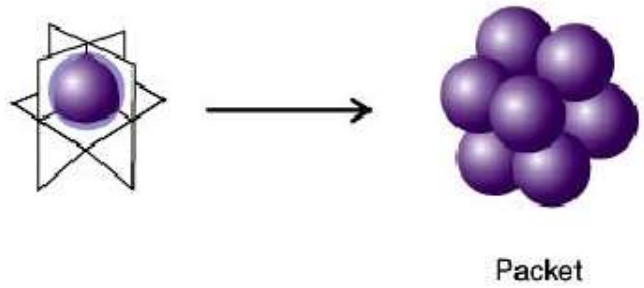
**(a) Chains**

Cell divides in one plane



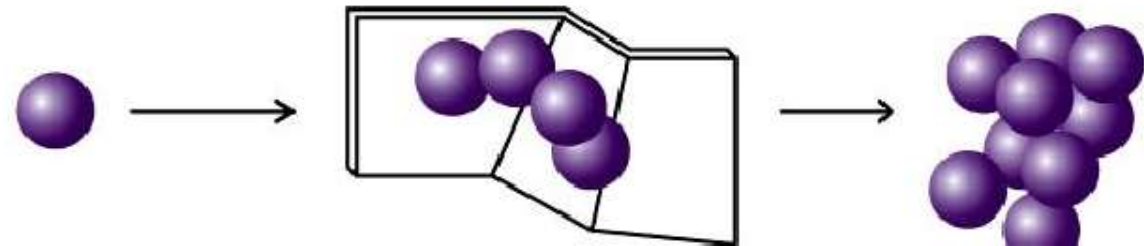
**(b) Packets**

Cell divides in two or more planes perpendicular to one another



**(c) Clusters**

Cell divides in several planes at random

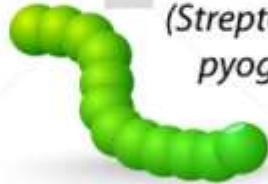


# SHAPES OF BACTERIA

## COCCI



**Diplococci**  
(*Streptococcus pneumoniae*)



**Streptococci**  
(*Streptococcus pyogenes*)

### **Tetrad**



**Staphylococci**  
(*Staphylococcus aureus*)

**Sarcina**  
(*Sarcina ventriculi*)

## BACILLI



**Chain of bacilli**  
(*Bacillus anthracis*)



**Flagellate rods**  
(*Salmonella typhi*)



**Spore-former**  
(*Clostridium botulinum*)

## OTHERS



**Vibrios**  
(*Vibrio cholerae*)



**Spirilla**  
(*Helicobacter pylori*)



**Spirochaetes**  
(*Treponema pallidum*)



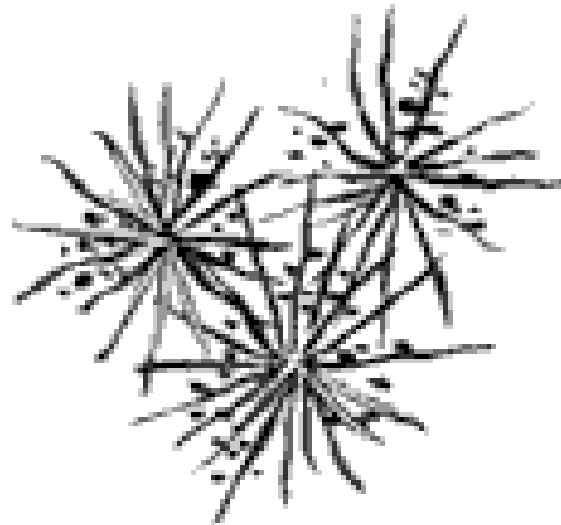
- **Bacilli** – These are rod-shaped bacteria. On the basis of arrangement of organisms, they can be described as
  - **Diplobacilli**
  - **Streptobacilli**
  - **Palisades**
  - **Chinese-letter form**
  - **Coccobacilli**
  - **Comma-shaped**

# Morphological classification

## **2. ACTINOMYCETES (actin- ray, mykes-fungus)**

These are rigid organisms like true bacteria but they resemble fungi in that they exhibit branching and tend to form filaments.

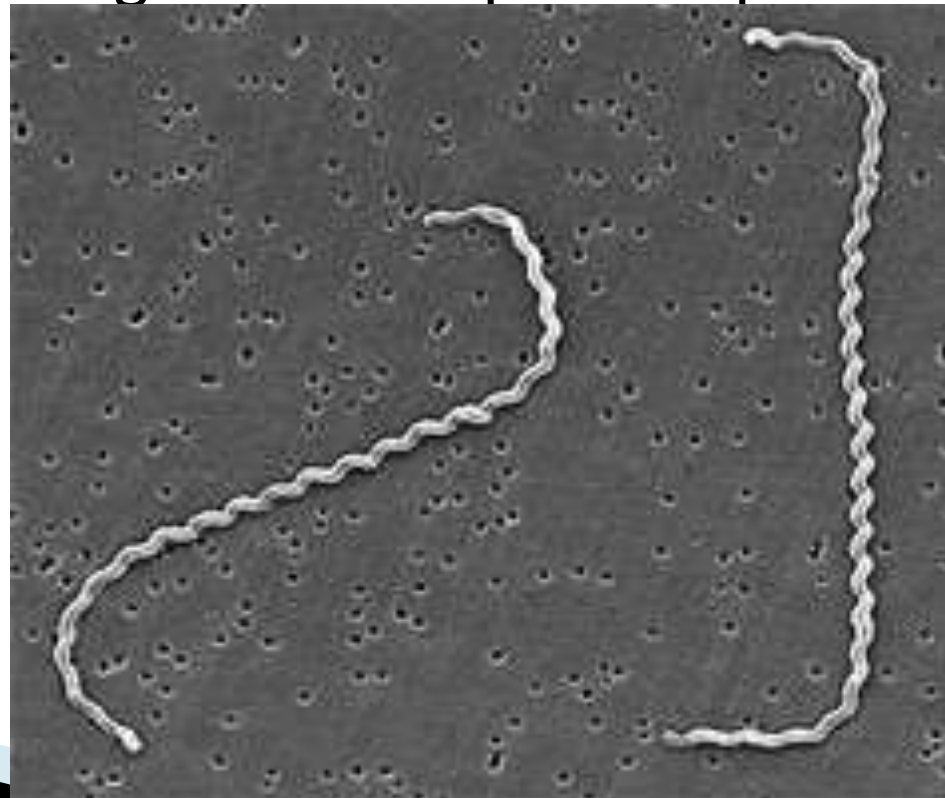
They are termed such because of their resemblance to sun rays when seen in tissue sections.



# Morphological classification

## 3. Spirochaete

These are relatively longer, slender, non-branched microorganisms of spiral shape having several coils.



# Morphological classification

## 4. Mycoplasmas

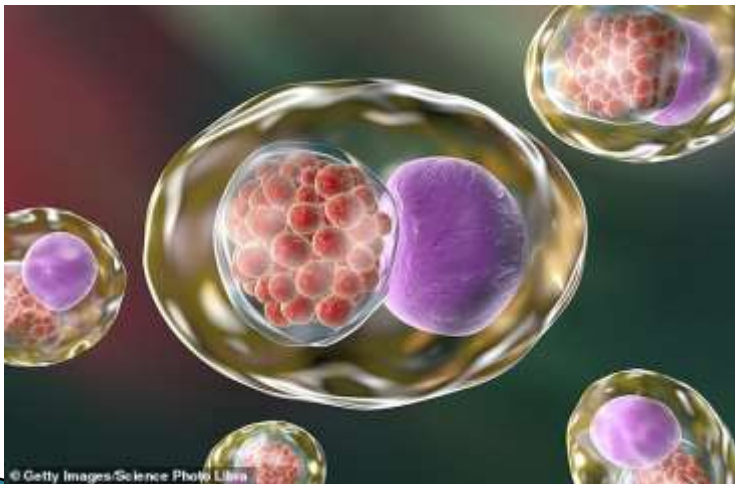
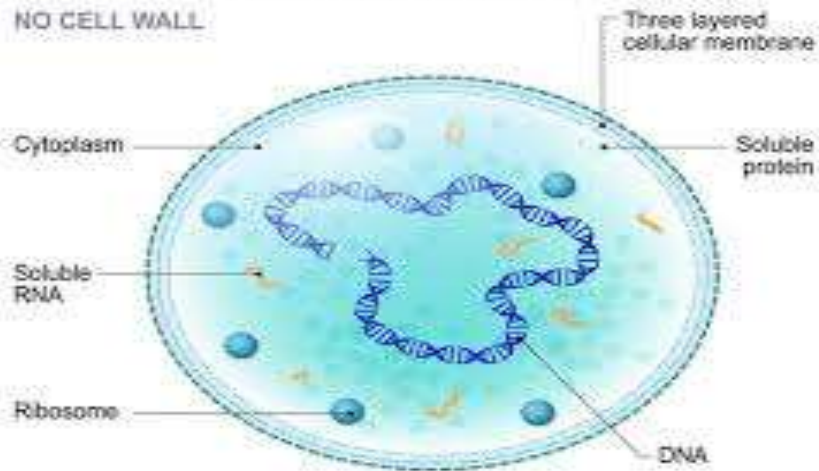
- ▶ These bacteria lack in rigid cell wall (cell wall lacking) and are highly pleomorphic and of indefinite shape.
- ▶ They occur in round or oval bodies and in interlacing filaments.

