MICROBIOLOGY

Mr. KIWA

BScN/KRCHN.

MICROBIOLOGY

MODULE COMPETENCES

- To enable the learner to acquire knowledge of the normal structure and function of the human body, microbiology, and apply relevant skills and attitudes to promote health, prevent and manage illnesses.

Module objectives

- To apply knowledge of microbiology,parasitology and immunology in promoting health, preventing illnesses, diagnosing, managing and rehabilitating patients/clients suffering from diseases caused by microorganisms.
- To acquire knowledge of the normal structure and function of the human body as a basis for identifying deviations from normal.

CONTENT

Microbiology

- infection
- Sources of microorganisms
- Modes of transmission
- Classification of microorganisms and their clinical importance.

Parasitology

- sources of parasites
- classification of parasites:- *ascariasis,hookworm,tapeworm,filariliasis,plasmodium*
- modes of transmission
- life cycle and clinical importance.

Immunology

- Types of immunity: *humoral,cellular,passive,active and herd immunity.*
- Immunological processes
- Immunizing agents and clinical importance.

MICROBIOLOGY

Learning objectives

Define microbiology,pathogen,non-pathogen,and opportunistic pathogen

List reasons why microorganisms are important

Explain historical development of microbiology

Describe the characteristics of microorganisms

Explain the classification of microorganisms

Discuss the significance of microbiology in nursing

Identify microorganisms in a laboratory

MICROBIOLOGY

What is microbiology?

- **Micro** means very small-anything so small that it must be viewed with a **microscope**(A microscope is an optical instrument used to observe small objects) **. Bios** refers to living organisms and **Logy** means the study of
- Therefore, **microbiology** is the study of very small living organisms- called microorganisms or microbes. Microorganisms are said to be **ubiquitous** meaning they are virtually everywhere.
- The various categories of microorganisms include: ***Viruses,Bacteria,Archaeans,Certain Algae,Protozoa and CertainFungi.***

What is microbiology? Cont'd

- Most scientists do not consider viruses to be living organisms,they are often reffered to as infectious agents or infectious particles rather than microorganisms.
- Disease causing microorganisms are called **pathogens**. Only about 3% of known microbes are capable of causing disease. Thus, the vast majority known microorganisms are **nonpathogens** (_microorganisms that do not cause disease.)

Why study microbiology?

- Although they are very small, microorganisms play very important role in our lives.

1. organisms living on and in our bodies (e.g on our skin, in our mouth, and interstinal tract) are known as **indigenous microflora .** They are important to us because inhibit the growth of pathogens in those areas of the body where they live by occupying space, depleting the food supply, and secreting materials(wasteproducts,toxins,antibiotics etc)that may prevent or reduce growth of pathogens.

Why study microbiology cont'd?

2. Some organisms that colonize (inhabit) our body are known as opportunistic pathogens (or opportunists.). Although such organisms do not usually cause any problems, they have the potential to cause infections if they gain access to a part of our anatomy where they do not belong. Other opportunistic pathogens strike when a person becomes run down, stressed out or debilitated by disease or condition.

   Opportunistic pathogens can be thought of as microorganisms awaiting the opportunity to cause disease.

Why study microbiology cont'd?

3. Microorganisms are essential for life on this planet because they produce oxygen by the process known as photosynthesis. Actually microorganisms contribute more oxygen to our atmosphere than do plants. Such organisms include algae and cyanobacteria (a group of photosynthetic bacteria).

4. Many microorganisms are involved in the decomposition of dead organisms and waste products of living organisms. Collectively they are called decomposers or saprophytes. A **saprophyte** is an organism that lives on dead and or decaying organic matter.

Why study microbiology cont'd?

5. Microorganisms are involved in breaking down dead organic materials into inorganic nutrients (e.g. nitrates and phosphates). This is important to farmers.

6. Microorganisms serve as important links in food chains. e.g Algae and Bacteria serve as food for tiny animals, larger animals eat small creatures and so on.

7. Some microorganisms which live in the intestinal tracts of animals' aid in the digestion of food and, in some cases, produce substances that are of value to the host animal. E.g E.coli produces vitamins **K** and $\mathbf{B_1}$ which are used and absorbed by human body.

Why study microbiology cont'd?

8. Certain bacteria and fungi produce antibiotics that are used to treat patients with infectious diseases. An **antibiotic** is a substance produced by a microorganism that is effective in killing or inhibiting the growth of other microorganisms.

9. Microbes are essential in the field of genetic engineering. Bacteria and yeast have been engineered to produce a variety of substances, such as insulin, various types of growth hormone, interferones, and materials for use as vaccines.

Why study microbiology cont'd?

10. Microorganisms cause diseases. The diseases are of two categories, infectious diseases and microbial intoxications .

An infectious disease results when a pathogen colonizes the body and subsequently causes disease

A microbial intoxication results when a person ingests **a toxin** (poisonous substance) that has been produced by a microorganism.

DEVELOPMENT OF MICROBIOLOGY

- Bacteria and protozoa were the first microorganisms to be observed by humans. It then took about 200 years before a connection was established between microorganisms and infectious disease. Among the most significant events in the history of microbiology were:
- -development of microscopes
- -bacterial staining procedures
- -culture techniques
- -isolation of microorganisms

Pioneers in the science of microbiology

Anton van Leeuwenhoek (1632-1723).

He was the first person to bacteria and protozoa thus he is referred to as the father of microbiology. (Father of bacteriology, protozoology).

He was not a trained scientist. He was a fabric merchant, a surveyor, a wine assayer, and a minor city official in Delft, Holland.

As a hobby, he ground tiny glass lenses, which he mounted in small metal frames, thus creating what today is known as Single lens microscopes or simple microscope.

Anton van Leeuwenhoek (1632-1723)

During his lifetime he made more than 500 such microscopes. His fine art of grinding lenses that would magnify an object 200-300 times its size was lost at his death because he did not teach anyone his skill.

He had a curiosity of examining things as he used his microscope and he could examine almost anything he could get his hands. He examined scrapings from his teeth, water from the ditches and ponds, water which he had soaked peppercorns, blood, sperm, and his own diarrhea stools. In many of these specimens he observed a variety of tiny living creatures which he called animalcules. He recorded his observations in letters which finally convinced scientists of the late 17 th century of the existence of microorganisms.

Louis Pasteur (1822-1895).

Louis Pasteur is a French chemist who made numerous contributions to microbiology and those contributions are considered by many people to be the foundation of the science of microbiology and a cornerstone of modern medicine. Some of these contributions are:

-while attempting to discover why wine becomes contaminated with undesirable substances, Pasteur discovered what occurs during alcohol fermentation. He discovered different types of microorganisms that produce different fermentation products .e.g yeast convert glucose in grapes into ethyl alcohol(ethanol) by fermentation, acetobacter convert glucose to acetic acid(vinegar) by fermentation.

- Pasteur discovered forms of life that could exist in the absence of oxygen. He introduced the term aerobes(organisms that require oxygen to live) and anaerobes(organisms that do not require oxygen for life).
- -he developed the process of pasteurization (a process to kill microorganisms). Microorganisms were subjected to higher temperatures of 55 degree and the temperature for several minutes.

- Pasteur made significant contribution to the germ theory of disease, the theory that specific microorganisms cause specific infectious disease.
- -Pasteur championed changes in hospital practices to minimize spread of disease by pathogens. e.g aseptic technique and sterilization.
- -Pasteur developed vaccines to prevent chicken pox, anthrax, and swine erysipelas(a skin disease).

Robert Koch (1843-1910).

- Robert Koch a German physician, made numerous contributions to the science of microbiology.
- -he made significant contributions to the germ theory of disease. e.g he proved that anthrax bacillus(bacillus anthracis) was truly the cause of anthrax.
- -Koch discovered that bacillus anthracis produced spores capable of resisting adverse conditions.

Robert Koch (1843-1910) cont'd

- He developed method of fixing, staining, and photographing bacteria as well as methods of cultivating bacteria on a solid media (petri dish).
- Koch discovered the bacterium (mycobacterium tuberculosis) that causes tuberculosis and the bacterium (vibrio cholerae) that causes cholera.
- Koch's work on tuberculin (a protein derived from (M.tuberculosis) ultimately led to the development

Micro-organisms and infection

Few of the micro-organisms are disease producing in nature thus pathogenic to man.

Most of the micro-organisms live in soil, water or in air and are unable to invade the living body

Some obtain their energy from day light while others live and feed on their host known as **parasites**

Micro-organisms and infection cont'd

Others constitute the normal flora/indigenous micro-flora/commensals of the body.(they live and obtain nourishment from the areas they live in). such areas include:- the skin, mucous membranes of respiratory tract, intestines, vagina.

However under special circumstances they may cause **opportunistic infections**

Micro-organisms and infection cont'd

True pathogens are micro-organisms which overcome

body defenses and invade the tissue

Their growth or production of toxins(harmful/poisonous substances) damages the tissues and causes disease

This process of microbial invasion of the body is **infection**

INFECTION

Is the successful invasion of the body tissue by micro-organisms

Characterized by their multiplication inside the host

Incubation period:- period between invasion of organisms and manifestation of the disease

Host:- living organism in which a parasite grows and multiplies at hosts (its) cost.

Infection cont'd

Forms of infection

. **Primary infection** :- a fresh infection, primarily caused by a micro organism

Secondary infection :- when a second infection is superimposed on a primary infection

Mixed infection :- when more than one organism simultaneously infect a host

Focal infection:- localized or circumscribed infection in the body

Infection cont'd

Endogenous infection:- infection caused by commensals due to lowering of host immunity

Exogenous infection:- infection caused by pathogenic organism from outside the host

Reservoir :- a host which harbors a parasite and acts as a sources of infection

- **Vector :-** an anthropoid which acts as an important agent for transmission of the parasite to human

Sources of micro-organisms

Animals:- especially zoo noses(have an animal reservoir)

Insects/ arthropods:-like

- mosquitoes-malaria,
- fleas-plague,
- louse-epidemic typhus fever,
- ticks-relapsing fever

Soil:-Ingestion

Air :-expelled in spitting, blowing, sneezing or coughing

Sources of micro-organisms cont'd

Food:- contaminated by food handlers, during preparation, hands.

Water: - contaminated poor environmental hygiene e.g. water washed -scabies, water borne-cholera, water related-malaria

Modes of transmission

1.Contact:-

- Direct skin-to-skin contact e.g common cold virus is frequently transmitted from the hand of someone who has just blown his nose to another person by hand shaking. Within the hospital this mode of transmission is common and that why it is important to wash hands after every patient contact.
- Direct mucous membrane –to mucous membrane contact by kissing or sexual intercourse. Most STDs are transmitted that way i.e syphilis, gonorrhea, and infections caused by Chlamydia, herpes and HIV.
- Indirectly via formites that become contaminated by respiratory secretions, blood, feces, vomitus, or exudates from hospitalized patients.

Modes of transmission cont'd

2.Inhalation (breathing):-

- Indirectly via airborne droplets of respiratory secretions usually produced as a result of sneezing or coughing e.g improperly cleaned inhalation therapy equipment can easily transfer these pathogens from one patient to another. Diseases such as mumps, colds, influenza, measles, chicken pox, and pneumonia spread this way.

3.Ingestion (swallowing):-

- Indirectly via contamination of food and water by fecal material

4.Mother to child:- before, During and after birth

Modes of transmission cont'd

5.Self-infection:-

- from normal flora

6.Medical or surgical procedures :-

- Indirectly via transfusion of contaminated blood or blood products from an ill person or by parenteral injection.
- Invasive procedures

CLASSIFICATION OF MICROORGANISMS

Micro-organism of medical importance is divided into **five** classes

- Bacteria
- Rickettsiae and Chlamydia
- Viruses
- Fungi
- protozoa

Classification of microorganisms cont'd

Bacteria:- are

- Unicellular
- Reproduce by binary fission
- Has a permeable cell wall which controls internal osmotic pressure
- Divided into gram- positive and gram-negative
- Within the cell there is cytoplasm surrounded by cytoplasmic membrane

Classification of microorganisms cont'd

- Within the cytoplasm there is ribosome's(containing cell`s **ribonucleic acid** (RNA) and chromosome or nuclear body consisting of **double-stranded deoxy-ribonucleic acid** (DNA)
- Some bacteria forms capsules outside their cell walls
- Some have whip-like or ganelle of locomotion (flagella) protruding from their surfaces .
- Others have Pilli (hair-like protrusions) enabling them to attach to surfaces
- A few forms **spores** helps in reducing metabolic activities and increase resistance to adverse conditions

Classification of microorganisms cont'd

Types of bacteria:-

- Bacteria varies greatly in size usually ranging from spheres, long spiral-shaped bacteria, to even longer filamentaous bacteria.
- There are three basic shapes of bacteria
- Round or spherical shaped- bacteria-the cocci
- Rectangular or rod shaped- bacteria-the bacilli
- Curved or spiral shaped-bacteria-the sprilla

Classification of microorganisms cont'd

The **cocci:-**

- May be seen in singly or in pairs
- May be seen in chains(streptococci)
- May be seen in clusters(staphylococci)
- May be in packets of four(tetrads)
- May be in packets of eight(octads)
- Examples of cocci include:- enterococcus spp, neisseria species, staphylococcus species, streptococcus spp.

Classification of microorganisms cont'd

The bacilli:-

May be tMay be short or longer(cocobacilli) e.g listeria monocytogenes(common cause of neonatal meningitis)

thick or thin

May be pointed or with curve or blunt ends

May be singly or pairs(diplobacilli)

May be in chains(streptobacilli)

May have long filaments or branched

May be stuck up next to each other

May be side by side in a palisade arrangement e.g corynebacterium diphtheriae

Classification of microorganisms cont'd

Examples of bacilli:-

-members of enterobacterial family- enterobacter, escherichia, klebsiela, proteus, salmonella, and shigella spp

-haemophilus influenzae

-Pseudomonas aeruginosa

-bacillus spp and

-clostridium spp

Classification of microorganisms cont'd

Curved and spiral shaped bacteria :- e.g vibrio spp(vibrio choleriae-cholera), vibrio parahaemolyticus-(common cause of diarrhea)

Are curved(comma shaped) bacilli:-

-a pair of curved bacilli resmbles a bird and is described as having a gull-wing morphology e.g campylobacter spp(common cause of diarrhea)

Spiral shaped bacteria(spirochetes)

- Are cork-crew like spirals.
- they may be singly or in form of pairs .

Classification of microorganisms cont'd

Staining procedures

- Bacteria are colorless, transparent, and difficult to see
- Different staining methods have been devised in examining bacteria-
- Bacteria are smeared onto a glass microscope slide (smear), air-dried, and then fixed'

Two common methods are used:-

- Heat fixation:

  -tends to distort morphology of cells

  -Smear is passed through a bunsen burner flame

- Methanol fixation:

  -is a more satisfactory fixation technique

  -It is accomplished by flooding the smear with absolute methanol for 30 seconds.

Rickettsiae

- Are very short rods
- Have a cell wall(resembles that of gram-negative rods)
- They are bacteria as they contain RNA and DNA
- They are obligate intracellular parasites
- However they are smaller than bacteria
- Divide by binary fission within the host cell
- Some Rickettsiae are Cocci or bacilli

Chlamydia

- Chlamydiae are obligate intracellular bacteria i.e they can grow only within cells.
- They have a rigid cell wall but lack a typical peptidoglycan layer.
- Their cell wall resemble those of gram-negative bacteria but lack muramic acid.
- Chlamydia are spherical and have intracellular developmental cycle where infective forms are phagocytosed by host cell and develop inside the cell to reticulate bodies
- In 40hrs become elementary bodies and rupture within 48-72hrs to infect other cells

Virus

- Very small unclear whether they are living or not hence referred to as **active** and **inactive**
- **Virion –**is a virus particle
- Viruses are particles composed of an internal core containing either RNA or DNA(but not both) covered by a protective coat.
- Viruses do not have a nucleus, cytoplasm, mitochondria,or ribosomes.
- The nucleic acid core is packed within **protein coat (capsid)** which protects it during transmission between host cells. Multiply by replication in host cell(are obligate intracellular parasites)
- Classified according to nucleic acid, presence of envelop, size and symmetry of the capsid

Clssification of medically important viruses

DNA VIRUSES

- Parvovirus
- Polyomaviruses
- Papllomaviruses
- Adenoviruses
- Hepadnaviruses
- Herpesviruses
- Poxviruses

RNA VIRUSES

- Picornaviruses
- Caliciviruses
- Reoviruses
- Flaviviruses
- Togaviruses
- Retroviruses
- Orthomyxoviruses
- Paramyxoviruses
- Rhabdoviruses
- Filoviruses
- Coronaviruses
- Arenaviruses

Virus cont'd

PATHOGENESIS

- The ability of virus to cause disease can be viewed in two levels:-

1. Changes that occur within individual cell
2. Process that takes place in infected patient

Effects of viral infection on the cell

- Death, fusion of cells to form multinucleated cells, malignant transformation ,and no apparent morphologic or functional change.

NB:- assignment

Make short notes on various types of viruses.

Fungi

- The study of fungi is called mycology
- Fungi are a diverse group of eucaryotic organisms that include yeasts,molds,and mushrooms
- Fungi have no chlorophyll
- Fungal spores are very resistant structures that are carried great distances by wind-resist heat,cold,acids bases,and other chemicals. Many people are allergic to fungal spores.
- Are found almost everywhere on earth
- Some are (saprophytic) living on organic matter in water and soil.
- Others are parasitic living on and within animals and plants
- Some are harmful and others beneficial
- Beneficial fungi are important in production of cheese,beer,wine,and other foods as well as certain drugs.

Fungi cont'd

- Have thick cell wall which contains cytoplasmic membrane target for antifungal drugs
- Their cell wall do not contain cellulose
- Fungal cell wall contain chitin(polysaccharide)
- Although many fungi are unicellular(e.g yeast) others grow filaments called hyphae
- Reproduce by budding,hyphal extension or formation of asexual spores(conidia)
- Many fungi pathogenic for men are dimorphic (affects skin)

Types of fungi /classes of fungi

- They are divided into five classes based in their mode of sexual production
- Zygomycotina(zygomycetes)-include the common bread molds and other fungi that cause food spoilage.
- Chytridiomycotina(chytrdiomycetes)-live in water(water molds) and soil.
- Ascomycotina(ascomycetes)-include certain yeasts and some fungi which cause plant disease. E.g dutch Elm disease
- Basidiomycotina(basidiomycetes)-include some yeasts and some fungi which cause plant disease and the fleshy fungi that live in the woods. e.g mushrooms, toadstools bracket fungi
- Deutromycotina(deutromycetes)-contains fungi having no mode of sexual reproduction e.g aspergillus and penicillium

Classes of fungi cont'd

N.B

- Yeasts are microscopic ,eurcaryotic,single celled organisms that lack mycelia, usually they reproduce by budding

Fungal diseases

Yeast:- e.g candida albicans-causes thrush, creptococcus neoformans-causes creptococcosis(lung infection, meningitis etc)

Molds:- e.g aspergillus spp-causes aspergillosis(lung infection,systemic infection, tinea(ring worm) infections.

Protozoa

The study of protozoa is called protozoology

Are eucaryotic organisms

Are unicellular(single celled)

Larger than bacteria

Reproduction mechanism vary from simple binary fission to complex life circles

They do not have cell walls

All protozoa cells posses cell membranes, nuclei, mitochondria, centrioles, food vacuoles, lysosomes, golgi bodies, and endoplasimic reticulum.

Protozoa

- Most of them are free living organisms- live in soil and water
- They do not have chlorophyll hence can not make their own food
- Some protozoa are parasites:-parasitic protozoa break down and absorb nutrients from the body of the host in which they live e.g plasmodium, giardiasis.
- A typical life cycle of protozoa consists of two stages:-

  -**The trophozoite stage:-is** the motile, feeding dividing stage in protozoan's stage

  -**The cyst stage:** -is the dormant, survival stage

Classification of Protozoa

Sarcodina. e.g ameba-move by means of cytoplasimic extensionscalled pseudopodia

Mastigophora(flagellates).e.g move by whip like flagella. e.g trypanosoma cruzi, trypanosoma brucei, trichomonas vaginalis, giardia lambia

Ciliates(ciliophora)-move about by means of a large number of hair-like cilia on their surfaces e.g balantidium coli(causes dysentry)

Sporozoa e.g Plasmodium

PARASITOLOGY

Parasitology is the study of parasites.

- Parasites occur in two distinct forms:-

  Single-celled **protozoa**

  Multicellular metozoa **helminths**

PARASITOLOGY cont'd

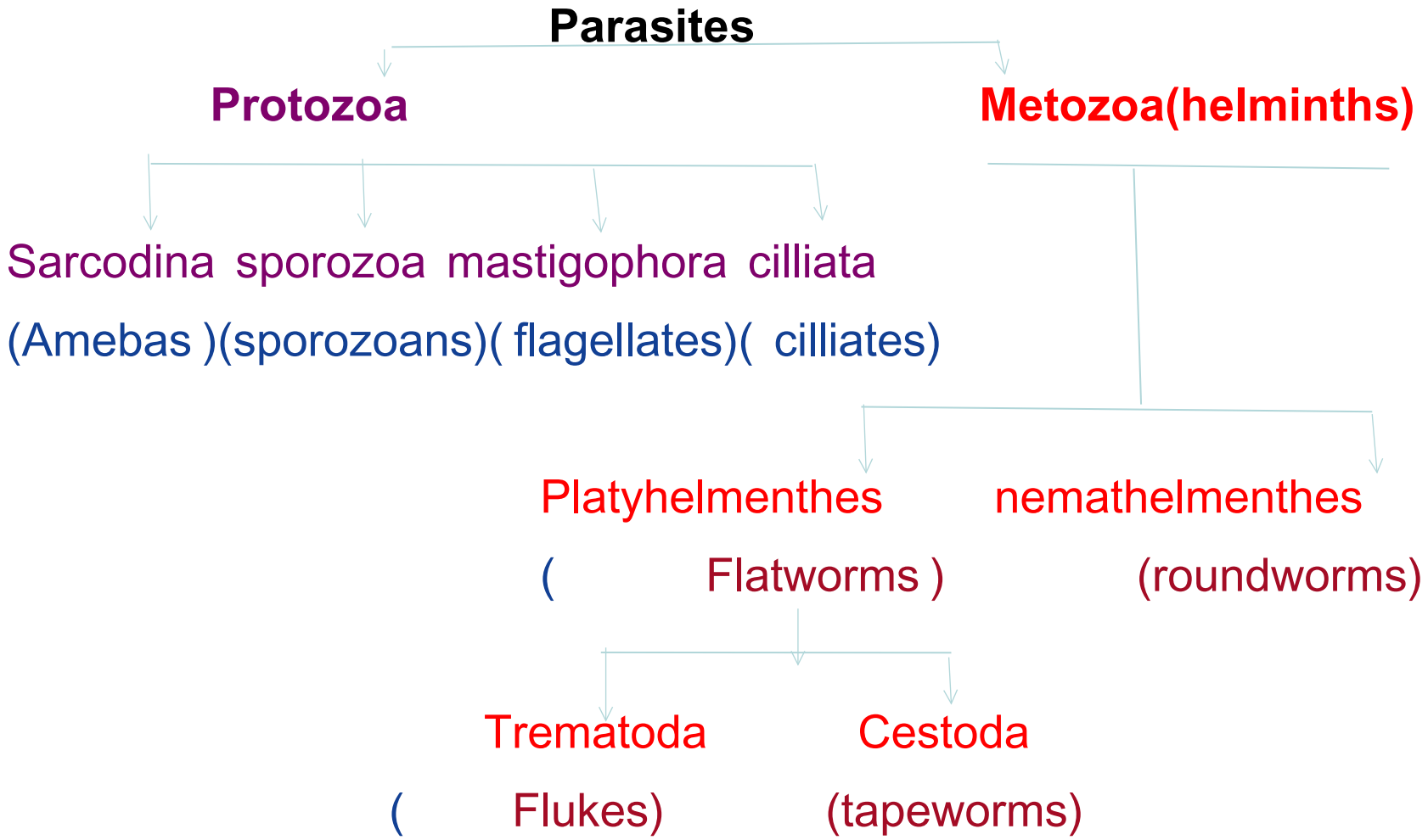
Metozoa are divided into:-

- Platyhelminthes(flatworms)
- Nemathelminthes

Platyhelminthes contains two medically important classes:-

- Cestoda(tapeworms)
- Trematoda(flukes)

classification of parasites



parasitology cont'd

Plasmodium (Blood and tissue protozoa)

- Plasmodium is a malaria causing parasite.

