Microbiology

Lecture 1:- History Of Microbiology

Prof. fatima abood

Microbiology

- Microbiology is the study of living organisms of micro- scopic size. The term was introduced by the French chemist Louis Pasteur.
- Microorganisms : Small living organisms that generally can not be seen with the naked eye. Include:
  - Bacteria
  - Fungi (yeasts and molds)
  - Protozoa
  - Algae
  - Multicellular parasites

Branches of microbiology

A. On basis of taxonomic characters
1. Bacteriology:- the study of bacteria
2. Mycology:- the study of fungi
3. Phycology :- the study of algae
4. Parasitology :- the study of parasites
5. Immunology:- the study of immune system
6. Virology:- the study of viruses
7. Nematology :- the study of nematodes
8. Protozoology : the study of protozoa

Branches of microbiology

B. On basis of application

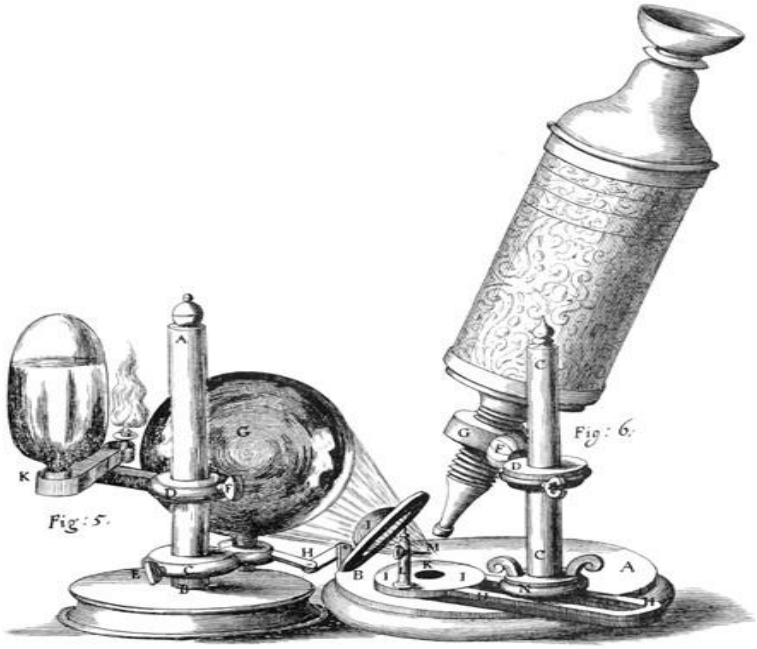
1. Air
2. Water
3. Sewage
4. Soil microbiology
5. Milk microbiology
6. Industrial microbiology
7. Medical microbiology
8. Genomicrobiology
9. Biotechnolog

Medical microbiology

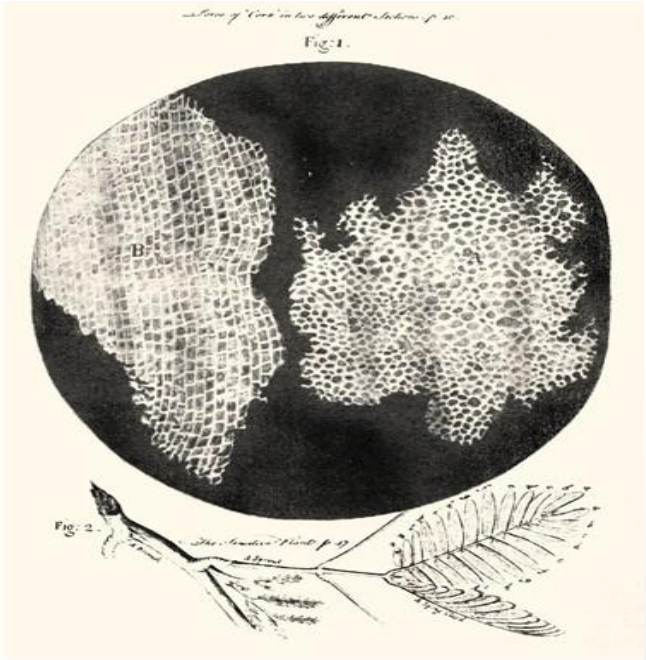
- Is the study of causative agents of infectious disease of human being and his reaction to such infection . It deals with etiology, pathogenesis, lab-oratory diagnosis, treatment, epidemiology and control of infection.

Early Developments

- **Robert Hooke**
  - Cell Theory n
  - Early microscope
- **Antoni Leeuwenhoek**
  - Improved microscope
  - Microbes viewed



(a)



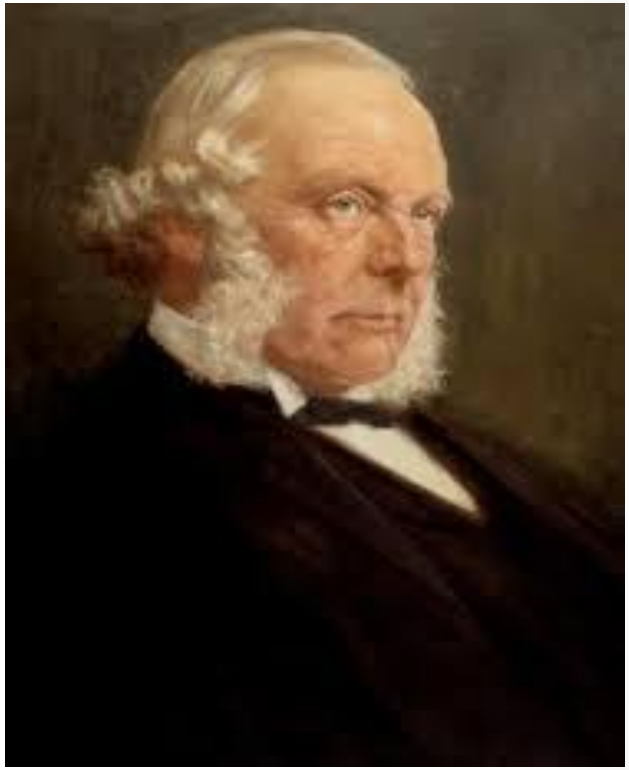
(b)

Louis Pasteur

- Germ Theory of Disease
  - Similar disease symptoms
  - Germ = pathogen
- Fermentation
- Pasteurization
- Father of Microbiology

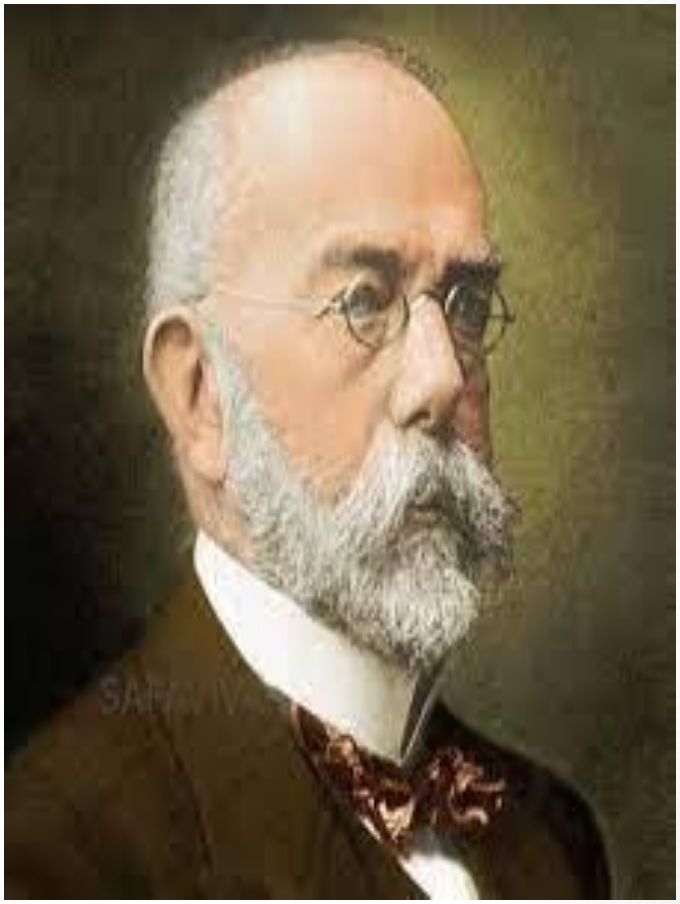
Joseph Lister

- Aseptic Technique
  - Surgical Site prep with phenol
  - Continued Handwashing, as previously demonstrated by Semmelweis

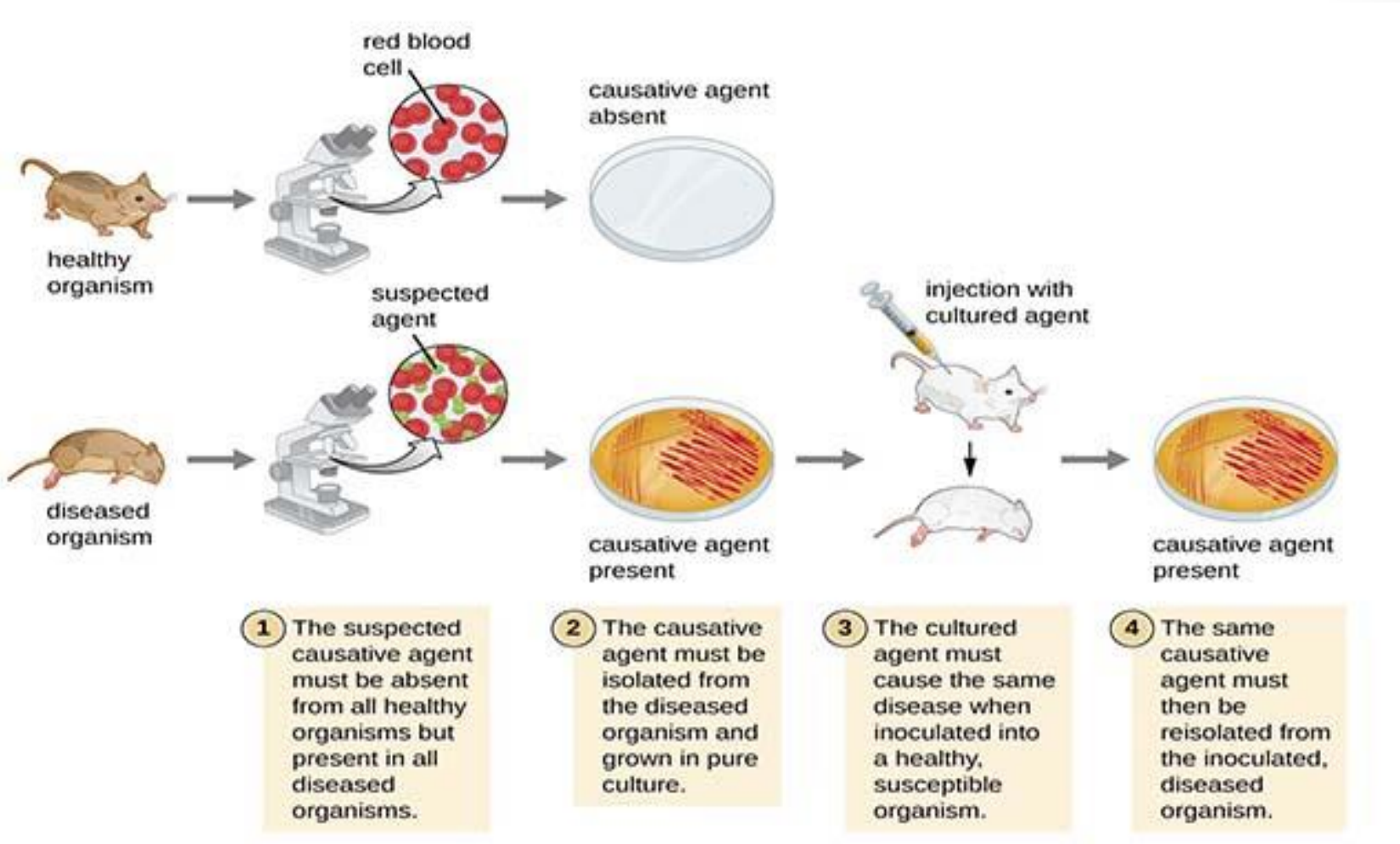


Robert Koch

- Simple Stain technique
- Solid growth Media
- Aseptic lab techniques
- Isolated Bacteria as causative agents for
  - Anthrax
  - TB
  - Cholera
- Koch's Postulates n
  - Series of experimental steps to show that specific organism causes a specific disease



Original Koch's Postulates



Edward Jenner

- Vaccination
  - Cowpox scrapings
  - Smallpox
- Immunology field

John Snow

- Cholera Prevention
- Father of Epidemiology
- First to use anesthesia (ether) during surgery

Florence Nightingale

- Nursing care
- Hygeine
- Improved nurse training

Christian Gram

- Differential Staining of cell walls using various dyes
  - Gram positive
    - “purple”
  - Gram negative
    - “red”

Thanks for your attention

Microbiology

Lecture 2:- Bacterial morphology , bacterial cell structure

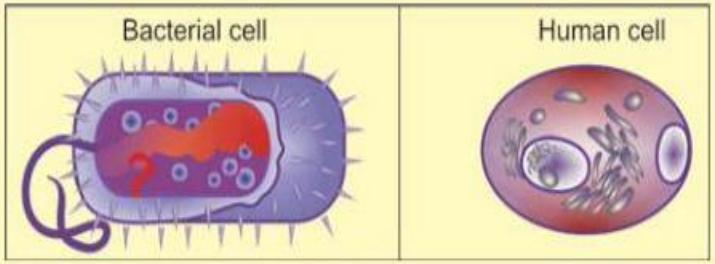
Prof. fatima abood

bacterial morphology , bacterial cell structure

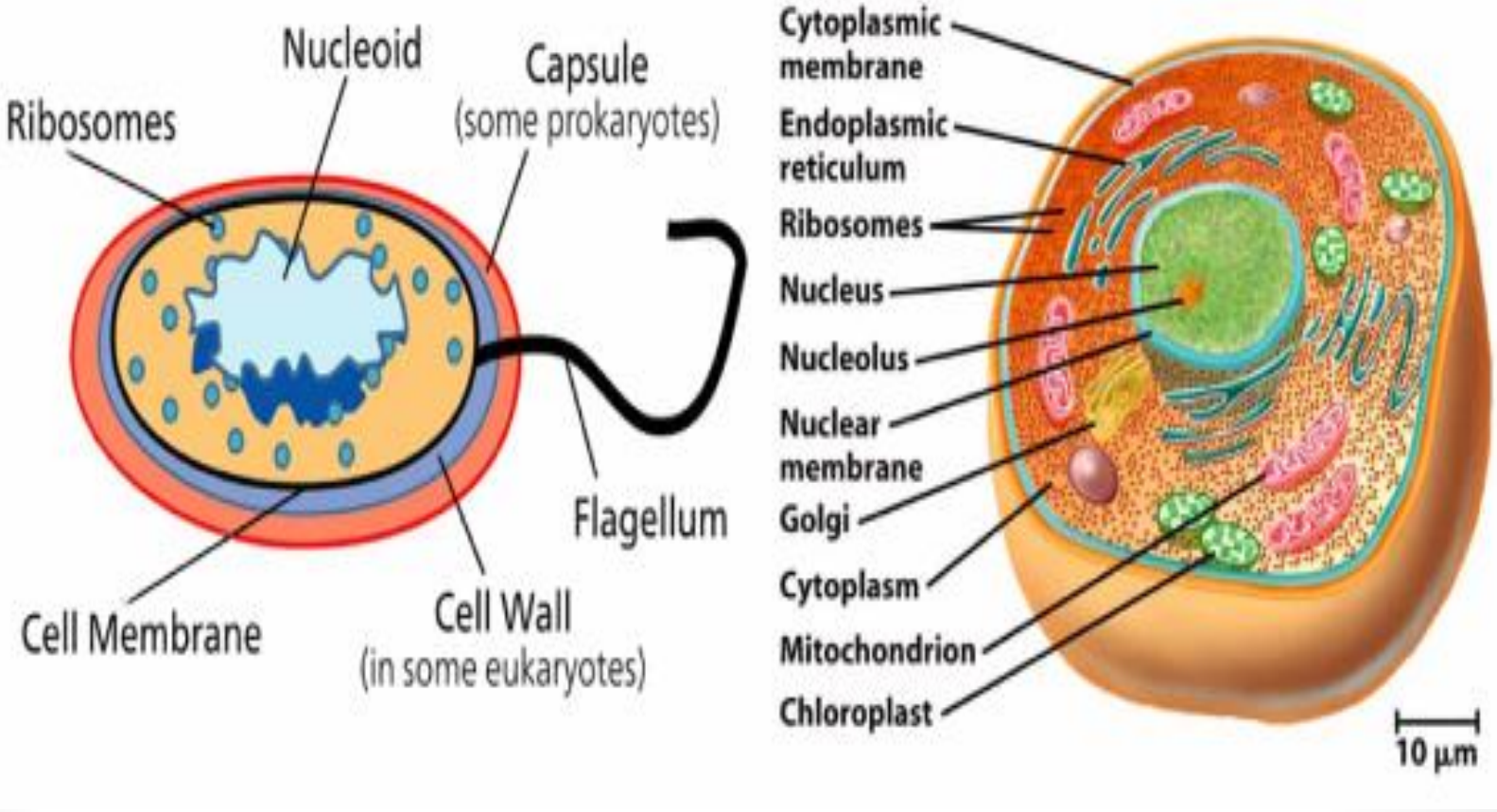
- Bacteria are unicellular free living organisms without chlorophyll having both DNA and RNA. They are capable to all essential processes of life ex. growth , metabolism and reproduction ,they are belong to the Kingdom Protista-group prokaryotes.

Table 3–2. Differences between prokaryotes and eukaryotes

Function/structure	*Characteristic*	*Prokaryotic cell*	*Eukaryotic cell*
Genetics	DNA	Circular	Linear
	Chromosome number	One	More than one
	True nucleus	–	+
	Nuclear membrane	–	+
Reproduction	Mitosis	–	+
Biosynthesis	Golgi apparatus	–	+
	Endoplasmic reticulum	–	+
Respiration	Mitochondria	–	+
Size	µm	1	2-100
Example		Bacterial cell	Human cell



Prokaryotes vs Eukaryotes



bacterial morphology , bacterial cell structure

The morphology of bacterial cell includes characteristics such as size, shape, structure etc. First of all, Leeuwenhoek revealed the gross appearance of microorganism including bacteria by light microscope. By the discovery of electron microscope in early 1940's the study of structural bacterial cell has been made very easier. The morphological characteristic of a bacterial cell is as follows.

