جامعة شط العرب الاهلية
كلية العلوم -قسم التحليلات المرضية

Principles of Microbiology

Lec-10- **Fungi as human pathogen**

Prof. Dr. Mohammed A. Fayyadh

Characteristic of fungi

Fungi are eukaryotic , differ from bacteria and other prokaryotes.

1.Cell walls containing chitin(rigidity & support), mannan , giucan &other polysaccharides.

2.Cytoplasmic membrane contains ergosterols.

3.Possess true nuclei with nuclear membrane & paired chromosomes.

4.Reproduce asexually, sexually or by both

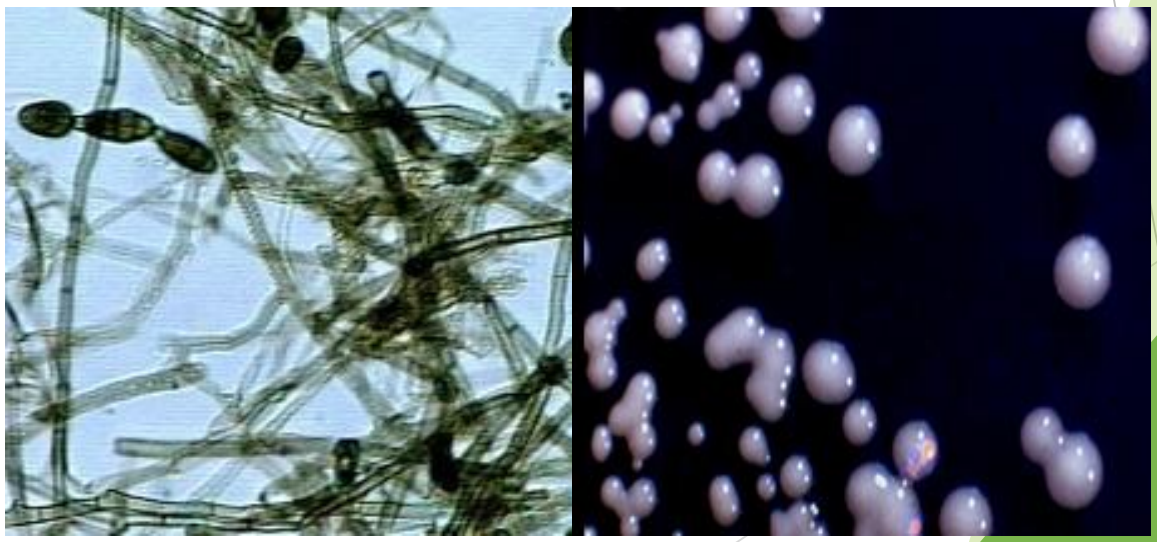
5.Unicellular(yeast) or multicellular (filamentous fungi)

Among the thousands of fungal species, there are 300 species that are pathogenic to humans. According to their morphology , fungi are classified in to:

1-Filamentous fungi (molds)

2-Yeast

3-Dimorphic Fungi



The harm caused by fungi to humans is divided into two main categories:-

A:-Mycotoxicoses . Some fungi produce toxic compounds (mycotoxins) on the food materials on which they grow, the most important of which is aflatoxin produced by the fungus *Aspergillus flavus* , which is one of the most important causes of liver cancer.

B:-Mycoses . It refers to infections caused by the fungus itself. Most fungal infections occur on the skin, hair, and nails**.**

Types of fungal infection (Mycoses)

Fungal infections are classified into three main categories:

A-Superficial

B-Subcutaneous

C-Systemic

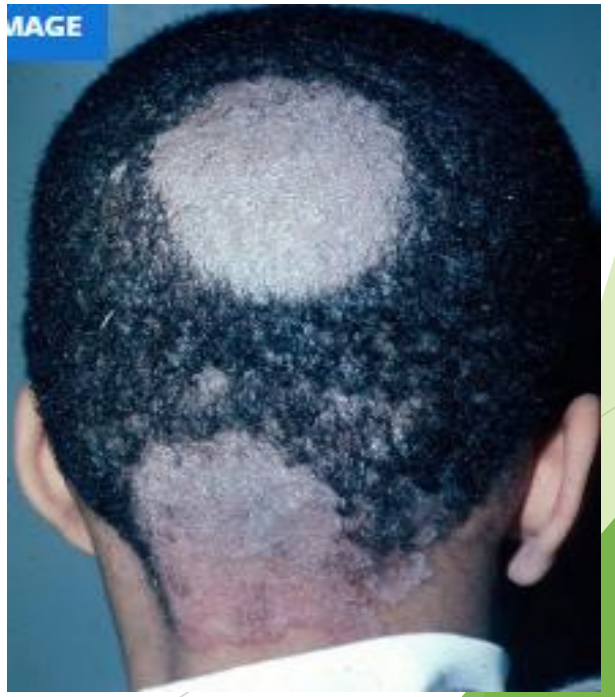
A- Superficial Fungal Infections

These infections affect the outer layers of the skin, hair, and nails(=Dermatophyte fungi). They are usually mild but can cause discomfort and cosmetic issues . The most important are:-

1-Dermatophytosis (Ringworm): Caused by dermatophytes (e.g., *Trichophyton* , *Microsporum*).Commonly affects skin, scalp, and nails (e.g., athlete's foot, and scalp ringworm).

Tinea capitis(Ringworm)

caused by *Trichophyton tonsurans*



*** Pathogenicity factors :-** **All fungi infect Skin, Hair and Nails**

Secrete keratinase, an enzyme that degrades keratin.