  There are four types of plasmodia that cause malaria:-

- Plasmodium vivax
- Plasmodium ovale
- Plasmodium malariae
- Plasmodium falciparum

parasitology cont'd

- P. vivax and p. falciparum are more common causes of malaria than are p.ovale and p.malriae.
- The vector and definitive host for plasmodia is the female anopheles mosquito(only the female takes a blood meal).
- There are two phases in the **lifecycle of plasmodia**
  - A sexual circle - which occurs primarily in the mosquitoes
  - The asexual circle which occurs in humans(the intermediate host)

parasitology cont'd

- The sexual cycle is called sporogony because sporozoites are produced.
- The asexual cycle is called schizogony because schizoints are made.
- **Lifecycle in humans**
- The lifecycle in humans begins with the introduction of sporozoites into the blood from the saliva of the biting mosquito.
- The sporozoites are taken up by hepatocytes within 30 minutes.
- This "exoerythrocytes" phase consists of cell multiplication and differentiation into merozoites . p.vivax and p.ovale produce a latent form(hypnozoite) in the liver; this form is the cause of relapses seen with vivax or ovale malaria.

lifecycle cont’

- Merozoites are released from the liver cells and infect red blood cells.
- During the erythrocytic phase , the organism differentiates into ring-shaped trophozoite.
- After release, the merozoites infect other erythrocytes. This cycle in the red blood cells repeats at regular intervals typical for each species.
- The periodic release of merozoites causes a typical recurrent symptoms of chills, fever, and sweats seen in malaria patient.

lifecycle cont’

- The asexual cycle begins in human red blood cells when some merozoites develop into male and others into female gametocytes.
- The gametocyte containing red blood cells are ingested by the female anopheles mosquito and, within her gut, produce a female macrogamete and eight sperm like male microgametes.
- After fertilization, the diploid zygote differentiates into a motile ookinate that burrows into gut wall, where it grows into an oocyst within which many haploid sporozoites are produced.
- The sporozoites are released and migrate to the salivary glands ready to complete the cycle when the mosquito takes her next meal.

METOZOA HELMINTHS (WORMS)

Helminths cause much disease and are the largest of human parasites.

- Helminths of medical importance are divided into three zoological classes ,namely

  Nematodes

  Cestodes

  Trematodes

CESTODES (tapeworms)

- Tapeworm consist of two main parts
  - A rounded head called a **scolex**
  - Flat body of multiple segments called proglottids
- The scolex has specialized means of attaching to the intestinal wall-suckers,hooks,or sucking grooves
- The worm grows by adding new proglottids from its germinal centre next to the scolex.
- The oldest proglottids at the distal end are gravid and produce many eggs ,which are excreted in the feces and transmitted to various intermediate hosts such as cattle,fish,and pigs.

Cestodes(tapeworm) cont'd

- Humans acquire the infection when undercooked flesh containing the larvae is ingested.
- Two important diseases caused by **cestodes**(tapeworms)

  Hydatid disease

  Cystercosis

- **There are four medically important cestodes**

  Taenia solium-causes cystercosis(human)

  Taenia saginata-cause cystercosis(in other animals not human)

  Diphyllobothrium latum(lives in fish)-causes diphyllobothriasis

  Echinococcus granulosus(dogs definitive host,sheep intermediate host)-causes echinococcosis(hydatid cyst).

Trematodes(flukes) cont'd

- Trematoda(flukes) and cestoda(tapeworm) are the two large classes of parasites in the phylum platyhelminthes.

  The most important trematodes are:-

  Schistosoma species-blood flukes(schistosomiasis) e.g schistosoma mansoni,schistosoma japonicum(gastrol interstinal tract),schistosoma haematobium-urinary tract.

  Clonorchis sinensis -liver fluke(cause clonorchiasis)

  Paragonimus westerman-lung fluke(cause paragonimiasis)

- Schistosomiasis have the greatest impact in terms of the number of people infected,morbidity,and mortality.

Trematodes(flukes) cont'd

- The lifecycle of the medically important trematodes involves asesual cycle in humans(definitive host) and a sexual reproduction in fresh water snails(intermediate host).
- Transmission to humans takes place either through penetration of the skin by the free-swimming cercariae of the schistosomes or through ingestion of undercooked (raw) fish or crabs in clonorchis and paragonimus infection,respectively.

NEMATODES (NEMATHELMINTHES)

Nematodes are round worms with acylindrical body and complete digestive tract including the mouth and an anus.

The body is covered with a noncellular, hihly resistant coating called a cuticle.

Nematodes have separate sexes;-female usually larger than male. The male has typically has a coiled tail.

Medically important nematodes are divided into two categories according to their primary location in the body.i.e

Interstinal nematodes

Tissue nematodes

Interstinal nematodes

Interstinal nematodes include

- **Enterobius(pinworm)-**causes enterobiasis(human)
- **Trichuris(whipworm)-**causes trichuriasis(human);may cause diarrhea and rectal prolapse in children.
- **Ascaris(giant round worm)-**causes ascariasis(human)
- **Necator**
- **Ancylostoma(the two hookworm)**
- **Strongyloides(small roundworm)-**causes strongoloidiasis
- **Trichinella.**

Tissue nematodes

The important tissue nematodes include:-

- **Wuchereria**-causes filariasis(elephantiasis);-transmitted by female a mosquito anopheles and culex.
- **Onchocera**-causes onchoceriasis;-transmitted by black fly
- **Loa**-causes loasis;-transmitted by deer fly(mango fly)

The three are called filarial worms because they produce motile embryos called microflariae in blood and tissue fluids.

A fourth species is the guinea worm- **dracunculus** whoose larvae inhabit tiny crustaceans(copepods) and are ingested in drinking water.

Nematodes cause disease as a result of presence of adult worms within the body.

IMMUNOLOGY

Introduction

Humans and animals have survived on earth for hundreds of thousands of years because they have many built-in or naturally occurring mechanisms of defense against pathogens and infectious disease they cause.

The ability of any animal to resist these invaders and recover from disease is due to many complex interacting functions within the body.

Immunology cont'd

Immunology

is the scientific study of the immune system and immune responses, including the active and passive acquired immunity to infectious agents,antibody production, cell-mediated immune responses, and allergic responses, other types of hypersensitivity reactions, autoimmune disorders and immunodiagnostic procedures.

- The immune system is the third line of defense against pathogens; it is a specific host defense mechanism.

Immunological processes

The body protects against harmful pathogens through two ways

- **Nonspecific host defense mechanism**

  First line of defense

  Second line of defense

- **Specific immunity or specific host defense mechanism**. It is also called the third line defense.

Definition of terms

- **Host defense mechanisms** :-are ways in which the protects itself from pathogens.
- **Non-specific defense mechanisms** :-are ways in which the attempts to destroy all types of substances that are foreign to it including pathogens.
- **Specific host defense mechanisms** :-is the immune response ,very specific –because antibodies(special proteins) are usually produced in the body in response to the presence of foreign substances(antigens).
- **Antigens** :- are foreign substances.

NONSPECIFIC HOST DEFENSE MECHANISMS

- These are general and serve to protect the body against many harmful substances.

FIRST LINE OF DEFENSE

a) Mechanical and physical factors

ii. Skin:-

- intact, unbroken skin that covers our bodies serves as a physical or mechanical barrier to pathogens.
- very few pathogens are able to penetrate the skin.
- the dryness of most areas of skin inhibits colonization by many pathogens.

Mechanical and physical factors

ii. Mucous membranes:-

- they serve as physical and mechanical barriers to pathogens.
- most pathogens can only pass when these membranes have are cut or scratched.
- the sticky mucous produced by the goblet cells within the mucus membranes serve to entrap invaders(pathogens).They can be removed by normal reflex like coughing or sneezing.
- Such areas include nose (respiratory tract), mouth, and vagina

b).Cellular and Chemical factors:-

- Body temperature -<37ºc and acidity of the skin inhibit the growth of pathogens.
- the oily sebum that is produced by sebaceous glands in the skin contains fatty acids which are toxic to some pathogens.
- Perspiration (sweat) aids in flushing organisms from pores and surface of skin.
- Sweat contains enzyme-lysozyme which degrades peptidoglycan in bacteria cell walls.
- Sloughing off of dead skin cells removes potential pathogens from the skin.

Cellular and Chemical factors cont'd

- Sticky mucus produced by the mucous membranes contains lysozyme,lactoferin,and lactoperoxidase that kill bacteria or inhibit growth.
- Lactoferrin binds with iron, a mineral that is required by all pathogens;because they are unable to compete with lactoferrin for free iron,the pathogens are deprived of these essential nutrient.
- Lactoperoxidase is an enzyme that produces superoxide radicals, highly reactive forms of oxygen which are toxic to bacteria.

Cellular and Chemical factors cont'd

- Because mucosal cells are among the most rapidly dividing cells in the body, they are constantly being produced and released from the mucous membranes. Bacteria that is adhering to the cells are often expelled along with the cells they are attached.
- The hair, mucous membranes and irregular chambers of the nose serve to trap much of the inhaled debris.
- The cilia present on the epithelial cells of the posterior nasal membranes, nasal sinuses, bronchi and trachea sweep the trapped dust and microbes upward toward the throat where they are swallowed or expelled by sneezing and coughing.

Cellular and Chemical factors cont'd

- Swallowing of saliva can be thought of as a non-specific defense mechanism ,because thousands of bacteria are removed from the oral cavity every time we swallow. Humans swallow approximately 1 litre of saliva per day.
- Digestive enzymes, acidity of the stomach (approx.PH 1.5), alkalinity of the intestines protects the digestive system from bacteria colonization.
- Peristalsis and expulsion of feces serve to remove bacteria from the intestine. Bacteria make up 50% of feces.

Cellular and Chemical factors cont'd

- Microorganisms are continually flushed from the urethra by frequent urination and expulsion of mucus secretions.
- The low PH of vaginal fluid usually inhibits colonization of the vagina by pathogens.

c). Microbial antagonism:-

- The indigenous microflora prevent colonization by new arrivals to a particular anatomical site through competition for colonization sites, nutrients and production of substances that kill other bacteria.

SECOND LINE OF DEFENSE

Pathogens able to penetrate the first line of defense are usually destroyed by non-specific cellular and chemical responses(second line of defense).

A complex sequence of events develops involving production of fever, interferons, activation of the complement system, inflammation, chemotaxis, and phagocytosis .

Second line of defense cont'd

a) Transferrin:-

- a glycoprotein synthesized in the liver has a high affinity for iron.
- Its normal function is to store and deliver iron to the host cells.
- Transferrin serves as a nonspecific host defense mechanism by sequestering iron and depriving pathogens of these essential nutrient.

b) Fever:-

- normal body temperature fluctuates between 36.2c and 37.5c. Average 37.2c.
- A body temperature greater than 37.8c is generally considered to as be fever..

Second line of defense cont'd

- substances that stimulate production of fever are called pyrogens or pyrogenic substances
- Fever acts as a body nonspecific host defense mechanism by:-

  Stimulating white blood cells(leukocytes) to deploy and destroy invaders

  Reducing the available free plasma iron ,which limits growth of pathogens that require iron for replication and synthesis of toxins.

  Inducing the production of interleukin-1(IL-1) which causes the proliferation,maturation,and activation of lymphocytes in the immunologic response.

Second line of defense cont'd

c). interferons:- are small antiviral proteins produced by virus-infected cells .

- They are called interferons because they "interfere" with viral replication.
- There are three types of interferons – **alpha**, **beta** and **gamma** induced by different stimuli, including viruses ,tumors, bacteria and other foreign cells.
- Alpha-interferon - are produced by B lymphocytes(B cells),monocytes, macrophages.
- Gamma-interferon - activated by T lymphocytes(T cells) and Natural killer cells(NK cells).
- Beta-interferon - by fibroblasts and other virus-infected cells.

Second line of defense cont'd

- Interferons produced by a virus-infected cell are unable to save that cell from destruction, but once they are released from that cell, they attach to the membranes of surrounding cells and prevent viral replication from occurring in those cells.
- Thus the spread of infection is inhibited ,allowing the body to fight the disease more effectively.

Second line of defense cont'd

d). The complement system:-

- is not a single entity, but rather a group of approximately 30 different proteins(including nine proteins designated as C1-C9) that are found in normal blood plasma.
- Proteins of the complement system sometimes collectively referred to as complement components, interact with each other in a step-wise manner called complement cascade.

Second line of defense cont'd

- The complement system assists in the destruction of many different pathogens by
  - Initiation and amplication of inflammation
  - Attraction of phagocytes to the sites where they are needed(chemotaxis).
  - Activation of leukocytes
  - Lysis of bacteria and other foreign cells
  - Increased phagocytosis by phagocytic cells(opsonization).

Second line of defense cont'd

e). Inflammation:-the body normally responds to local injury,irritation,microbial invasion or bacterial toxin by a complex series of events collectively referred to as inflammation or inflammatory response.

- The 3 major events in acute inflammation are:-

i). An increase in the diameter of capillaries , which increases blood flow to the site.

ii). Increased permeability of the capillaries ,allowing the escape of plasma and plasma proteins.

iii). Egress(exit) of leukocytes from the capillaries and their accumulation at site of injury.

Second line of defense cont'd

- The primary purpose of the inflammatory response
  - -Localize an infection
  - -Prevent the spread of microbial invaders
  - -Neutralize any toxins being produced at the site
  - -Aid in the repair of any damaged tissue

Second line of defense cont'd

f). Phagocytosis:- is the process by which phagocytes surround and engulf (ingest) foreign material.

- The phagocytic white blood cells are called phagocytes.
- The three major categories of leukocytes found in blood are-
  -monocytes
  -lymphocytes and
  -granulocytes.
- **The three types of granulocytes are:-**
  -eosinophils
  -basophils and
  - neutrophils.

Second line of defense cont'd

- The two most important groups of phagocytes in the human body are macrophages and neutrophils; sometimes called professional phagocytes ' because their major function is phagocytosis.
- Phagocytes serve as a clean-up crew' to rid the body of unwanted and often harmful substances such as dead cells, unused cellular secretions, debris and microorganisms.
- Granulocytes –are named from the prominent cytoplasmic granules that they posses. The phagocytic granulocytes include neutrophils and eosinophils .
- Neutrophils are much more efficient in phagocytosis than eosinophils .

Second line of defense cont'd

- Macrophages-develop from monocytes during the inflammatory response to infections.
- Those that leave the blood stream and migrate to infected areas are called wandering macrophages. Fixed macrophages remain in the tissues and organs and serve to trap foreign debris.
- Macrophages are extremely efficient phagocytes. They are found in tissues of the reticuloendothelial system(RES).

g). Chemotaxis:-phagocytosis begins when phagocytes move to the site where they are needed. The directed migration is called chemotaxis and is the result of chemical attraction called chemotaxic agents.

Second line of defense cont'd

- Chemotaxic agents produced that are produced by various cells of the human body are called chemokines.
- Chemotaxic agents are produced during the complement cascade and inflammation.
- The phagocytes move along the concentration gradient, meaning they move from areas of low concentration of chemotaxic agents to the area of the highest concentration.
- The area of highest concentration is the site where the chemotaxic agents are being produced or released-often the site of inflammation.

SPECIFIC IMMUNITY or THIRD LINE OF DEFENSE

- Micro-organisms that overcome non-specific are faced with specific immunity
- The antigens of the invading micro-organisms comes into contact with cells of immune system (macrophages and lymphocytes) and initiate a response
- The response takes two ways:- **humoral immunity** and **cell-mediated immunity**

Humoral immunity

Humoral(antibody-mediated) immunity is directed primarily against

Exotoxin-mediated diseases such as tetanus and diphtheria

Infections in which virulence is related to polysaccharide capsules (e.g meningococci,pneumococci,haemophilus influenzae).

Certain viral infections.

Antibody synthesis is by

- The primary response
- Secondary response

The primary response

- When an antigen is first encountered, antibodies are detectable in the serum after a long period.
- The lag period can is typically 7-10 days but can be longer depending on the nature and dose of the antigen and the route of administration(oral or parenteral).
- A small clone of B cells and plasma cells specific for the antigen is formed.
- Serum antibody concentration continues to rise for several weeks,then drops to low levels.
- The first antibodies formed are IgM,followed by IgG,IgA or both.IgM levels decline earlier than IgG levels.

The secondary response

- When there is a second encounter with the same antigen or closely related one, months or years after the primary response, there is a rapid antibody response(in 3-5 days) to higher levels than primary response.
- This is due to persistence of antigen-specific memory cells after the first contact.
- In the secondary response the amount of IgM produced is qualitatively similar to that produced during first contact with the antigen;
- However, much more IgG is produced and the levels tend to persist longer than in the primary response.

ANTIBODIES

- **Antibodies(immunoglobulins)** are formed by B lymphocytes-each individual has a large pool of different B lymphocytes that have a lifespan of days or weeks and are found in the bone marrow, lymph nodes, and gut associated lymphoid tissues
- B cells display immunoglobulin on their surface.
- They serve as receptors for specific antigen
- An antigen interacts with B lymphocyte that shows the best fit" by of its immunoglobulin surface receptor

Antibodies or immunoglobulins

IgG:-

- It has two identical antigen binding sites
- Is the predominant antibody in secondary responses and constitutes an important defense against bacteria and viruses.
- It is the only antibody that can pass the placenta barrier and is the most abundant immunoglobulin in newborns.

IgM:-

- Is the main immunoglobulin produced early in the primary response
- It is present in the surface of virtually all uncommitted B cells. It has ten binding sites
- It is the most efficient immunoglobulin in agglutination complement fixation and other antigen body reactions

Antibodies cont'd

IgA:-

- is the main immunoglobulin in secretions such as milk, saliva, and tears and secretions of the respiratory, interstinal and genital tract.
- It protects the mucous membranes from bacteria and viruses.

IgE:-

- It binds to the receptor on the surface of mast cells, basophils, and eosinophil

IgD:-

- It acts as an antigen receptor when present on the surface of certain B lymphocytes
- It is present in serum only in trace amounts

CELL-MEDIATED IMMUNITY

This depends on development of lymphoid cells which are specifically sensitized to the inducing antigen and which react directly with the antigen to bring about cytotoxic effects

Development of activated macrophages can also result from this process

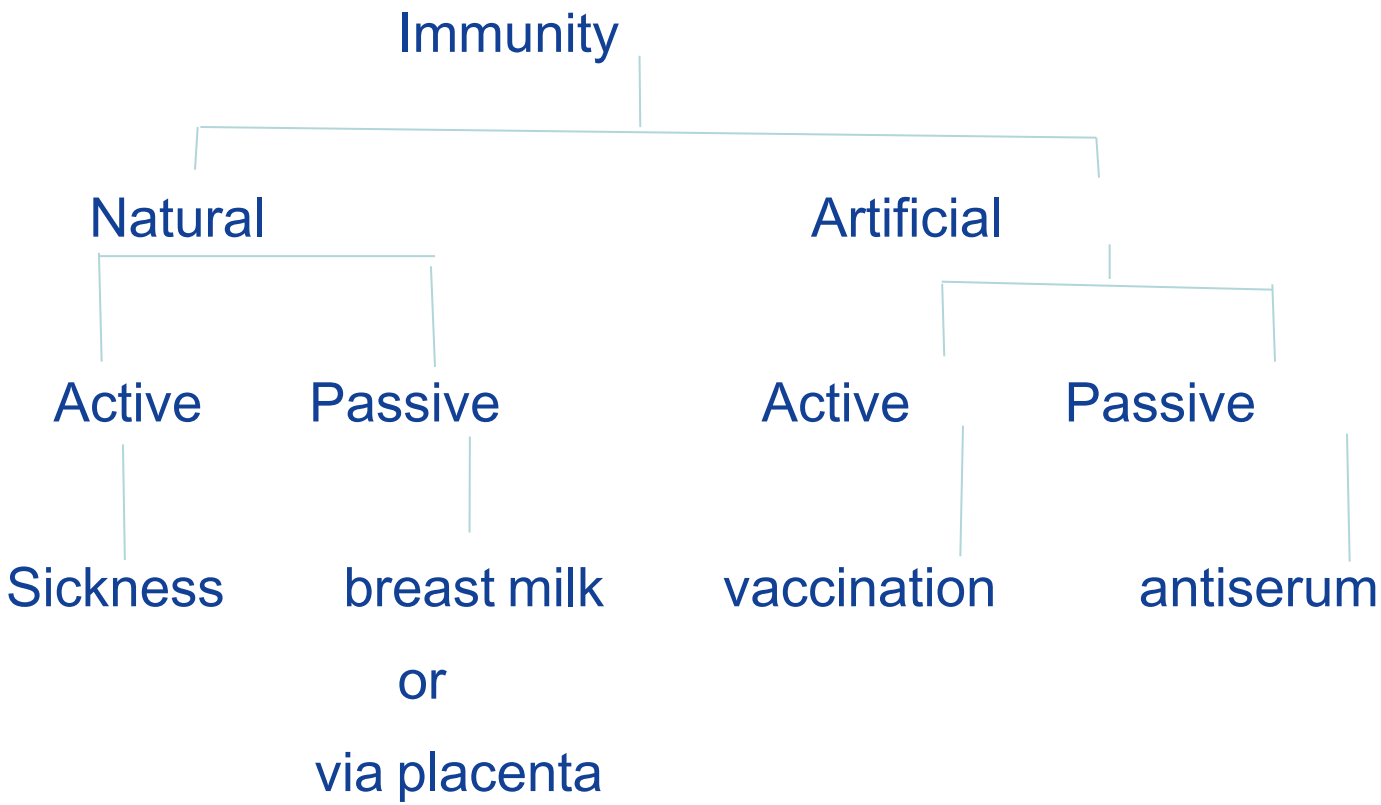
Antibody response is a physiological reaction to the introduction into the body of foreign materials, irrespective of whether it is harmful or not.

Immunity can be **natural** or **acquired**

Specific immunity may be acquired in two ways

- **actively** or **passively**

types of immunity



Active immunity:-

- is induced after contact with foreign antigens. This contact may consist of clinical or sub-clinical infections, immunization with live or killed infectious agents or antigen exposure to microbial products e.g toxins, toxoids
- The host actively produces antibodies and lymphocytes acquire the ability to respond to the antigens.
- Advantages:-

  -long-term protection
- Disadvantages:-

  -slow onset of protection.

  -Need for prolonged or repeated contact with the antigen.

Active immunity can be acquired naturally or artificially e.g

- The production of antibodies in response to a pathogen that has entered the body is an example of natural active acquired immunity.
- The production of antibodies in response to a vaccine is an example of artificial active acquired immunity.

- **Passive immunity:-**is transmitted by antibodies or lymphocytes performed in another host.
- Advantage:-

  -prompt availability of large amounts of antibodies.
- Disadvantages:-

  -short lifespan of antibodies

  -Possible hypersensitivity reactions if antibodies from another species are administered.
- Passive immunity can be acquired naturally or artificially

- A fetus receiving antibodies that were produced by the mother is an example of natural passive acquired immunity.
- A soldier receiving antibodies contained in a shot of gamma globulin is an example of an artificial passive acquired immunity.