Size: Bacteria vary in size from cell to cell. It can be as small as 0.1 to 0.2 μm in width to as large as more than 50 μm in diameter. A few very large prokaryotes such as Epulopiscium fishelsoni that inhabits the intestinal tract of Surgeon fish are up to 50 μm in diameter and can be more than 0.5 mm in length. However, the dimension of an average rod cell prokaryotes E.coli are about 1×3 μm.

Shape and arrangement

The shape of cell is referred to as its morphology. Several shapes of bacteria has been recognized and have been given different names.

1. **Coccus**: A bacteria that is spherical or ovoid in morphology. Example; *Staphylococcus* species.
    1. Cocci in cluster :- ex staphylococcus aureus
    2. Cocci in chain :- streptococcus pyogenes
    3. Cocci in pair (diplococci) :- pneumococcus and Neisseria.
    4. Cocci in group of four (Tetrads) Ex; Micrococcus
    5. Cocci in group of eight (Sarcina) Ex Sarcina

2. **Rod or bacillus**: A bacterium with cylindrical shape. Example; E.*coli* , *Salmonella*

Shape and arrangement

3. **Spirillum**: Some rods are curved frequently forming spherical shape pattern. Example; *Rhodospirillum rubrum*

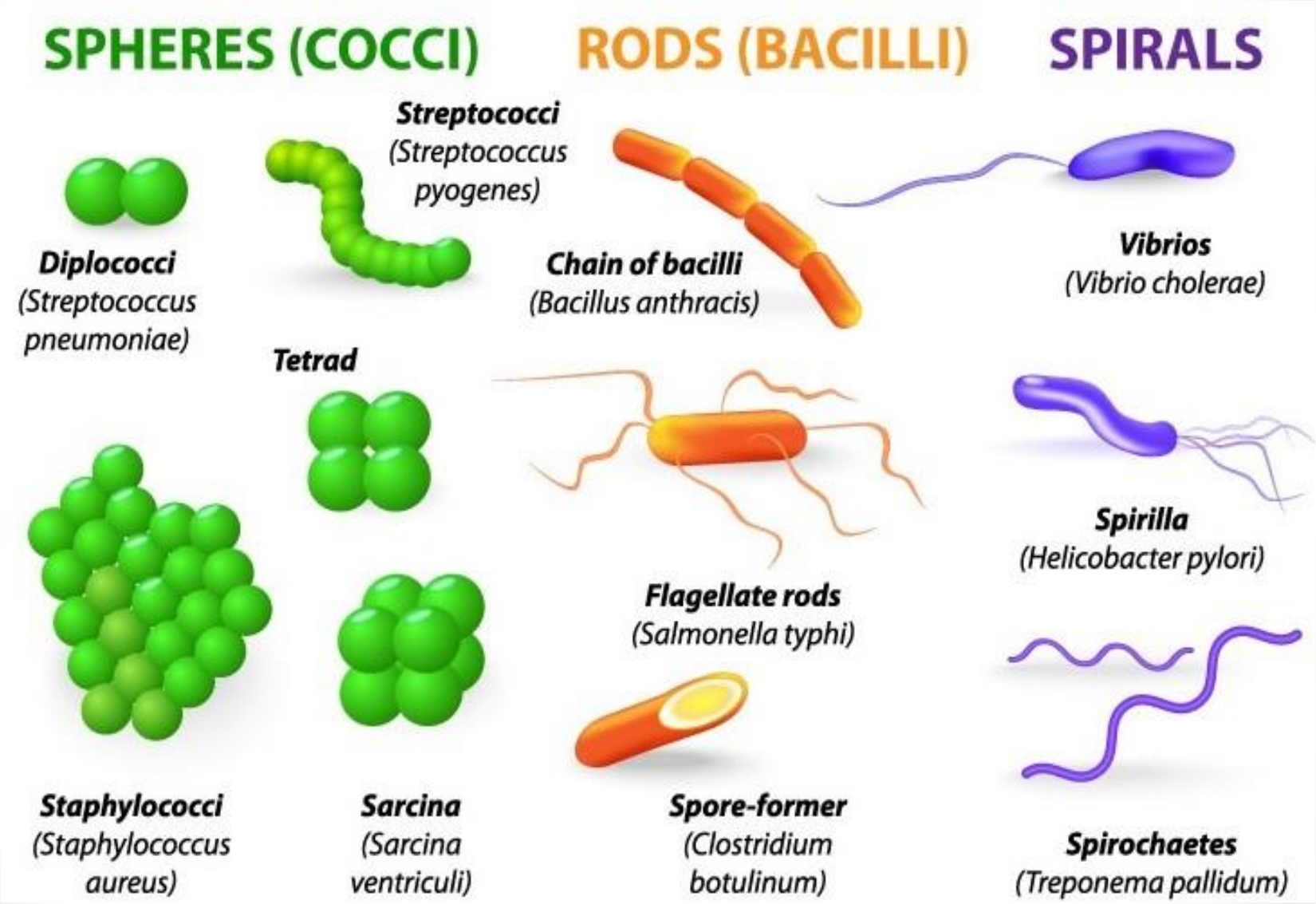
4. **Spirochete**: Several group of bacteria which are tightly coiled. Example; *Spirochaeta stenostrepta* and *Treponema pallidum*

5. **Vibroid**: Bacterial cell having less than one complete twist form. Example; *Vibrio cholerae*.

6. **Appendaged**: Bacteria which possess extension of their cell as their long tubes or stalks. Example; *Rhodomicrobium* species

7. **Filamentous**: Bacteria which are long and filament like structure. Example; *Chloroflexus* species

8. **Pleomorphic bacteria**: Bacteria having irregular shape and can change their structure. Example; *Rhizobium* species and *Mycobacterium* species


SPHERES (COCCI)
RODS (BACILLI)
SPIRALS
Streptococci
(Streptococcus pyogenes)
Diplococci
(Streptococcus pneumoniae)
Chain of bacilli
(Bacillus anthracis)
Vibrios
(Vibrio cholerae)
Tetrad
Spirilla
(Helicobacter pylori)
Flagellate rods
(Salmonella typhi)
Staphylococci
(Staphylococcus aureus)
Sarcina
(Sarcina ventriculi)
Spore-former
(Clostridium botulinum)
Spirochaetes
(Treponema pallidum)

Structure of Bacteria

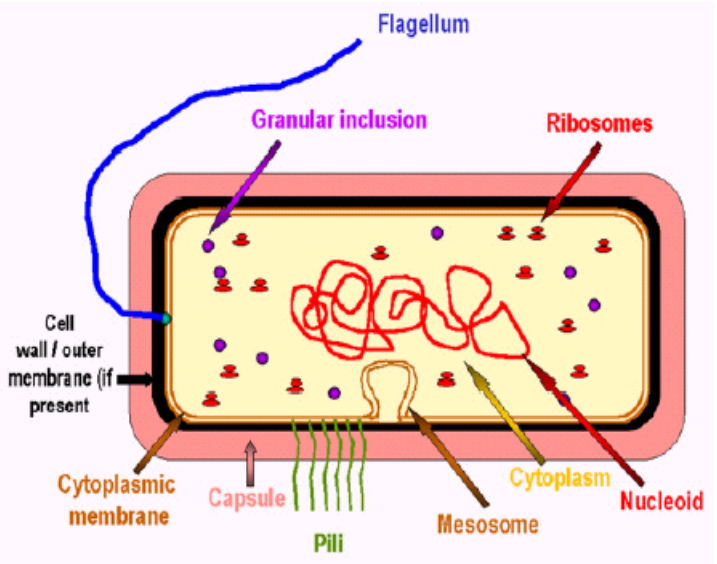
Essential structures

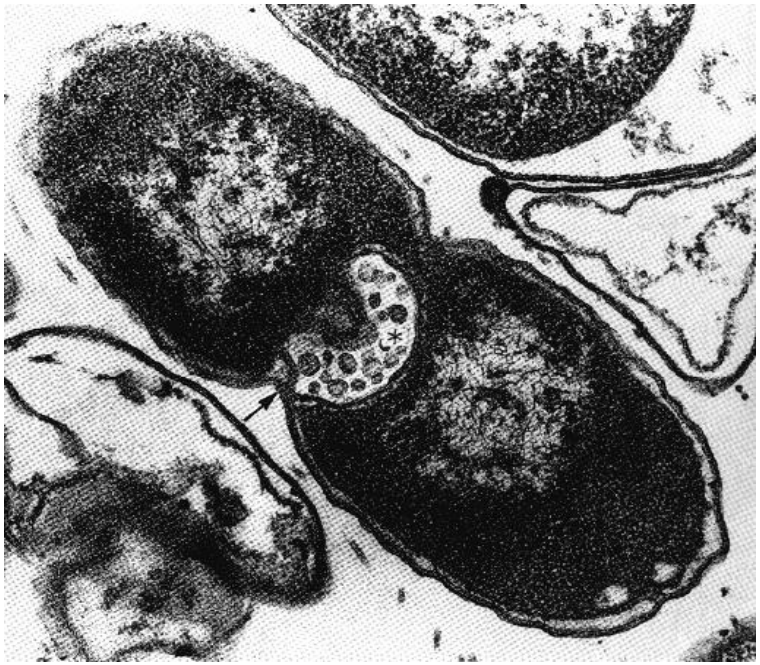
Cell wall

Cell membrane

Cytoplasm

Nuclear material





Particular structures

Capsule

Flagella

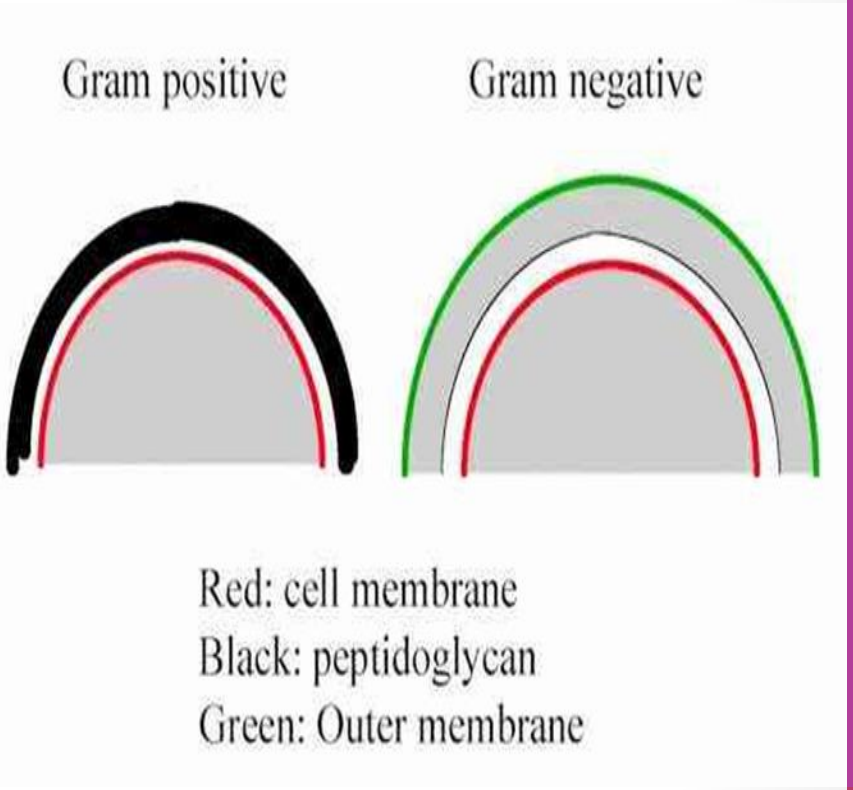
Pili

Spore

Cell Envelope

The cell envelope is all the layers from the cell membrane outward, including the cell wall, the periplasmic space, the outer membrane, and the capsule.

- All free-living bacteria have a cell wall
- periplasmic space and outer membrane are found in Gram-negatives
- the capsule is only found in some strains



Cell wall

- **Definition**

➢ It's the outermost basic component of all bacteria

➢ It's multilayered structure located external to cytoplasmic membrane

- **Function**

➢ Maintain the shape: rigid structure

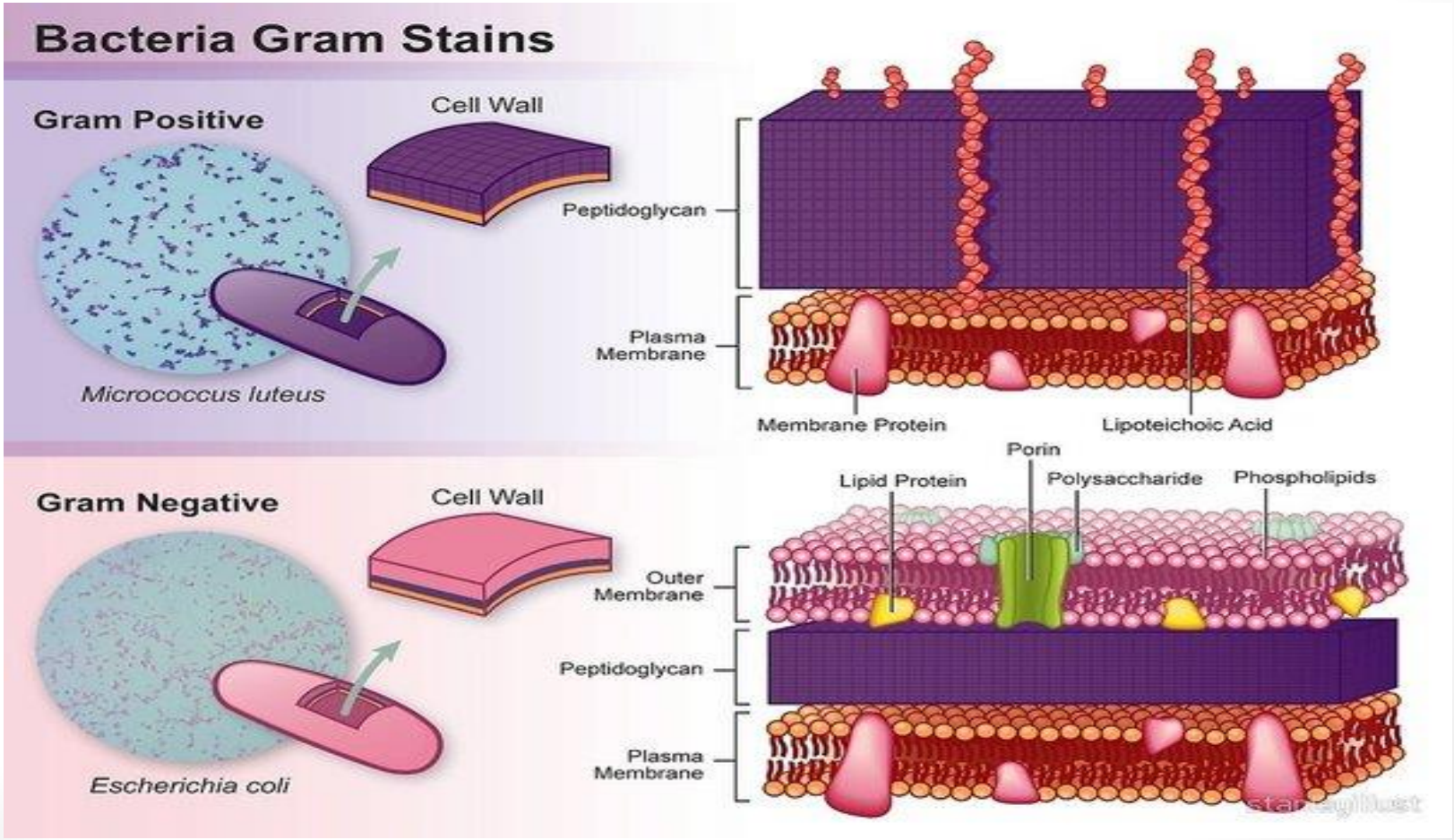
➢ Protect and support C M: Osmotically insensitive

➢ Has role in replication: transverse septum

➢ Responsible stain affinity: G +ve or G –ve

Cell wall

The cell wall of the gram negative bacteria (GNB) is consist mainly from Mucopeptides + proteins + lipids. In gram positive bacteria (GPB) consist of mucoprptides.