## 5. Rickettsiae and Chlamydiae

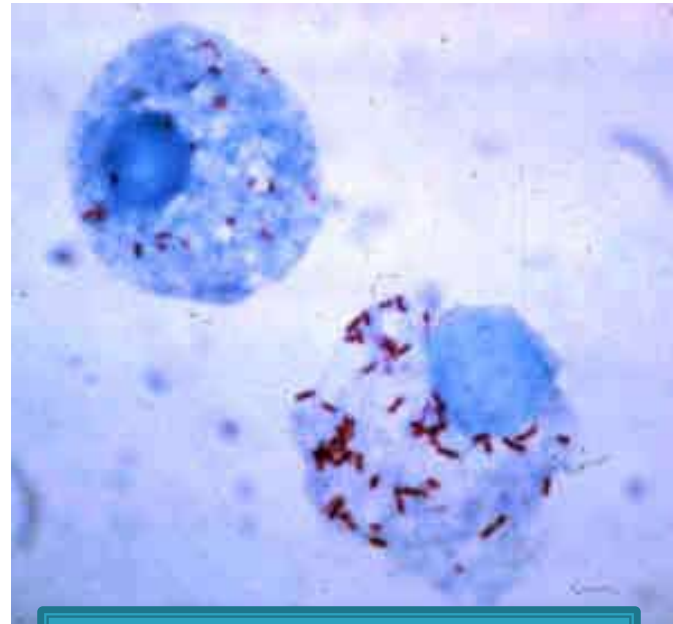
- ▶ These are very small, obligate parasites, and at one time were considered closely related to the viruses. Now, these are regarded as bacteria.



# *Mycoplasma*



**Chlamydiae**

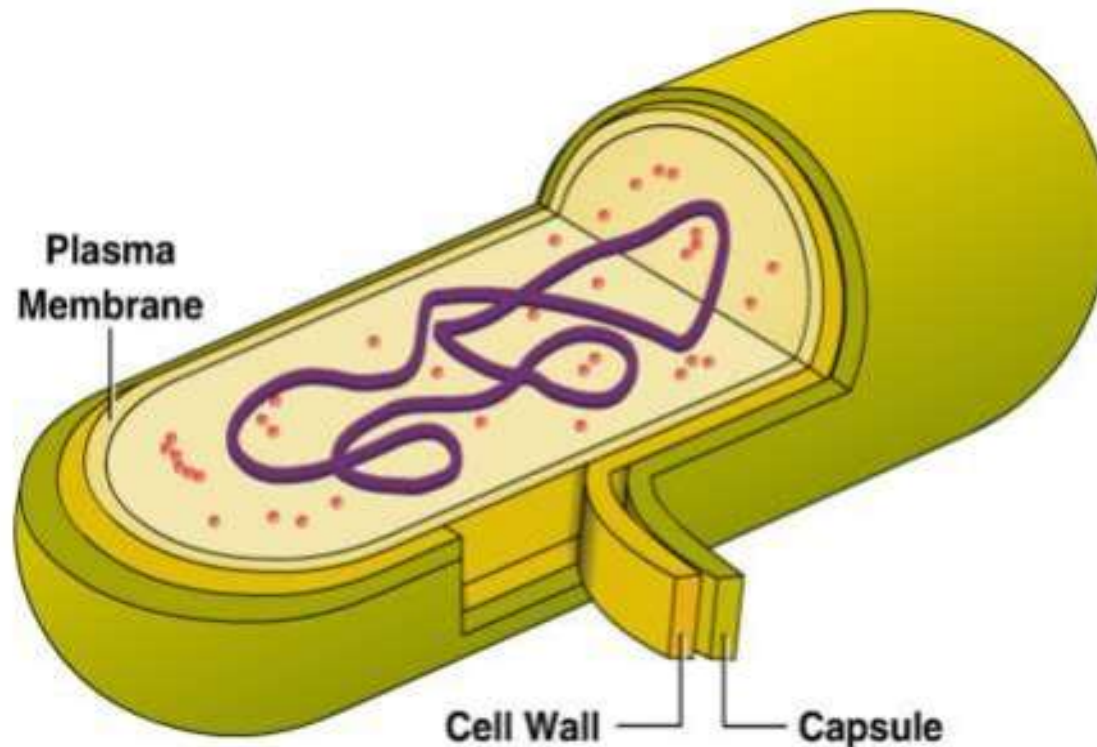


**Rickettsiae**

# BASED ON ANATOMICAL FEATURES

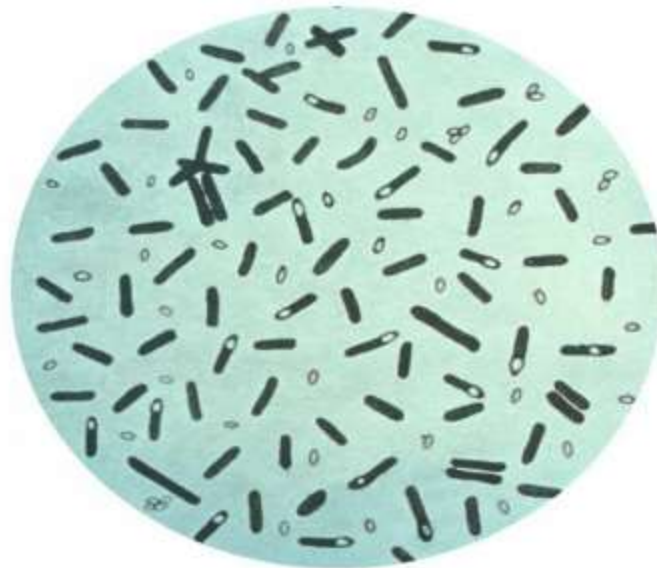
## ○ Capsule

- Capsulate- *Streptococcus pneumoniae*
- Non-capsulate - Viridans streptococci



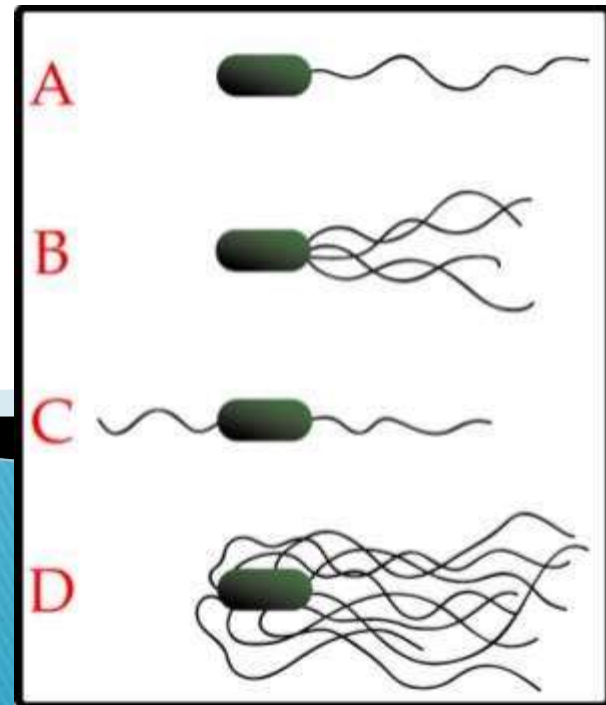
## ◉ Spore

- Spore-forming - *Bacillus* spp.
- Non-sporing - *Escherichia coli*



## ◉ Flagella

- Flagellate -
  - Monotrichous
  - Lophotrichous
  - Amphitrichous
  - Peritrichous
- Aflagellate - *Shigella* spp.





# BASED ON STAINING REACTION

## (a) **Gram stain:**

- 1) Gram positive: after the gram stain organism which occur violet in colour.
- 2) Gram negative: Which appear pink or red

## (b) **Acid fast stain:**

- 1) Acid fast organism: after the ziehl - neelsen stain it will show pink in colour
- 2) Non acid fast organism: after this stain organism will appear blue in colour

# Based on Staining reaction

- **GRAM'S STAIN**

- Gram-positive cocci – *Staphylococcus aureus*
- Gram-negative cocci – *Neisseria gonorrhoeae*
- Gram-positive rods – *Clostridium* spp.
- Gram-negative rods – *E. coli*

- **ACID FAST STAIN**

- Acid-fast bacilli – *Mycobacterium tuberculosis*
- Non-acid-fast bacilli – *Staphylococcus aureus*

# Based on Cultural characteristics

- **Extra growth factors requirements**
  - **Fastidious** – *Hemophilus influenzae*
  - **Non-fastidious** – *Escherichia coli*
- **Hemolysis on Sheep Blood Agar**
  - **Alpha-hemolysis** – *Streptococcus pneumoniae*
  - **Beta-hemolysis** – *Streptococcus pyogenes*
- **Utilization of carbohydrates**
  - **Oxidative** - *Micrococcus*
  - **Fermentative** – *Escherichia coli*

# Based on Cultural characteristics

- **Growth rate**
  - **Rapid growers** – *Vibrio cholerae*
  - **Slow growers** – *Mycobacterium tuberculosis*
- **Pigment production**
  - **Pigment producer** – *Staphylococcus aureus*
  - **Pigment non-producer** – *Escherichia coli*



# BASED ON PATHOGENICITY

- A) **pathogens**: the organism which is able to spread disease and can cause disease.ex-
- B) *Micobacterium tuberculosis*  
**Non pathogens**: which does not cause and disease; e.x: lactobacilli
- C) **Commensals**: normaly non pathogenic but sometime they show the disease when immunity impaired. Ex- E. coli

# Based on Nutrition

**Autotrophs- can prepare its own food ex- Cyanobacteria**

**It is of 2 types**

- **1. photoautotrophs**
- **2. chemoautotrophs**

**Heterotrophs- depends on other for collecting food .**

**Ex- Marinobacter**

- **It is of 4 types**
- **1.chemoheterotrophs**
- **2. photoheterotrophs**
- **3.organoheterotrophs**
- **4.lithoheterotrphs**

# Based on environmental factors

- **Temperature**
- **Oxygen dependence**
- **pH**
- **Salt concentration**
- **Atmospheric pressure**



# Temperature

- **Psychrophiles** (15-20°C) – *Pseudomonas fluorescens*
- **Mesophiles** (20-40°C) – *Escherichia coli*, *Salmonella enterica*, *Staphylococcus aureus*
- **Thermophiles** (50-60°C)- *Bacillus stearothermophilus*
- **Extremely thermophiles** (as high as 250°C)