Herd immunity

When a large proportion of people are immunized in a community, even those few people who have not been vaccinated also get some protection because the disease becomes so uncommon. This is called herd immunity.

It is mainly effective for those diseases that pass from man to man e.g measles, polio and pertusis.

Immunizing agents and clinical importance

- **Immunization:-** is the process of protecting a person from a particular disease.
- It happens when a vaccine against a disease has been given. This is called active immunization.
- Some vaccines are made from live bacteria or viruses that have been modified enough not to cause a severe infection, but they are still similar to the original bacteria or viruses for the body not to be able to make a difference. They are called **live attenuated vaccine.**
- Other vaccines are made out of dead bacteria(inactivated) or by modifying the toxins that some bacteria produce. The modified toxins are called **toxoids.**
- **The vaccines are given either by mouth or injections. They act as antigens.**

references

The end

MICROBIOLOGY

C.M GARAMA

Dept. of Clinical Medicine

Introduction to Microbiology

- To understand:
  a) Definition of common terms
  b) Structure & Function of Prokaryotic / Eukaryotic Cells
  c) Staining Procedures
  d) Preventive & Control Measures
  e) A Quiz

COMMON TERMINOLOGIES

- **Abscess**:
  - A localized collection of pus.

- **Acid fast:**
  - Resistant to decolorization by acid after staining with hot carbol fuchsin and hence retaining a red color when stained by Ziehl-Neelsen method

- **Adjuvant:**
  - Insoluble materials which act to keep antigens in tissues for longer period, thus cause a longer stimulation of antibody production.

Cont....

- **Aerobe:**
  - An organism which requires oxygen to live and reproduce.
- **Agglutinate:**
  - To join together to form clump.
- **Allele:**
  - One of a group of genes which can occupy a given place on a pair of identical chromosomes.

- **Allergy:**
  - An abnormal sensitive reaction.
- **Anaerobe:**
  - A microorganism not requiring oxygen to live or reproduce
- **reaction:**
  - level in response to irrelevant stimulus

- **Anhydrous**:
  - Containing no water
- **Antagonism:**
  - Impairment of the efficacy of drug in the presence of the other.
- **Antibiotic**:
  - A substance used to kill microorganisms. It is a product of microorganism
- **Antibody**:
  - A globulin produced in the body in response to the antigen or foreign bodies

- **Antigen:**
  - Any substance which can cause the production of antibodies
- **Asepsis:**
  - Without infection
- **Attenuated**:
  - Reduced virulence but retaining antigenecity for host
- **Atypical:**
  - Unusual. Auto- Infection of oneself. infection: Automatic: Doing something by itself

B

- **Bacilli:**
  - Stick-like or rod-like bacteria.
- **Bacteria:**
  - Single celled organisms containing both RNA and DNA which reproduce by binary fission.
- **Bacteriology:**
  - The study of bacteria.
- **Bacteremia:**
  - Presence of bacteria in bloodstream.

- **Bacteriocide**:
  - A chemical used to kill bacteria
- **coli:**
  - agent of balantidiasis, a type of dysentry
- **Beaded:**
  - Staining at intervals along the length of bacillus.

- **Binary fission** :
  - Simple cell division by which the nucleus and cytoplasm divides into two.

- **Biopsy:**
  - The removal of small piece of tissue during life for examination.

- **Bio-type:**
  - A classification or a group of genetically similar organisms.

- **Bi-polar:**
  - The staining of bacillus at both ends
- **Blister:**
  - A small swelling in the skin filled with serum
- **Budding:**
  - An asexual form of reproduction of unicellular organisms, e.g. yeast cells.
- **Buffer**:
  - A solution, the reaction of which is not easily altered by adding an acid or alkali

C

- **Capsid:**
  - The protein coat surrounding the genome of virus.
- **Capsomere:**
  - One of the units of which virus capsid is composed.
- **Capsule:**
  - A coating outside cell walls of some bacteria and fungi.

- **Carrier:**
  - One who is harboring but not currently suffering any ill-effect from pathogenic organism
- **Cell**:
  - A microscopic mass of protoplasm containing nucleus
- **Cellulitis:**
  - The result of a spreading infection of pyogenic bacteria in the subcutaneous tissues

- **Chemotherapeutic agent:** -
  - A synthetic chemical suitable for systemic administration and effective in treatment of microbial infections

- **Chitin**:
  - Polysaccharide containing glucosamine, characteristic of cell walls of some fungi and also found in insects

- **Chromatin:**
  - Darkly staining nuclear material.

- **Chromosomes**:
  - Thread-like structure in the cell nucleus which contains genes carrying inherited characteristics

- **Coccus:**
  - A rounded or ovoid bacterium.

- **Colony:**
  - A number of organisms living or multiplying together on culture media and they result from multiplication of a single organism

- **Commensal:**
  - Deriving nourishment from a host without causing any harm or benefit to host.
- **Conjugation**:
  - Exchange of genetic material between bacteria.
- **Culture:**
  - The growth and multiplication of microorganism

- **Culture media:**
  - The material used in a culture to nourish the growth of microorganism

- **Cytopathic effect**:
  - Degenerative changes occurring in tissue culture cells as a result of microorganism infection

- **Cytoplasmic streaming:**
  - Continuous movement of cytoplasm within the cell which results in constant distribution of intracellular contents. It provides amoebic motility to some types of cell

D

- **Decolorize**:
  - To remove color.

- Di**plococci:**
  - Cocci which occur in pairs.

- **Disinfectant:**
  - A substance of chemical nature used for destroying pathogenic microorganisms.

E

- **Embed**:
  - To penetrate into tissue.
- **Encapsulate**:
  - To surround with a capsule
- **Endemic**:
  - A disease constantly present in an area.

- **Endogenous**:
  - Originated by organisms or factors already present in the patient's body before onset of disease

- **Endotoxin**:
  - A toxic component of microorganism (Gram negative), largely dependent on the death or disruption of the organism for its release

- **Enriched medium**:
  - A culture medium to which an extra nourishing substance is added.

- **Exogenous**:
  - Originated by organisms or factors from outside the patient's body.
- **Exotoxin**:
  - A toxin released by living microorganisms into the surrounding medium or tissues.
- **Exudate**:
  - A fluid, often from formed elements of blood, discharged from tissue to a surface or cavity.

- **Facultative**:
  - Able to behave in a specified way, with the implication that is not, however, the usual behavior
- **Filament:**
  - A fine thread-like structure.
- **Fimbria**:
  - Hair-like protrusion from bacterial cells
- **Flagellum**:
  - Whip-like organ of motion.

- **Fomites:**
  - Objects contaminated with pathogenic microorganisms.
- **Fungus**:
  - A simple unicellular or multicellular structure which reproduces by forming spores.
- **Fusiform**:
  - Spindle shaped

G

- **Gram- negative:**
  - Staining red by Gram's method.
- **Gram- positive:**
  - Staining violet by Gram's method
- **Growth factor:**
  - An ingredient of which at least small amount must be present in a culture medium so that it supports the growth of given organism
- **Granules:**
  - Small grains or particles, e.g. metachromatic granules of diphtheria bacilli.

H

- **Hereditary**:
  - Transmitted from one generation to the other
- **Heterologous:**
  - Related to different kind of organism.
- **Homologous**:
  - Related to same kind of organism
- **Host:**
  - The organism from which a parasite takes its nourishment

- **Immune:**
  - Protected from disease by the presence of antibodies
- **Immunoglobulin:**
  - Globulins which act as antibodies
- **Infection:**
  - The entry and multiplication of pathogenic organisms within the body
- **Inoculate:**
  - To introduce a living organism into a culture medium.

M

- **Macrophage:** A large mononuclear phagocytic cell.
- **Medium:** A nutrient substance used to grow microorganisms
- **mutation:** effect that a wrong amino acid has been put into essential protein.

- **Molecule:**
  - The smallest part of an element or compound which can exist in normal way.
- **Morphology:**
  - A study of the form of cells and organisms
- **Motile**:
  - Capable of movement
- **Mutation:**
  - An alteration in genetic material.

- **Nodule**:
  - A small rounded swelling.
- **Nucleus:**
  - An essential part of the living cell, containing the chromosomes and controlling cell activity
- **Nucleoid**
  - Genome.
- **Nucleocap**
  - The genome and capsid

O

- **Obligatory anaerobe:**
  - An organism which cannot live in oxygen.

- **Occult:**
  - Hidden

- **Oxidation:**
  - Combination with oxygen.

P

- **Parasite:**
  - An organism which takes its food from another organism without giving anything in return

- **Passive immunity:**
  - Dependent upon injection of readymade antibodies and not upon the subject's own immunological mechanisms.

- **Pathogen:**
  - An organism which can cause disease.

- **Plasmid:**
  - An extrachromosomal portion of genetic material.
- **Polymerase:**
  - General name of enzymes concerned with synthesis of nucleic acid
- **Protoplast**:
  - A bacterium deprived of its cell wall.

R

- **Replication**:
  - Virus reproduction.
- **Ribonucleo protein**:
  - Material in the cytoplasm and nucleus of cell.
- **Reticuloendothelial:**
  - The system of phagocytic cells in the body.

S

- **Saprophytic**:
  - Living on dead organic matter
- **Serology:**
  - The study of serum especially antibody contents.
- **Sterilization**:
  - The process of killing all living microorganisms including spores.
- **Symbiotic:**
  - Living in mutually with the host.

T

- **Tissue:**
  - A group of similar cells.
- **Toxoid:**
  - Toxin rendered harmless but retaining antigenicity
- **Transduction:**
  - Transfer of genetic material from bacterial strain to another by means of bacteriophage.

U

- **Unicellular**:
  - Single celled.

- **Undulating:**
  - Up and down, i.e. wavy.

V

- **Vector:**
  - An insect which carries microorganism or parasite and is capable of transmitting this
- **Viremia:**
  - Presence of viruses in the bloodstream.
- **Virion:**
  - A virus particle.
- **Virulent:**
  - Harmful.

Y

- **Yeast:**
  - A unicellular fungus.

Z

- **Zygote:**
  - The cell formed by the fertilization of a female cell by a male cell.

END

REF: The Short book of Microbiology

By Satish Gupte

STRUCTURE & FUNCTION OF PROKARYOTIC & EUKARYOTIC CELL

C. M. Garama
Dept. of Clinical Medicine

OBJECTIVES

- Understand structure and functions of both prokaryotic & Eukaryotic cells
- Structural differences

INTRODUCTION

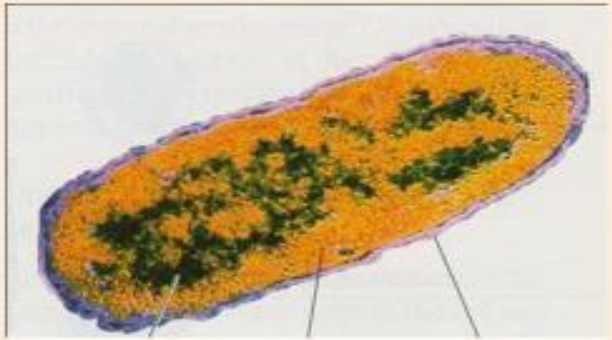
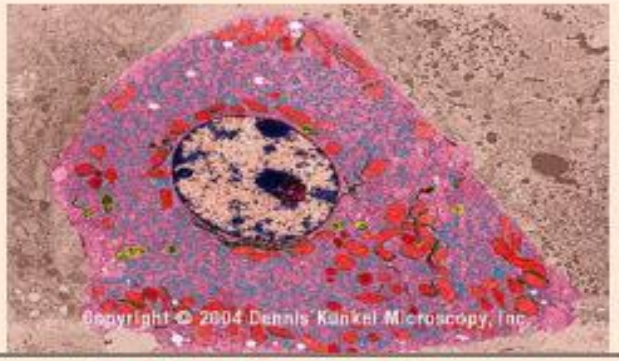
- Prokaryotic cells and eukaryotic cells are the two types of cells that exist on Earth.
- There are several differences between the two, but the biggest distinction between them is that eukaryotic cells have **a distinct nucleus containing the cell's genetic material**, while prokaryotic cells **don't have a nucleus** and have **free-floating genetic material instead.**

INTRODUCTION

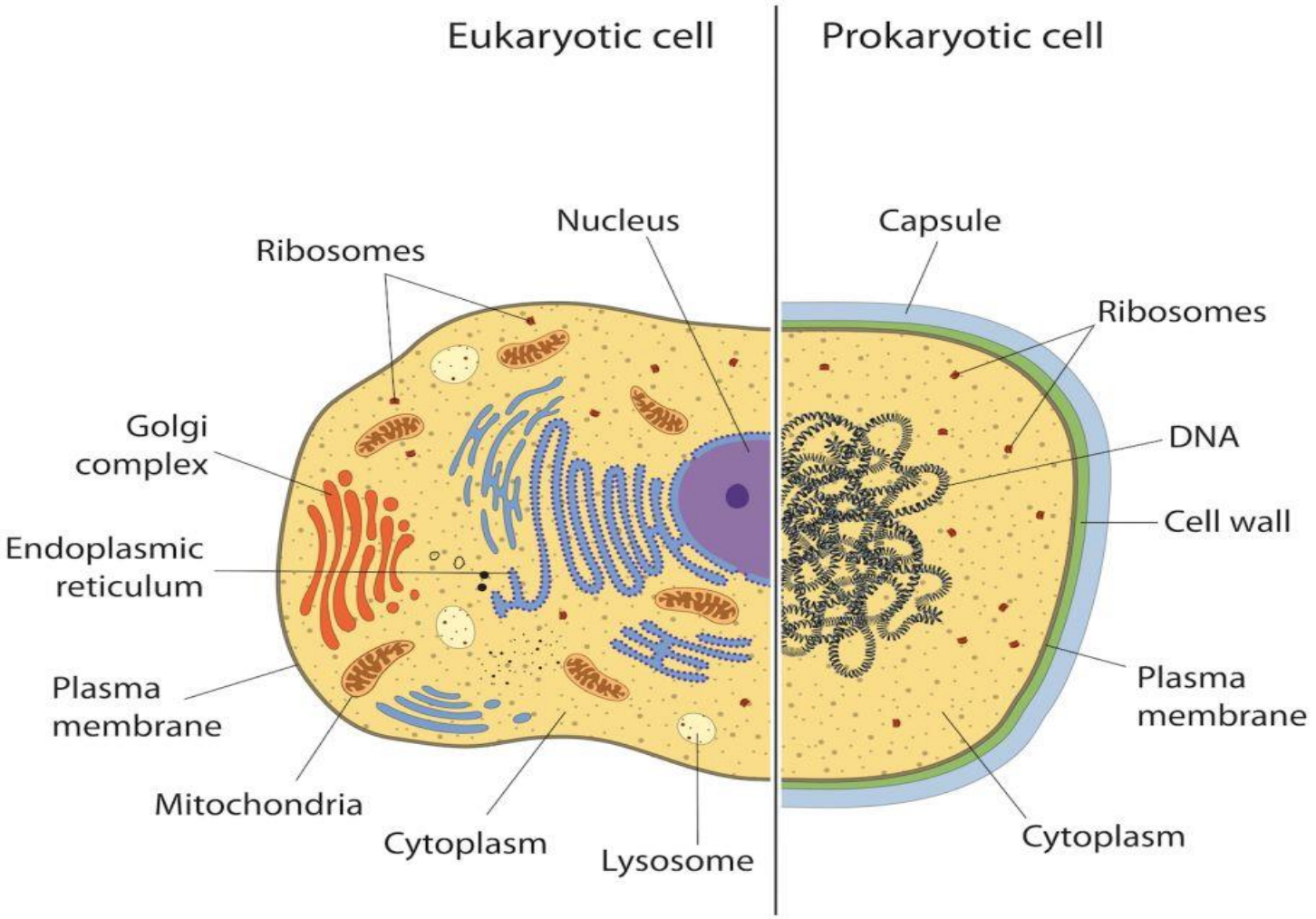
- All living things can be divided into three basic domains:
  1) Bacteria,
  2) Archaea and
  3) Eukarya.
- single-celled organisms found in the **Bacteria** and **Archaea** domains are known as **prokaryotes** (made of prokaryotic cells — the smallest, simplest and most ancient cells).
- Organisms in the **Eukarya domain** are made of the more complex eukaryotic cells(can be unicellular or multicellular). They include;
  1. animals,
  2. plants,
  3. fungi and
  4. protists

DIFFERENCES OF THE TWO CELLS

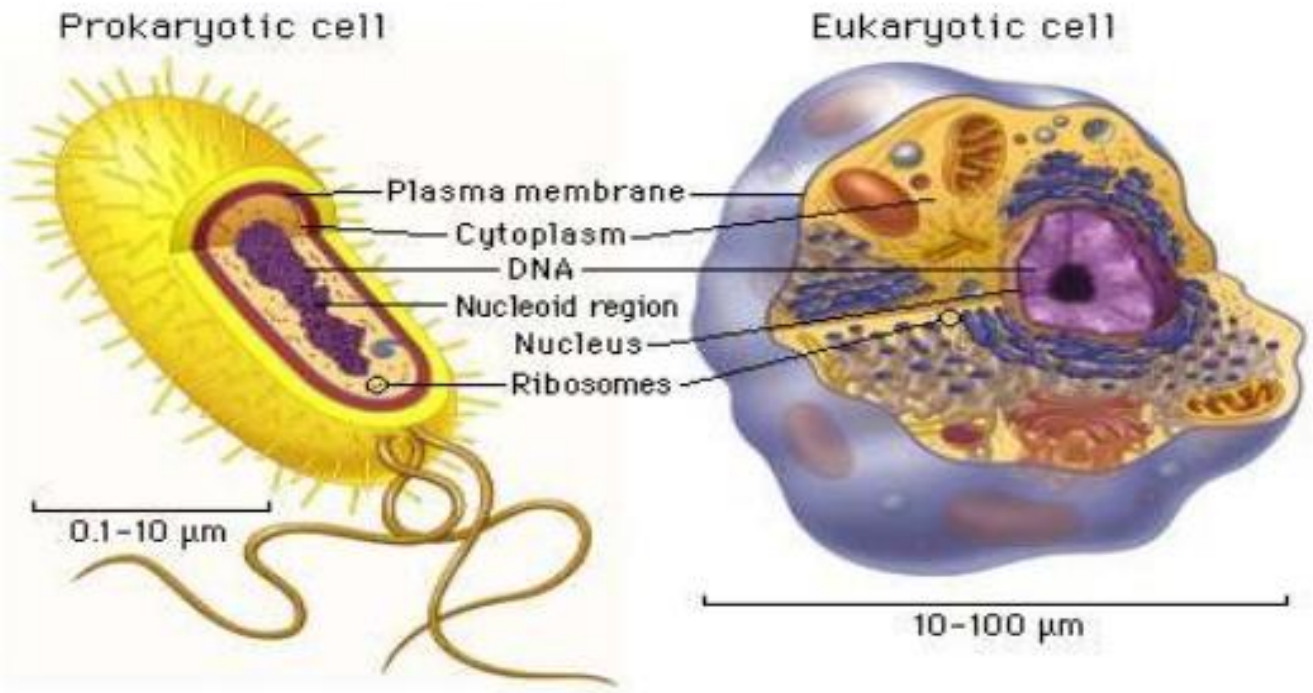
Prokaryotes vs. Eukaryotes

Prokaryote	Eukaryote
	
No nucleus (DNA not enclosed)	DNA in nucleus
No membrane-enclosed structures	Membrane-enclosed structures (organelles)
0.1-10 micrometers (µm)	10-1000 micrometers (µm)
Evolved 3.5 billion years ago (first life)	Evolved 1.5 billion years ago
Archaea and bacteria only	All other cells