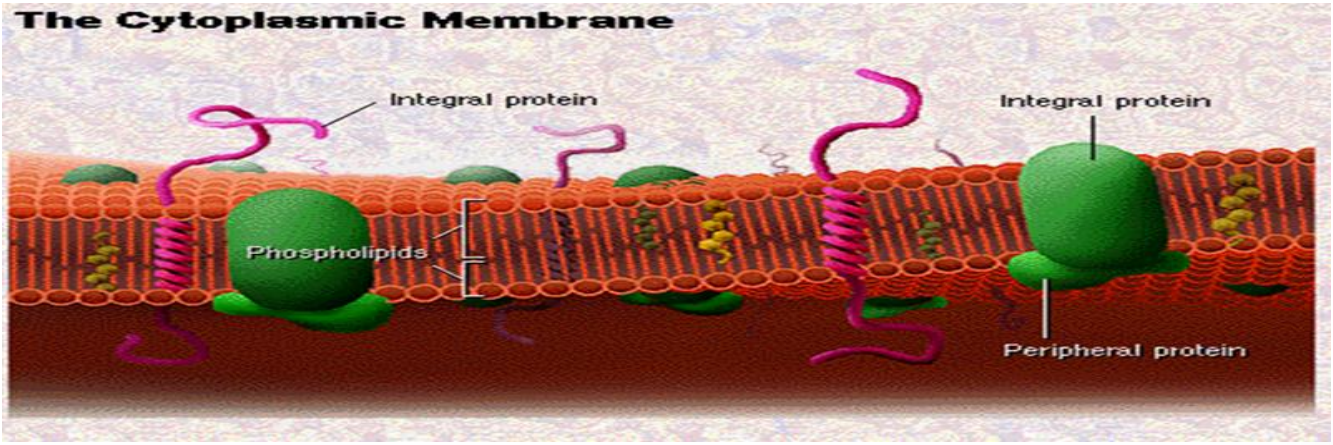
Cell wall

- The chemical structure of the cell wall for G+ve & G-ve bacteria

G+ve bacteria	G-ve bacteria
1- Thick layer of peptidoglycan	1- Thin layer of peptidoglycan
2- polysaccharides	2- lipopolysaccharides
3- teichoic acid	3- lipoprotein

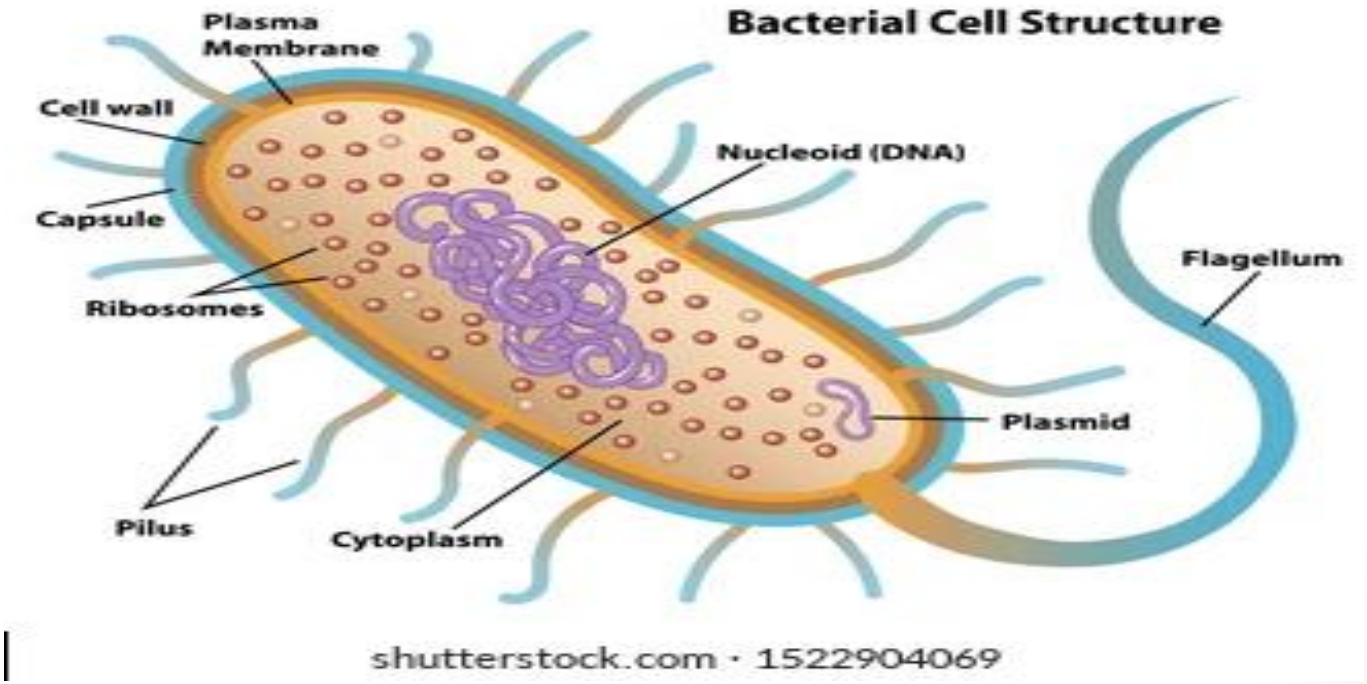
Cytoplasm membrane

- Its thin semi permeable membrane which covers the cell wall from the inside and consist of lipoprotein with small amount of carbohydrate.
- Functions
  1. It contains inflow and outflow of metabolites to and from protoplast
  2. Permease plays important role in passage through membrane



Cytoplasm

- Is suspension of organic and inorganic solutes in viscous watery solution. It contains ribosome and mesosomes , Inclusions and vacuoles.



Nucleus

- It is a long filament of DNA coiled inside the cytoplasm. The bacterial nucleus is not surrounded by nuclear membrane and don't have nucleolus.
- The genome consists of a single molecule of double stranded DNA arranged in the form circle bacterial chromosomes in haploid and replicate by simple fission.
- **Ribosome's**
  - These are ribonuclcoprotein granules, They are sites of synthesis
- **Mesosomes**
  - They are the sites of respiratory in bacteria and coordinate nuclear and cytoplasm division

Flagellum

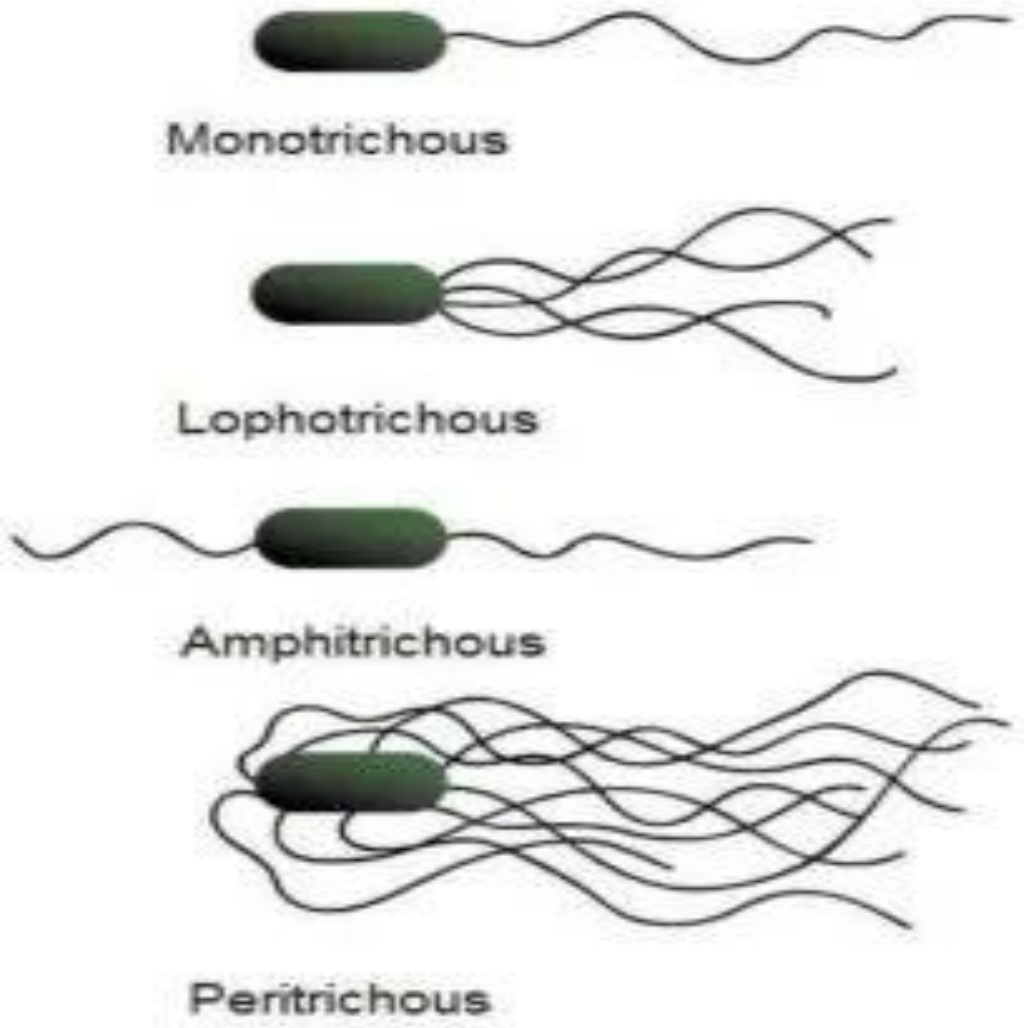
- (Flagellum):- These are thread like structure arises from the cytoplasm and its function is for locomotion. Chemically flagella composed mainly of a protein called flagellin very few.
- Note: flagella occur most commonly among rod shaped bacteria.

Distribution (Arrangement) of flagella

- The arrangement of flagella may be in one of the following ways

1. Monotrichous: one flagellum at one end of the organism . ex : vibrio ,pseudomonas
2. Amphitrichous: one flagellum at both the poles . ex : Alcaligenes faecales
3. Lophotrichus : a tuft of flagella at one end of organism ex : pseudomonas.
4. Peritrichus : several flagella present all over the surface of bacteria ex: E.coli , Salmonella

The arrangement of flagella



- **Fimbriae**

They are filamentous short , thin , straight hair like appendage also called and project from cell surface.

- Types of pilli (fimbriae)
  - common pilli
  - F(fertility) pili
  - Coli (colicin)
- Function
  - .Organ of adhesion
  - .Conjunction tube
  - .They are antigenic

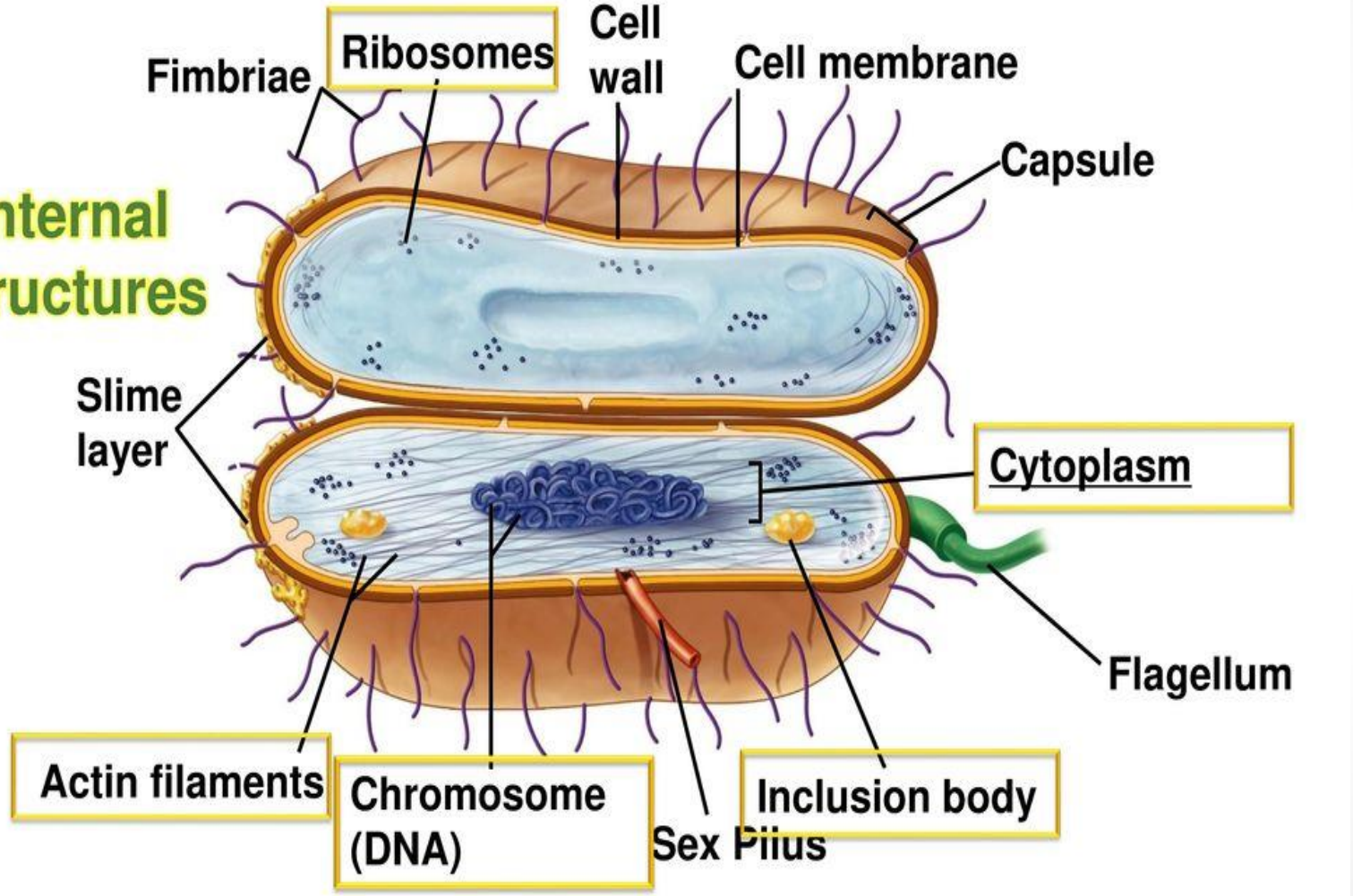
- **Spors**
  - They are highly resistance dormant state of bacteria found in certain genera ex: Bacilli and Clostridium .
  - **:Function**

They make survival of organism possible under unfavorable conditions like dry state. Spores are resistant to freezing and toxic chemicals

- **Capsule**
  - It is gelatinous secretion of bacteria which gets organism as a thick coat around cell wall, it :may be composite of

1. Complex polysaccharide = pneumococcal , klebsilla
2. .Polypeptide = bacilli

Internal Structures



Thanks for your attention

Microbiology

Lecture 3:- Bacterial requirement , Growth curve

Prof. fatima abood

Nutritional Requirement of Bacteria

- Bacteria may require adequate nutrition of optimum pH , temperature and oxygen for multiplication and growth .Bacteria can be classified into following types on the basis of nutritional requirement .
- **1- On the basis of energy sources .**
- **A- Photrophics** which get energy from photochemical reactions .
- **B- Chemotrophic** gets energy from chemical reactions .
- **2- On the basis of their ability to synthesize essential metabolites .**
- **A- Autotrophic** :- These are the organisms in which all essential metabolites are synthesized from inorganic sources . They use carbon dioxide as the main source of carbon and simple inorganic salts . e.g. : nitrates , niters , ammonium sulphate , phosphates .
- **B-Heterotrophic** :- Here some of the essential metapolites are not synthesized . Organic compounds e.g. protein , peptones , amino acids , vitamins and growth factor are supplied from outside . Most of the bacteria producing disease in man are heterophic.

Nutritional Requirement of Bacteria

- The other nutritional requirement are as under :
- **1-Minerals** :- These are sodium , potassium ,magnesium , calcium ,iron , chlorine, zinc , copper , iodine and traces . These are essential for physiological activities of bacteria.
- **2-Gas requirements** :
- **A-Oxygen** :- The capacity of bacteria to grow in the presence of oxygen and to utilize it depends on possession of a cytochrome oxidase systems .
  - **1. Aerobes** :- The aerobe organisms grow only in the presence of oxygen .e.g. *Pseudomodaceae , bacillus , nitrobacter sarcina* etc
  - **2. Facultative anaerobes** :- They are the organisms that can live with or without Oxygen .e.g. *vibrio , E.coli , salmonella* and *staphylococcus*. The micro – Aerophilic organism grow well with relatively small quantites of oxygen .e.g. Haemophilus .
  - **3. Obligate anaerobes** :- The strict anaerobes multiply only in the absence of oxygen .e.g. bacteroides ,clostridium

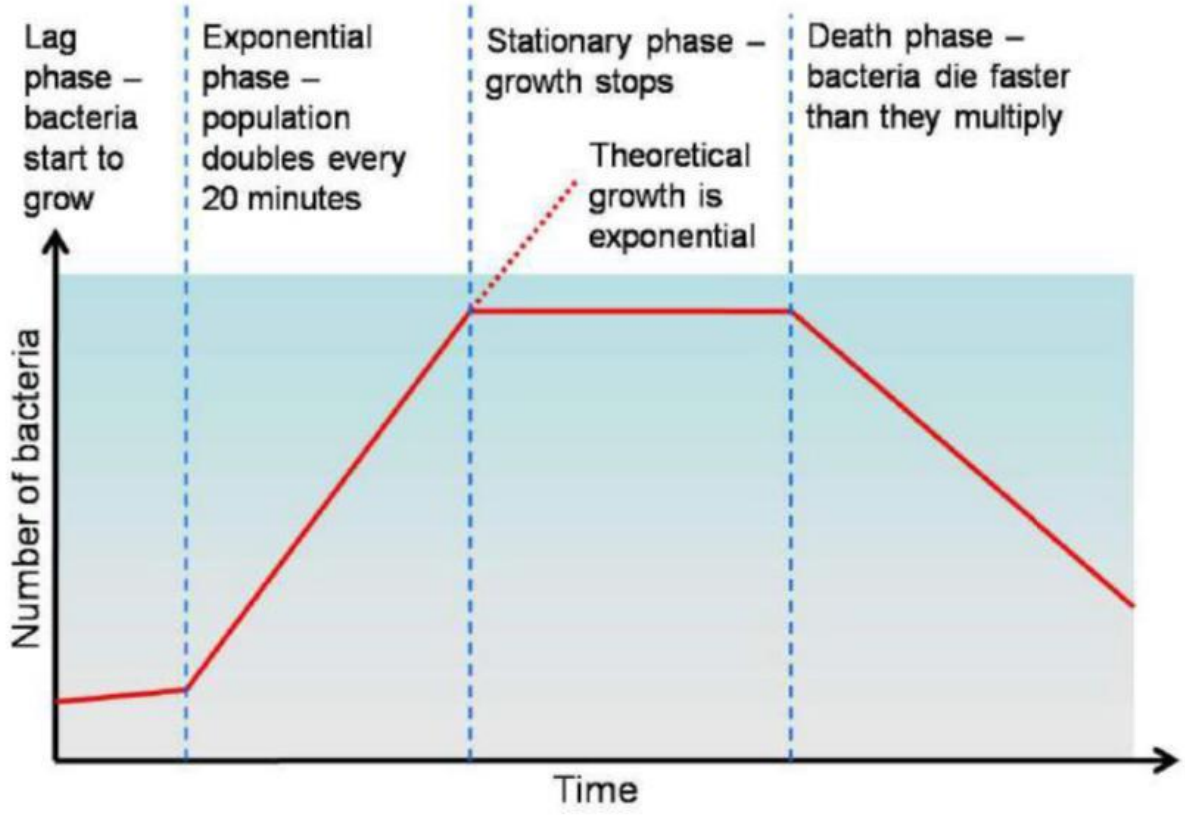
Nutritional Requirement of Bacteria

- **.B. Carbon dioxide** : The metabolic activator of some organisms like Neisseria , Brucella abortus are greatly enhanced by the presence of extra amount of carbon dioxide in atmospheric air .
- **3- Moisture** :- Bacteria require water for their growth . Desiccation may kill most of bacteria like Neisseria gonorrhoeae .
- **4- Necessary nutritional requirement** :- Most often the necessary growth factors are vitamins . The requirement of growth factors differ widely in various bacteria .
- e.g. : *Neisseria gonorrhoeae* ..... Glutathione .
- *Staphylococcus aureus* .....However 0.5% sodium .

Growth Curve

When organism are cultured in appropriate fluid media there would be increase in the size of bacteria without any multiplication for some time . This is followed by multiplication and increase in numbers of bacteria to the extent that media look turbid to the naked eye (log phase) . After some time growth rate becomes stationary and later on declines . Counting of bacteria at different periods after inoculation and then events of sequences are represented on a graph which is called growth curve .