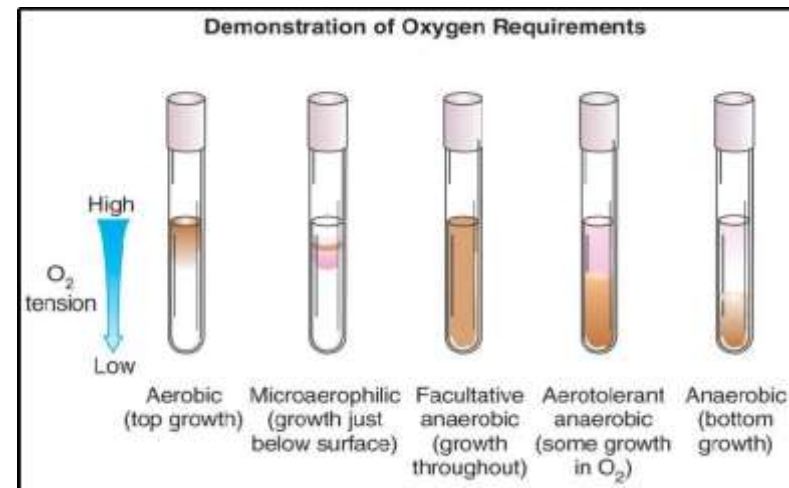
# Oxygen dependence

- **Aerobe** (grow in ambient temperature, which contains 21% O<sub>2</sub> and a small amount of CO<sub>2</sub>, 0.03%)
- **Obligate aerobes** – Strictly require O<sub>2</sub> for their growth (*Pseudomonas aeruginosa*)
- **Microaerophilic** (grow under reduced O<sub>2</sub>, 5-10% and increased CO<sub>2</sub>, 8-10%)- *Campylobacter jejuni*, *Helicobacter pylori*



# Oxygen dependence

- **Facultative anaerobe** (capable of growing either in presence or absence of  $O_2$ )- *E. coli*
- **Obligate anaerobe** – *Clostridium* spp.
- **Capnophilic** (require increased concentration of  $CO_2$ , i.e., 5-10%) –  
*H. influenzae*,  
*N. gonorrhoeae*
- **Aerotolerant**





# pH

- **Acidophiles** (*Lactobacillus acidophilus*)
- **Alkaliphiles** (*Vibrio*)
- **Neutralophiles** (pH 6-8)

Majority of the medically important bacteria grow best at neutral or slightly alkaline reaction (pH 7.2-7.6)



# Salt concentration

- **Halophiles**
- **Non-halophiles**

# BASED ON RELATIONSHIP OF HOST AND ORGANISM.

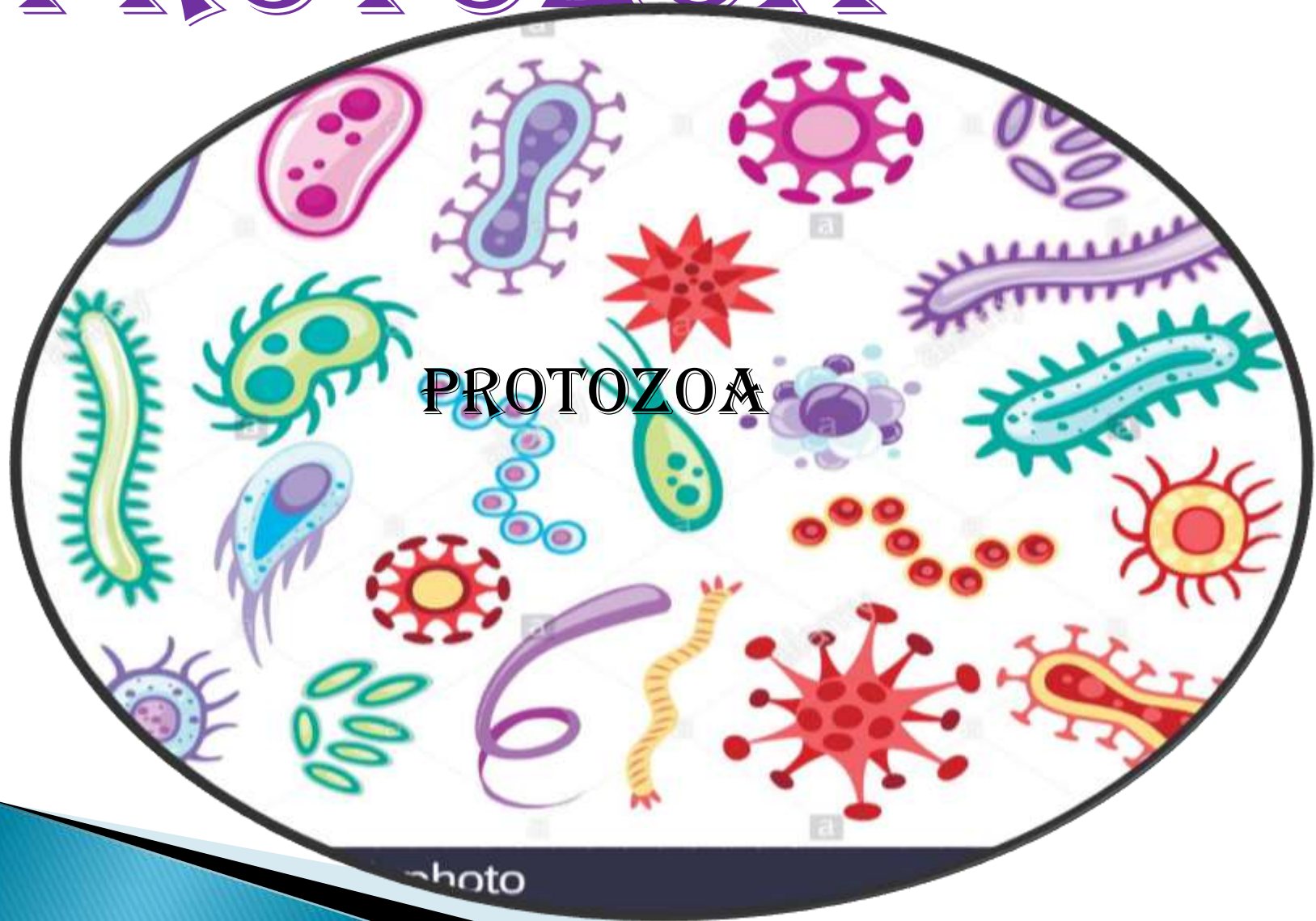
- 1) **saprophytes**: free living microbes on dead animals or decaying things that can be found in soil and water and play important role in degradation of organic matter.
- 2) **Parasites**: that establish themselves and multiply in hosts.
- 3) **Commensals**: microbes that live in complete live with harmony but they can produce disease when host resistance is lowerd.E.x: normal flora organism

# Other ways of classification

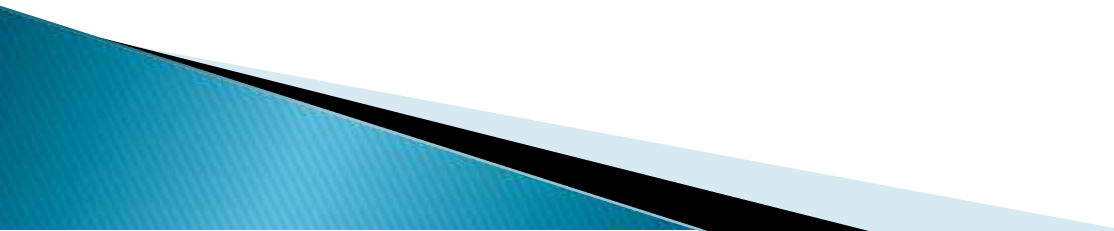
- **Motile/Non-motile**
- **Pathogenic/Non-pathogenic**
- **Sensitive/Resistant (to particular antibiotic/ chemicals)**
- **Lactose fermenter/Lactose non-fermenter**
- **Bergey's Manual of Determinative Bacteriology**
  - Gram-negative eubacteria that have cell walls
  - Gram-positive eubacteria that have cell walls
  - Cell wall-less eubacteria: Mycoplasma
  - Archaeobacteria



# PROTOZOA



# Protozoa:

- The word protozoa is come from Greek protozoon word meaning “First Animal”.
  - Protozoa are unicellular (may be Multicellular) Eukaryotic microorganism.
  - Protozoa constitute a large group of about 65,000 species. Most of which are harmless free living and inhabits water and soil
  - A few species are pathogenic in nature parasitize human and other animals causing hundreds of million of infections in a year around the world
- 

# Characteristics

- ▶ □ Mostly Unicellular organism with fully functional cell
- ▶ □ Live freely, may be parasitic or symbiotic
- ▶ □ Protozoa are chemo-heterotrophs
- ▶ □ They are motile have locomotive organelles.