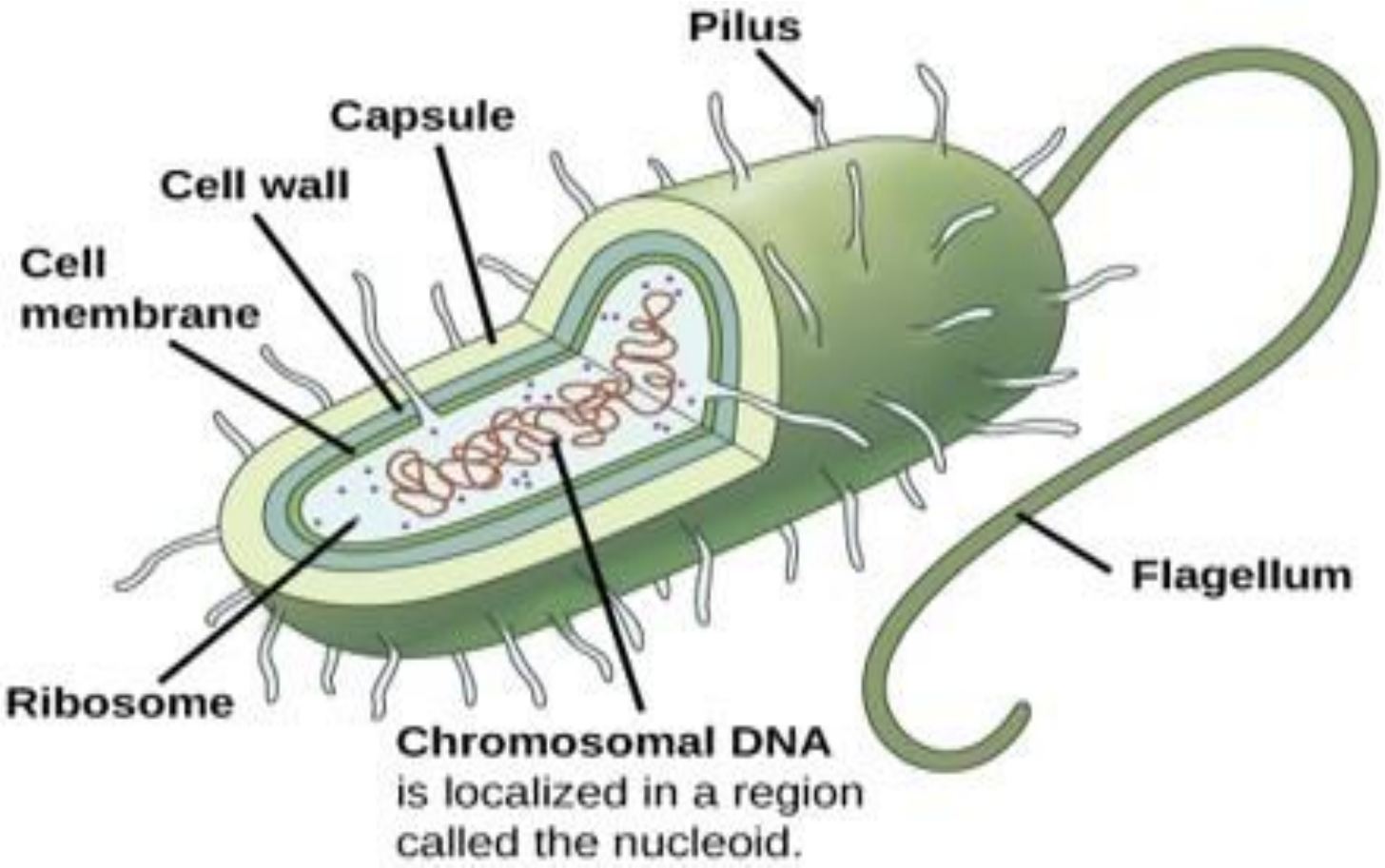
DIFFERENCES OF THE TWO CELLS



Cells: Prokaryote vs Eukaryote



Prokaryotic Cell



GENERAL STRUCTURE OF P/CELL

- Cell Appendages
- Cellular Envelope
- Internal Structure

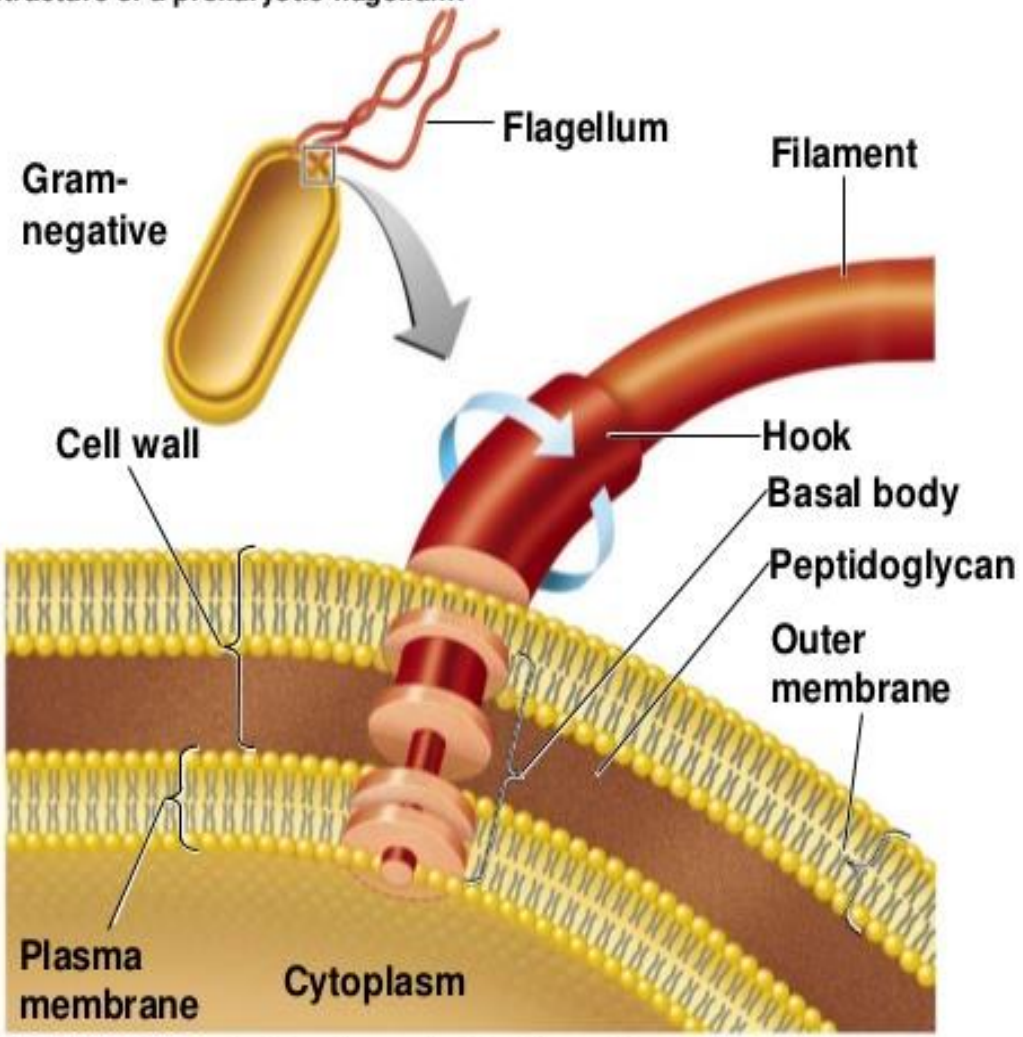
A. General Structure

1. Cell Appendages

A) Flagella

- Functions in movement of the cell
- 3 components
  a) **Filament**
    I. Whip-like, helical structure
  b) **Hook**
    I. Holds the filament
    II. Attached to the rod portion of the basal body
  c) **Basal body**
    I. A complex structure consisting of a rod, 4 rings and a motor contained within the cell envelope
    II. Activation of the motor causes the hook (and therefore the filament) to swivel

Figure 4.8a The structure of a prokaryotic flagellum.

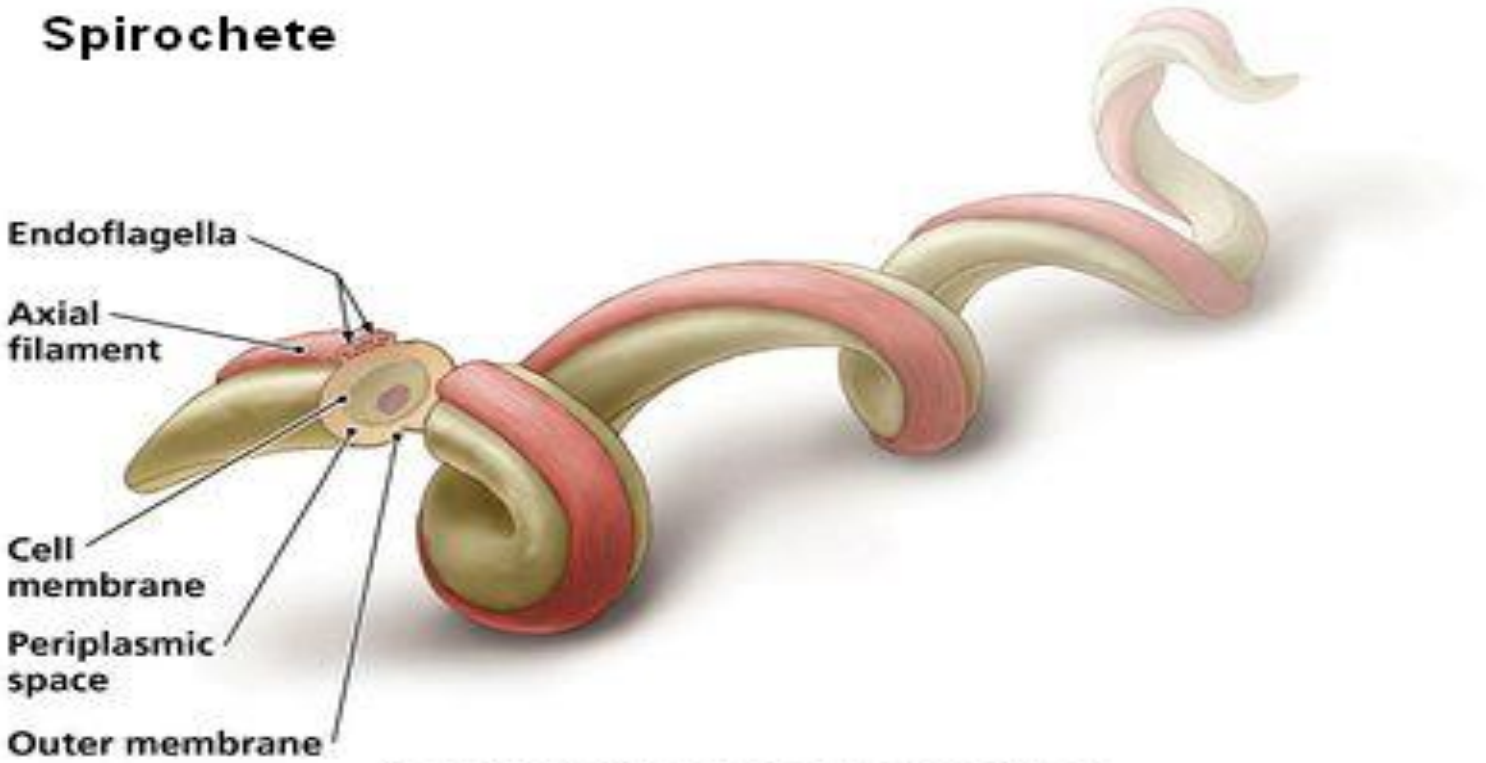


(a) Parts and attachment of a flagellum of a gram-negative bacterium

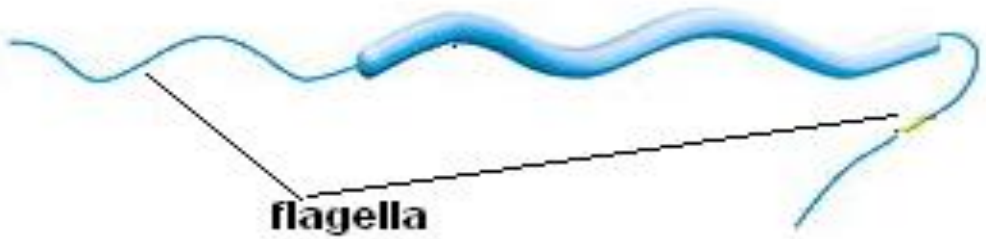
B) Periplasmic Flagella

- A type of modified flagella
- Found in a special bacteria known as **spirochetes**
- Consist of a filament and a hook but the entire structure is located between the cell wall and membrane (the periplasmic space)

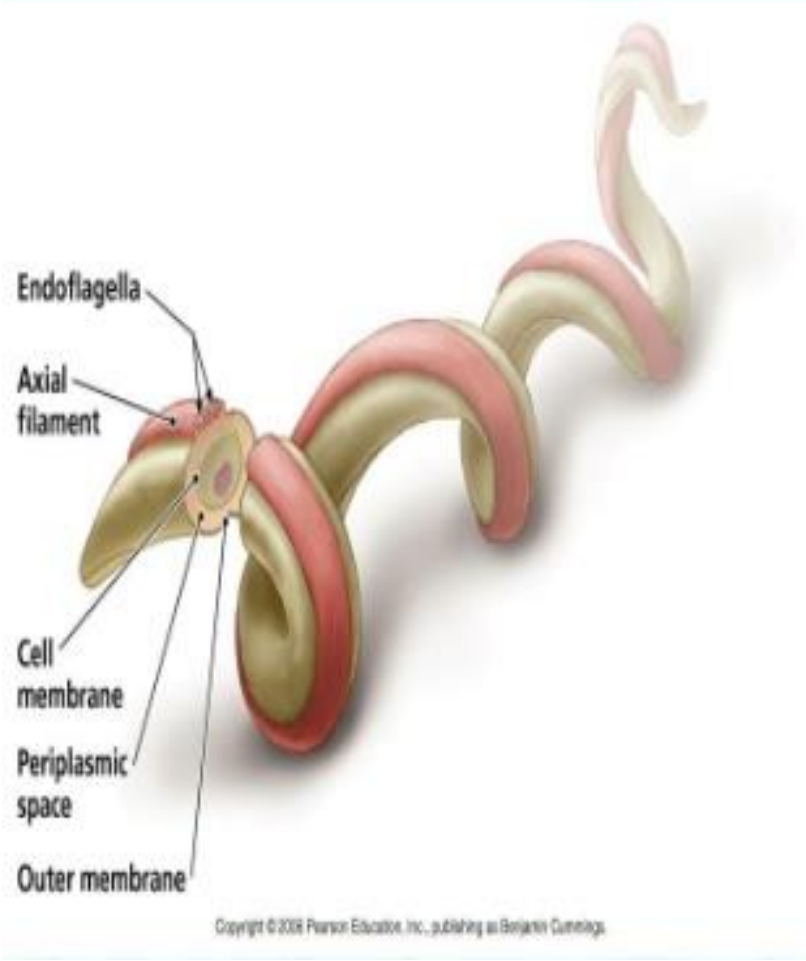
Spirochete

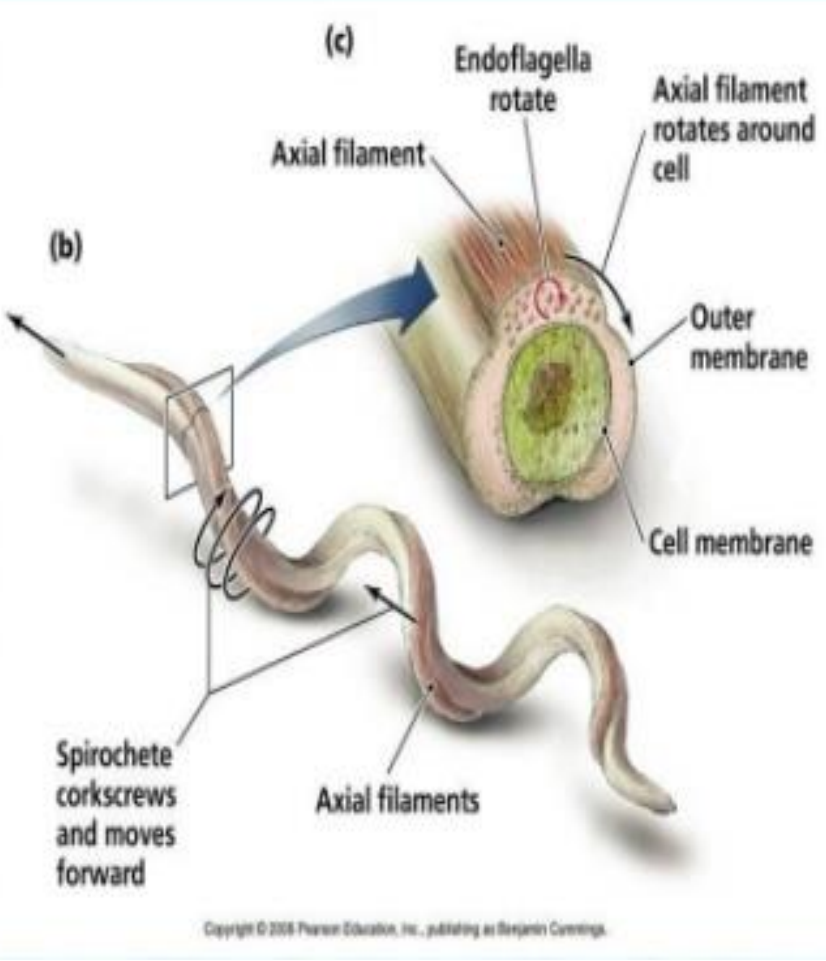


Spirillum



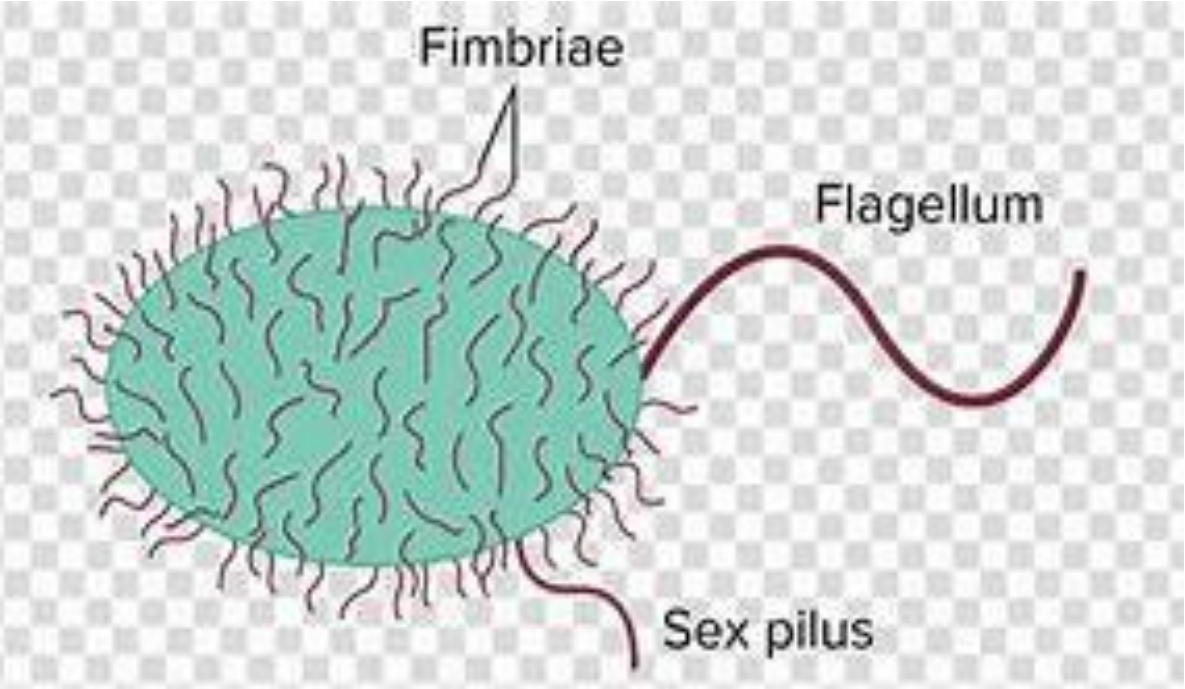
Periplasmic Flagella Diagram





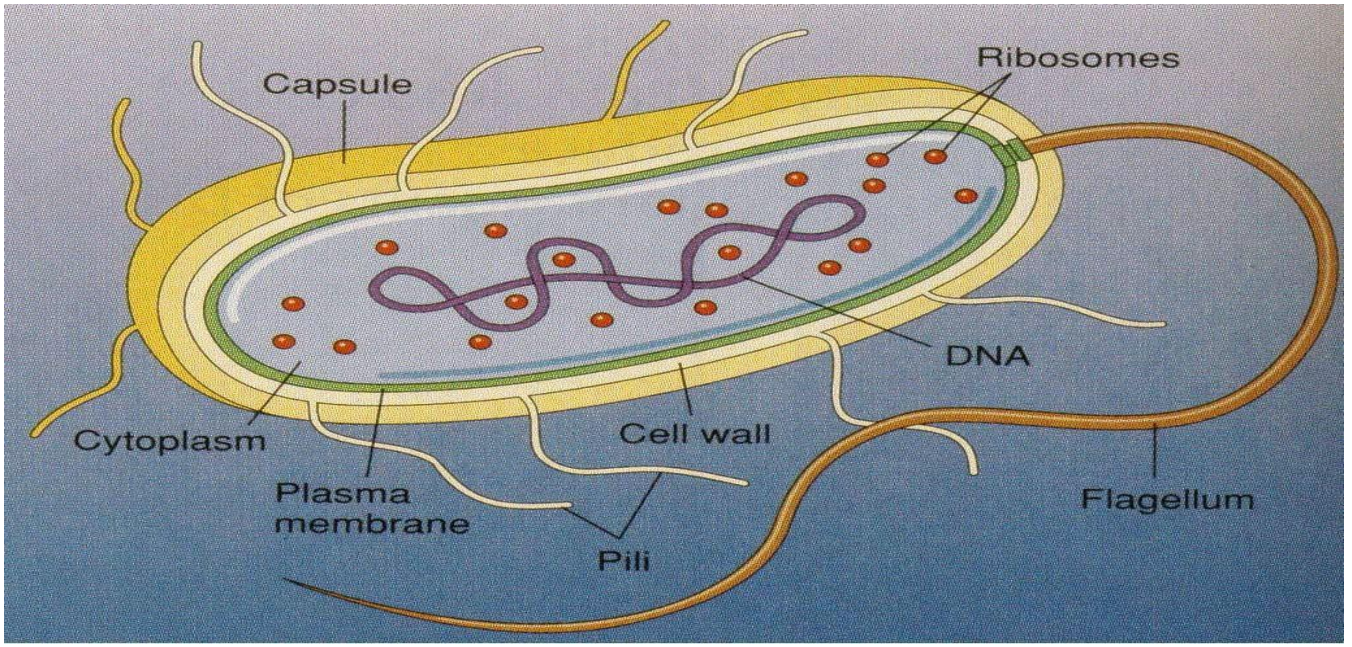
c) Fimbriae

- A small, hair-like fibers on the surface of the cell
- Tend to stick to each other as well as other surfaces



D) Pilus

- Elongated, tubular structure
- Only present on certain species of Gram-negative bacteria
- Primarily involved in attachment, movement, and <u>conjugation</u>
  - The transfer of DNA from one bacterium to another



2. Cellular Envelope

A) Glycocalyx

- Refers to the gel-like outer covering of some bacteria
- Its usually sticky, "sugar coating" (glue)
- Are of 2 types
  a) **Slime layer**
     - Diffuse & irregular structure

  b) **Capsule**
     - Distinct & gelatinous structure
- **Functions**
  a) Protection against phagocytosis
     - Encapsulated bacteria tend to have a greater pathogenicity because of this

Cont.....

b) Helps bacteria adhere to its environment or other bacteria

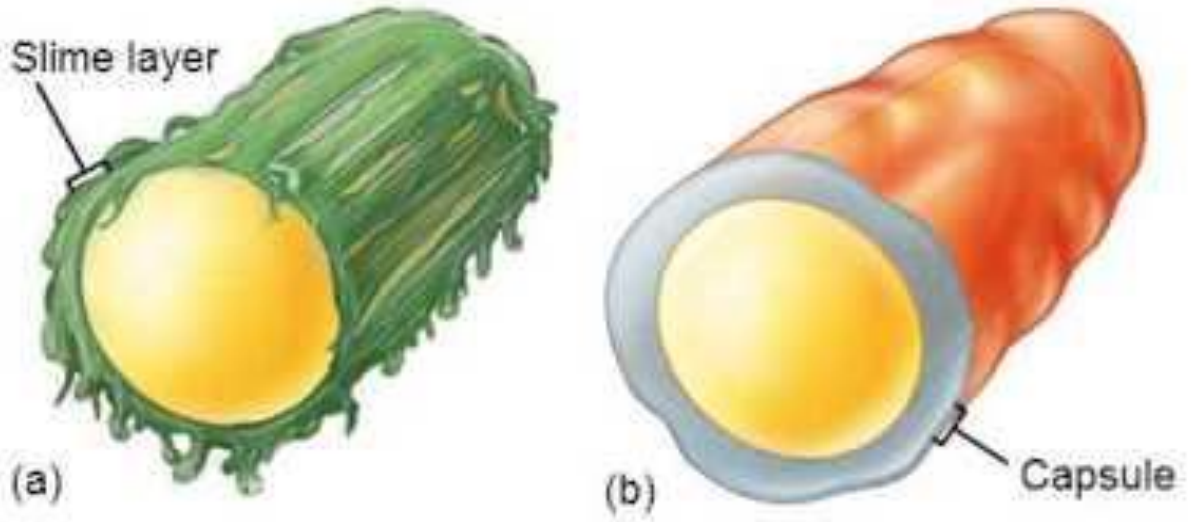
- All the bacteria to stick to a larger number of substances including tooth enamel and hospital equipments
- Allows bacteria to grow as a biofilm (i.e dental plague)

c) Help prevent the loss of water and nutrients

Glycocalyx

Coating of molecules external to the cell wall, made of sugars and/or proteins

1. **Slime layer** - loosely organized and attached
2. **Capsule** - highly organized, tightly attached



B) Cell Wall

- Lies immediately below the glycocalyx
- Provides the bacteria with structure and protection from lysis
  - Certain drugs, including penicillin, destroy the cell wall allowing cell lysis to occur

- Composed primarily of peptidoglycan
  - Basic structure
  - Composed of 2 repeating sub-units
    - *N*-acetylmuramic acid (NAM)
    - *N*-acetylglucosamine (NAG)
      - Covalently bonded together to form a glycan chain
  - Adjacent glycan chains are held together by tetrapeptide chains attached to each NAM