Growth Curve



Growth Curve

- **A-Lag phase** :- During this phase there occurs
- 1- Increase in size of cell .
- 2-Increase in metabolic rate .
- 3-Adaptation to new environment and necessary enzymes and intermediate metabolites are built up for multiplication proceed.
- **The length of lag phase depends upon :**
- a-Type of bacteria .
- b-Better the medium , shorter the lag phase.
- c-The phase of culture from which inoculation in taken
- d-Size of inoculum.
- e-Environmental factors like temperature .

Growth Curve

- **B-Log phase** :- Following lag phase . The cells start dividing and their number increase by geometric progress on with time . Logarithms of viable count plotting against time gives straight line , during this periods .
- i. Bacteria have high rate of metabolism .
- ii. Bacteria are more sensitive to antibiotics .Control of log phase is brought about by :
  - a-Nature of bacteria .
  - b-Temperature .
  - c-Rate of penetration of the medium . It depends on the concentration of material in the medium.
- **C-Stationary phase** :-After some time a stage comes when rate of multiplication and death becomes almost equal. It may be due to :
- a-Depletion of nutrient .
- b-Accumulation of toxic products . Sporulation may occur during this stage.
- **D- Decline phase** :-During this phase population decrease due to death of cells .Factors responsible for the phase are :
- a-Nutritional exhaustion
- b-Toxic accumulation .
- c-Autolytic enzymes . Involution is common in phase of decline.

- **Survival phase** :-When most organisms have died , a few survive for several months or years .

Factors influencing growth:

- **1-Temperature**:The temperature range at which an organism grows best is called optimum temperature . It human , parasitic organisms , optimum temperature ranges between 30c and 37c.
- There are three groups of bacteria as regards the temperature of growth :
  - **a-Psychrophilic**:- These are the organisms growing between 0c to 25c . They are mostly soil and water bacteria.
  - **b-Mesophilic**:- They grow between 20c and 45c . This group includes bacteria producing disease .
  - **c-Thermophilic**:- Some organisms grow between 50c and 60c . e.g. bacillus and algae.
- **2-Hydrogen ion concentration** :- Most of pathogenic bacteria grow best at pH(7.2-7.6) .However lactobacilli grow at acidic ph while Vibrio cholera grows at alkaline pH .
- **3-Moisture**:- Water in quite essential for the growth of bacteria . Organism like *Neisseria gonorrhea* and *Treponema pallidum* die almost at once on drying .However *mycobacterium tuberculosis* and *staphylococcus aureus* survive for quite along time even on drying .

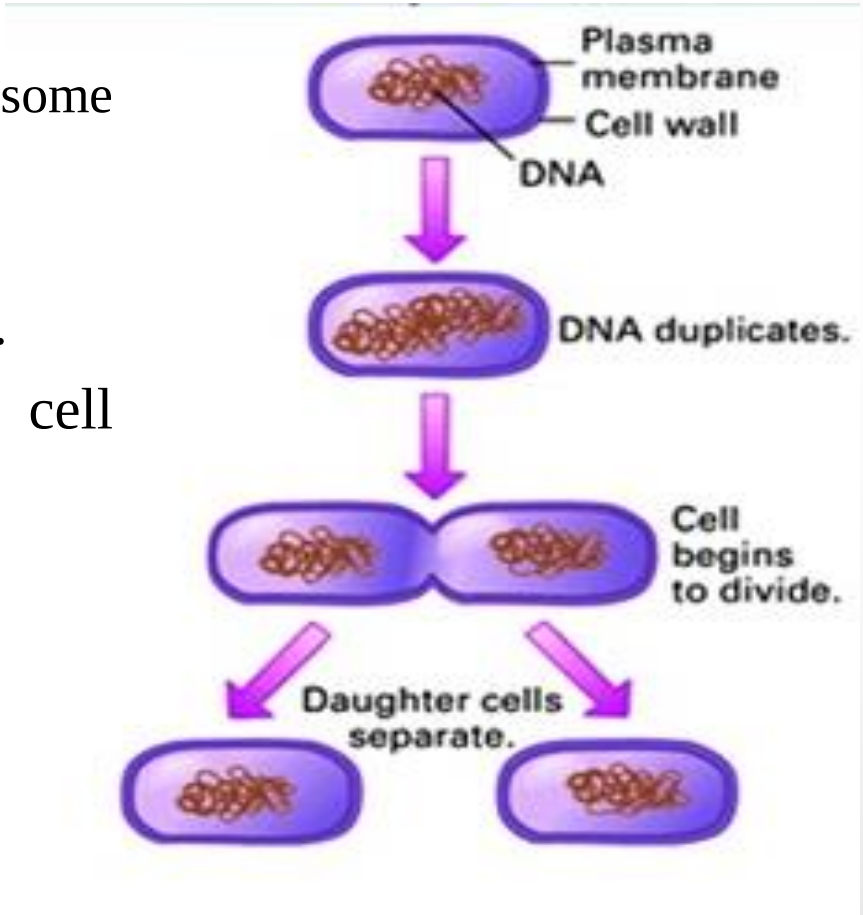
Growth Curve

- **4-Osmotic pressure** :-Bacteria are usually resistant to changes of osmotic pressure. However 0.5% sodium chloride is added to almost all culture media to make environment isotonic.
- **5- Light** :-Darkness usually favorable for the growth and viability of all the organisms . Direct light exposure shorten the survival of bacteria Photochromogenic mycobacteria form pigment on exposure to light . Organism are sensitive to ultraviolet and other radiations
- **6- Mechanical and sonic stress** :-Bacteria tough cell wall . Vigorous shaking and exposure to ultra sonic vibration may cause rupture or disintegration of cell wall .

Reproduction in bacteria

- Bacteria divide by simple binary fission .The cell grows in size , almost double its size . the process of cell division is initialed .The sequence of cell division include :-

1. Formation of initial of chromosome replication .
2. Chromosome duplication
3. Separation of chromosomes.
4. Formation of septa and cell division



Thanks for your attention

Microbiology

Lecture 4:- Control Of Microorganism

Prof. fatima abood

Sterilization and disinfection

Sterilization : is process of killing or removing all of viable organisms.

Disinfection : is process of kill or removing must but not all viable organisms.

Antiseptic : it means prevent of infection by inhibiting growth of bacteria.

Bactericidal agents : they are those which able to kill bacteria.

Bacteriostatic agents : only prevent multiplication of bacteria and they remain alive.

Various agents used is sterilization are:

- **1-physical method**
- **2-chemical method**

Sterilization and disinfection

1-Sun light 2- drying 3- heat 4- filtration 5-radiation

1-Sun light : it bactericidal activity. the action is due to ultraviolet ray.

2-Drying : drying in air has effect on many bacteria.

3-heat : the factors influencing sterilization by heat are :

a-Nature of heat

b-Temperature and time

c-Number of organisms

d-Whether organism has spore capacity

Type of heat

1-Dry heat

A-Red heat: it is used to sterilize metallic objects by holding them in a flam till they are red hot ex Wire loop , needles scalpels forceps, etc.

B-Flaming: the article is passed over flam without allowing it to become red hot e.g. culture tubes, glass, slides

Sterilization and disinfection

C- Hot air oven: requires temp- of 160 c for one hour - we can sterilize all glass, syringes , petri-dishes , test tubes flask , scissors etc

2- Moist heat: the lethal effect is by denaturation and coagulation of protein

A- Temp. below 1000C

Pasteurization of milk :temp. employed is either : 63C for 30 mints holder method or: 72 C for 15-20 second flash method

Mycobacterium , *Salmonella* , *Brucella* are killed

B- Temp. at 100C.

1-Tantalization: this is process by which medium is placed at 100c inflowing steam for 30 min. each on 3 successive days.

2- Boiling : most of vegetation from bacteria , fungi and are killed 50-70 C in short time for needles and instruments boiling in water for 10-30 min , is sufficient to Sterilization.

3- Steam under pressure : autoclave is used for bacteriological and surgical work because of spores kills all microorganisms including (HIV & hepatitis virus).

Sterilization and disinfection

Filtration ;- Is the method of sterilization, used filter paper useful for antibiotic solutions , sera , etc. Ex: Asbestos disc filter , membranous filter

Radiation

Ultraviolet radiations : it is chief bactericidal factor present in sun light , it cause following changes in cell

1. denaturation of protein
2. damage to DNA
3. inhibition of DNA replication
4. formation of H2O2 and organic peroxide in medium

B-Chemical methods:

1- Acid and alkaline: growth bacteria inhibition Mycobacterium is more resistant to acid than alkaline

2-Halogens: iodine is used chiefly for skin. combines with water to from hydrochloric acid which is Bactericidal.

3 -Formaldehyde: useful in ster. Bacterial vaccine and in inactivating bacterial toxin without affecting their antigenicity (5-10%) solution in water kills many bacteria. It is Bactericidal, sporicidal and lethal to viruses also.

Sterilization and disinfection

4- Dry : gentian and malachite green etc. are active against gram positive bacteria.

5- Soap and detergents: they are Bactericidal and bacteriostatic for gram positive bacteria and some acid fast organisms.

6-Aerosol and gaseous disinfectants S02 : chlorine and formalin vapor have been used as gaseous disinfectant . Propylene, glycol is powerful disinfectant

Infection

- Infection The lodgment and multiplication of organism in the tissue of the host. Classification of infection

1. Primary infection : - Initial infection with organism in the host .

2. Reinfection : - Subsequent infection by the same organism in the host.

3. Secondary infection : - In the host whose resistance is lowered by preexisting infection disease , anew organism may set up as infection .

4. Focal infection : - It is a condition due to infection at localized sites like appendix and tonsil .

5. Cross infection : - The patient suffering from a disease and new infection is set up from another host or from external source .

6..Nosocomial infection : - Cross infection occurring in hospital .

7.Subclinical infection : - When a patient clinical affects are not apparent .

Source of infection

1. Human : - is himself a common source of infection from a patient or1.carrier .

2. Animals : - Infectious diseases transmitted from animals to human are called zoonosis may be bacterial (e.g. plague from rat), viral (e.g. rabies from dogs) , protozoa (e,g leishmaniasis from dogs), helminthes (e.g. hydatid cyst from dogs), fungal from cats and dogs .

3. Insects : - The disease caused by insects are called arthropod borne disease .Insects like mosquitoes , flees ,lice that transmit infection are called vector. Transmission may be mechanical (transmission of dysentery or typhoid bacilli by house fly) these are called mechanical vector. They are called biological vector if pathogens multiplies in the body of vector e.g. Anopheles mosquito in malaria.

4. Some vector may act as reservoir host(e.g. ticks in relapsing fever and spotted fever).

5. Soil : - Soil may be serve as some of parasitic infection like round worm and hook worm. Spores of tetanus bacilli remain viable in soil for a long time.

6. Water : - Vibrio cholera , infective hepatitis virus .

7. Food :- Contaminated food may be source of infection.(food poisoning by staphylococcus).

Methods of transmission of infection

1. **Contact** : - Syphilis , gonorrhea , trachoma .

2. **Inhalation** : - Influenza , tuberculosis , small pox , measles and mumps .

3. **Infection** : - Cholera (water) food poisoning (food) dysentery (handborne) .

4. **Inoculation** : - Tetanus , (infection) rabies (dog), arbovirus (insects) , serum hepatitis (injection) .

5. **Insects** : - Act as mechanical vector (dysentery and typhoid by house fly) or biological vector (malaria) of infectious disease .

6. **Congenital** : - Congenital syphilis , Toxoplasma .

7. **Laboratory infection** : - Infection may be transmitted during procedure like injection , catheterization.

Respiratory system infection Lower respiratory tract infection (Consist of three types)

- 1. Trachea
- 2. Bronchiole
- 3. Lung
- Upper respiratory tract infection Sputum (Consist of types):
- 1. Tonsillitis.
- 2. Throat.
- 3. Nose.4.
- Nose sinuses
- 5. Larynx

- It is mucous that is coughed up from the lower airways .In medicine, sputum samples are usually used for microbiological investigation of respiratory tract Culture media which used :
- **1. MacConkey agar.**
- **2. Blood agar.**
- **Types of bacteria which cause respiratory tract infection**:
- *1. Staphylococcus.*
- *2. Streptococcus.*
- *3. Corynobacteria.*
- *4. Neisseria.*
- *5. Pneumonia.*
- *6. Haemophillus.*

Thanks for your attention

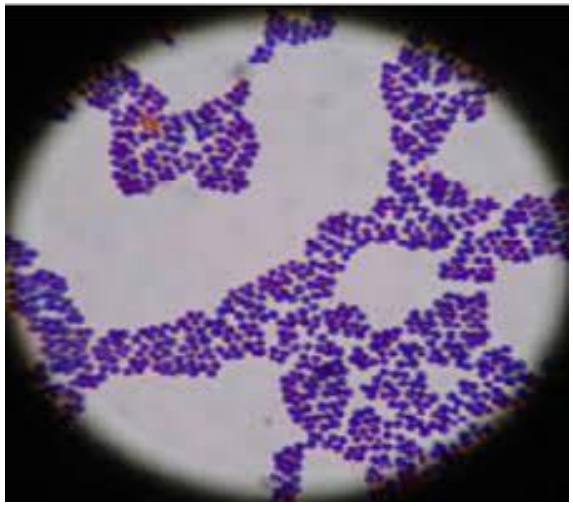
Microbiology

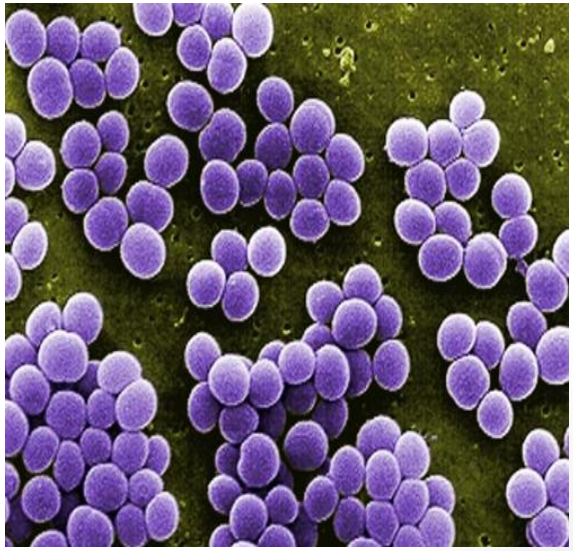
Lecture 5:- Staphylococcus

Prof. fatima abood

Staphylococcus

- **Family**: Micrococceae (consists of Gram positive cocci, arranged in tetrads, clusters)
- **Genus** : Staphylococcus
- **Term** "staphylococcus" derived from Greek :Staphyle = bunch of grapes and Kokkos = berry, meaning bacteria occurring in grapelike clusters or berry.





History

- **Robert Koch** (1878)- first to see staphylococci in pus specimen
- **Louis Pasteur** (1880)- first to cultivate in liquid medium
- **Sir Alexander Ongston** (1881)- named the bacteria as “staphylococcus”

Classification

- Based on pigment production:
  - *S.aureus* :-golden-yellow pigmented colonies
  - *S.albus* :- white colonies
  - *S.citrus* :-lemon yellow colonies

S. albus , *S. aureus* , *S. citrus* on Nutrient Agar

- Based on pathogenecity:
  - Pathogenic:- includes only one i.e., *S.aureus*
  - Non-pathogenic:- includes *S.epidermidis*, *S.saprophyticus*, *S.albus*, *S. citrus*, *S.hominis*,*etc*.
- Based on coagulase production:
  - Coagulase positive: *S. aureus*
  - Coagulase negative:

S. epidermidis, *S. saprophyticus*

S.aureus

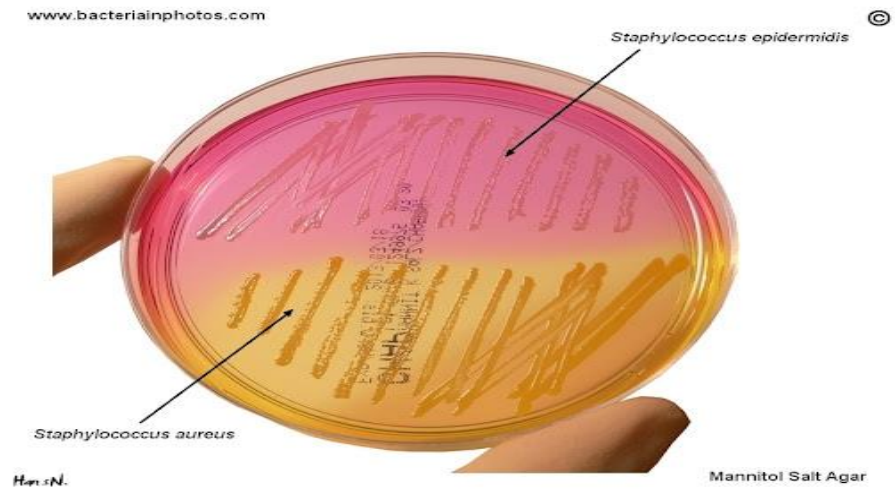
- Natural habitat:- Habitat is human skin and nose. Transmission is via the hands
- Morphology:-
  - Gram-positive, cocci, 0.5-1.5µm in diameter; occur characteristically in group, also singly and in pairs
  - Form irregular grapelike clusters (since divide in 3 planes)
  - Non-motile, non- sporing and few strains are capsulated
  - Facultative anaerobic
  - Factors in influencing pigment production:-
    1. Temperature— (20-25 c)
    2. Oxygen— aerobic
    3. Medium— on solid medium
    4. light: in presence of light pigmentation of colony is better

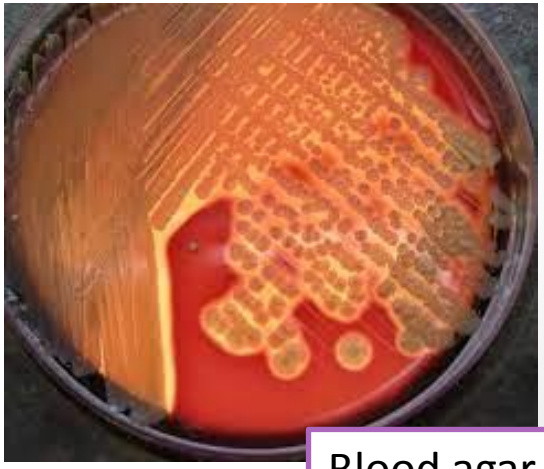
➢Laboratory

- Gram stained smear and culture yellow or gold. Colonies on blood agar
- *Staph. aureus* is coagulase – positive & API
- *Staph. Epidermidis* coagulase -negative. Serologic test not useful

➢Pathogenicity

1. cutaneous lesions: boils, abscess, impetigo
2. Deep infection :acute) osteomyelitis, pharyngitis, sinusitis, pneumonia, mengitis, endocarditis and renal abscess, staph, Septicemia is rare but senous disease
3. food poisoning.