E.g. Flagella and Cilia for movement

## Morphology

- Protozoa are Eukaryotic resemble to animal cell, contain major cell organelles (including Nucleus, Mitochondria)
- Their organelles are highly specialized for feeding, reproduction and movement
- The cytoplasm of protozoa are divided into an outer layer called *Ectoplasm*( cytoplasm out side the cell) and an inner layer called *Endoplasm*(cytoplasm in side the cell)

# Classification of Protozoa

on the basis of their motility they are classified into Four main types

Class	Name of the locomotary organ	Examples
Sarcodina/Amoeba	pseudopodia	Entamoeba histolytica
Flagellate/ Mastigophora	flagella	<i>Trichomonas vaginalis</i> , <i>Leishmania gonorrhoea</i>
Ciliates/Ciliophora	Cilia	paramecium, <i>Balantidium coli</i> .
Sporozoates	Spore formers	<i>Plasmodium</i>

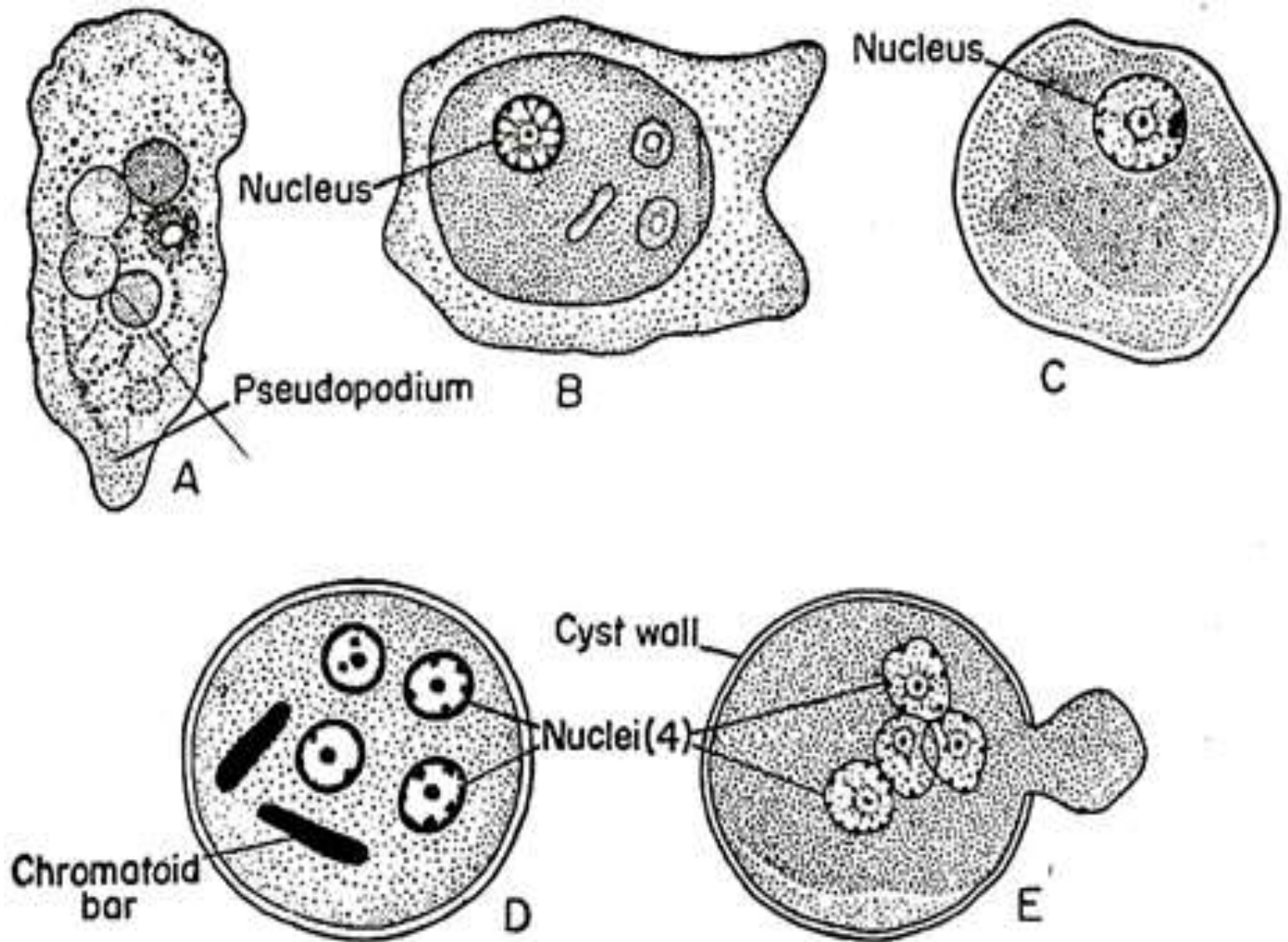
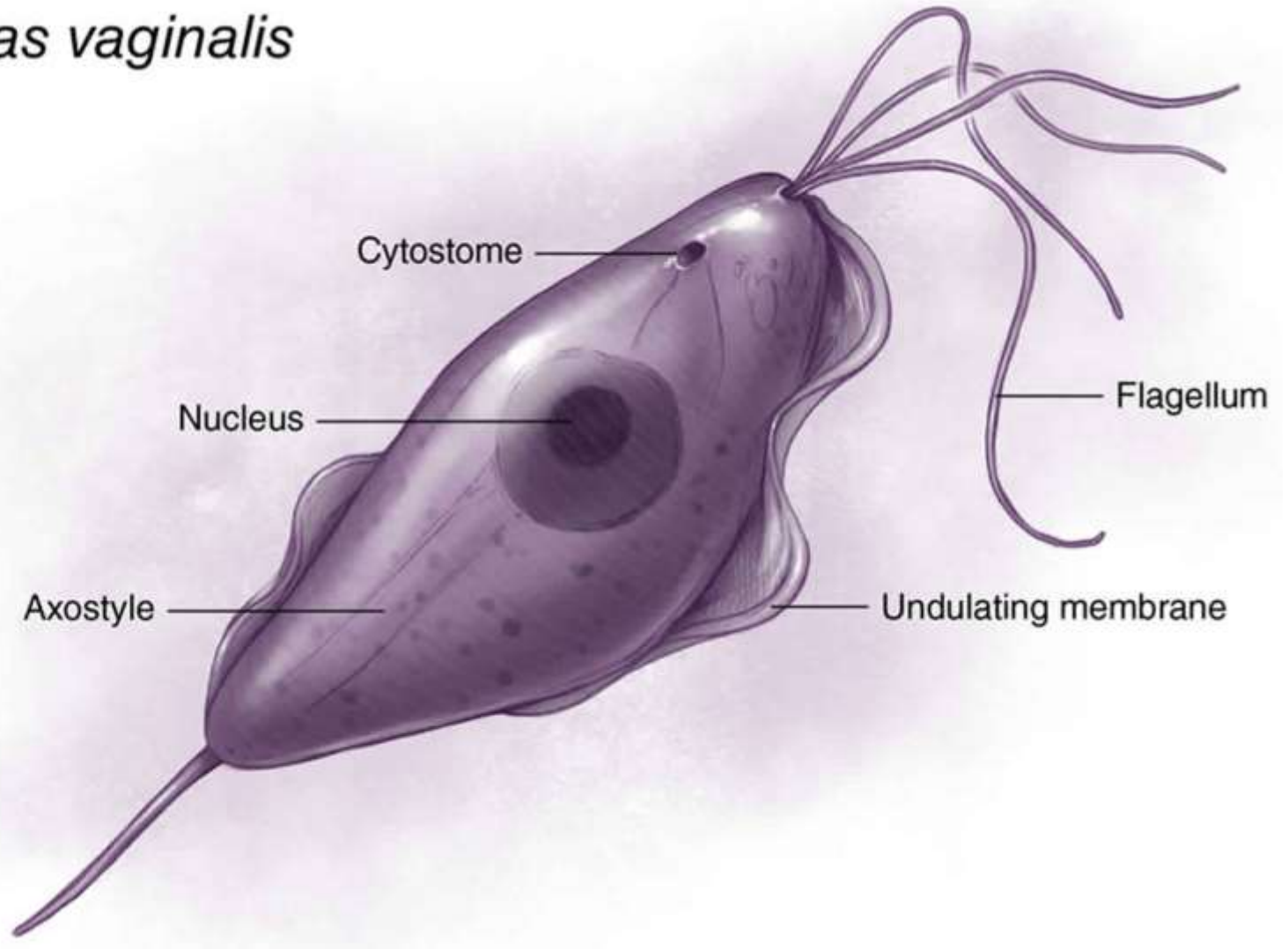


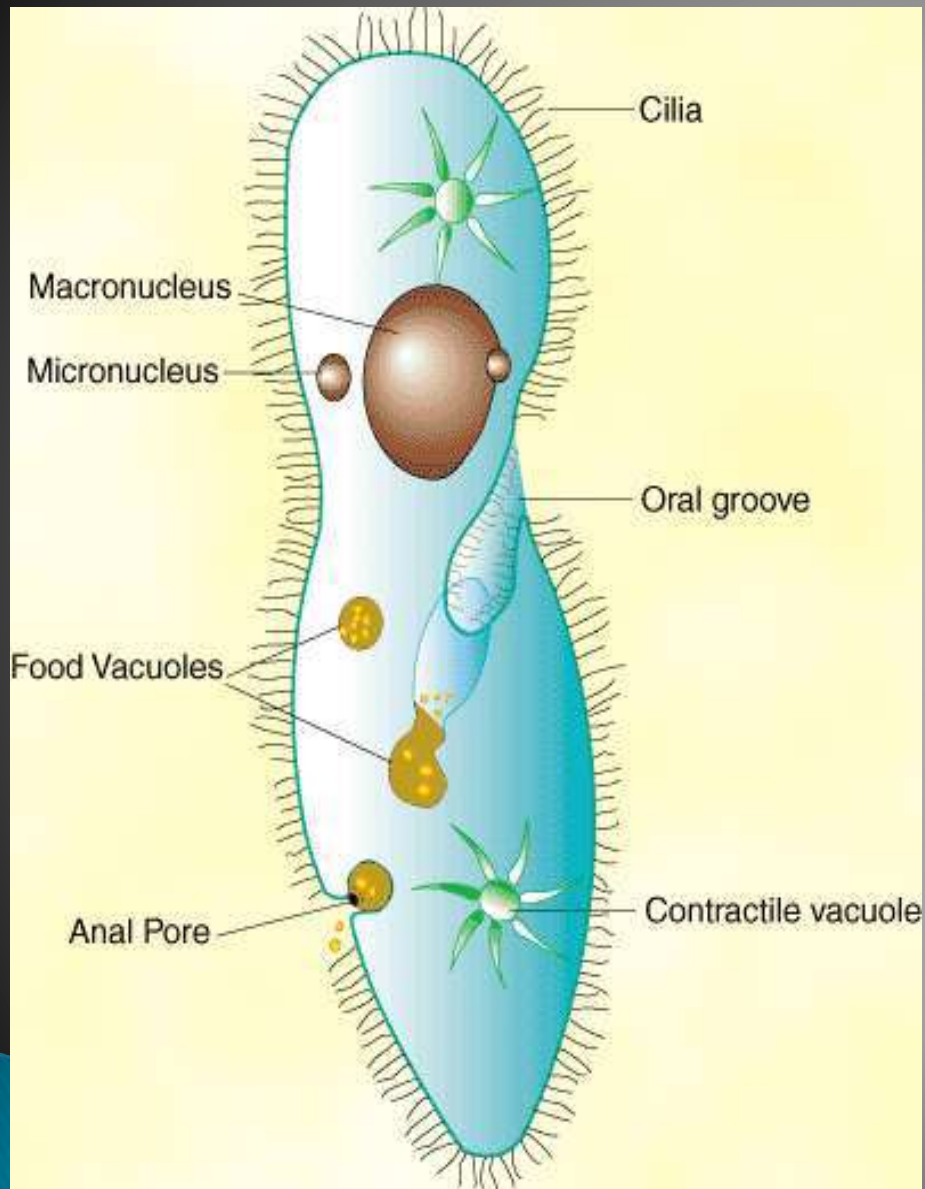
Fig. 50A. *Entamoeba histolytica*—Trophozoite—living (A) and Stained (B), Precystic stage, (C), Cyst (D), Emergence (E).