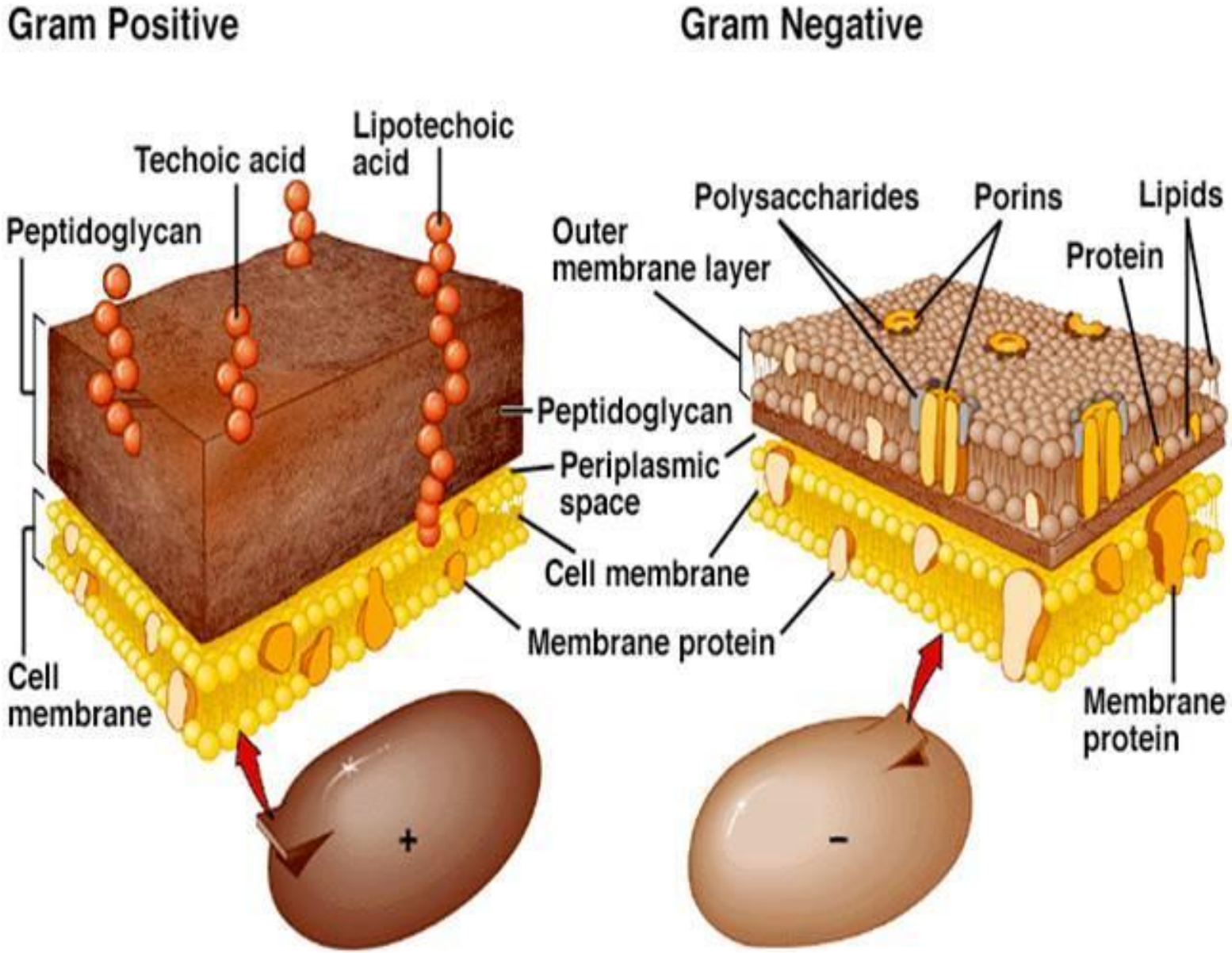
- Bacteria are lumped into 2 groups based on the staining of their cell walls
  - **Hans Christian Gram** developed Gram staining in 1884
    - The result is a group of bacteria that stain **violet (Gram-positive)** and a group that **stain red (Gram-negative)**

1) Gram-positive bacteria

- Cell wall composed of a thick layer of peptidoglycan
- There is a narrow periplasmic space
- Gram-positive bacteria are more permeable but less susceptible to lysis
- 2 molecules (besides peptidoglycan) are commonly found
  a) Teichoic acid – binds together layers of peptidoglycan
  b) Lipoteichoic acid- link the peptidoglycan layers to the cell membrane

2) **Gram-negative bacteria**

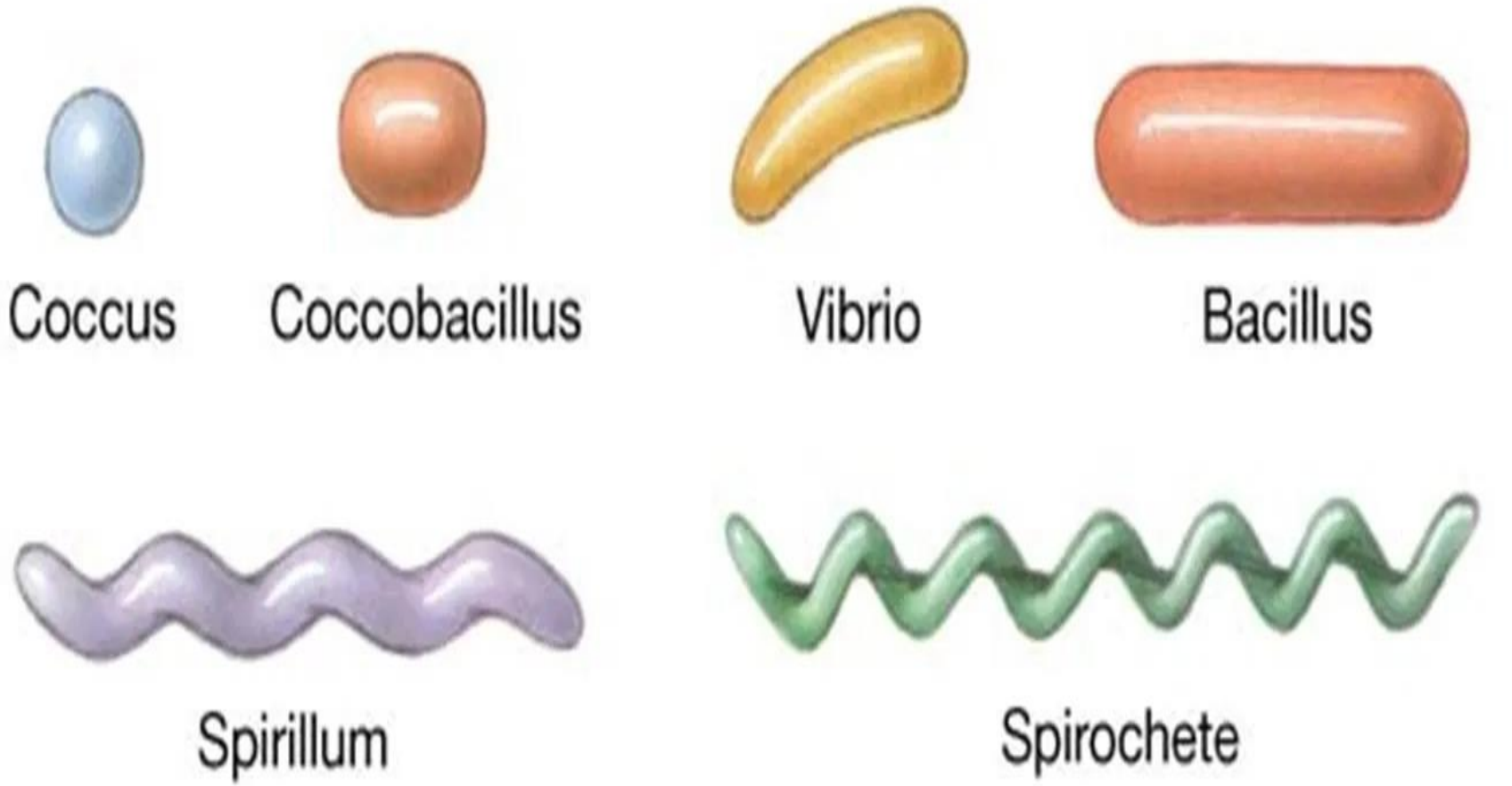
- Cell wall composed of a thin layer of peptidoglycan
- There is a wider periplasmic space
- Gram-negative bacteria are less permeable but more susceptible to lysis
- Surrounded by an outer membrane
  - Similar to cell membrane (lipid bilayer)
    - Inner layer of phospholipids bound to the cell wall by lipoproteins
    - Outer layer is composed of lipopolysaccharides


Gram Positive
Gram Negative
Techoic acid
Lipotechoic acid
Peptidoglycan
Cell membrane
Peptidoglycan
Periplasmic space
Cell membrane
Membrane protein
+
Polysaccharides
Porins
Lipids
Outer membrane layer
Protein
Membrane protein
−

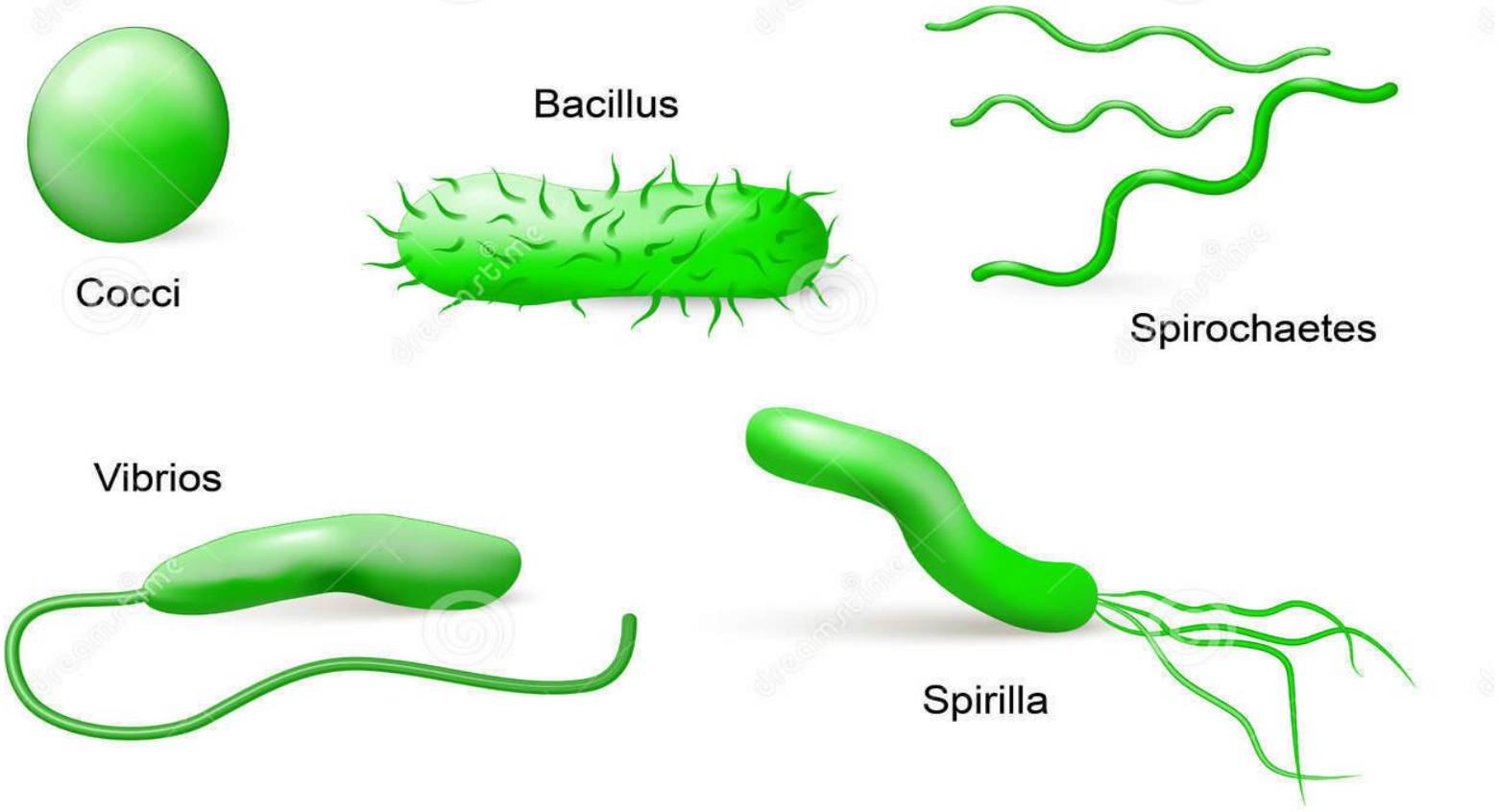
Gram negative

- Responsible for the multiple shapes seen in bacteria
  a) **Coccus** – Round
  b) **Bacillus** – Rod- shaped
     1) Coccobacillus – short, plump rods
     2) Vibrio – slightly bent rods
  c) **Spirillum** – spiral-shaped cylinder

SHAPES

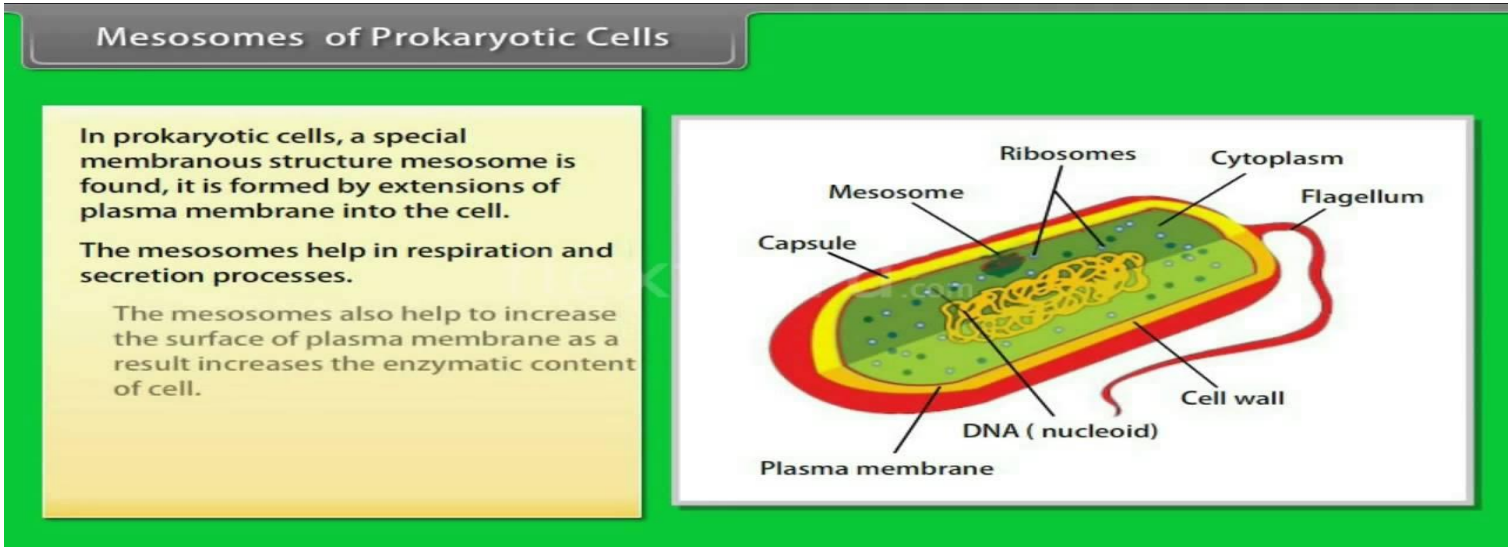

Coccus
Coccobacillus
Vibrio
Bacillus
Spirillum
Spirochete

SHAPES OF BACTERIA

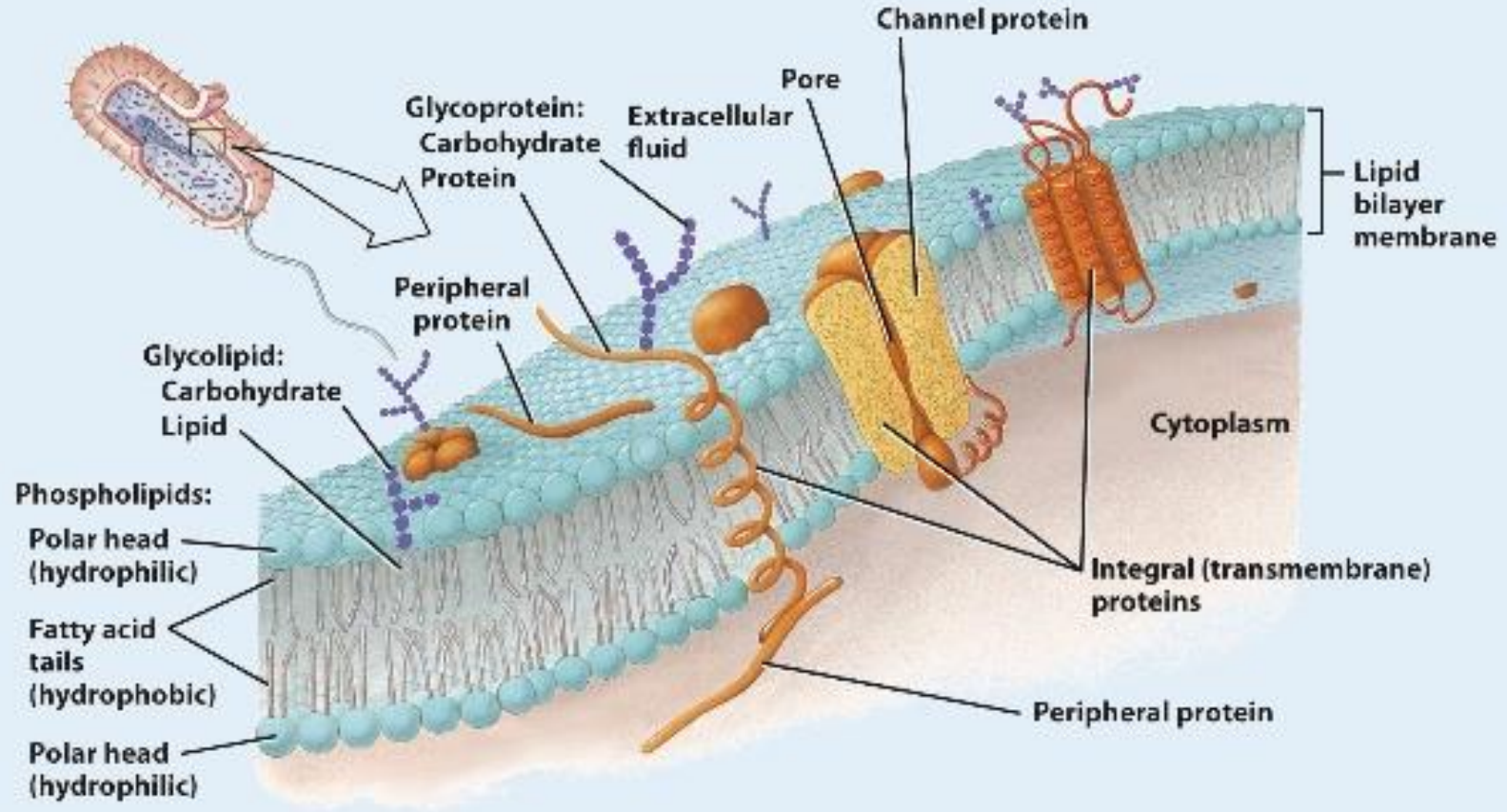


C) CELL MEMBRANE

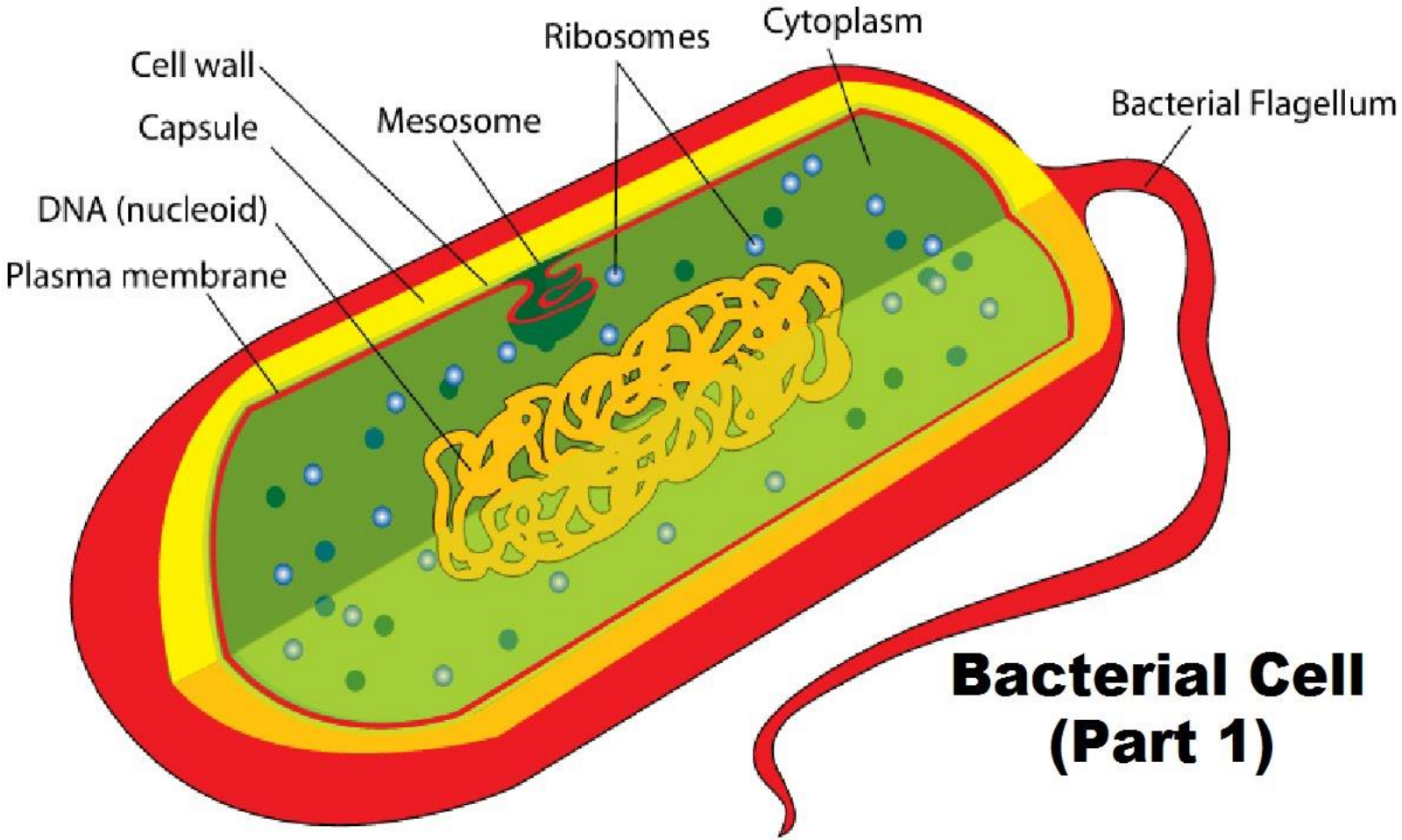
- Composed primarily of phospholipids
- Membrane proteins provide the membrane with structure and functionality
- Mesosomes are inward projections of the membrane
  - Believed to increase surface area for membrane activities
- Functions primarily in controlling the movement of substances into and out of the cell.