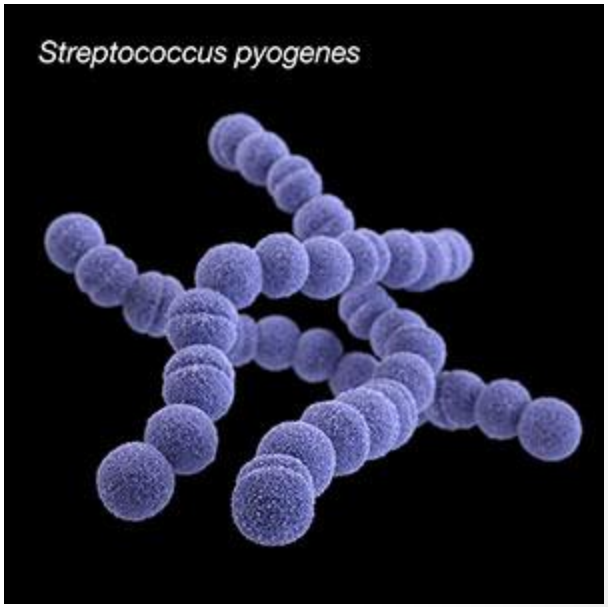




Blood agar

Streptococci

- Characters of Streptococci
  - Gram positive cocci
  - Size 1µm
  - Chains or pairs
  - Non motile
  - Non spore forming
  - Facultative anaerobes
  - Fastidious
  - Catalase negative



Classification of Streptococci

According to:

- **Oxygen requirement**
  - Anaerobic (Peptostreptococcus)
  - Aerobic or facultative anaerobic (Streptococcus)
- **Hemolysis on Blood Agar:-** α, β, ϒ
- **Lancefield classification:-** for β hemolytic streptococci, based on C antigen

Hemolysis on Blood Agar

Hemolysis on BA

□-hemolysis

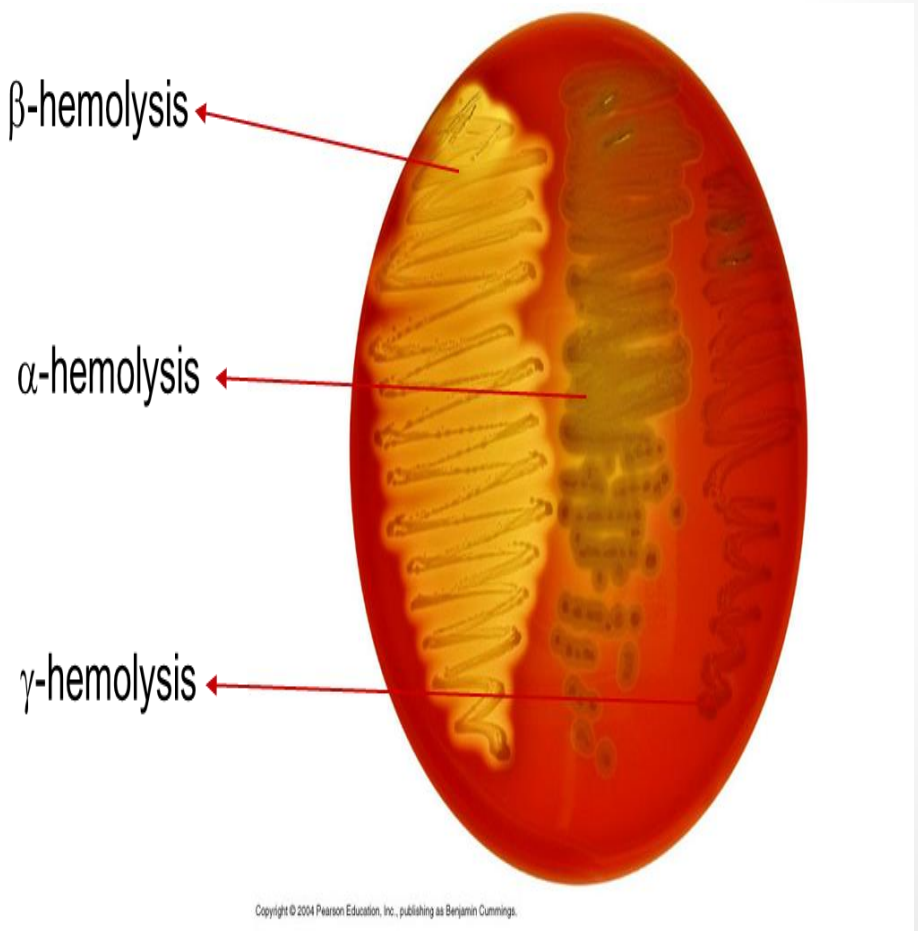
- Partial hemolysis
- Green discoloration around colonies
- e.g. *S. pneumoniae* & *S. viridans*

□-hemolysis

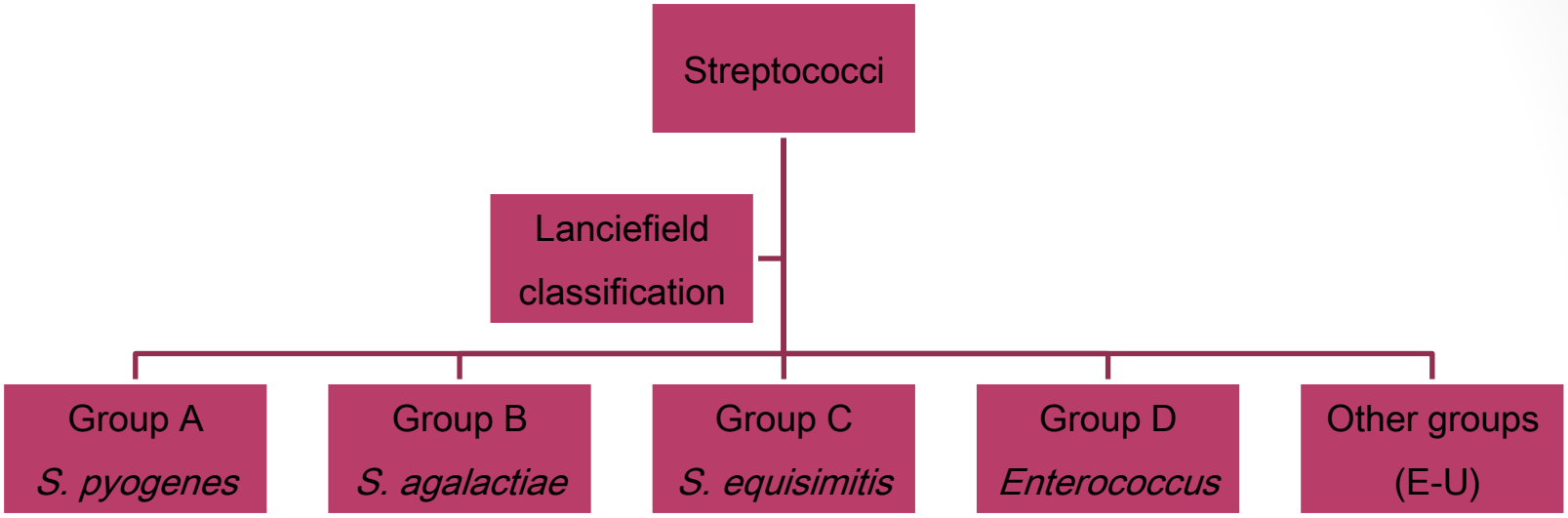
- Complete hemolysis
- Clear zone of hemolysis around colonies
- e.g. Lancefield Group A & B (*S. pyogenes* & *S. agalactiae*)

□-hemolysis

- No hemolysis
- e.g. Group D (*Enterococcus sp.*)



Lancefield Classification- β hemolytic



- Classification based on C- carbohydrate antigen of cell wall
- 20 Lancefield groups from A-H & K-V
- One or more species per group
- Group A- Further subdivided based on M, T, R protein (Griffith typing) in to 80 sertypes

Streptococcus pyogenes(group A)

- **Characteristic:**

  Gram-positive cocci in chains , beta hemolytic, catalase -negative ,non motile , non sporing , they are usually an capsulated ,it is composed of hyaluronic acid

- **Habitat and transmission**:

  habitats is the human throat and skin

  Transmission is via respiratory droplets

- **Pathogenesis:**

- Respiratory infection: sore throat, tonsillitis, pharyngitis, otitis media
- Scarlet fever: is caused by a strain producing erythrogenic toxin and characteristic erythematuous rash

  1-Skin infection: wound, burns, and cellulites

  2-Genital tract infection :- puerperal sepsis (nasophraynx of doctors and nurses are the source of infection

  3-other infection :-abscess of organ (brain, lungs, liver, kidney).it may cause septicemia

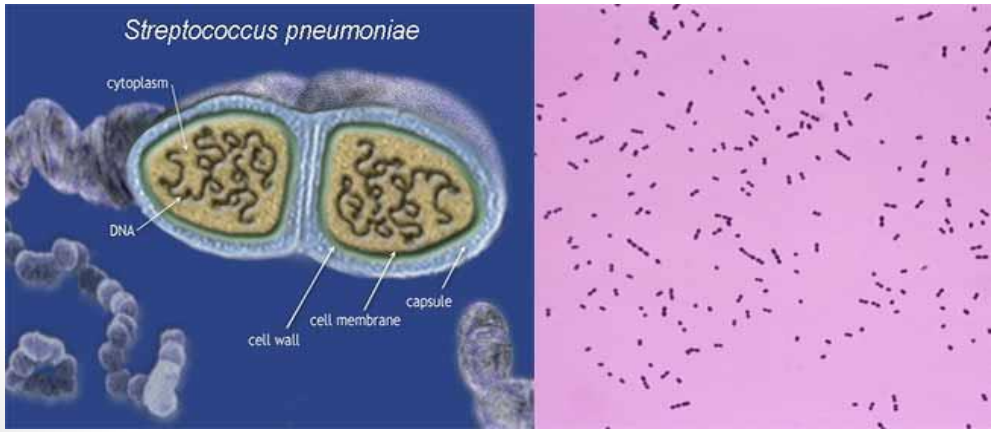
Streptococcus pyogenes(group A)

- **Laboratory diagnosis:**

  Gram stained smear and culture, beta hemolytic colonies on blood agar (hemolysis due to streptolysins O and S). If isolate is sensitive to bacitracin, it is identified as *Strep.pyogenes*

Streptococcus pneumoniae (pneumococcus)

- The pneumococcus are Gram positive diplococci , lancet shaped or arranged in chains , capsulated (polysaccharide)
- Pneumococcus are normal inhibit ants of the upper respiratory tract of humans and can cause : pneumonia , sinusitis , otitis , bronchitis , bacteremia , meningitis , and other
- **Culture:**
  - Pneumococci form small round colony , at first dome- shape , later developing a central plateau with elevated rim , alpha hemolysis on blood agar , growth is enhanced by 5 – 10 %CO2
- **Lab. Diagnosis:**
  - Blood is drawn for culture and sputum is collected for demonstration of pneu. by smear and culture



Thanks for your attention

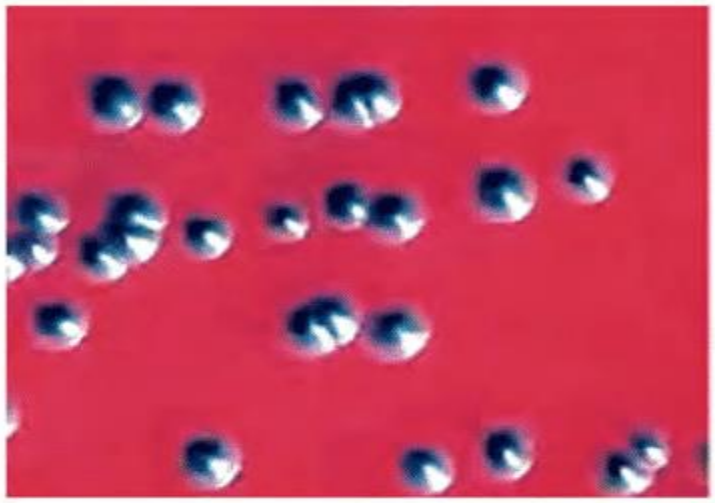
Microbiology

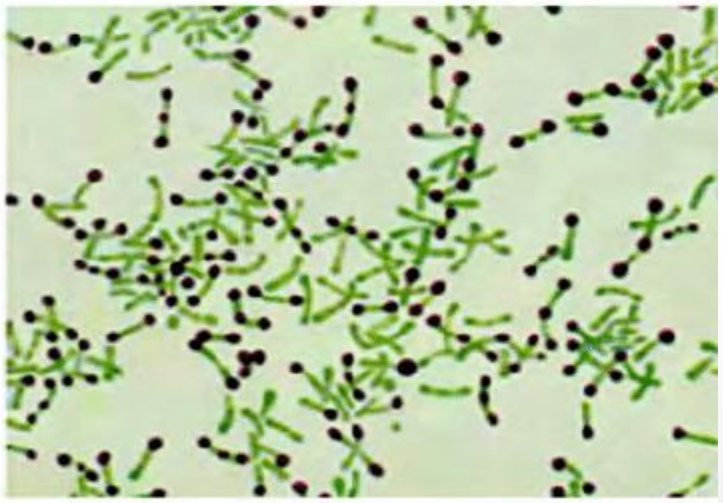
Lecture 6:- Corynebacterium diphtheria

Prof. fatima abood

Corynebacterium diphtheria

- **Morphology**:
- they are GPB non acid fast & non motile bacilli. Showing Clubbing at one or both ends. Non sporing & non capsulated. the presence Of metachromatic granules (Babes-Ernst) granules serve to distinguish it From diphtheroid. The granules are colored dark purple with methylene Blue. Albert or Neisse's stain
- The granules consist of polymerized metaphosphate. The bacilli seen in Chine's letter arrangement this is due to incomplete separation of Daughter cell after binary fission.





Corynebacterium diphtheria

- **Biochemical reaction**:

They are ferment glucose and maltose with acid production.

  - Catalase:- positive
  - Oxidase:- negative
  - Don’t liquefy gelatin
  - Urea is not hydrolyzed

- **Resistance:**
  - It is destroyed by heat (58C for 10 min)
  - It is sensitive to penicillin. Erythromycin & broad spectrum antibiotics .
  - It is resistant to drying

- **Toxin**:
  - Diphtheria produce very powerful exotoxin
  - Diphtheria toxin is protein in nature. It can be converted in to toxoid

Corynebacterium diphtheria

(toxin that has lost toxicity but not antigenicity) by :

1. Prolonged storage at 37C
2. Incubation at 37C for 4-6 weeks
3. %0.4-0.2 .3formalin

- The mechanism of action of toxin inhibits protein synthesis & rapidly kill Susceptible cell. It has affinity for myocardium. Adrenal tissue & nerve Endings.

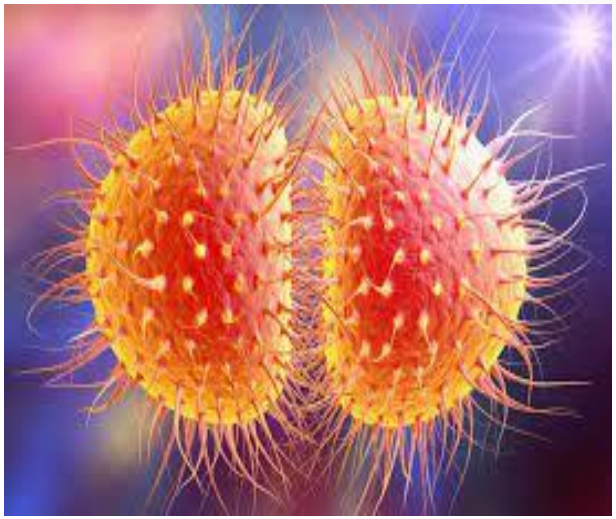
➢ **Pathogenesis**

Incubation period is 3-4 days. The site of infection may be:-

1. Facial
2. Iatyngeal
3. Nasal
4. Otitis
5. Conjunctiva
6. Cutaneous around mouth & nose.
7. Genital .

Neisseria

- **General character**: they are Gram negative, aerobic, none sporulation non motile, oxidase positive cocci ananged in pairs. The genus contains about 30 species. Two impottant pathogens are:
  - 1. *Neisseria meningitides*
  - 2. *Neisseria gonorrhea*



Neisseria meningitides

Morphology:

They are Gram negative, oval or spherical, arranged in pair with adjacent sides flattened

Classification: They are divided into 4 groups A, B, C, D. Three new groups have also recognized E,F and G.

Resistance:

They are highly susceptible to heat, desiccation, alteration in PH and disinfectants. They may acquire resistance to streptomycin readily.

Neisseria meningitides

Pathogenicity:

Meningococci are strict human parasites. The route of infection is usually

Nasopharynx. They produce cerebrospinal meningitis and meningococcal septicemia.

Toxin:

Endotoxin is released by the autolysis of organism, there are

Hemorrhagic manifestations

Neisseria gonorrhoeae

- **Morphology:**

it is strictly a parasite of man. The coccus is Gram negative, oval or spherical with adjacent side concave(bean shaped) arranged in pair. It is found predominantly within the polymorphs.

- **Classification:**

On the basis of colony morphology, autoagglutinability and virulence

there are four biotypes (T1, T2, T3, T4). T1&T2 are small, brown, autoagglutinable and virulent. T3&T4 produce large non pigmented colonies which are a virulent.

- **Resistance:**

They are killed by heat, drying and antiseptics. It is susceptible to

sulfonamides, penicillin and other antibiotics.