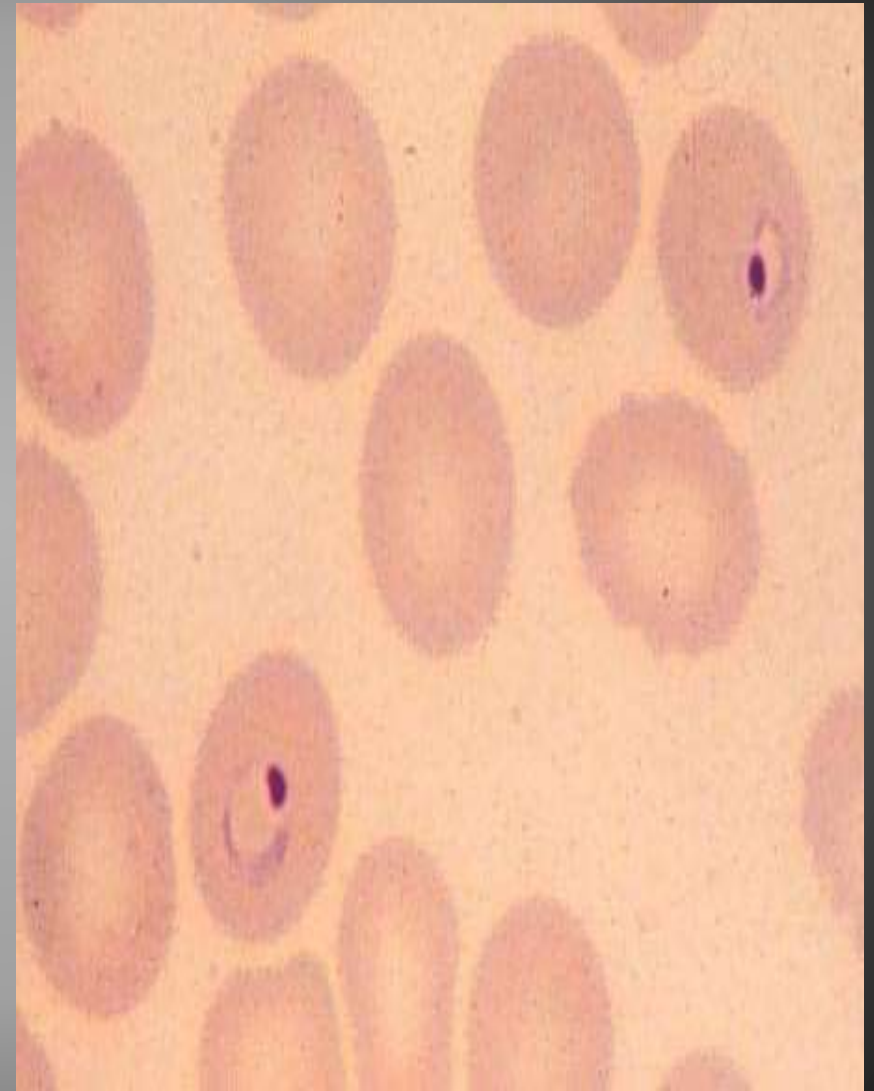
# *Trichomonas vaginalis*



Paramecium caudatum



Plasmodium



# FUNGI



# Fungi-

These are saprophytic or parasitic organisms possessing relatively rigid cell walls.

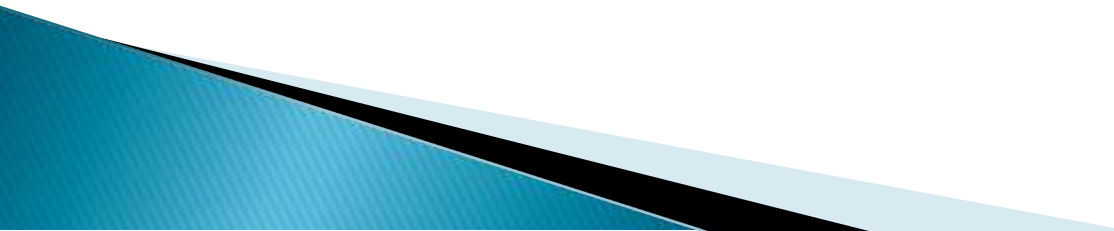
Characteristics -

Diverse group of chemo heterotrophs

- ▶ • Over 100,000 fungal species identified
- ▶ • Only about 100 are human or animal pathogens
- ▶ • Saprophytes - Digest dead organic matter
- ▶ • Parasites - Obtain nutrients from tissues of organisms
- ▶ • Most are aerobes or facultative anaerobes (can grow either in the presence or absence of oxygen)

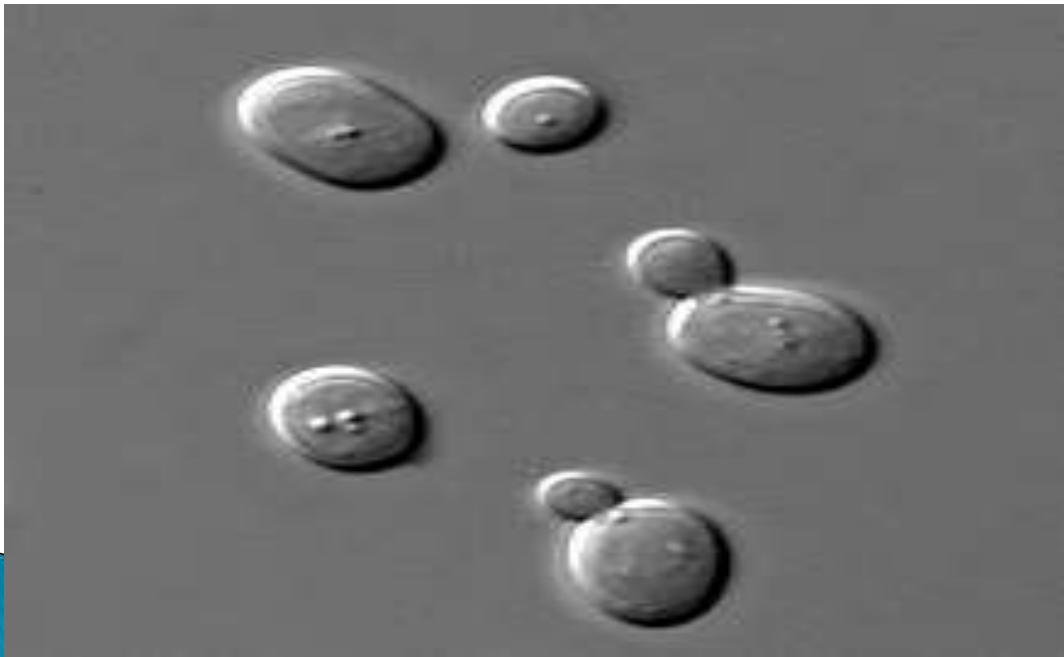
# Classification of fungi

## Depending on Morphology

- ▶ A. Yeasts
  - ▶ B. Yeast like fungi
  - ▶ C. Molds
  - ▶ D. Dimorphic fungi
- 



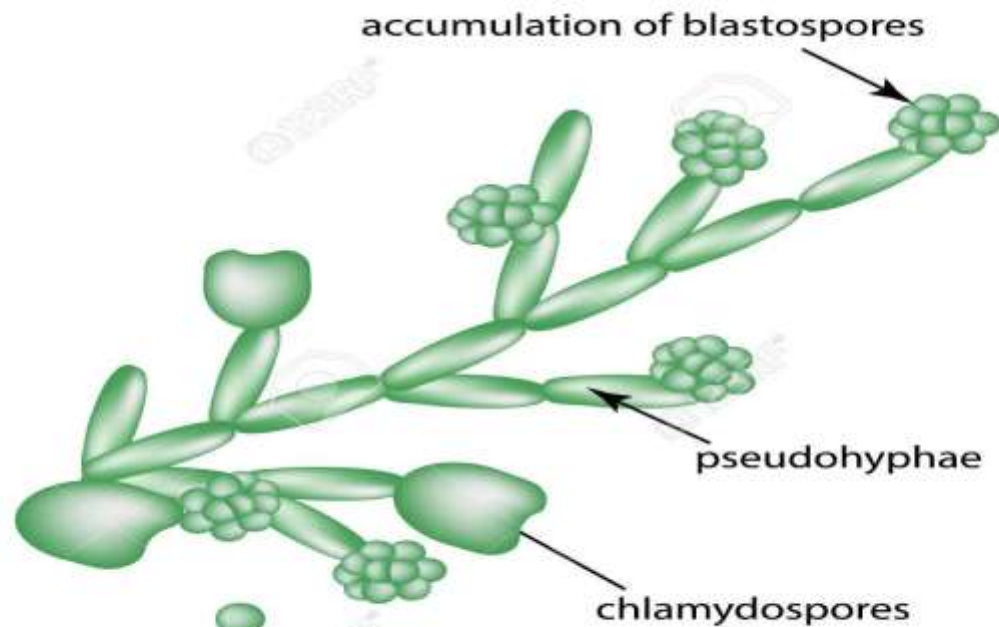
- a. **Yeasts: (Saccharomyces)** These are ovoid or spherical cells that reproduce asexually by budding and sexually with formation of spores.
  - ▶ Single celled , eukaryotic m.o
  - ▶ Eg. *Candida albicans*