Prokaryotic Plasma Membrane



3.Internal Structure

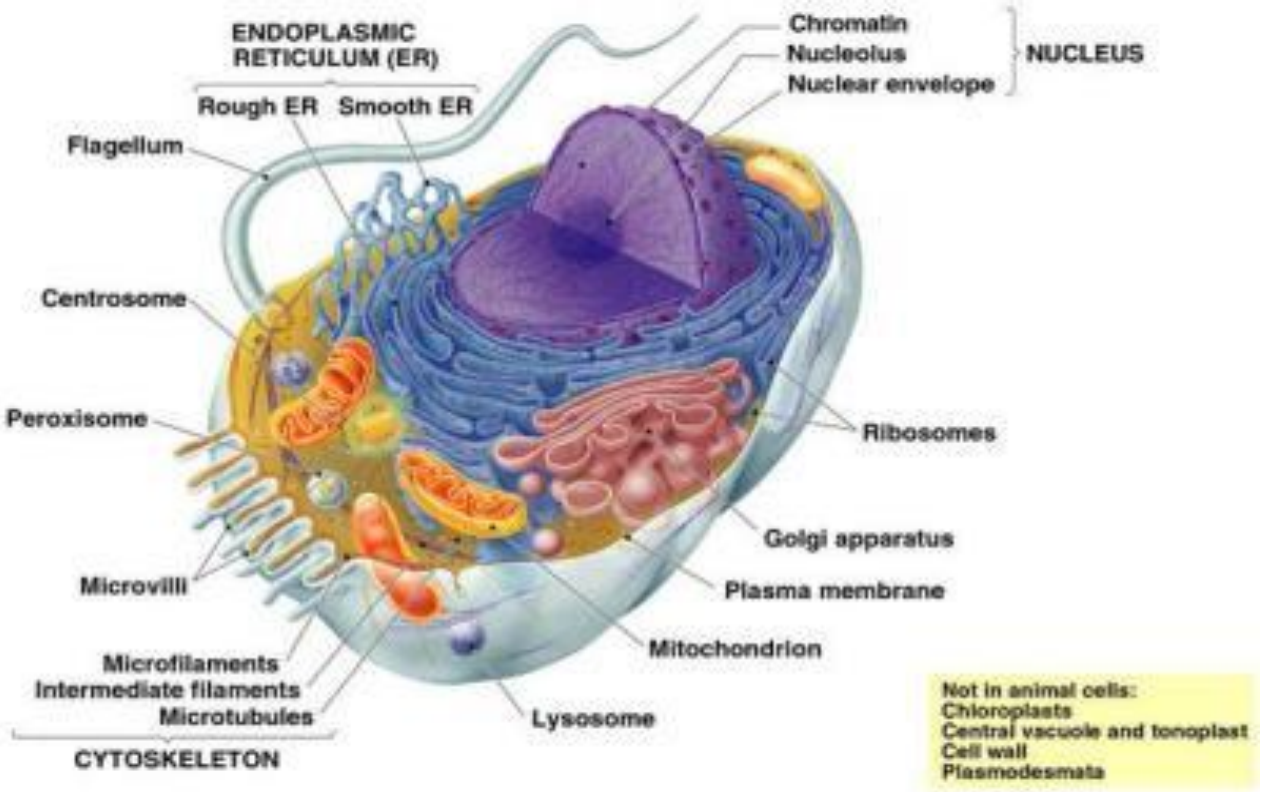


A)CYTOPLASM

- Fluid within the cell
- Primarily water containing dissolved nutrients & wastes
- Serve as a site for numerous metabolic reactions

B) CHROMATIN BODY

- A single, circular loop of a single DNA
- Aggregated in a dense area of the cell known as nucleoid



C) PLASMIDS

- Extra, nonessential pieces of DNA
- Arranged in isolated loops or attached to the chromatin body
- They are reproduced and passed on to the offspring
- Often contain protective traits
- Exchanged during conjugation

D) RIBOSOMES (70s)

- The site of protein production within the cell
- Composed of rRNA and proteins
- Comprised of 2 subunits
  - Small subunits (30S)
  - Large subunits (50S)

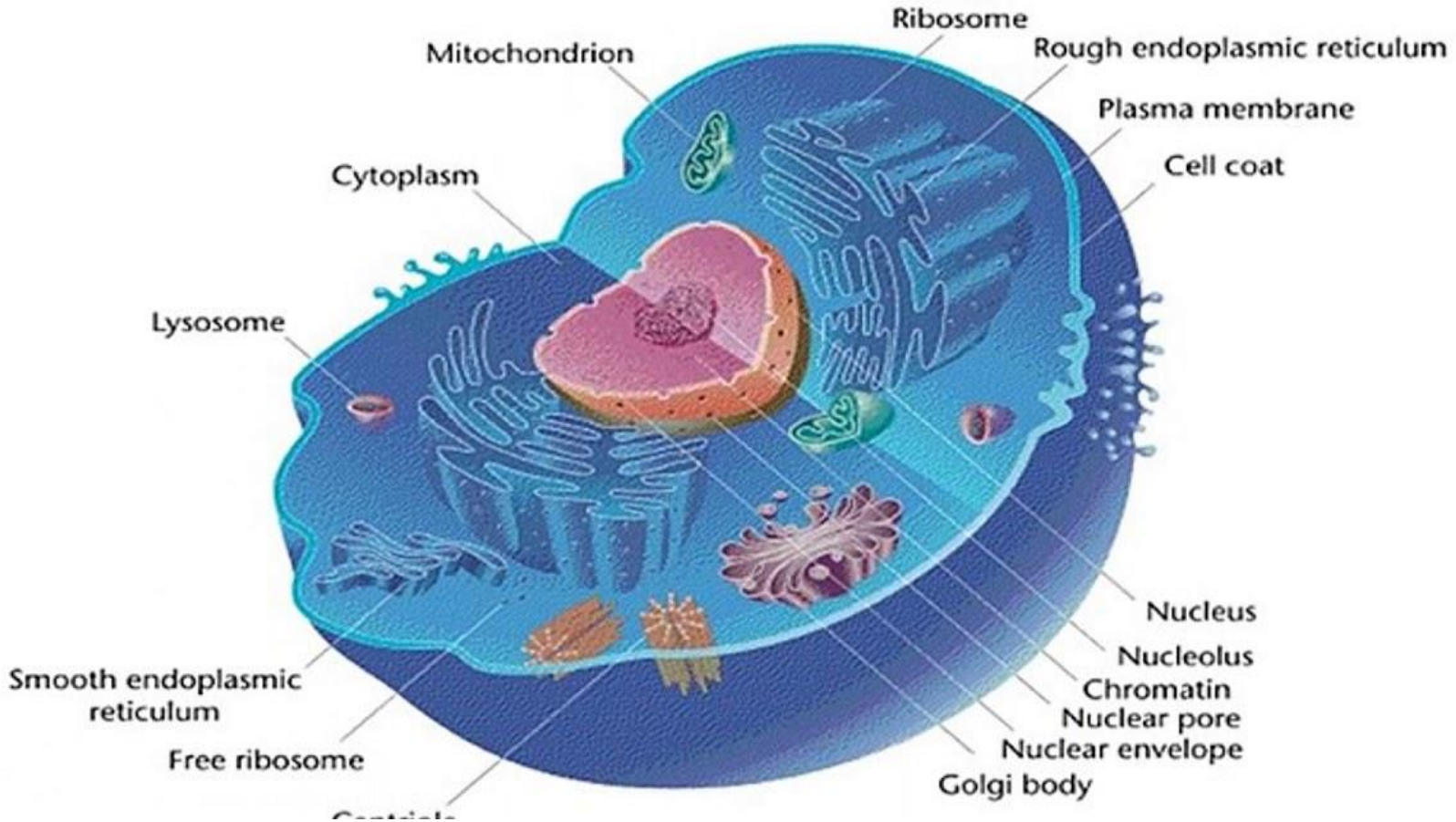
E) INCLUSION BODIES

- Aggregation of nutrients and other substances often needed by the cell
- May or may not be membrane-bound
- Allows the cell to go for long periods in the absence of essential nutrients

EUKARYOTIC CELLS

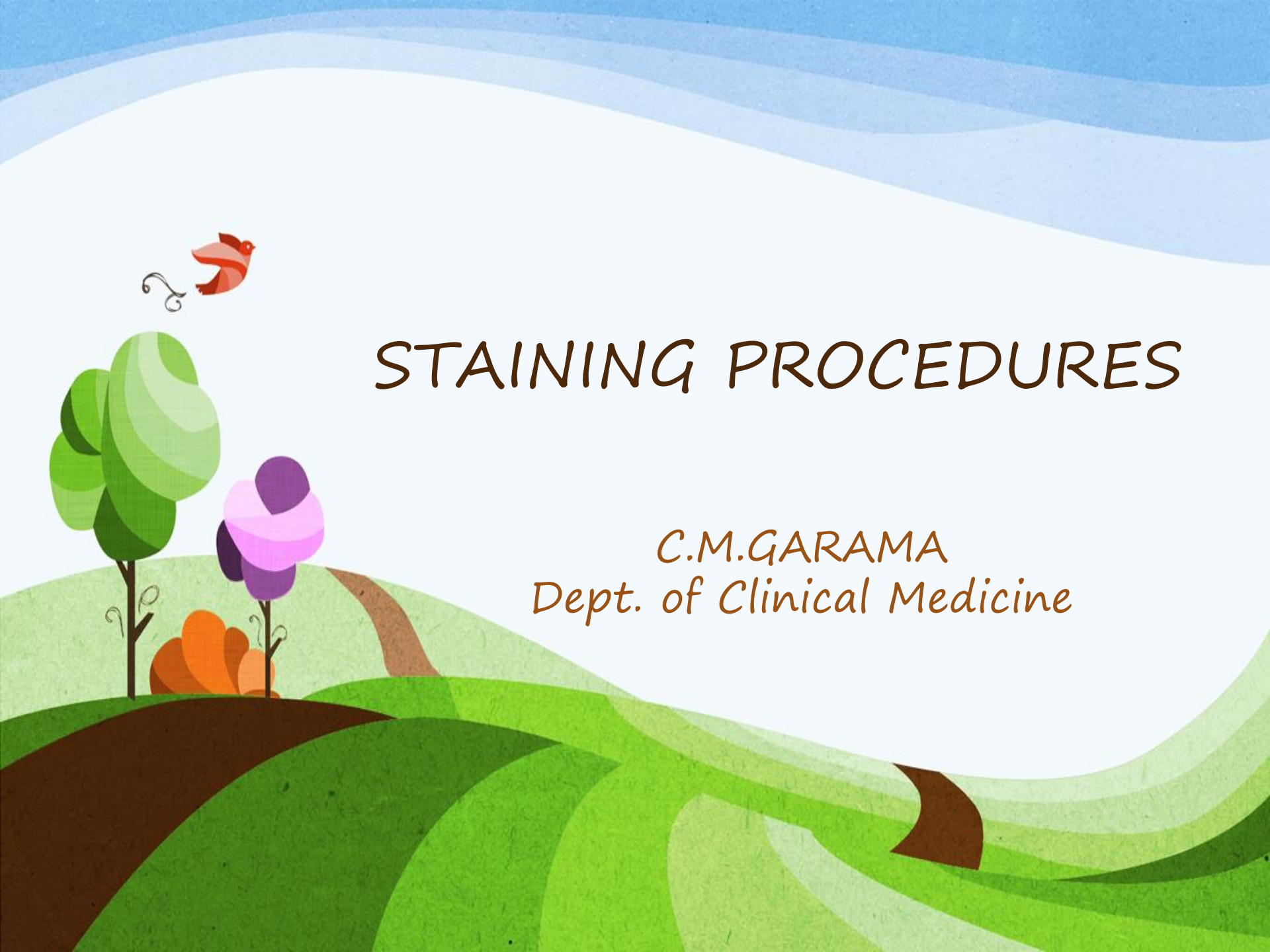
PART II

EUKARYOTIC CELL



Assigment

- The Function of ALL organelles found in the Eukaryotic cell



STAINING PROCEDURES

C.M.GARAMA
Dept. of Clinical Medicine

Objectives

- Define staining
- Describe the unique features of commonly used stains
- Explain the procedures and name clinical applications for Gram, endospore, acid-fast, negative capsule, and flagella staining

What is Staining?

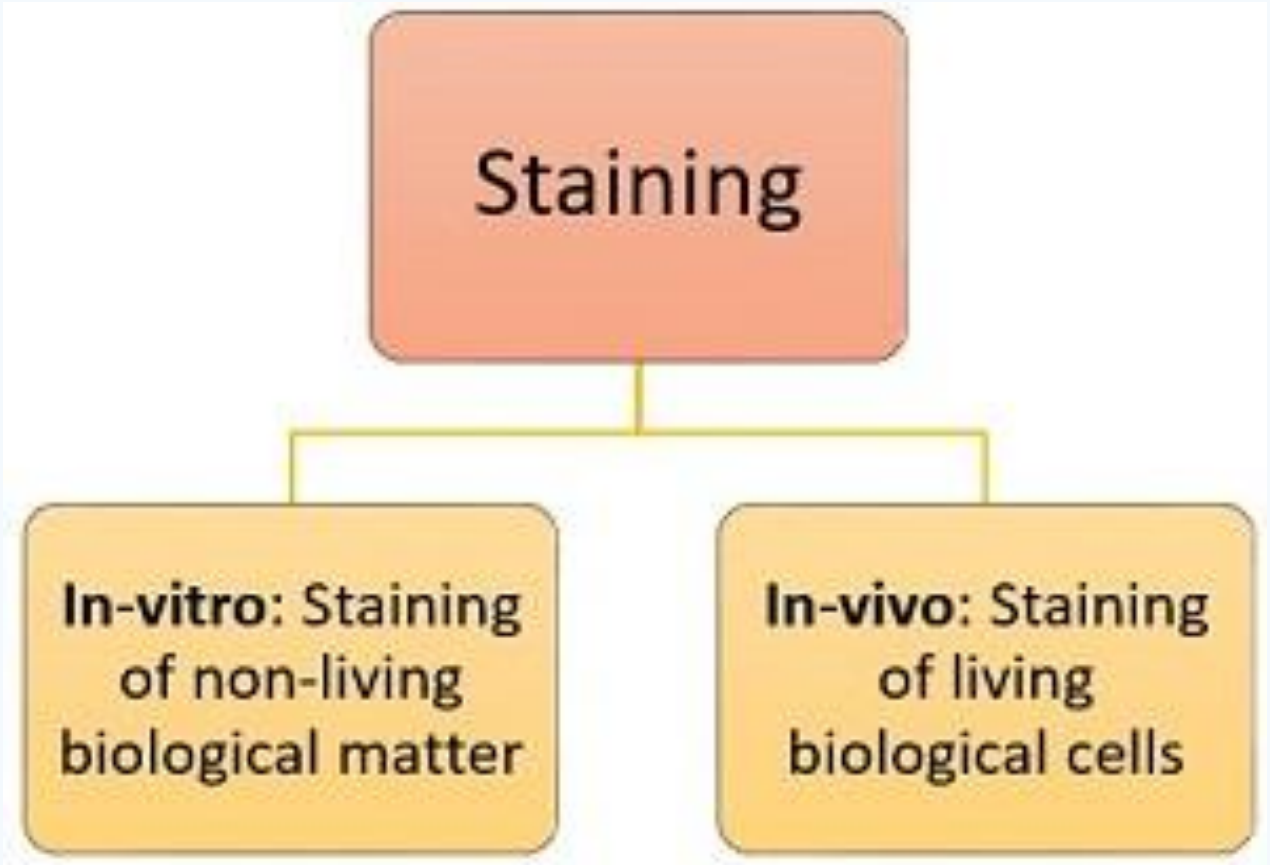
- Staining is a supplementary method that gives divergence to the microscopic image for better vision under the microscope.
- It is a technique that is widely used for the examination of cells, tissues and cellular components.

What is Stain?

- It's a chemical reagent or dye that is responsible for the discolouration of the specimen.

- It adds contrast to the microscopic image that gives a distinct view of the organism

Ways staining is done

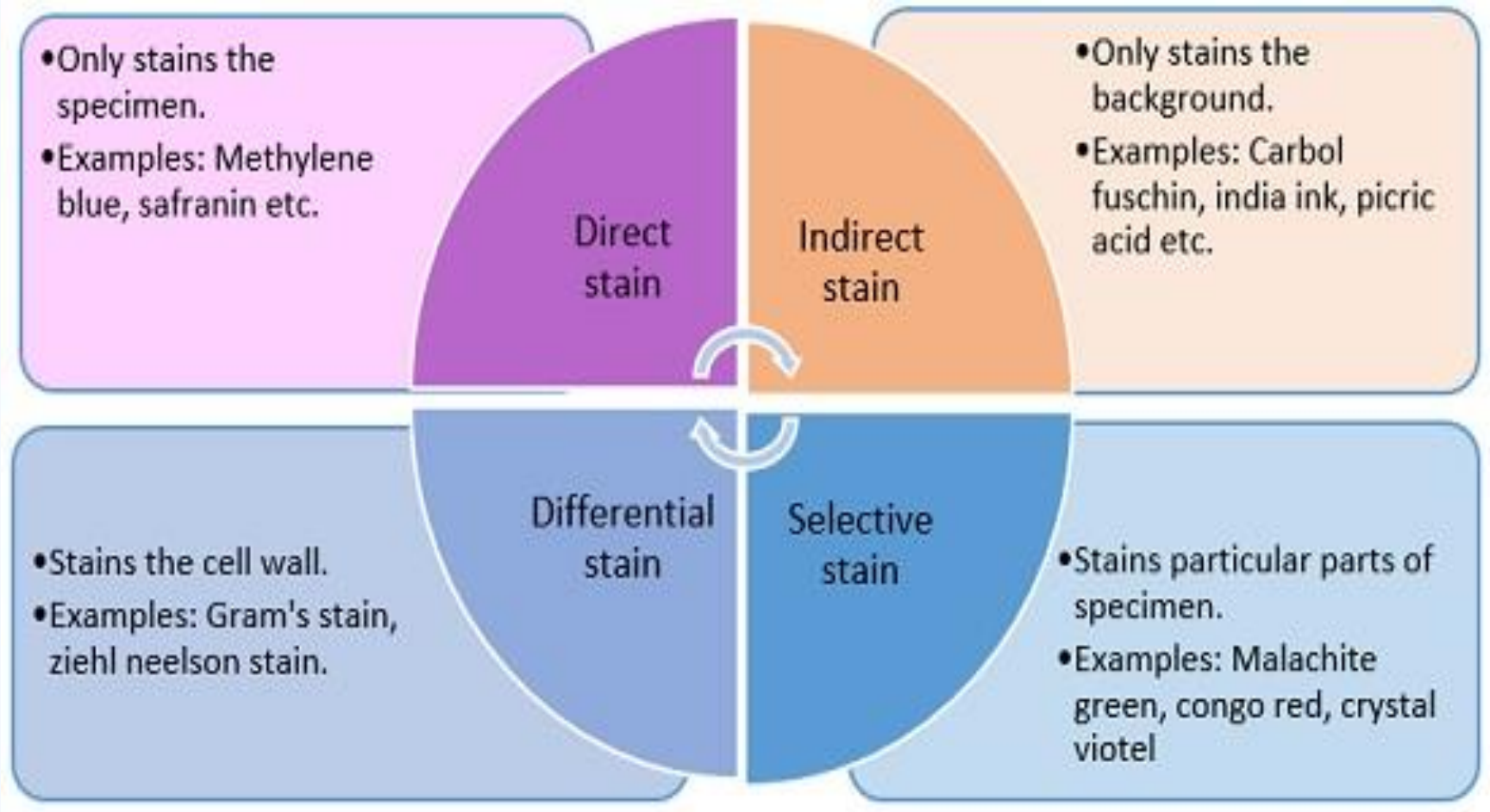


Classification of stains

a) Based on chemical nature:

ACIDIC STAIN	BASIC STAIN	NEUTRAL STAIN
• Carries negative charge • **Examples**:- Nigrosin, eosin, carbol fuschin, india ink, malachite green etc.	• Carries positive charge • **Examples**:- Crystal violet, methylene blue, safranin etc.	•Carries both positive and negative charge •**Examples**:- Geimsa's stain, leishman stain, wright's stain etc.