Neisseria gonorrhoeae

➢ Pathogenicity:

The gonococcus is a specific human parasite causing a venereal disease called gonorrhea. It produces lesion as follows:

- Incubation period is 2-8 days. In male it starts as acute urethritis with mucopurulent discharge containing gonococci, Infection may exited along urethra to prostate, seminal vesicle and epididymis.
- In females infection involves urethra and cervix uteri, Vagina is spared because of acidic PH. The infection may spread to Bartholin glands, endometrium and fallopian tubes.
- Pharyngitis and conjunctivitis may occur. Ophthalmic neonatorum occurs in new borne as a result of infection from genital tract of mother

Neisseria gonorrhoeae

Thanks for your attention

Microbiology

Lecture 7:- Food poisoning

Prof. fatima abood

Food poisoning

- **Food poisoning** is an illness caused by eating contaminated food with pathogenic microorganisms.
- More than 90 percent of the cases of food poisoning each year are caused by;-

❑ Bacterial Sources : such as

Staphylococcus aureus, Salmonella, Clostridium perfringens, Campylobacter, Listeria monocytogenes, Vibrio parahaemolyticus, Bacillus cereus, and Escherichia coli

❑ Non Bacterial Sources such as:

Fungal(*Aspergillus*),Parasitic(Giardiasis),Viral(Hepatitis A) .

Classification of food borne diseases:

1-Food borne infection

- Foodborne is caused by the ingestion of food containing live bacteria which grow and establish themselves in the human intestinal tract.

2-Food borne intoxication

- Foodborne is caused by ingesting food containing toxins formed by bacteria which resulted from the bacterial growth in the food item. The live microorganism does not have to be consumed.

Food poisoning or foodborne illness

Foodborne infections

Symptoms, after 8-24h

abdominal pain

diarrhea

Duration 1-3 days

Bacteria, virus &parasites

Foodborne intoxications

Symptoms, after 0-4h

nausea

vomiting

Duration 1 day

Bacterial toxin

Signs and symptoms

- The main symptoms include:

1. feeling sick (nausea)
2. vomiting
3. diarrhea, (blood or mucus)
4. stomach cramps and abdominal pain
5. a lack of energy and weakness
6. loss of appetite
7. a high temperature (fever)
8. aching muscles
9. chills

Protection :

- Wash hands, food preparation ,surfaces and utensils thoroughly before and after handling raw foods to prevent recontamination of cooked foods.
- Keep refrigerated foods below (5) C.
- Serve hot foods immediately or keep them heated above (60)C .

Foodborne diseases caused by bacterial infection

❑*Salmonellosis*

- Salmonella food poisoning or salmonellosis is a disease caused by a type of salmonella bacteria infection such as *S. typhimurium* .
- High protein foods such as meat, fish and eggs
- any food at improper temperatures can cause salmonellosis.
- contamination of cooked foods and insufficient cooking. contamination of cooked foods occurs from contact with surfaces or hands that were not washed after use with raw products.
- **The signs & symptoms of salmonellosis**
  1. Stomach cramps
  2. Diarrhea
  3. Fever
  4. Muscle pain
  5. Dehydration
  6. Nausea & vomiting .

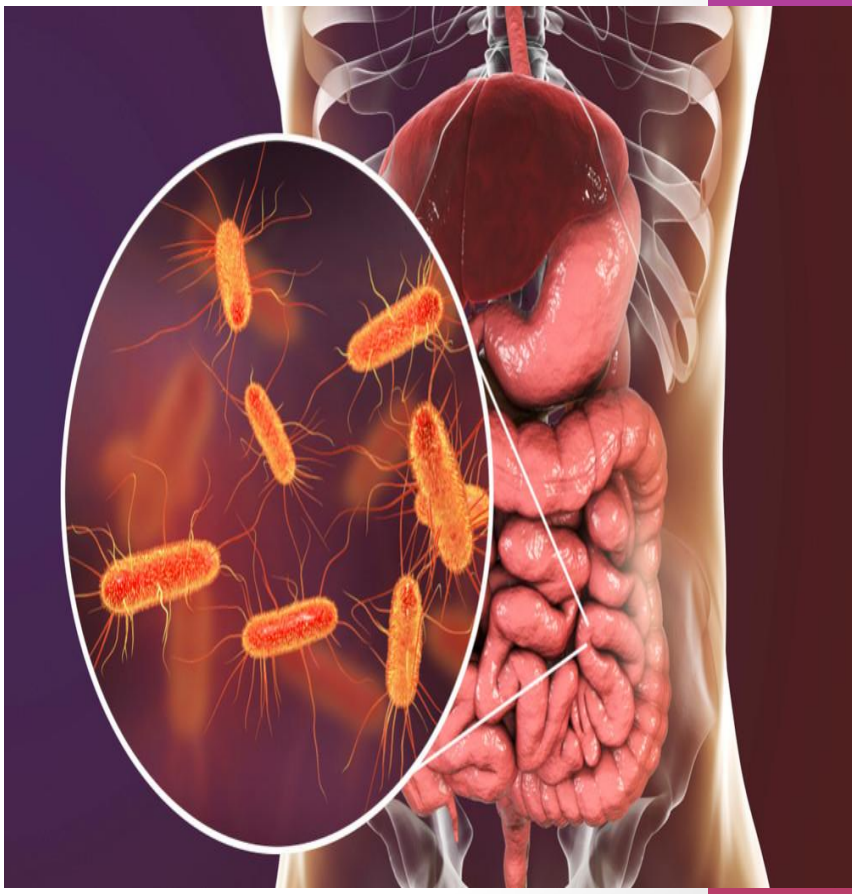
Vibrio parahaemolyticus

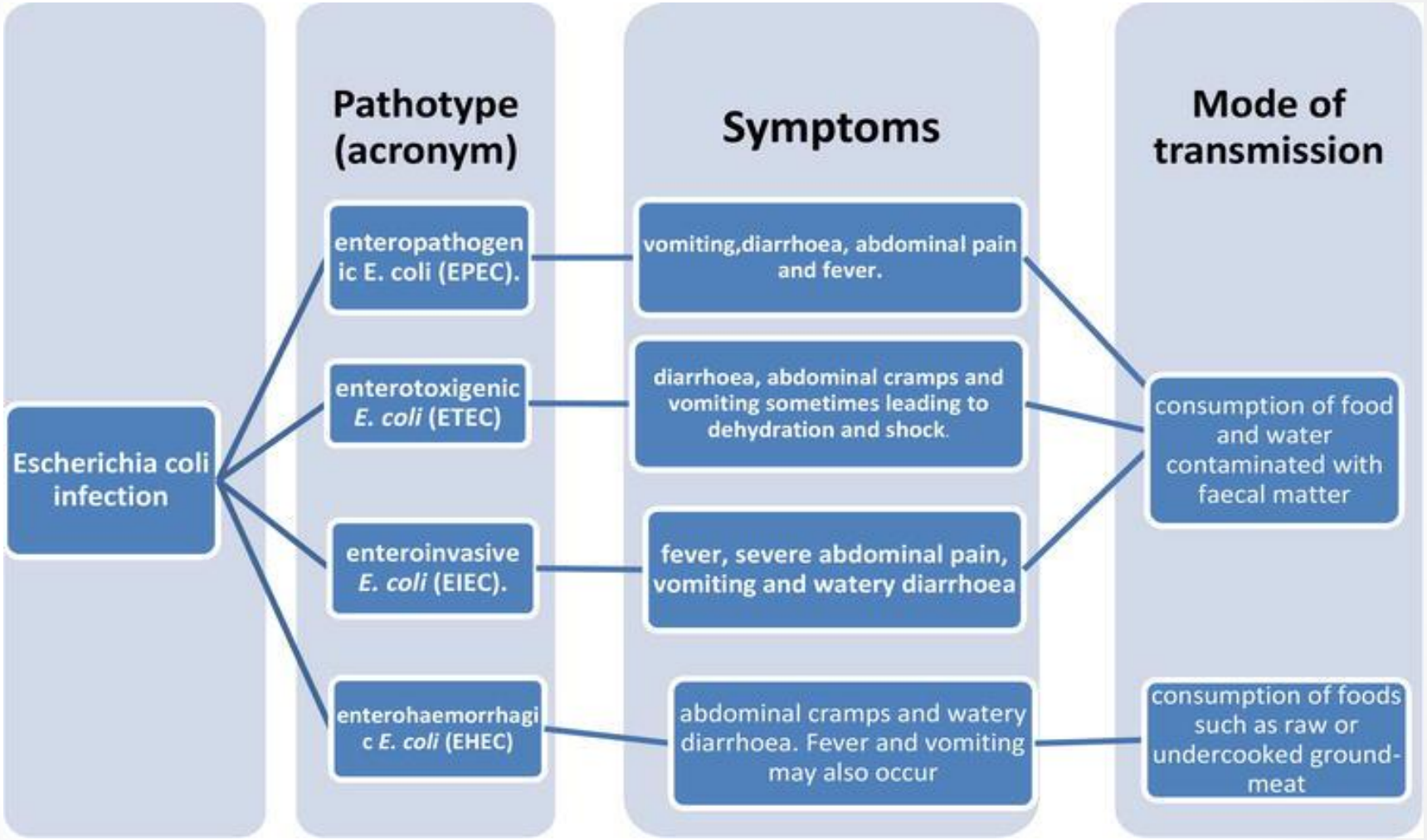
- *Vibrio parahaemolyticus* is a pathogenic bacteria causing food borne infection. whose natural found in the sea
- Human infections occur from sea foods oysters, crabs fish, clams , and requires the salt environment of sea water for growth.

Escherichia coli

- *E. coli* is potential food poising pathogens which are widely distributed.
- *E. coli* strains involved in food borne infection fall into the following qroups:

1. Enteropathogenic *E. coli* (EPEC)
2. Enterotoxigenic *E. Coli* (ETEC)
3. Enteroinvasive *E. coli* (EIEC)
4. Enterohemorrhagic *E. coli* (EHEC).




Escherichia coli infection
Pathotype (acronym)
enteropathogenic E. coli (EPEC).
enterotoxigenic E. coli (ETEC)
enteroinvasive E. coli (EIEC).
enterohaemorrhagic E. coli (EHEC)
Symptoms
vomiting,diarrhoea, abdominal pain and fever.
diarrhoea, abdominal cramps and vomiting sometimes leading to dehydration and shock.
fever, severe abdominal pain, vomiting and watery diarrhoea
abdominal cramps and watery diarrhoea. Fever and vomiting may also occur
Mode of transmission
consumption of food and water contaminated with faecal matter
consumption of foods such as raw or undercooked ground-meat

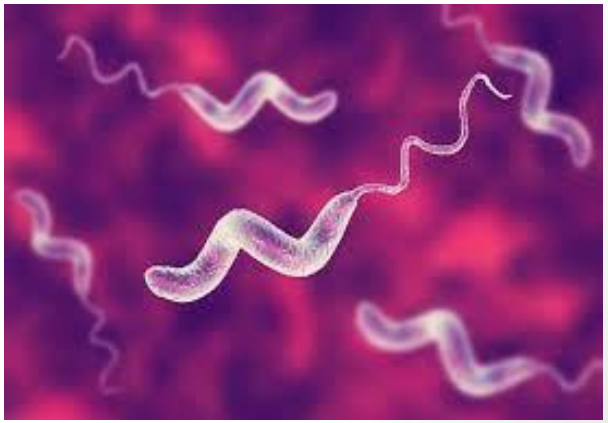
Campylobacteriosis

Campylobacter jejuni & campylobacter coli cause food poisoning and are associated with acute enterocolitis in man.

C. jejuni occur in large numbers in cattle feces as normal flora.

Transmission

- fecal contamination of food and water and contact with sick people or animals, meats, Milk.
- Meat from infected animals



Foodborne diseases caused by bacterial toxins

Bacillus cereus

- *B. cereus* is found in dust, soil and spices.
- It can survive normal cooking as a heat-resistant spore, and then produce a large number of cells if the storage temperature is incorrect.
- foods such as rice, macaroni and potato dishes are most often involved.
- The organism produces the following enterotoxins

❑Emetic toxin .

❑ Two diarrheal enterotoxins

✓Hemolysin

✓Non-hemolysin

Thanks for
your
attention

Microbiology

Lecture 8:-Contamination of hospitals

Prof. fatima abood

Nosocomial Infections

- Infection developing in patients after admission to the hospital, which was neither present nor in the incubation period at the time of hospitalization
- They may become evident during patient's stay or after their discharge
- Hospital acquired infections
- Hospital associated infections
- Hospital infections

Where do the microbes come from?

- Patient's own flora
- Cross infection from medical personnel
- Cross infection from patient to patient
- Hospital environment (inanimate objects): -
- Air
- Water
- Dust
- IV fluids & catheters
- Washbowls
- Bedpans
- Endoscopes
- Ventilators & respiratory equipment

Sources of Infection

- **Endogenous:**
  - Patients own flora may invade patient's tissue during some surgical operations or instrumental manipulations
  - Normal commensals of the skin, respiratory, GI, UG tract
- **Exogenous:**
  - From another patient / staff member / environment in the hospital
  - Environmental sources: Inanimate objects, air, water, food
  - Cross infection from: other patients, hospital staff (suffering from infections or asymptomatic carriers)

Microorganisms

- Any pathogen , on occasion, can cause HAI (healthcare-associated infections)
- Those that are able to survive in hospital environment & develop resistance to antibiotics & disinfectants: major cause
- **Commensal bacteria**: found in the normal flora of healthy people. significant protective role by preventing colonization by pathogenic microorganisms.

  Some commensal bacteria may cause infection if the host is compromised.

  Eg: *Staphylococcus epidermidis* (cause of i.v. infections), *Escherichia coli* (cause of urinary infections).
- **Pathogenic bacteria**: they have greater virulence, and cause infections (sporadic or epidemic) regardless of host status.

Bacteria:

- **Gram positive bacteria:**
- *Staphylococcus aureus*: bacteria that colonize the skin, nose and throat of patients and hospital staff. They cause a wide variety of lung, bone, heart and bloodstream infections and are frequently resistant to antibiotics.
- In hospitals commonly 40-50% of S. aureus isolates are MRSA.
- Multidrug resistant *Staphylococcus aureus* (MRSA): colonize hospitals & cause Nosocomial infections. Thus, known as 'Hospital Staphylococci
- *Staph epidermidis* & Group D Streptococci
- Streptococci: *Streptococcus hemolyticus*, *Streptococcus Pyogenes*
- *Clostridium tetani* spores: survive in dust for very long time

Gram negative bacteria

- In recent decades, enteric Gram negative bacilli → most important group of hospital pathogens
- **Enterobacteriaceae**: (*E. coli*, *Proteus*, *Klebsiella*, *Enterobacter*, *Serratia*) may colonize sites when the host defences are compromised. They may also be highly antibiotic resistant.
- ***Pseudomonas spp***: - often isolated in water .They may colonize the digestive tract of hospitalized patients.
  - Ability to survive & multiply at low temp
  - Resistance towards antibiotics & disinfectants

- **Viruses:**
  - HIV and Hepatitis B & C viruses: transmitted through blood & blood products •
  - Viral diarrhea & Chickenpox can be spread in hospitals
  - Cytomegalovirus, Herpes virus, Influenza, Enteroviruses & Arenaviruses can cause HAI
- **Fungi:**
  - *Candida albicans*, *Aspergillus*, *Mucor*
- **Protozoa:**
  - *Entamoeba histolyt*ica, *Plasmodia*, *Toxoplasma gondii*, *Pneumocystis carinii*

Modes of Transmission

1. **Contact**: Most common route of transmission

- Hands or Clothing: - Hands of staff: important vehicle of spread
  - E.g: *Staphylococcus aureus*, *Streptococcus pyogenes*
- Inanimate objects:- Improper disinfection of Instruments: endoscope, bronchoscope, cystoscope
  - Eg: *Pseudomonas aeruginosa*

2. Airborne:

  - Droplets: - Droplets of Respiratory infections: transmitted by inhalation
  - Dust: - Dust from bedding, floors & skin
  - E.g: *Pseudomonas aeruginosa, Staphylococcus aureus*

3. Oral Route: - Hospital food may contain Antibiotic-resistant bacteria → may colonize intestine → can cause infections

Common Nosocomial Infections

- **UTI:**
  - Most common HAI (40% of Nosocomial infections)
  - Usually associated with catheterization or instrumentation of urethra, bladder or kidneys
  - Eg: *E. coli*, *Klebsiella*, *Proteus*, *Serratia*, *Pseudomonas*, *Candida albicans*
- **Pneumonia (Respiratory Infections):**
  - *Eg: Staph. aureus*, *Klebsiella*, *Enterobacter*, *Serratia*, *Proteus*, *Pseudomonas*, *Acinetobacter*, *Legionella*, *E. coli*

- **Wound & skin sepsis:**
  - Follow surgical procedure where causative agents are introduced into the tissue during operations
  - Non-surgical wounds due to burns, bed sores.
  - Eg: *Staph aureus*, *Pseudomonas aeruginosa*, *E. coli*, *Proteus*
- **Gastrointestinal infections**:
  - Food poisoning due to *Salmonella*, *Shigella sonnei*
  - Diarrhea due to E. coli
- **Bacteremia & Septicemia:**
  - Bacterial invasion of bloodstream in various HAIs
  - Gram negative bacilli: common pathogens

Thanks for your attention

Microbiology

Lecture 9:- **General Characters Of Fungi**

Prof. fatima abood

- **Medical Mycology** :- is the study of human diseases caused by fungi and **Mycosis** is the term given to any disease caused by a fungus .
- **General Characters Of Fungi**

1. All fungi are eukaryotic
2. Obligate or facultative aerobic
3. Natural habitat soil, water and decaying organic debris
4. Chemotrophic organisms
5. Fungi are Heterotrophic "depend on other organism for food and are different from plants which are "Autotrophic".

   Heterotrophic organisms are 3 kinds:

   A) **Saprophytic**: the fungus is living on dead organic matter.

   B) **Symbiotic**: the fungus is living together with other organism.

   C) **Parasitic**: the fungus is living in an organism and it is harmful to it e.g. *Candida albican.*
6. Beneficial fungi are important in the production of cheeses and antibiotics e.g. Penicillin.
7. Most of Fungi are microscopic but some can be seen by naked eye.