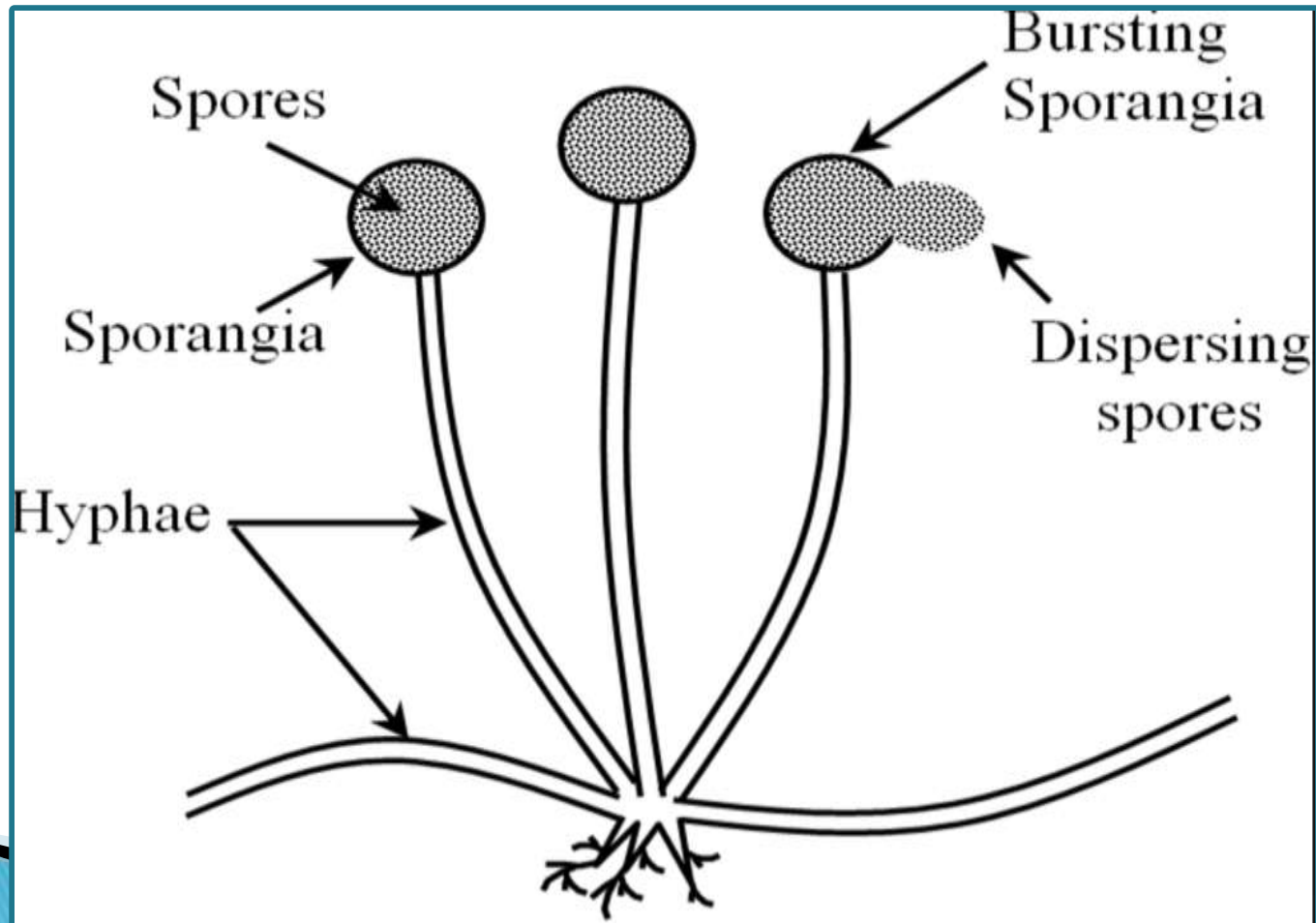
**Brewer's yeast**

**b. Yeast- like fungi:** Grow partly as yeasts and partly as elongated cells resembling hyphae which are called pseudo hyphae .  
e.g. *Candida albicans*

## Candida Albicans



- ▶ c. Molds: **Multicellular, Filamentous with hyphae and mycellium**(a mass of branching, thread-like hyphae) ,Produce conidia [spores]  
Eg. *Aspergillus niger*



d. Dimorphic fungi: can exist in the form of both mold and yeast.

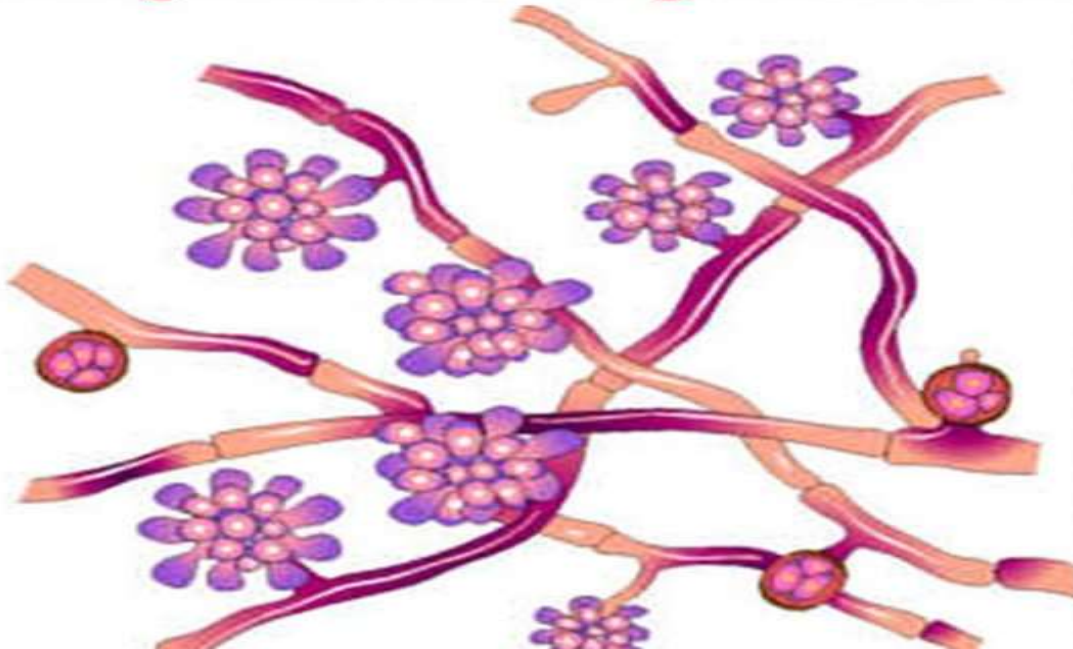
Also described as **thermally dimorphic fungi**.↓