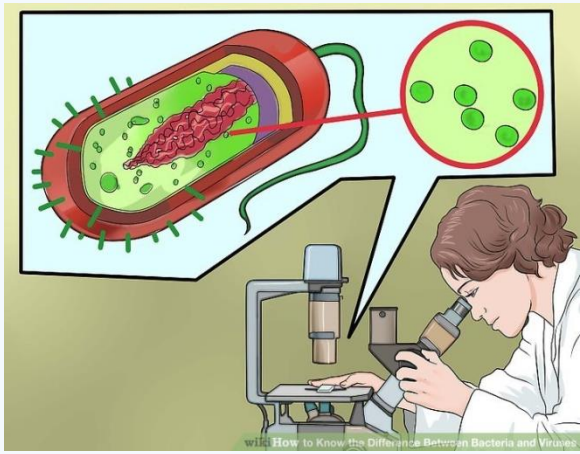
b)Based on the staining method



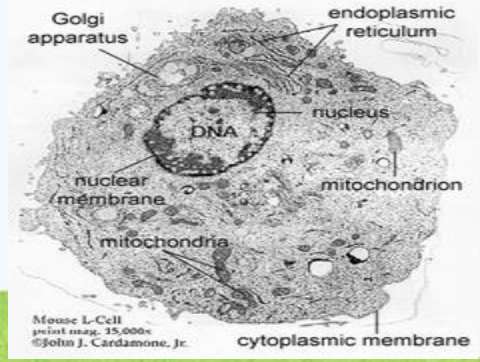
Objectives of Staining

1. Enables us to see the organism better

2. Helps to differentiate organisms



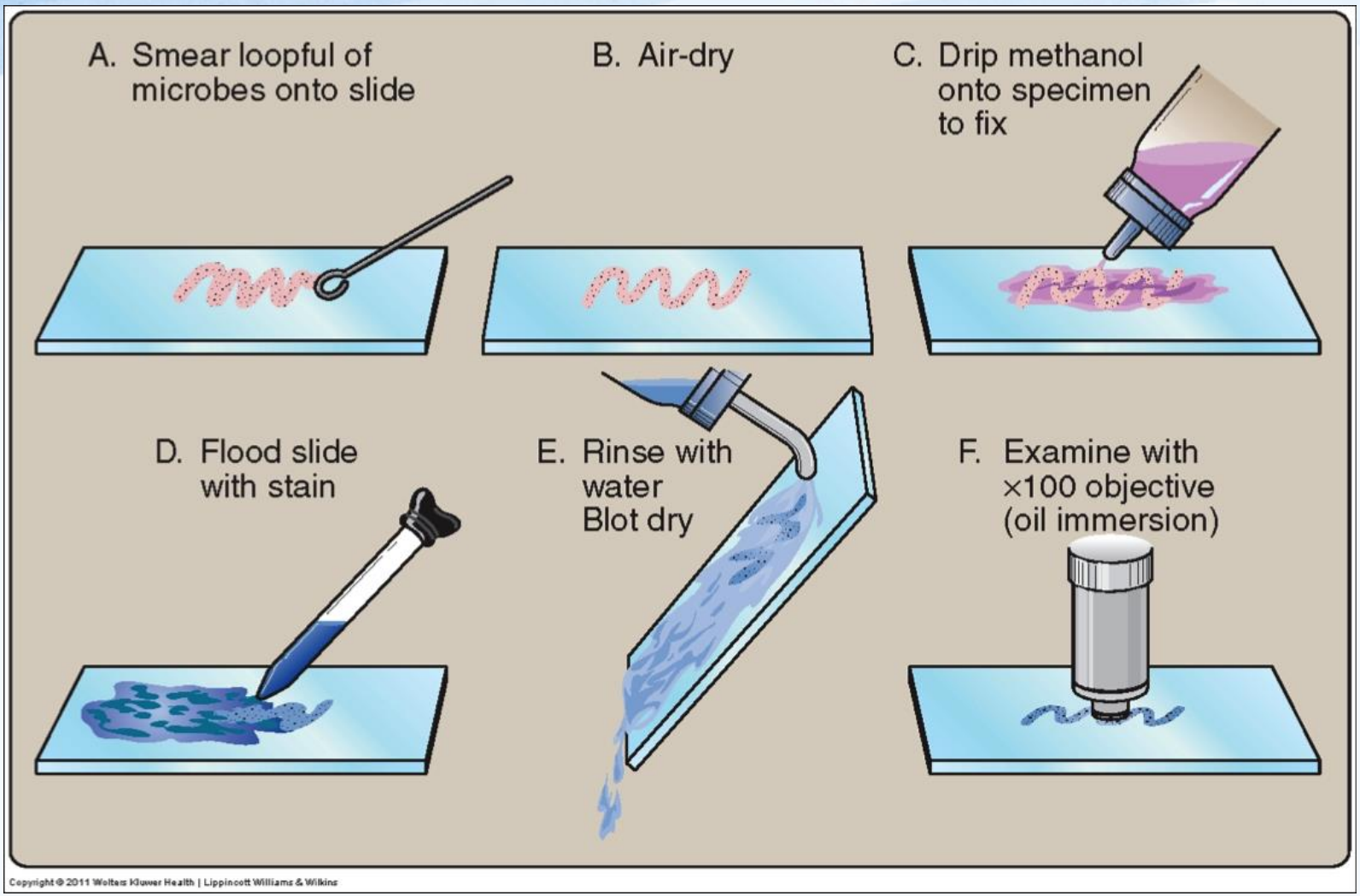
3. Identify a particular structure

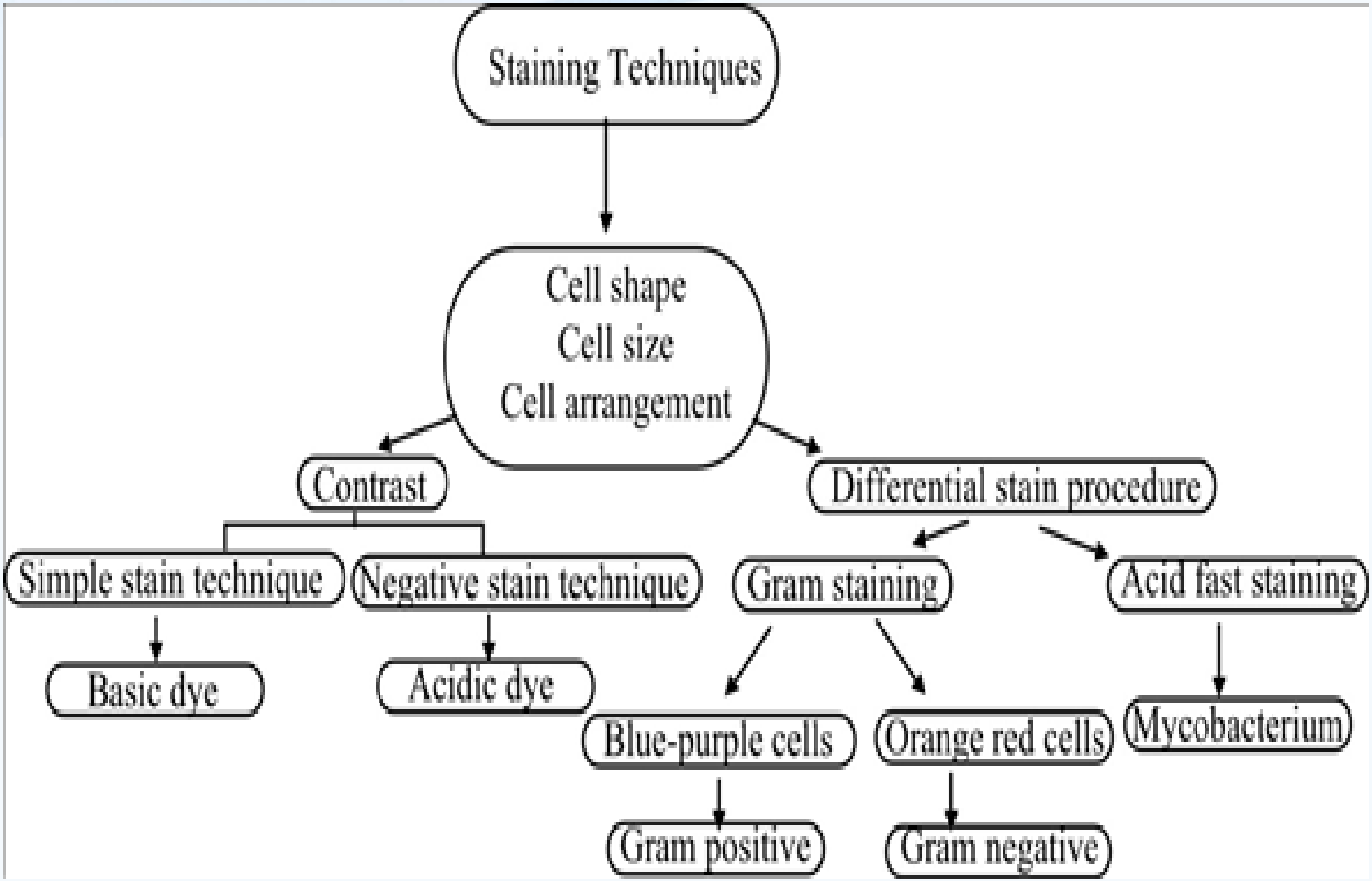


Staining Techniques

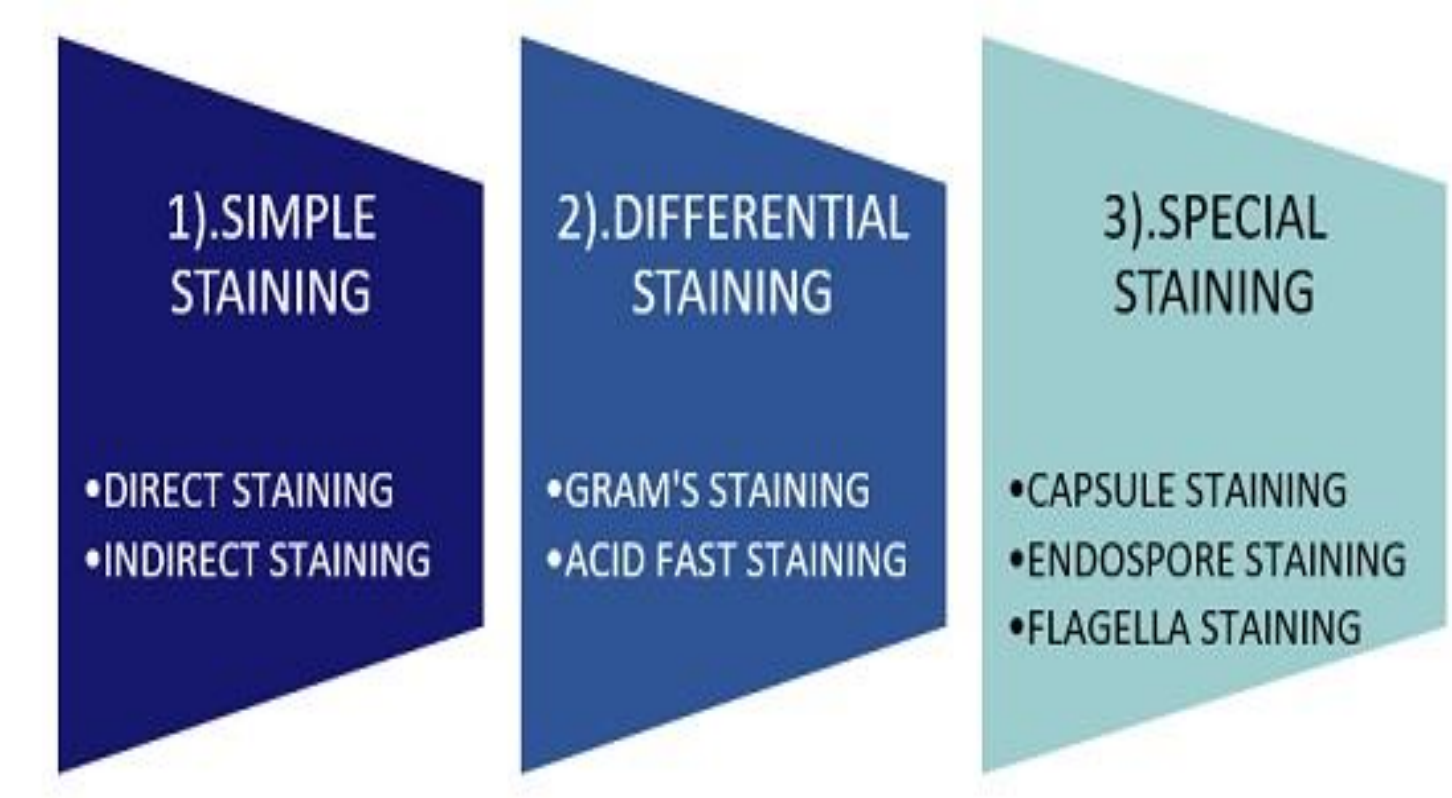
- Staining generally involves three steps

  1. Preparation of smear
  2. Fixation of smear
  3. Staining of the specimen



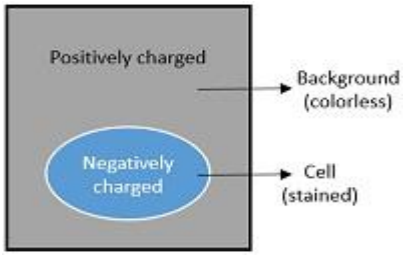
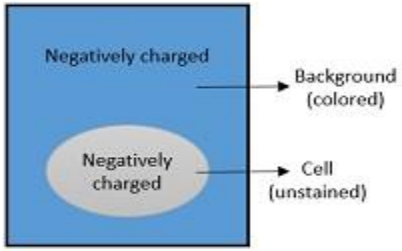

Staining Techniques
Cell shape
Cell size
Cell arrangement
Contrast
Differential stain procedure
Simple stain technique
Negative stain technique
Gram staining
Acid fast staining
Basic dye
Acidic dye
Blue-purple cells
Orange red cells
Mycobacterium
Gram positive
Gram negative

Types of Staining



1)SIMPLE STAINING

- It determines the cell shape, size and arrangement of the microorganism.
- It is a very quick or simple method to perform.
- To perform this staining, it requires the use of a single stain only.
- These are of two types, namely ;
  - direct and indirect staining

CHARACTERISTICS	DIRECT STAINING	INDIRECT STAINING
Stain used	Basic stain	Acidic stain
Charge of stain	Positive	Negative
Examples	Methylene blue, crystal violet, carbol fuschin	Nigrosine, india ink, congo red
Outcome	Stains the specimen	Stains the background
General view after staining		
Principle for discoloration	Because of the positively charged stain, it gets attracted towards the negatively charged cell, hence it get fixed to the cell that retain the color of stain results in colorless background with colored cell.	Because of the negatively charged stain, it gets repelled by the negatively charged cell, hence it does not fixed to the cell, results in colorless cell with colored background.

2) DIFFERENTIAL STAINING

- It differentiates between the physical and chemical properties of two different groups of an organism based on cell-wall characteristics.
- To perform this staining, it requires the use of multiple or more than one stains.
- It is categorised into two types
  a. Gram staining
  b. Acid fast staining

a) Gram staining

- It identifies and classifies two major groups of bacteria, i.e. Gram-positive and Gram-negative.
- Dr Hans Christian Joachim Gram introduced it in 1884.
- This process is Carried out by differential stain known as Gram's stain.

Gram staining	Protocol	Gram positive bacteria	Gram negative bacteria
Primary staining	Heat fixed smear is flooded by crystal violet and allowed to stand for 1min.		
Mordanting	After washing, iodine is then flooded and allowed to stand for 1min.		
Decolourization	After washing, alcohol is added that is washed immediately		
Counter staining	At last, safranin is flooded over the smear and allowed to stand for 30sec, then washed by water.		
Observation	After air drying, place one drop of oil immersion over the smear and adjust the microscope to identify the specimen, whether it is gram negative or gram positive.		
		Appear purple in colour because of teichoic acid that resist the primary stain.	Appear pink in color due to lack of teichoic acid, alcohol creates pore in the cell which decolourizes the primary stain

b) Acid fast staining

- It differentiates species of mycobacterium from the other group of bacteria.
- Paul Ehrlich first developed it in 1882.
- And later, modified by Ziehl Neelson

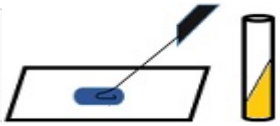
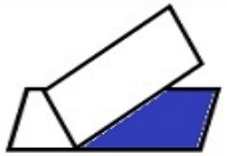
ACID FAST STAINING	PROTOCOL	ACID FAST BACTERIA	NON ACID FAST BACTERIA
Primary staining	Heat fixed smear is flooded with carbol fuschin and allowed to stand for 1 min.	 Red	 Red
Decolourization	After washing, acid alcohol is added.	 Red	 Colorless
Counter staining	At last, methylene blue is flooded over the smear and allowed to stand for 30 sec, then wash it with water	 Red	 Blue
Observation	After air drying, place one drop of oil immersion over the smear and adjust the microscope to identify the specimen, whether specimen is acid fast or not.	 Red	 Blue
		Appears red in colour due to presence of mycolic acid that resist the color of primary stain and does not decolourize.	Appears blue in colour, as they lack mycolic acid, alcohol creates pore in the cell that decolourizes the primary stain.

3) SPECIAL STAINING

- It identifies particular internal and external structural components of the specimen.
- It is of three types, namely
  a. Capsule,
  b. Endospore
  c. Flagella staining.

a) Capsule

- It differentiates the capsule from the rest of the cell body.
- This is carried out by the use of both positive and negative dyes.
- Capsule acts as an envelope around the cell wall that consists of a polysaccharide
- Functions:
  a. it protects the cell from desiccation
  b. it protects the cell from phagocytic actions
  c. helps in attachment of bacteria to the host cell

CAPSULE STAINING	PROTOCOL	DIAGRAM
Primary staining	Drop of India ink is placed on a clean slide.	
Smearing	Inoculum is then smeared in a dye.	
Dragging	Use another slide to drag the mixture into thin film, and then air dried.	
Secondary staining	Crystal violet is flooded over the thin film, and then air dried.	
Observation	Examine the cells whether they are encapsulated or not.	

Interpretation of result

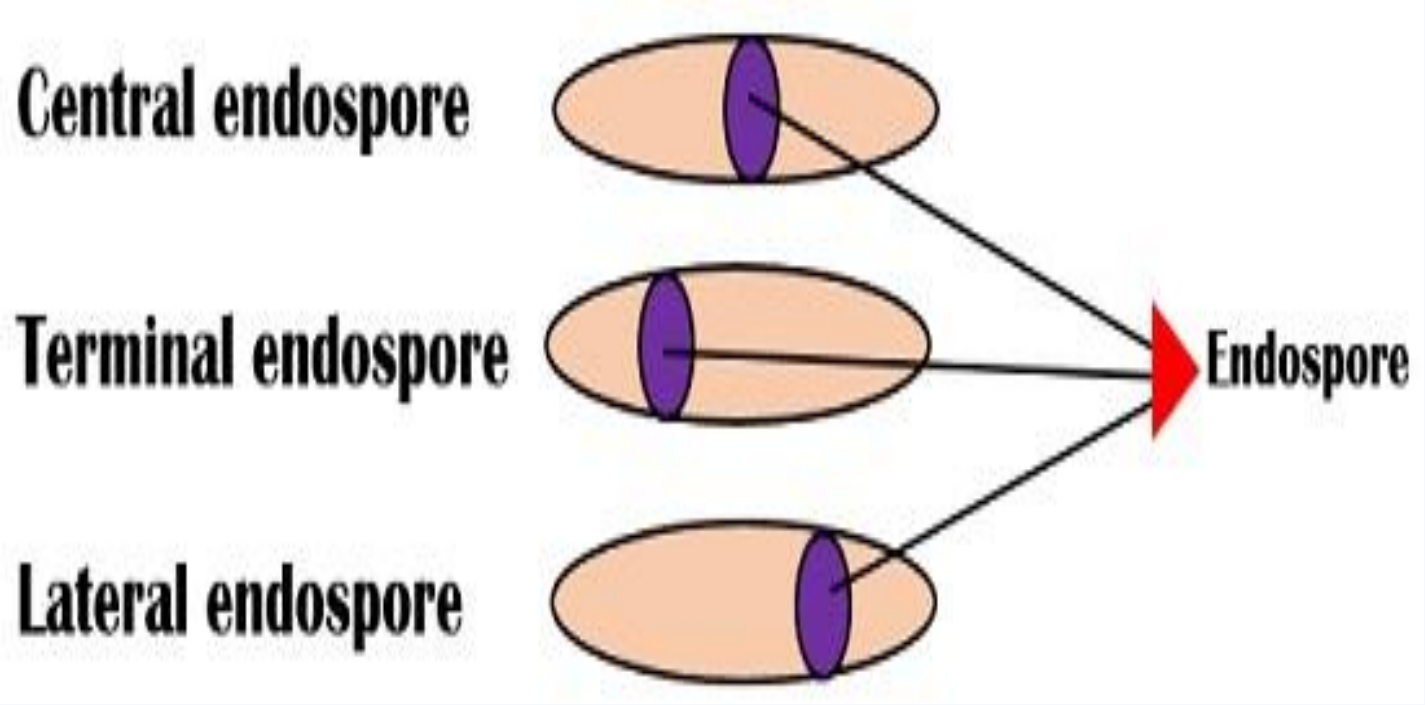
Positive: Zone formation occurs against dark background

Negative: Zone formation does not occur

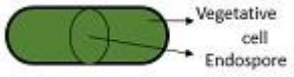
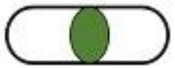
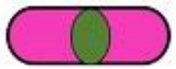
b) Endospore Staining

- It differentiates the endospore from the vegetative cell.
- This also makes the use of both acidic and basic stains.
- **Endospore** (endo: means inside and spore: means reproductive structure) Therefore, these are the reproductive structures that form within the cell.

Types of Endospore



procedure

ENDOSPORE STAINING	PROTOCOL	DIAGRAM
Primary staining	Malachite green is flooded over the smear	
Heat fixing	Then the mixture is heat fixed	
Decolourization	Decolourized by water	
Counter staining	Safranin is then flooded over the mixture and then air dried	
Observation	Examine the slide under the microscope, whether endospore is present or not	

Interpretation of result:

Positive: If Endospore present, it will appear green in color whereas vegetative cell appears as pink

Negative: And if endospore is absent then only vegetative cells will appear pink in color

c) Flagella Staining

- It identifies the motility of bacteria by the presence or absence of flagella.
- It makes the use of acidic and neutral stain.
- Its primary function is to provide motility or locomotion.

Types of Flagella

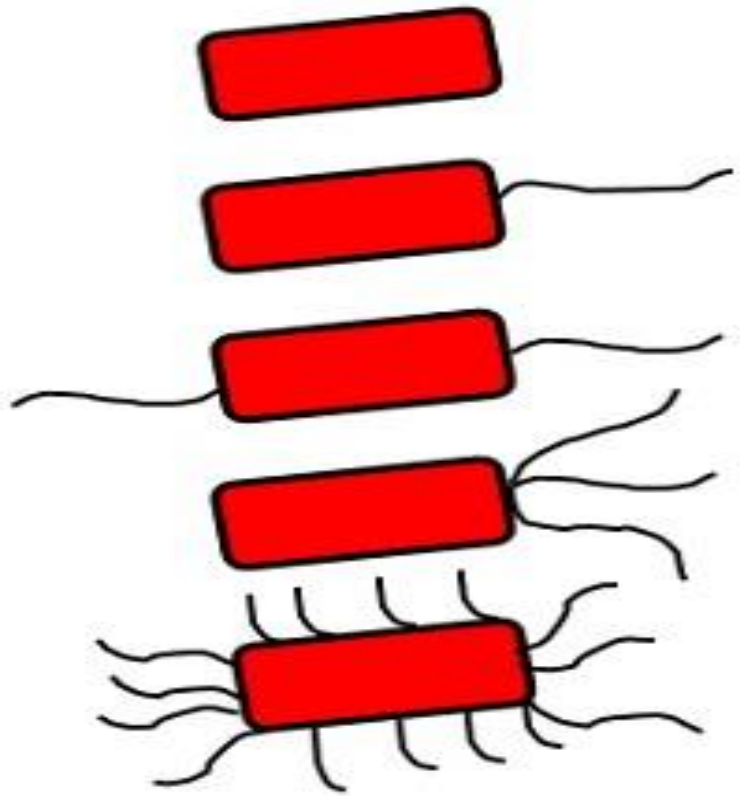
Atrichous

Monotrichous

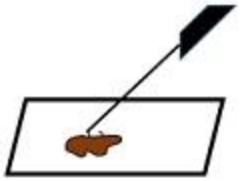
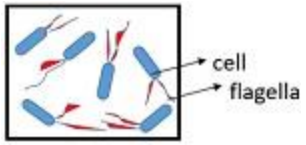
Amphitrichous

Lophotrichous

Peritrichous



Procedure

FLAGELLA STAINING	PROTOCOL	DIAGRAM
Primary staining	One drop of leifson's stain is flooded over the smear	
Secondary staining	After that methylene blue is added, and allowed to stand for one minute	
Observation	Examine the appearance of flagella to know whether the bacteria is motile or not	

Interpretation of result:

Positive: If flagella is present, then it will appear red in color while cell appears blue

Negative: And if not present, only cell will appear blue in color

Reference

- https://biologyreader.com/staining.html
- Short Book of Microbiology

MYOCARDITIS & PERICARDITIS

C. M. Garama
Dept. of Clinical Medicine

OBJECTIVES

1. **Myocardial Disease**
   - Myocarditis
   - Cardiomyopathy

2. **Pericardial Disease**
   - Pericardial fluid accumulation
   - Pericarditis

MYOCARDITIS

- Its Inflammation of the heart muscle
- It is a rather common form of heart disease that can occur at any age.
- Its exact incidence is difficult to ascertain as the histological examination has been largely **confined to autopsy material**.
- Reports from different studies have estimated the incidence of myocarditis in **1 to 4% of all autopsies**

CLASSIFICATION OF MYOCARDITIS

1. **General Classification**
   I. Interstitial and parenchymatous type
   II. Specific and non-specific type
   III. Acute, sub-acute and chronic type

2. **Etiologic Classification**
   I. Infective myocarditis
   II. Idiopathic (fiedler's) myocarditis
   III. Myocarditis in connective tissue diseases
   IV. Miscellaneous types of myocarditis

General Classification

I. **Interstitial and parenchymatous type**
   - depending upon whether the inflammation is confined to interstitial tissue or the parenchyma

II. **Specific and non-specific type**
   - depending upon whether the inflammation is granulomatous or non-specific type

III. **Acute, sub-acute and chronic type**
   - depending upon the duration of inflammatory response.

ETIOLOGIC CLASSIFICATION

I). INFECTIVE MYOCARDITIS

1. Viral myocarditis
2. Suppurative myocarditis
3. Toxic myocarditis
4. Infective granulomatous myocarditis
5. Syphilitic myocarditis
6. Rickettsial myocarditis
7. Protozoal myocarditis
8. Helminthic myocarditis
9. Fungal myocarditis

1. VIRAL MYOCARDITIS

- Some of the common examples are influenza, poliomyelitis, infectious mononucleosis, hepatitis, smallpox, chickenpox, measles, mumps, rubella, viral pneumonias, coxsackievirus and HIV infections.
- **Grossly**, the myocardium is pale and flabby with dilatation of the chambers. There may be focal or patchy areas of necrosis.
- **Histologically**, there are changes of acute myocarditis. Initially, there is oedema and infiltration of the interstitial tissue by neutrophils and lymphocytes. Later, there is necrosis of individual myocardial fibres and the infiltrate consists of lymphocytes and macrophages

2. SUPPURATIVE MYOCARDITIS

- **Pyogenic bacteria**, chiefly Staphylococcus aureus or Streptococcus pyogenes, which cause septicaemia and pyaemia

- **Grossly,** There are either abscesses in the myocardium or there is diffuse myocardial involvement.

- **Microscopically**, the exudate chiefly consists of neutrophils, admixed with lymphocytes, plasma cells and macrophages. There may be foci of myocardial degeneration and necrosis with areas of healing by fibrosis.

3. TOXIC MYOCARDITIS.

- A number of acute bacterial infections produce myocarditis by **toxins** e.g. in diphtheria, typhoid fever and pneumococcal pneumonia
- It manifests clinically by **cardiac arrhythmias** or acute **cardiac failure** due to involvement of the conduction system. It may cause sudden death
- **Grossly,** the appearance is similar to that seen in viral myocarditis.
- **Histologically**, there are small foci of coagulative necrosis in the muscle which are surrounded by nonspecific acute and chronic inflammatory infiltrate.