Differences from bacteria

Characteristics	Prokaryotic cell	Eukaryotic cell
Nucleus	Primitve nucleous	One or more true nucleus
Genetic material	Circular DNA	Arranged in chromosomes
Size of cell	Usually smaller	Usually larger
Cell wall	Contains peptidoglycan	No peptidoglycan
Division	Simple binary fission	Mitosis and Meiosis

Classification of fungi

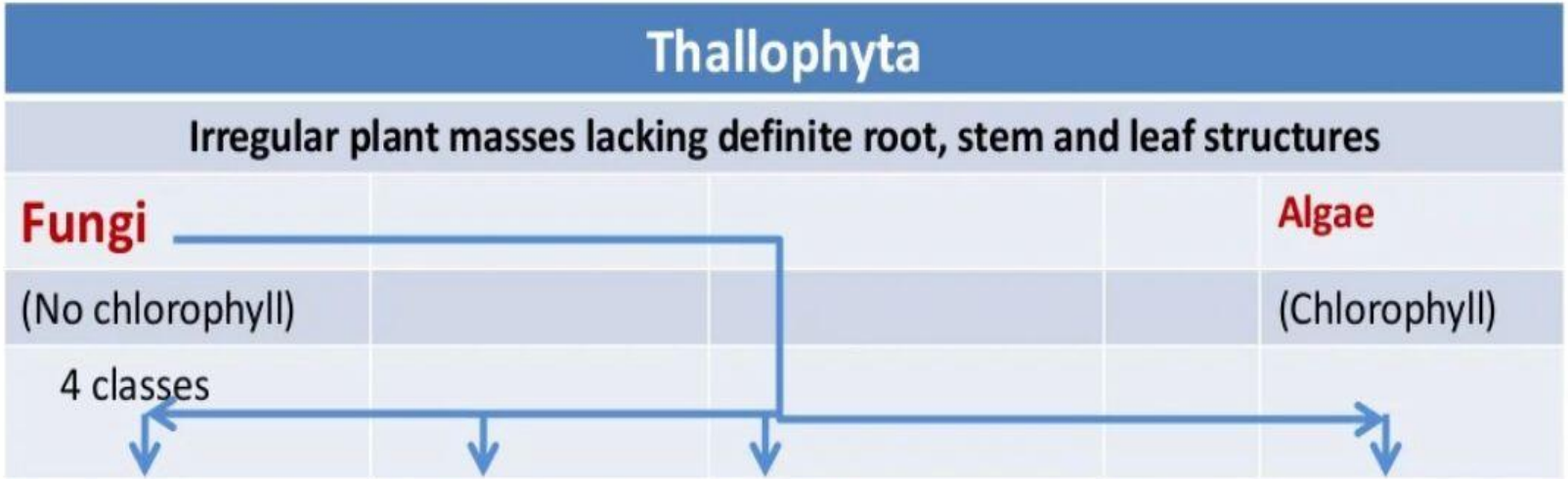
A. Taxonomic classification

- Phylum Thallophyta
- Four classes of fungi

B. Morphological classification

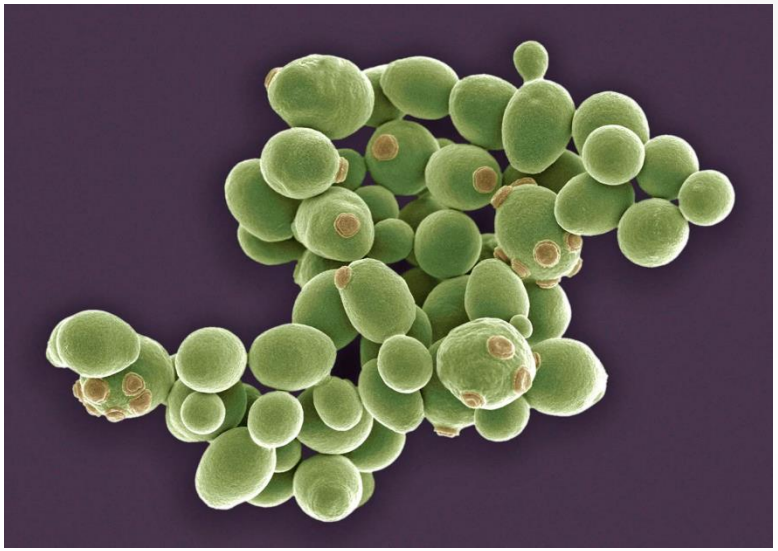
- Yeasts
- Yeasts like fungi
- Moulds
- Dimorphic fungi

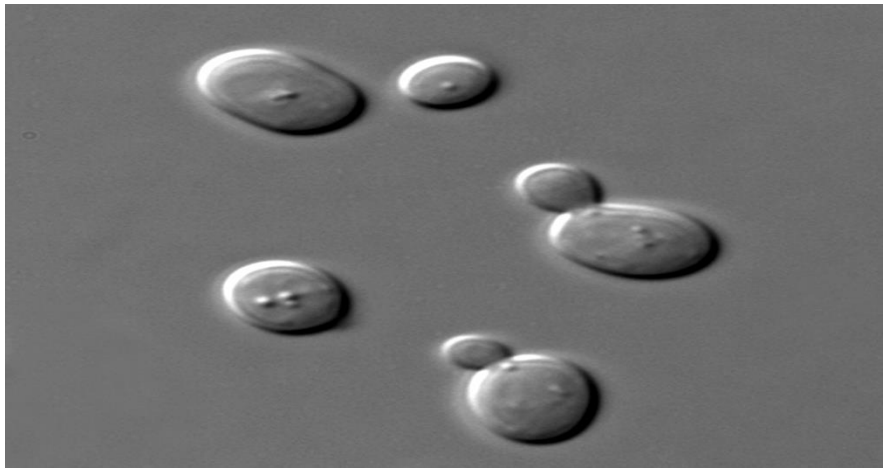
Thallophyta



Yeasts

- Round to oval unicellular
- Reproduce by budding
- Creamy mucoid colonies
- *E.g.* *Cryptococcus neoformans*





Yeasts like fungi

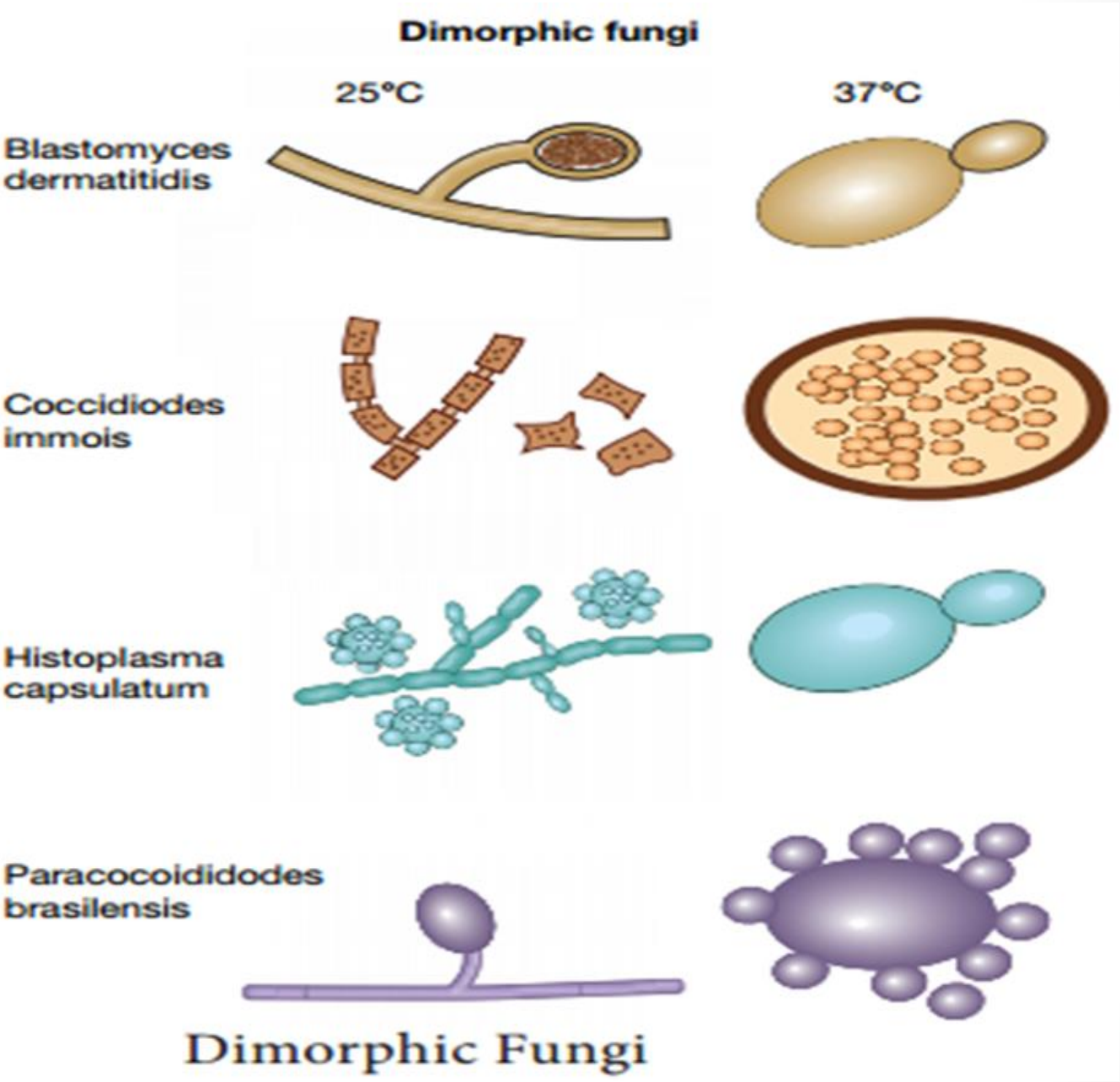
- Partly as yeasts and partly as elongated budding cells
- Germ tube to demonstrate pseudohyphae

Moulds

1. Grow as branching filaments – hyphae
2. Hyphae septate or nonseptate
3. Continue growth called as mycelium
4. E.g Dermatophytes, *Aspergillus*, *Penicillium* and *Rhizophus*

Dimorphic fungi

- They exists as yeasts in host tissue and in cultures as mycelial growth
- *Blastomyces dermatitidis*, *Paracoccidioides*, *Coccidiodes immitis*, *Histoplasma*, *Sporothrix*


Dimorphic fungi
25°C
37°C
Blastomyces dermatitidis
Coccidiodes immois
Histoplasma capsulatum
Paracocoididodes brasilensis
Dimorphic Fungi

Laboratory Diagnosis

A. A. Direct microscopy
   - KOH preparation
   - Gram staining
   - India ink preparation

B. Culture
   - SDA

C. Slide culture test

Fungi diseases

Mycotic infections are classified by the tissue levels that are colonized.

- **Superficial infections** are generally limited to the outer layers of the skin and hair.
- **Cutaneous infections** are located deeper in the epidermis, hair and nails. (e.g. dermatophytes cause ringworm)
- **Subcutaneous infections** involve the dermis, subcutaneous tissues and muscle.(e.g. Sporotrichosis)
- **Systemic**, generally originating in the lungs and other organs. (e.g. Coccidioomycosis & Histoplasmosis)
- **Opportunistic**, and these may involve a variety of body sites. (e.g. Aspergillosis & Systemic Candidiasis & Cryptococcosis)

Superficial mycoses

- **Pityriasis versicolor** – pigmented lesion on torso (trunk of the human body).
- **Tinea nigra** – gray to black macular lesion on palms.
- **Black piedra** – dark gritty deposits on hair.
- **White piedra** – soft whitish granules along hair shaft.

❖ All diagnosed by microscopy and easily treated by topical preparation.

Pityriasis versicolor

Thanks for your attention

Microbiology

Lecture 10:- **The viruses**

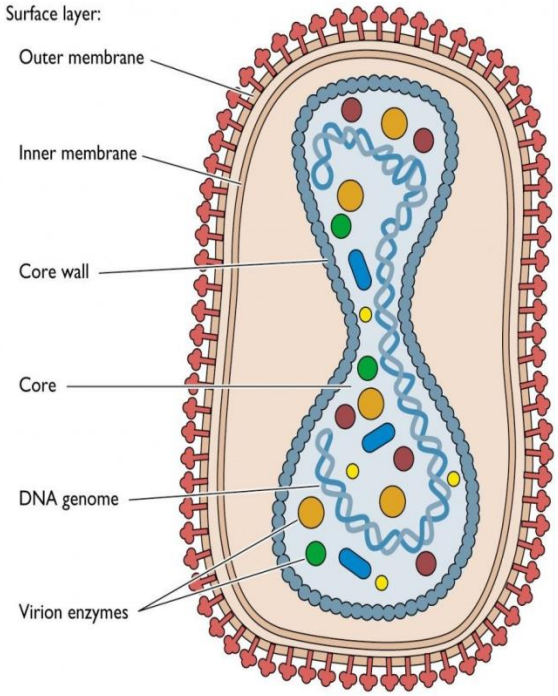
Prof. fatima abood

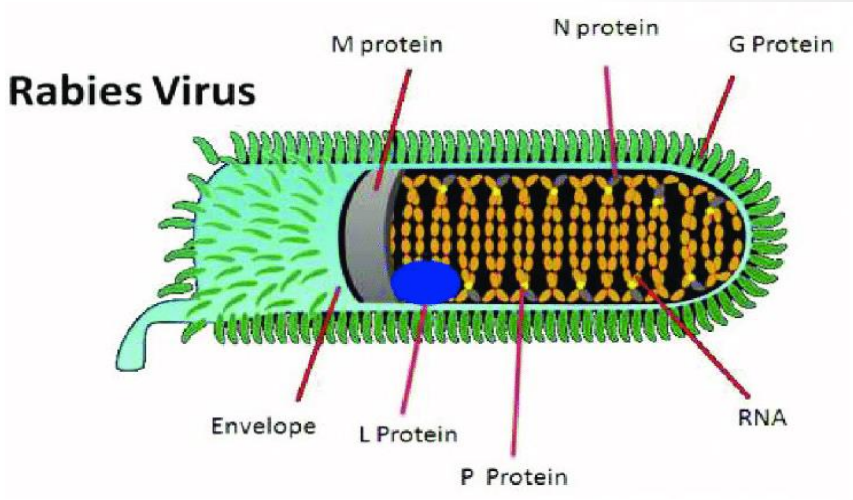
Viruses

- **Virus** is unicellular ultramicroscopic particles, containing either RNA or DNA, reproducing inside living cells .
- **Characters:-**
  1. do not posses cellular organization
  2. Contain one type of nucleic acid either RNA or DNA never both
  3. Lack enzymes necessary for protein and nucleic acid synthesis
  4. They multiply by complex process inside living cell called replication not by binary fission
  5. They are unaffected by antimicrobial or antibiotic
  6. They are sensitive for interferon, which is chemical substance give resistance to the immunity system .

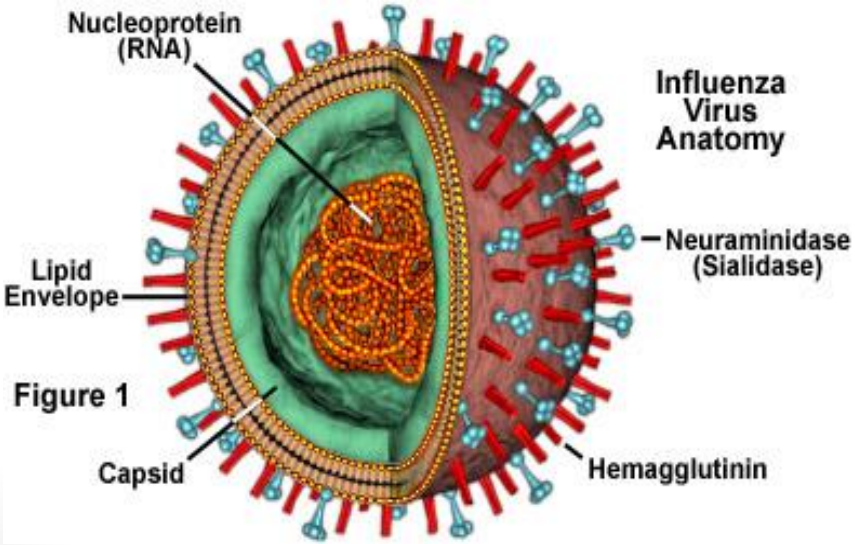
Morphology of virus

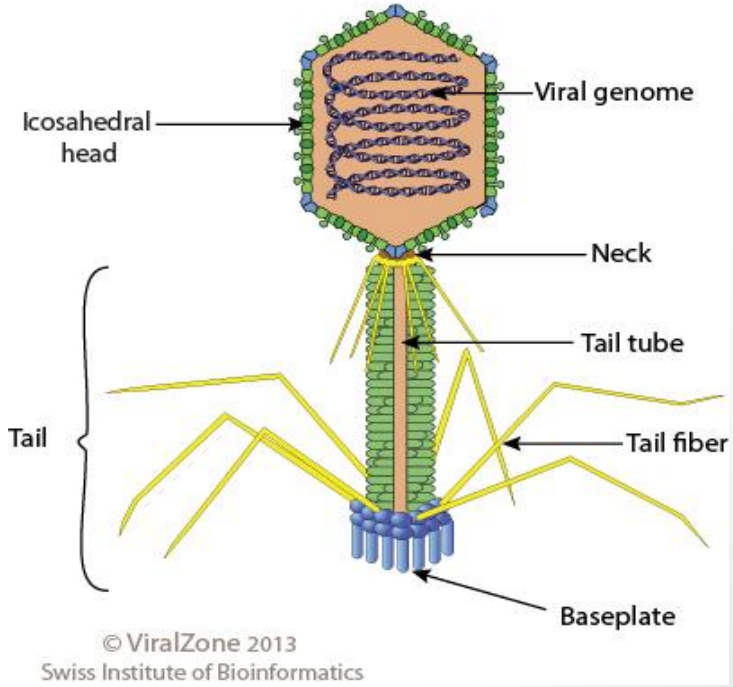
- **Size :-**
  - Viruses are very widely in size .
    - The largest virus them is pox viruses measuring about 300 nm.
    - The smallest virus are foot and mouth virus measuring about 20 nm
- **Shape:-**
  - Viruses are also widely in shape , some have characteristic shape like,
    - Rabies virus have bullet shape,
    - Pox virus have brick shape,
    - Influenza virus have spherical shape,
    - Bacteriophage have head ,neck & tail