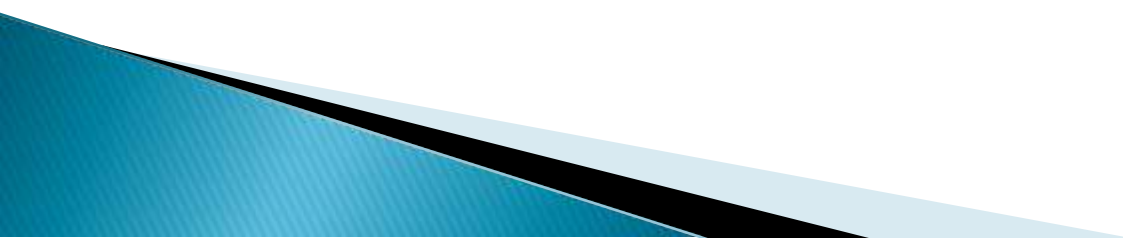
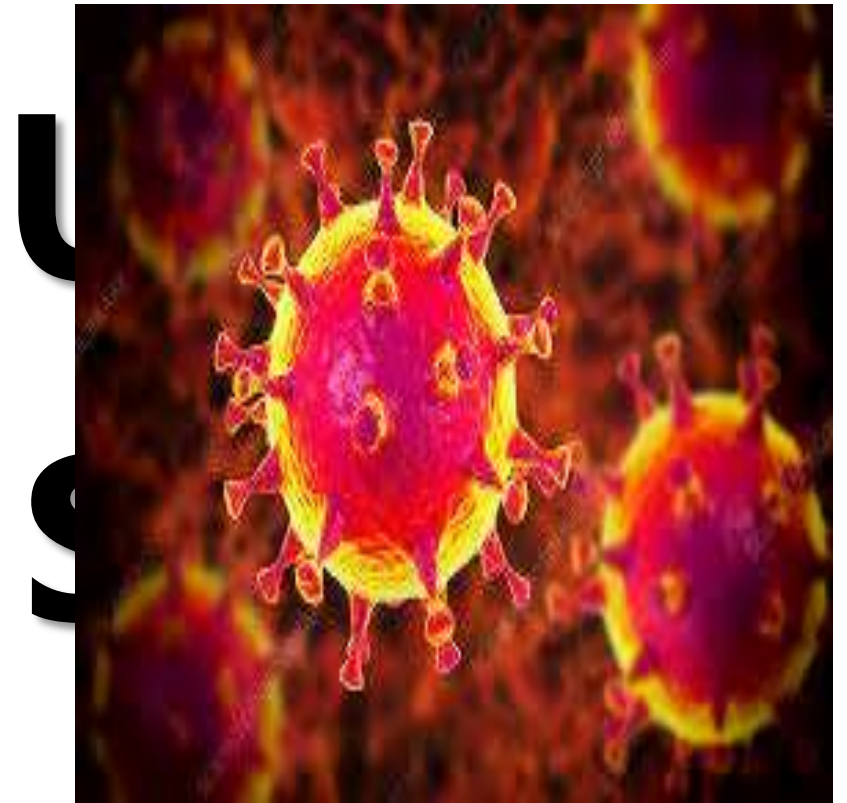
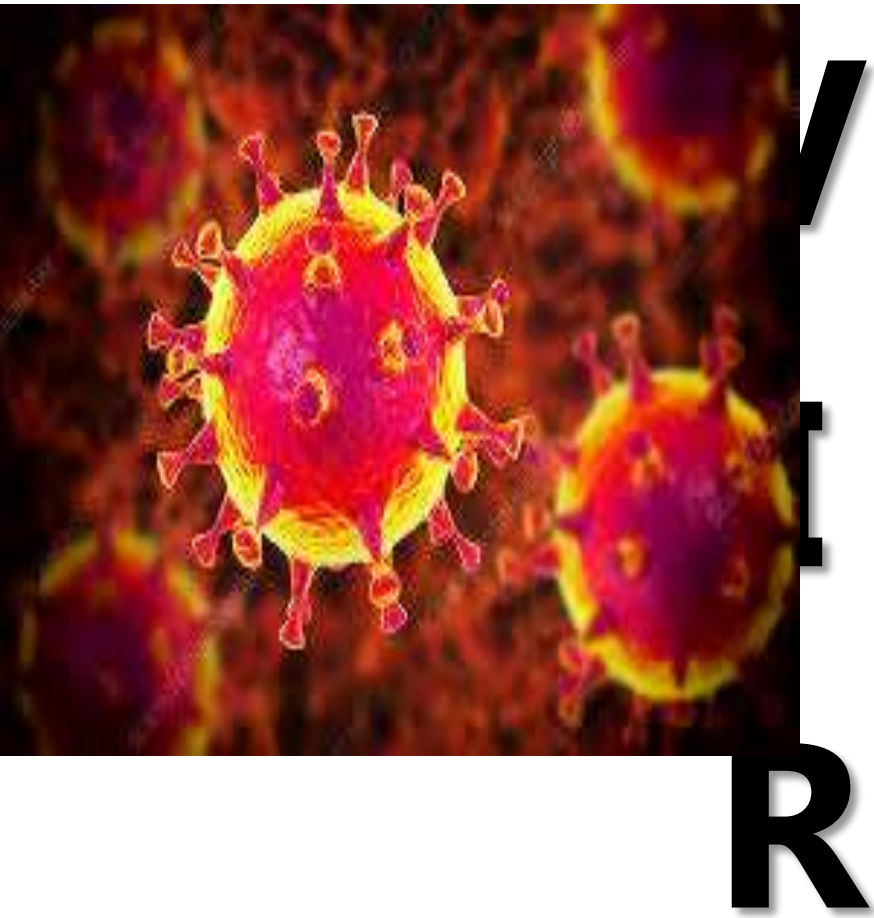
**Mold in the Cold, Yeast in the Heat.**

**Eg. Histoplasma causing histoplasmosis in lungs.**

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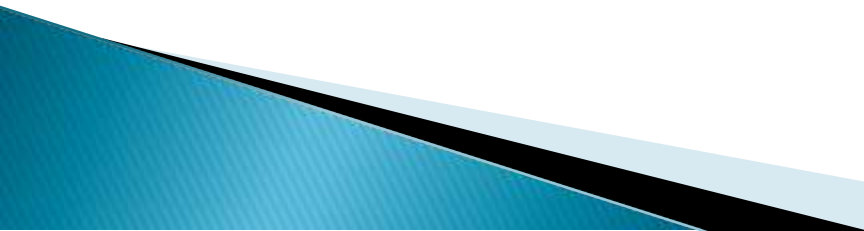
*Histoplasma capsulatum*





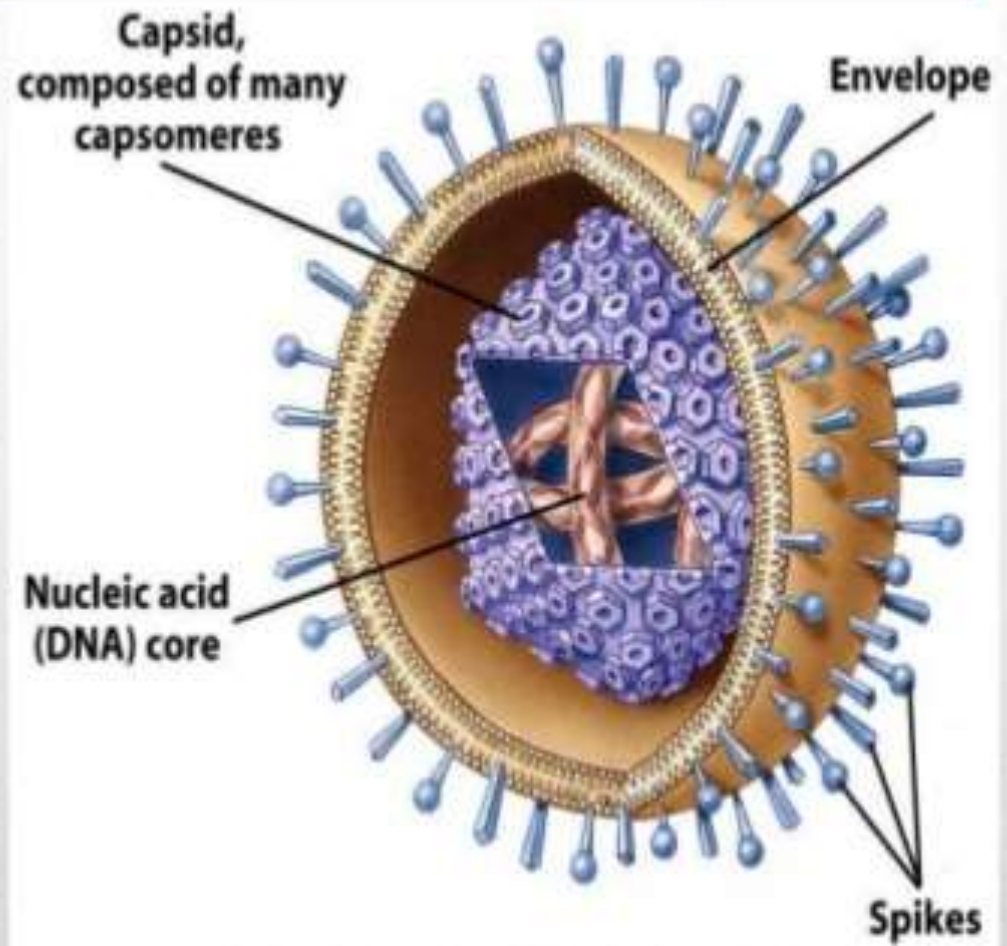


## 4– The viruses:

- ▶ Viruses consist of DNA or RNA enclosed in a simple protein shell known as a capsid.
  - ▶ **General properties of viruses**
  - ▶ They are very small in size, from 20–300 nm.
  - ▶ They contain one kind of nucleic acid (RNA or DNA) as their genome.
  - ▶ They are metabolically inert
  - ▶ They are obligate intracellular parasites.
  - ▶ They are only seen by electron microscope.
  - ▶ Depend on the parasitized cell for survival and multiplication
- 

## Viral components

- Nucleic acids
- Capsid
- Envelope



**Generalized Structure:**

# Classification of Medically important virus

Viruses are classified according to their

1) Nucleic acid:

- Type of nucleic acid: DNA, RNA
- Double- vs. single-stranded
- Single or segmented pieces of nucleic acid
- Positive (+) or negative (-) stranded RNA
- Complexity of genome

2) Capsid:

- Icosahedral
- Helical

3) Envelope:

- Naked
- Enveloped

# DNA Viruses

## **Double stranded**

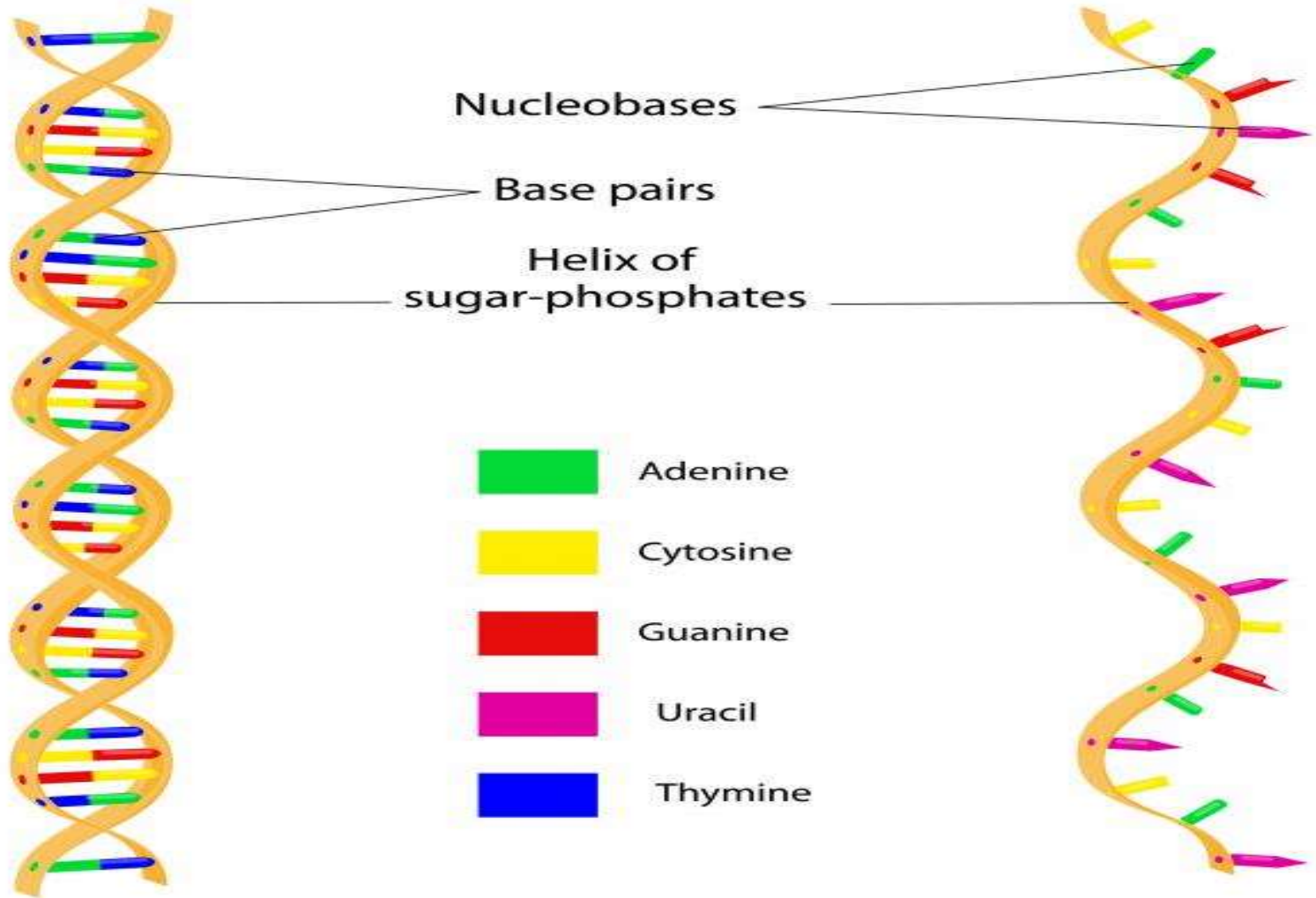
- Sometimes referred to as the HHAPPPy viruses:
- Herpes
- Hepadna
- Adeno
- Papova
- Parvo
- **Pox**

# RNA VIRUS– Single Stranded

- Toga
- Corona
- Retro
- Picorna
- Calici
- Reo
- Orthomyxo
- Paramyxo
- Rhabdo
- Bunya
- Arena
- Fibo

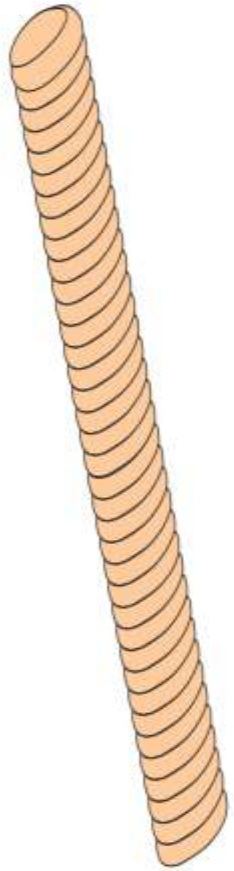


# Structure of DNA & RNA

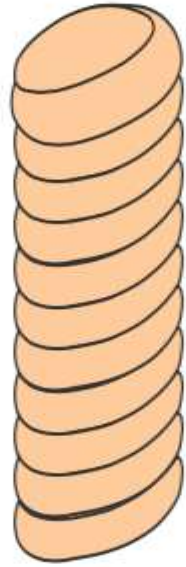


**Deoxyribonucleic acid  
(DNA)**

**Ribonucleic acid  
(RNA)**

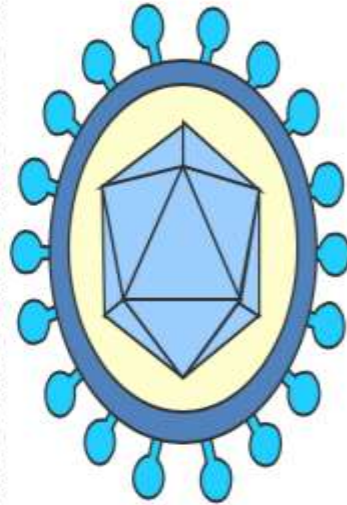


Tobacco mosaic virus



Rabies virus

Helical viruses

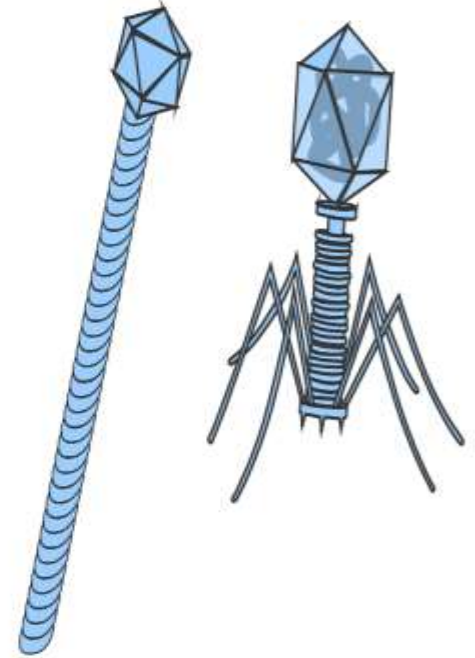


Herpes simplex virus



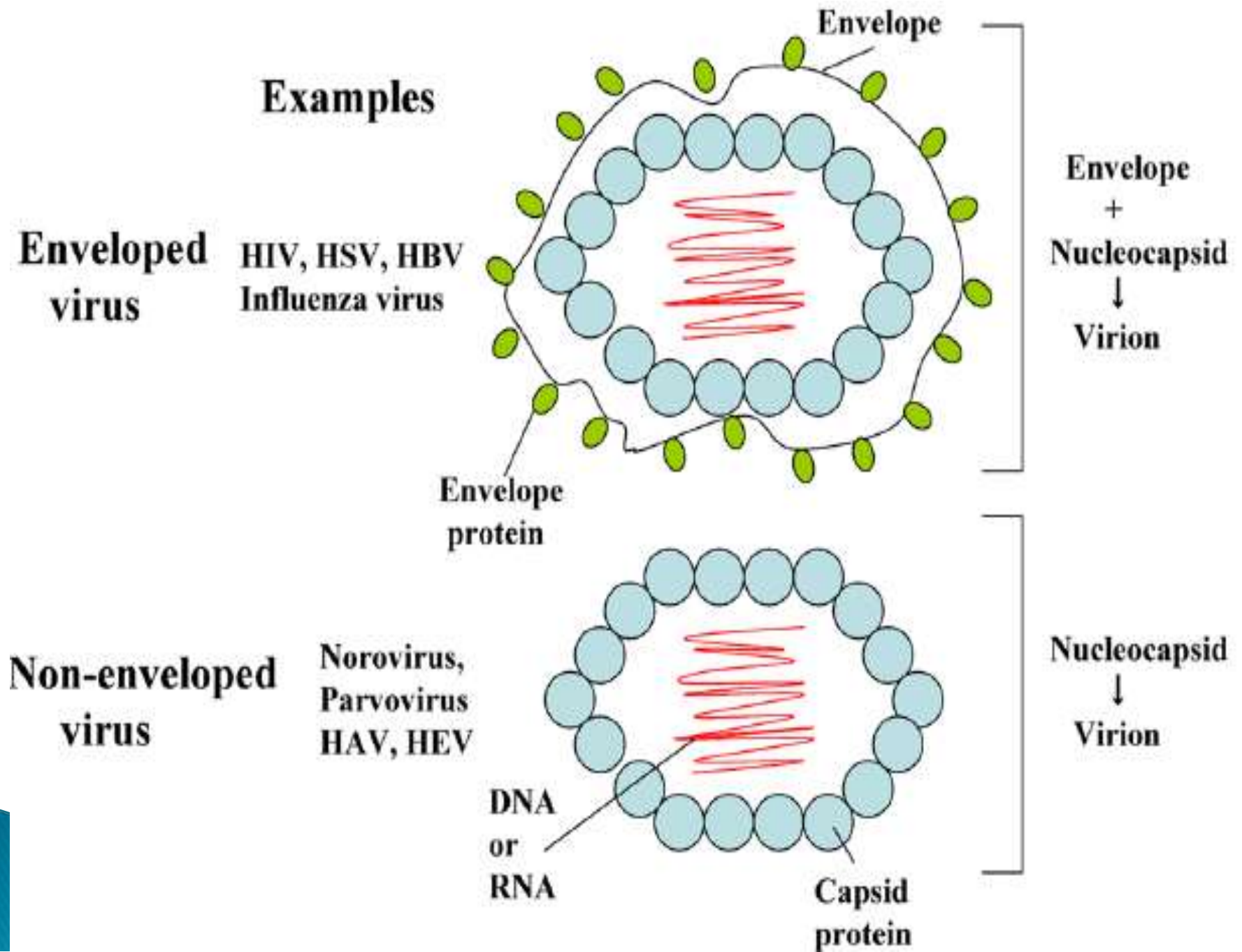
Poliovirus

Icosahedral viruses



Bacteriophages

Complex viruses



S H

S S

T O

T A

A M

A F

Y E

Y E





A photograph of a sunset over the ocean. The sun is a large, bright orange circle in the upper right quadrant, partially obscured by the text. The sky is a pale blue, and the water below is dark blue with a shimmering reflection of the sun. The text 'Thank You' is written in a blue, cursive font across the middle of the image, positioned above the horizon line.

Thank You