4. INFECTIVE GRANULOMATOUS MYOCARDITIS

- Tuberculosis, brucellosis and tularaemia are some examples of bacterial infections characterized by granulomatous inflammation in the myocardium.

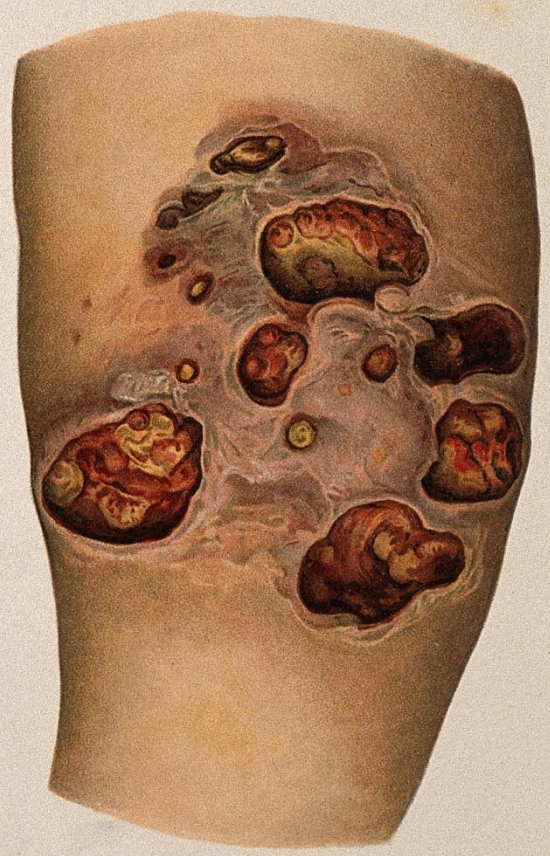
- Sarcoidosis, though not a bacterial infection, has histological resemblance to other granulomatous myocarditis

- Tuberculous myocarditis is rare and occurs either by haematogenous spread or by extension from tuberculous pericarditis.

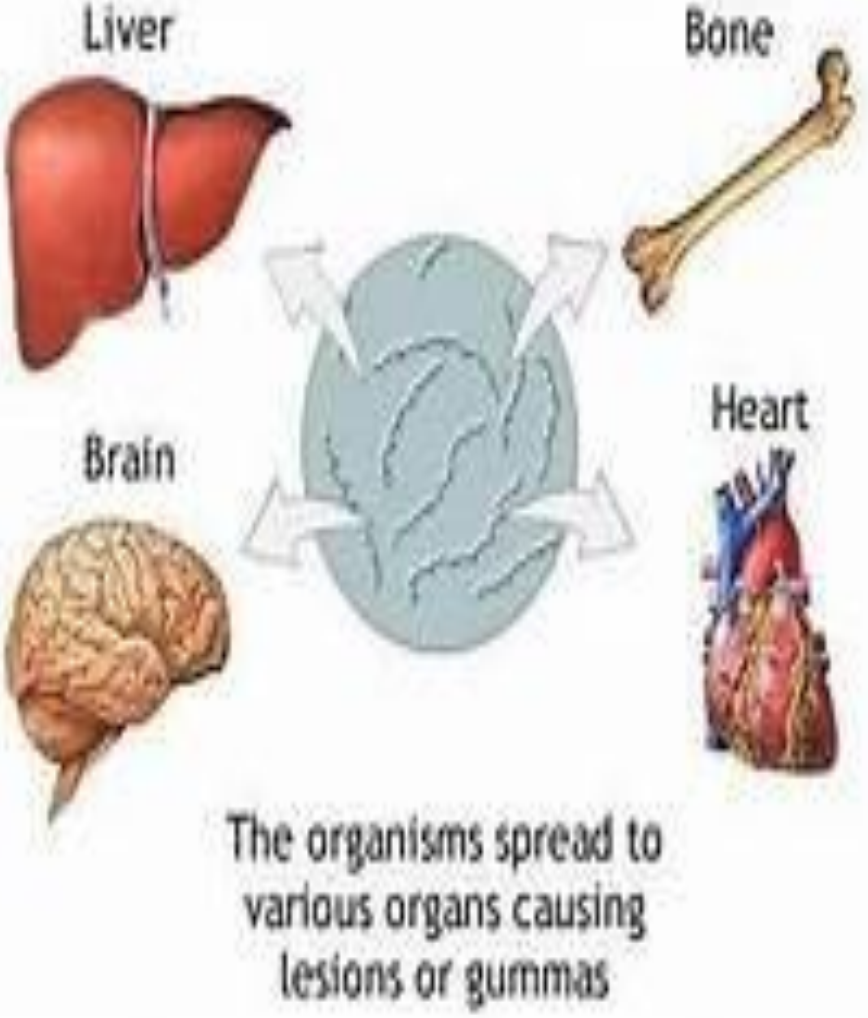
5. SYPHILITIC MYOCARDITIS

- Syphilitic involvement of the myocardium may occur in 2 forms—a **gummatous lesion** consisting of granulomatous inflammation which is more common, and a primary non-specific myocarditis which is rare.
- The syphilitic gummas in the myocardium may be **single or multiple** and may be **grossly discernible.**
- The gummas may affect the **conduction system of the heart**

PLATE XXI.



Gummatous syphiloderm, showing somewhat diffused infiltration and ulcers of right calf (Mracek).



6. RICKETTSIAL MYOCARDITIS

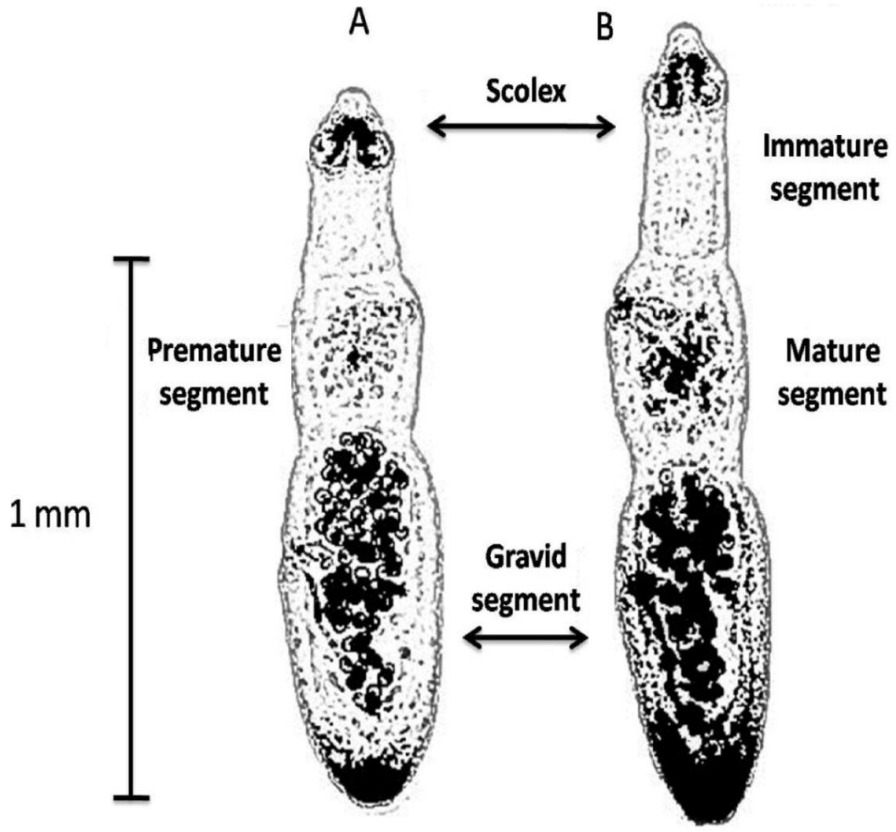
- Myocarditis occurs quite frequently in scrub typhus (R. tsutsugamushi) and Rocky Mountain typhus fever caused by spotted rickettsii
- **Microscopically**, there is interstitial oedema and focal or patchy infiltration by inflammatory cells which include lymphocytes, plasma cells, macrophages, mast cells and eosinophils but necrosis and degeneration are generally not present.

7. PROTOZOAL MYOCARDITIS

- Chagas' disease and toxoplasmosis are the two protozoal diseases causing myocarditis. Chagas' disease caused by Trypanosoma cruzi frequently attacks myocardium besides involving the skeletal muscle and the central nervous system.
- **Microscopically**, both these conditions show focal degeneration and necrosis of the myocardium, oedema and cellular infiltrate consisting of histiocytes, plasma cells, lymphocytes and a few polymorphs.
- The organisms are found in the muscle fibres.

8. HELMINTHIC MYOCARDITIS

- **Echinococcus granulosus** and **Trichinella spiralis** are the two intestinal helminths which may cause myocarditis.



9. FUNGAL MYOCARDITIS.

- Patients with immunodeficiency, cancer and other chronic debilitating diseases are more prone to develop fungal myocarditis.
- They include:
  - candidiasis,
  - aspergillosis,
  - blastomycosis,
  - actinomyosis,
  - cryptococcosis,
  - coccidioidomycosis
  - histoplasmosis.

II). IDIOPATHIC (FIEDLER'S) MYOCARDITIS

- Idiopathic or Fiedler's myocarditis is an isolated myocarditis **unaccompanied** by **inflammatory changes** in the endocardium or pericardium and occurs without the usual apparent causes.

- The condition is rapidly progressive and causes sudden severe cardiac failure or sudden death.

- **Grossly**, the heart is soft and flabby. The cardiac chambers are generally dilated and sometimes show hypertrophy. There are yellow-grey focal lesions throughout the myocardium. Mural thrombi are commonly present.

- **Histologically**, two forms of idiopathic myocarditis are described: diffuse type and giant cell (idiopathic granulomatous) type.

i) Diffuse type

- Its more common of the two and characterised by diffuse non-specific inflammatory infiltrate consisting of lymphocytes, plasma cells, macrophages, eosinophils and a few polymorphs in the interstitial tissue without formation of granulomas.
- Late stage shows healing by fibrosis.

ii) Giant cell type or idiopathic granulomatous type

- characterised by formation of non-caseating granulomas consisting of macrophages, lymphocytes, plasma cells and multinucleate giant cells.

- The giant cells are of foreign body or Langhans' type or of myogenic origin.

III. MYOCARDITIS IN CONNECTIVE TISSUE DISEASES

- Inflammatory involvement of the myocardium occurs in a number of connective tissue diseases such as
  - rheumatoid arthritis,
  - lupus erythematosus,
  - polyarteritis nodosa,
  - dermatomyositis
  - scleroderma.
- The pathologic changes in the heart muscle are similar to the changes seen in other organs in these conditions

IV. MISCELLANEOUS TYPES OF MYOCARDITIS

1. Physical agents
2. Chemical agents
3. Drugs
4. Immunologic agents
5. Metabolic derangements

1. Physical agents

- Physical agents initiate non-specific myocarditis, example of agents are;
  - ❖contusion of the myocardium
  - ❖heat stroke
  - ❖cardiac surgery
  - ❖irradiation
- The features consist of an infiltrate of neutrophils, eosinophils and mononuclear cells and shows contraction-band necrosis of the myocardial fibres

2. Chemical agents

- Toxic chemicals cause focal areas of **degeneration and necrosis** of myocardial fibres and nonspecific inflammatory reaction, chiefly consisting of lymphocytes and macrophages
- Examples are;
  - arsenic,
  - phosphorus
  - carbon monoxide

3. Drugs

- Changes similar to those induced by chemical poisons are produced by certain drugs such as;-
  - ❖phenothiazine compounds,
  - ❖sulfonamides,
  - ❖catecholamines
  - ❖cytotoxic compounds

4. Immunologic agents.

- Myasthenia gravis, Friedreich's ataxia, and progressive muscular dystrophies initiate a state of autoimmunisation against the myocardium resulting in focal myocardial degeneration and necrosis with secondary inflammatory reaction. Later, myocardial fibrosis may occur

5. Metabolic derangements

- **Uraemia**, **hypokalaemia** and **shock** are associated with degeneration and necrosis of the myocardial fibres, oedema of the interstitial tissue and nonspecific inflammatory reaction.

PERICARDIAL DISEASES

I. Pericardial fluid accumulations

II. Pericarditis

PERICARDITIS

- Pericarditis is the **inflammation of the pericardial layers** and is generally secondary to diseases in the heart or caused by systemic diseases.
- Primary or idiopathic pericarditis is quite rare.
- Based on the morphologic appearance, pericarditis is classified into **acute and chronic** types with their subtypes based on the character of the exudate,

Classification of Pericarditis

A. ACUTE PERICARDITIS

1. Serous pericarditis
2. Fibrinous or serofibrinous pericarditis
3. Purulent or fibrinopurulent pericarditis
4. Haemorrhagic pericarditis

B. CHRONIC PERICARDITIS

1. Tuberculous pericarditis
2. Chronic adhesive pericarditis
3. Chronic constrictive pericarditis
4. Pericardial plaques (milk spots, soldiers' spots)

A. ACUTE PERICARDITIS

1. SEROUS PERICARDITIS.

- may be accompanied by accumulation of **serous effusion**
- caused by

  i) **Viral infection** e.g. coxsackie A or B viruses, influenza virus, mumps virus, adenovirus and infectious mononucleosis.

  ii) **Rheumatic fever.**

  iii) **Rheumatoid arthritis.**

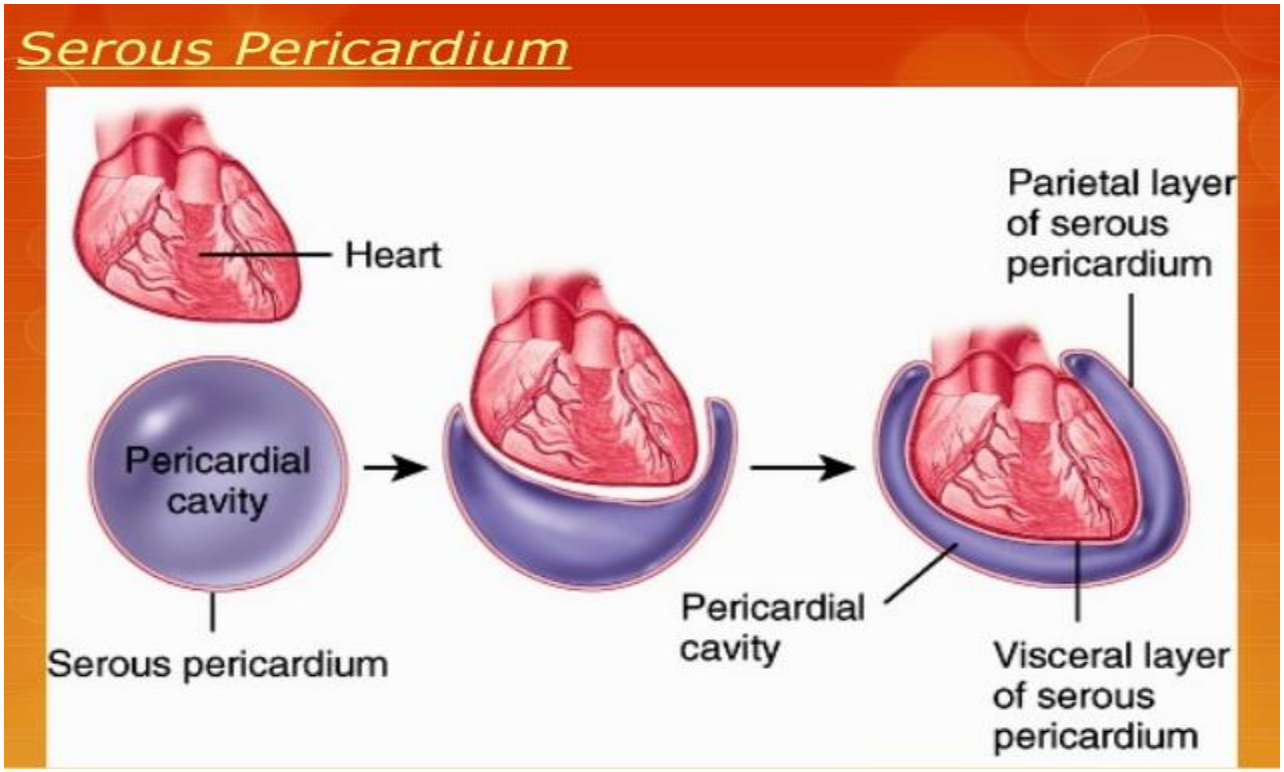
  iv) **Systemic lupus erythematosus.**

  v) **malignant tumour** e.g. carcinoma lung, mesothelioma and mediastinal tumours.

  vi) **Tuberculous** pericarditis in the early stage

Cont..

- **Microscopically**, the epicardial and pericardial surfaces show infiltration by some neutrophils, lymphocytes and histiocytes.
- The fluid usually resorbs with the resolution of underlying disease.



2. FIBRINOUS AND SEROFIBRINOUS PERICARDITIS.

- Quite often, there is admixture of fibrinous exudate with serous fluid.
- The various causes of this type of pericarditis are as follows:

  i) Uraemia

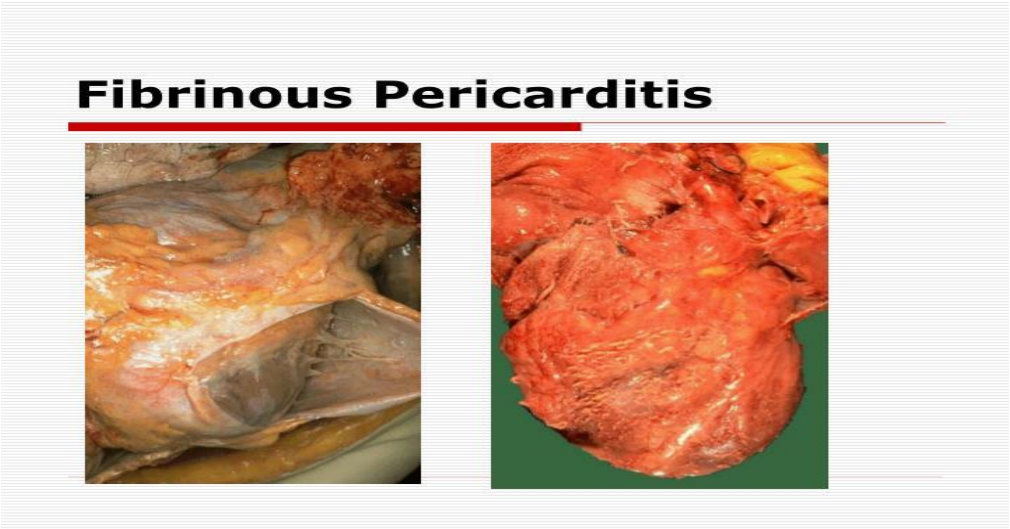
  ii) Myocardial infarction

  iii) Rheumatic fever

  iv) Trauma such as in cardiac surgery

  v) Acute bacterial infections.

- The amount of fluid accumulation is variable. The cardiac surface is characteristically covered by dry or moist, shaggy, fibrinous exudate which gives '**bread and butter**' appearance.
- Clinically, these cases manifest by **friction rub**
- pericarditis heals by organisation and develops fibrous adhesions resulting in **adhesive pericarditis.**



3. PURULENT OR FIBRINOPURULENT PERICARDITIS

- Mainly caused by pyogenic bacteria (e.g. staphylococci, streptococci and pneumococci) and less frequently by fungi and parasites
- The infection may spread to the pericardium by the following routes:
  - i) By direct extension from neighbouring inflammation e.g. in empyema of the pleural cavity, lobar pneumonia, infective endocarditis and mediastinal infections.
  - ii) By haematogenous spread.
  - iii) By lymphatic permeation.
  - iv) Direct implantation during cardiac surgery

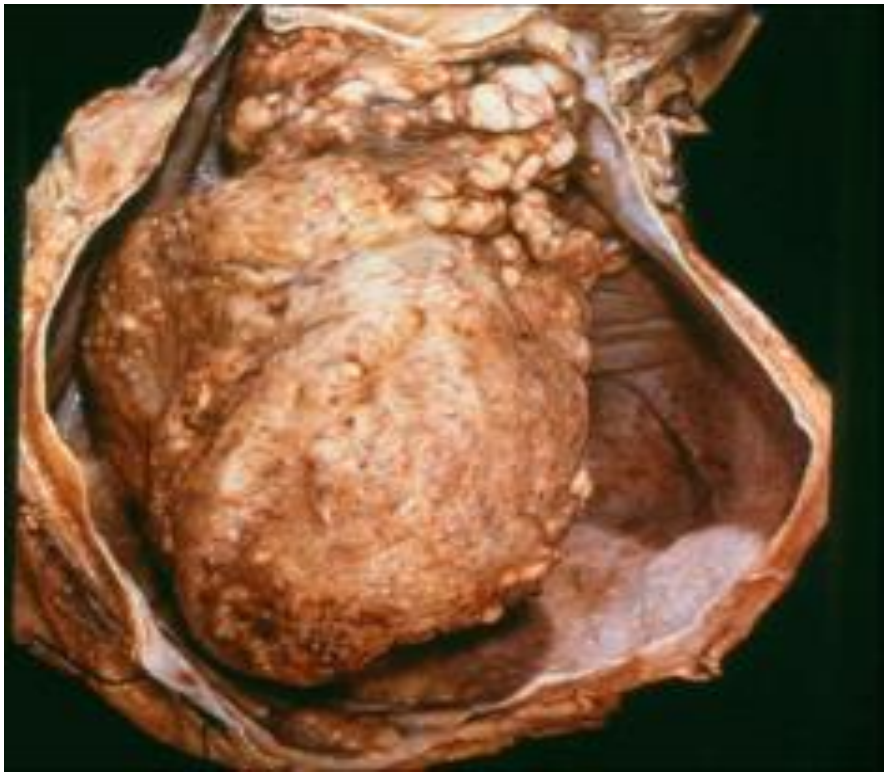
- The amount of exudate is variable and is generally thick, creamy pus, coating the pericardial surfaces
- **Microscopically**, besides the purulent exudate on the pericardial surfaces, the serosal layers show dense infiltration by neutrophils. Purulent exudate generally does not resolve completely but instead heals by organisation resulting in adhesive or chronic constrictive pericarditis

4. HAEMORRHAGIC PERICARDITIS

- One in which the exudate consists of admixture of an inflammatory effusion of one of the foregoing types along with blood.
- The causes are as under:
  - i) Neoplastic involvement of the pericardium
  - ii) Haemorrhagic diathesis with effusion
  - iii) Tuberculosis
  - iv) Severe acute infections

B. CHRONIC PERICARDITIS

- Chronic pericarditis is the term used for tuberculous pericarditis and the healed stage of one of the various forms of acute pericarditis already described



1. TUBERCULOUS PERICARDITIS

- Tuberculous pericarditis is the most frequent form of granulomatous inflammation of the pericardium.
- The lesions may occur by the following mechanisms:
  - i) Direct extension from an adjacent focus of tuberculosis.
  - ii) By lymphatic spread e.g. from tracheobronchial lymph nodes, chronic pulmonary tuberculosis or infected pleura
- The exudate is slightly turbid, caseous or blood-stained with sufficient fibrin.
- Tubercles are generally visible on the pericardial surfaces and sometimes caseous areas are also visible to the naked eye

- **Microscopically,** typical tuberculous granulomas with caseation necrosis are seen in the pericardial wall. The lesions generally do not resolve but heal by fibrosis and calcification resulting in chronic constrictive pericarditis

READ ON

2. CHRONIC ADHESIVE PERICARDITIS.

3. CHRONIC CONSTRICTIVE PERICARDITIS.

4. PERICARDIAL PLAQUES (MILK SPOTS, SOLDIERS' SPOTS)