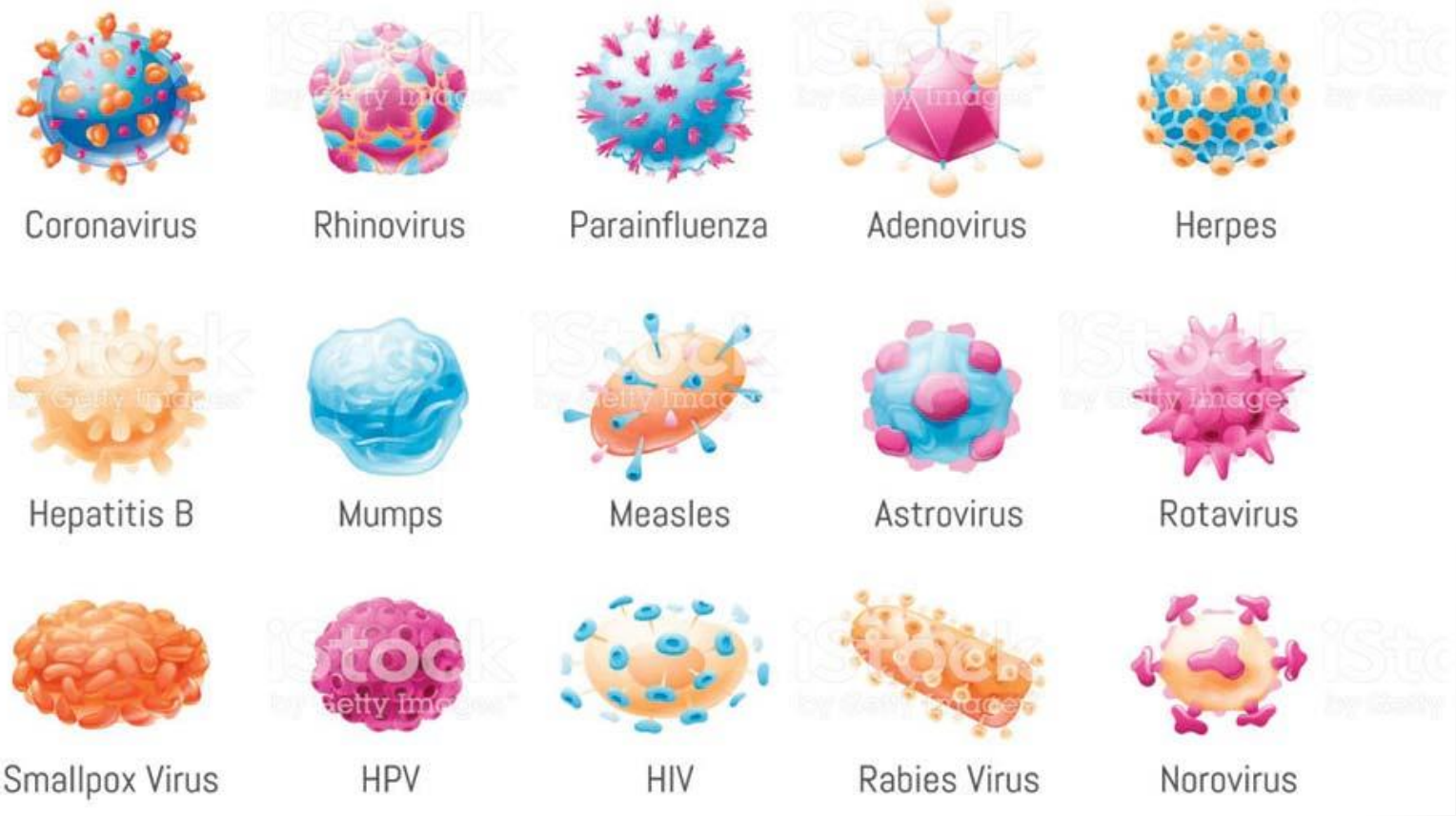


Typical structure of Tailed bacterial virus





Shapes of viruses



Structure

A virus particle, or virion, consists of the following:

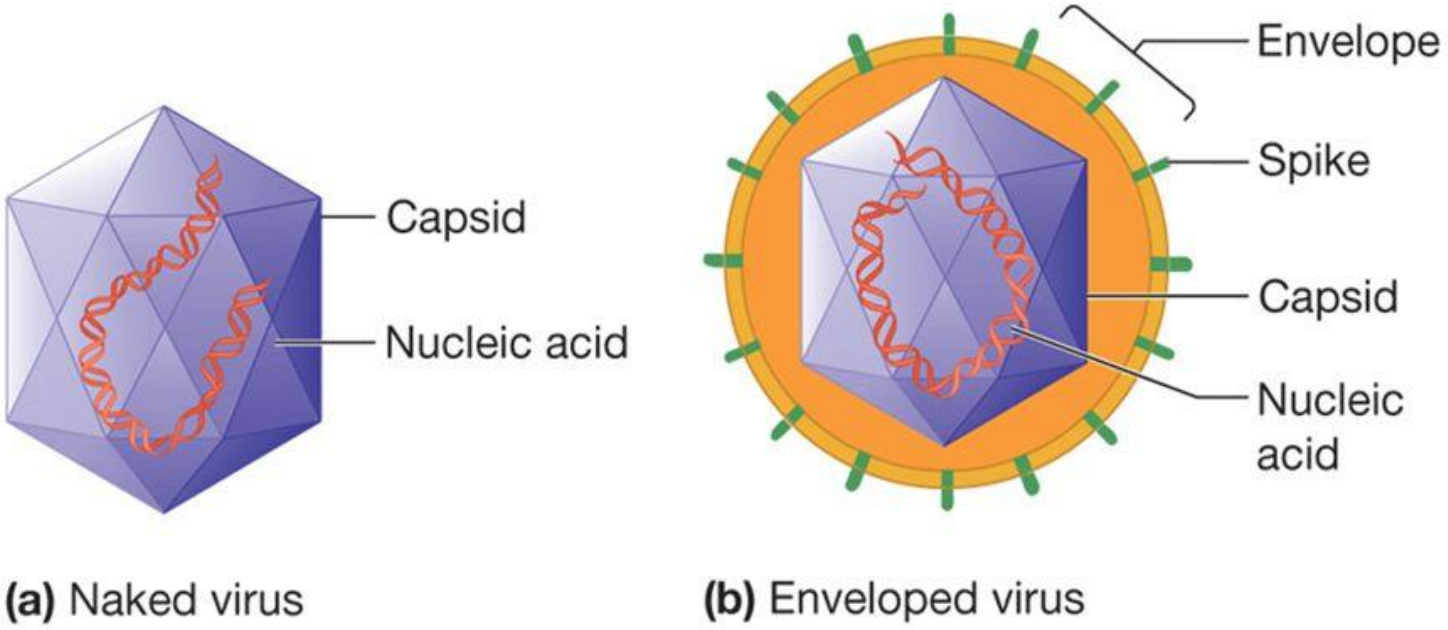
Nucleic acid - genetic instructions, either DNA or RNA

Protein coat (capsid) - Surrounds the DNA or RNA; for protection of genetic material

Lipid membrane - Surrounds the protein coat (found only in some viruses, including influenza)

These types of viruses are called enveloped viruses as opposed to naked viruses

Generalized Structure of Viruses

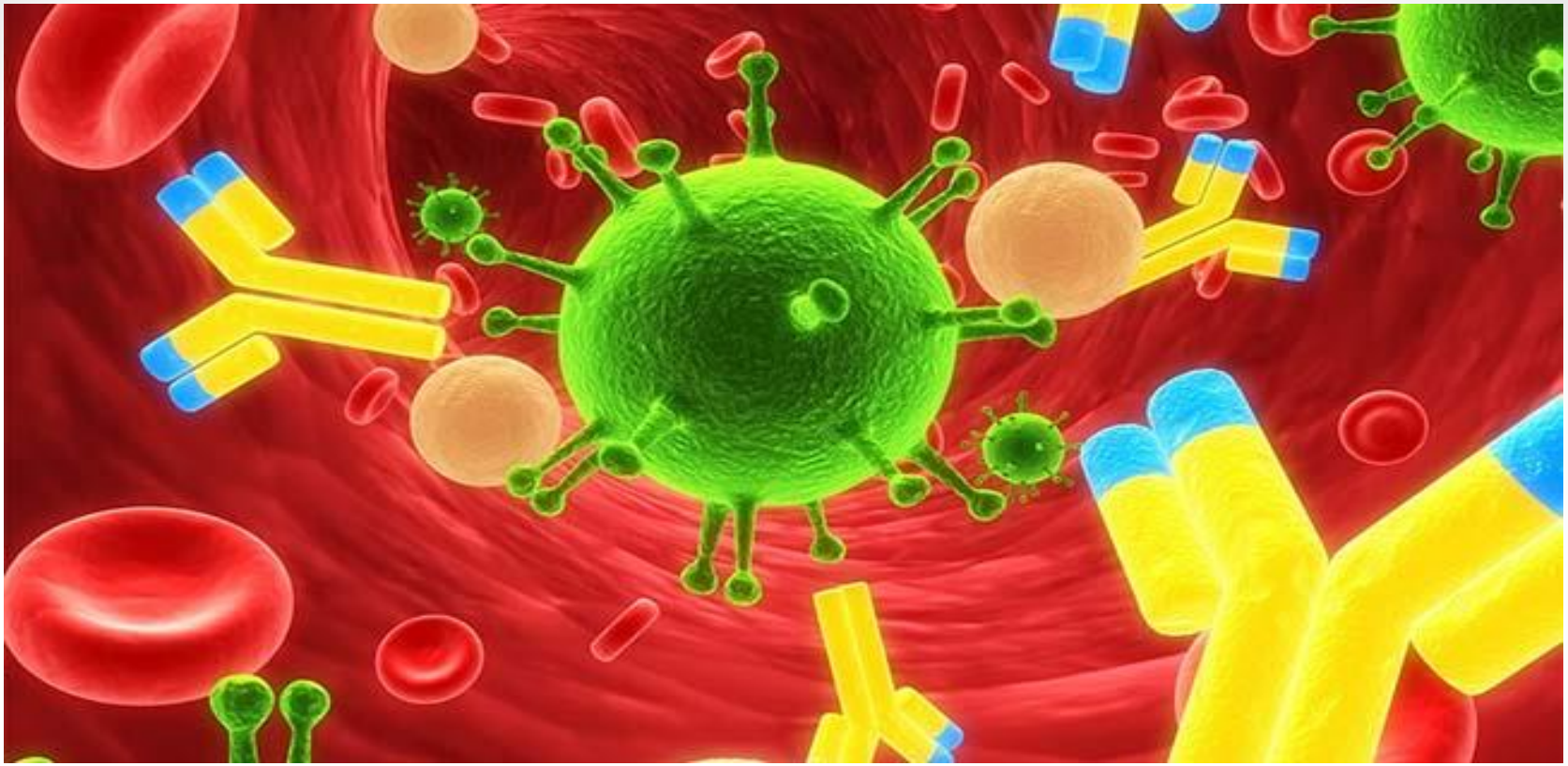


- virions having envelopes = enveloped viruses
- virions lacking envelopes = naked viruses

Some virual diseaes

- Influenza virus
- Mumps virus
- Small pox virus
- Poliomyelitis virus
- Measles virus
- Coronavirus
- Hepatitis virus
- HIV
- Ebola virus

Thanks for your attention



Immunology

Lecture11 :- Introduction Of immunology

Prof. fatima abood

Immunology

- **Immunology**: is the science that studying the immune system and deferens mechanisms against diseases and pathogens.
- **Immunity** : refers to all the mechanisms used by the body for protection against environmental agents that are foreign to the body.
- The immunity may be **innate** or **acquired(adaptive)**.
- **What is make the immune system different other systems?**

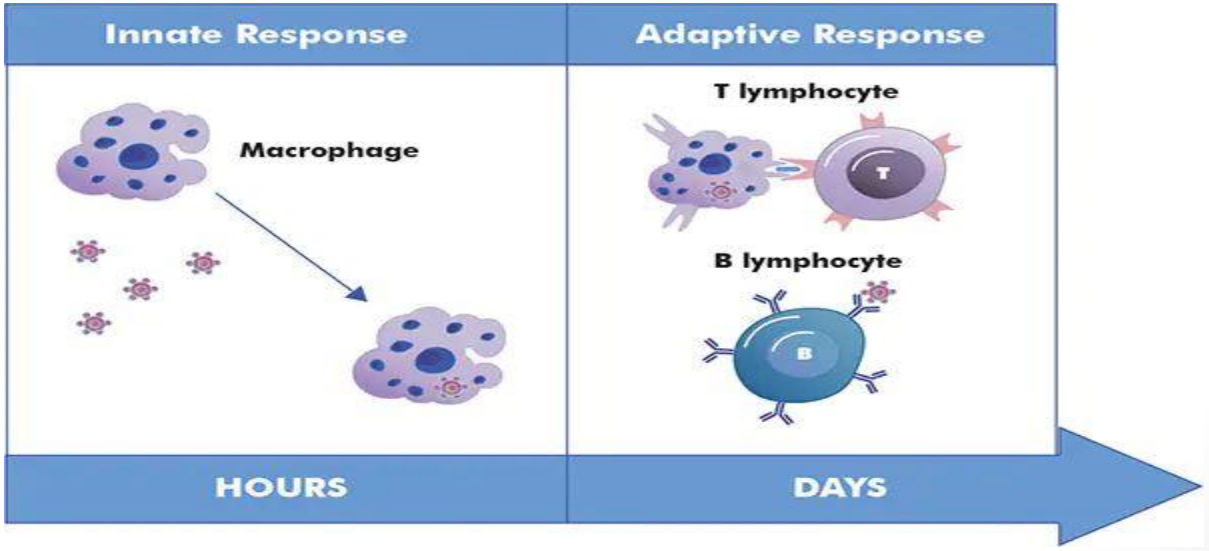
  1- specificity

  2- adaptiveness

  3- discrimination between self and nonself

  4- memory

Property	Innate	adaptive
characteristics	Antigen nonspecific Rapid response (minutes to hours) No memory	Antigen specific Slow response (days) Memory
Immune components	Natural barriers (e.g. skin, mucous Membranes Phagocytes and natural killer cells	Lymphocytes Antigen recognition molecules (B and T cell receptors

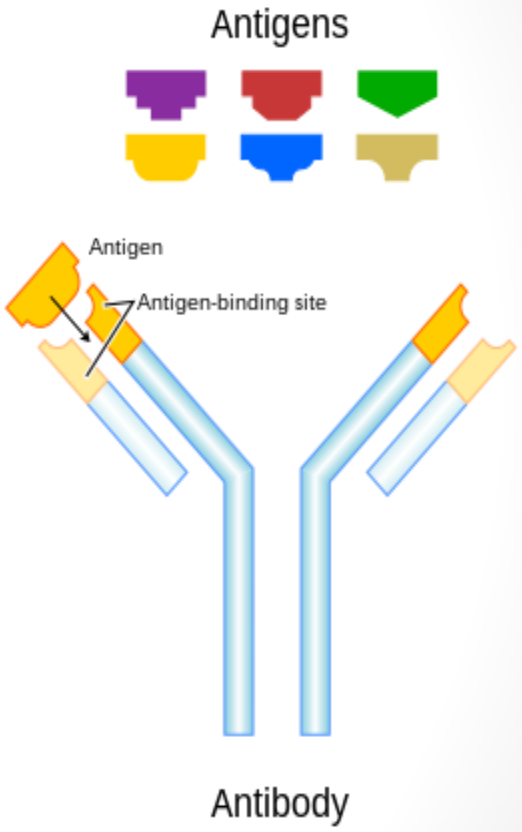


Antigen

- **Antigen**: is any agent that capable of binding specifically to components of the immune response such as lymphocytes and antibodies.
- **Immunogen**: is any agent capable of inducing an immune response.
- **Haptens** are small molecules that elicit an immune response only when attached to a large carrier such as a protein
- **Autoimmunity**: the body respond to it own components.
- **Characteristics of antigens**
  - 1- Foreignness
  - 2- High molecular weight
  - 3- Chemical complexity
  - 4- Degradability
  - 5- Genetic constitution

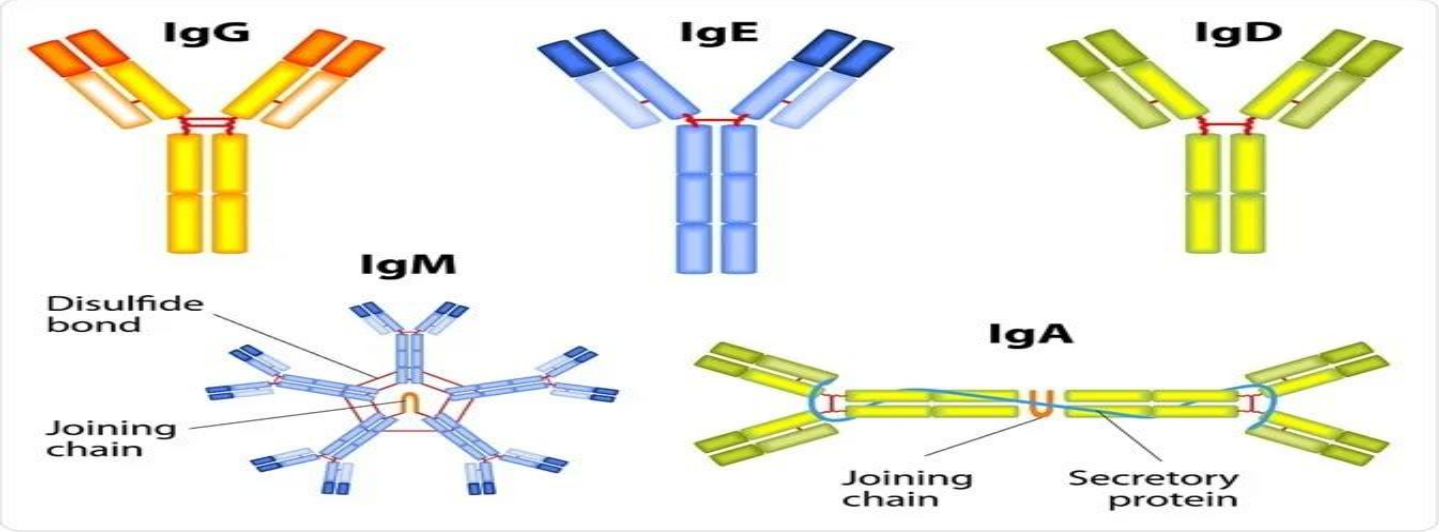
Antibody

- **antibody (Ab)**, also known as an immunoglobulin (Ig), is a large, Y-shaped protein used by the immune system to identify and neutralize foreign objects such as pathogenic bacteria and viruses
- The antibody recognizes a unique molecule of the pathogen, called an antigen.



Antibody types

- There are 5 types of heavy chain constant regions in antibodies (immunoglobulin) and according to these types, they are classified into **IgG**, **IgM**, **IgA**, **IgD**, and **IgE**. They are distributed and function differently in the body.
- **IgG** Cross of placenta; **IgA** found in saliva & mucous: **IgE** responsible for allergic reaction ; **IgD** activation mast cells ; **IgM** have 5 arms



Thanks you