*** Transmission :-Infection is transmitted by direct contact or contact with infected hair (hair salon) or cells (nail files, shower floors).**

- 2-**Candidiasis (Cutaneous)**: Caused by *Candida* species, particularly *Candida albicans*. Affects moist areas of the skin, such as armpits, groin, and under the breasts.

3-Tinea Versicolor (Pityriasis Versicolor): Caused by *Malassezia* species . Leads to discolored patches on the skin, often affecting the chest, back, and shoulders.

- **4-Onychomycosis:** Fungal infection of the nails, most commonly caused by *Dermatophytes* such as *Trichophyton spp* .Nails may become thick, discolored, and brittle.

Symptom's of *Trichophyton rubrum*

B- Subcutaneous fungal infection (Mycetoma)

Subcutaneous infections : involve deeper layers of skin causing allergic or inflammatory response. May be localized infection, or spread by mycelial growth.

*Common among barefoot(حافي القدمين) peoples of the tropics.

*Most fungi are Soil borne Species .

*Enters human through wound by thorns or wood slivers (الاشواك وشظايا الخشب)

Fungus grows -host cells respond by rapid cell division on feet or legs

Sub Cutaneous Infections- Disease process

- **Fungus stimulates epithelial cells of skin to divide more frequently** (تحفز الخلايا الطلائية على الانقسام)
- **Makes more keratin available to fungus** (مما يوفر كيراتين للفطر)
- **Some species race specific in humans** (بعض سلالات الفطر متخصصة في اصابة الانسان)
- **Some species body location specific** (بعض انواع الفطر متخصصة في اصابة مواضع معينة من جسم الانسان)

Trichophyton rubrum : As example for **Subcutaneous infection** .

Severe nail infection with *Trichophyton rubrum* in a 37-year-old male AIDS patient.

Example for Sever Subcutaneous Infections

Skin ruptures and some colonies extrude:-

Pathgen:- *Fonescaea pedrosi*

C:- Systemic(infection) Mycoses

*** Fungal infections deep within the body. Can affect a number if tissues and organs.**

Caused by:-

1-Specialized pathogens most are :-

Dimorphic filamentous outside the host yeast form inside the host

2- Opportunistic fungi . Cause infection to immunocompromised patients.

Examples: Histoplasmosis

Histoplasma capsulatum

*Initial infection in lungs. Later spreads through blood to most organs.

*Grows on bird droppings, chicken manure, bat guano.

Opportunistic mycoses

Caused by organisms that are generally harmless unless individual has weakened defenses:

- **AIDS and cancer patients**
- **Individuals treated with broad spectrum antibiotics**
- **Very old or very young individuals (newborns).**

Examples for Opportunistic mycoses

A- Aspergillosis: (داء الرشاشات) Inhalation of *Aspergillus fumigatus* spores. That cause Bronchiopulmonary aspergillosis --- severe allergic reaction and Aspergilloma -- Forms a mycelia ball in lung cavity .

B- yeast Infections or Candidiasis(داء المبيضات) :Caused mainly by *Candida albicans* . Part of normal mouth, esophagus, and vaginal flora.

Examples for Opportunistic mycoses

C- Mucormycosis (Zygomycosis): (الفطر الاسود)is a rare but serious fungal infection that can affect many parts of human body such as eyes, sinuses, brain, lungs, gastrointestinal tract or skin. It most commonly affects people with diabetes and weakened immune systems. Most Mucormycosis caused by :- *Mucor spp* , *Rhizopus spp* .

*Spores enter through sinuses Grows rapidly outward to the eyes and inward towards the brain.

Laboratory Diagnosis for fungal infection

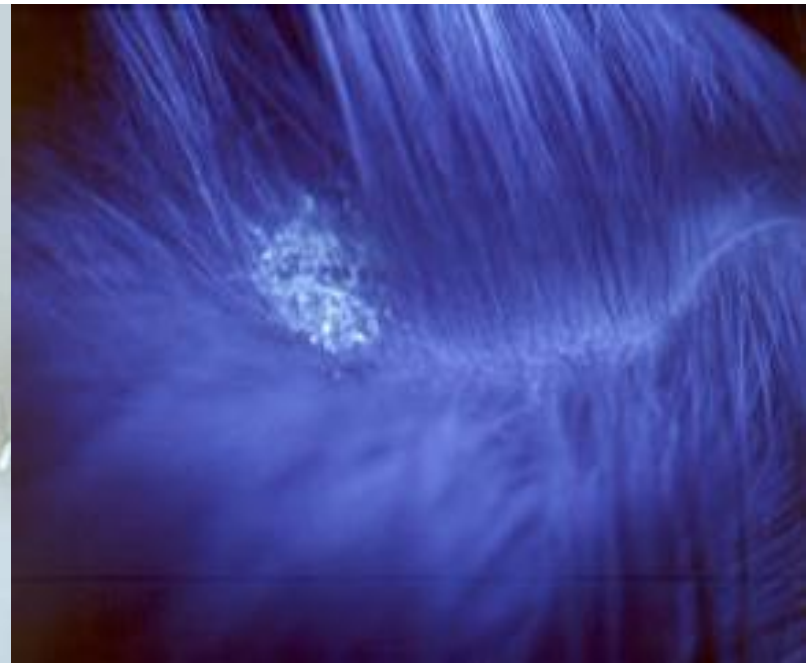
1- Direct Microscopy: Skin Scrapings, nail scrapings and epilated hairs should be examined using 10% KOH and Parker ink .

2- Culture: Specimens should be inoculated onto primary isolation media, like Sabouraud's dextrose agar containing cycloheximide and incubated at 26-28˚C for 4 weeks.

3- Wood lamp examination : A Wood lamp examination is a test that uses ultraviolet (UV) light to look at the skin closely.

4-PCR technique.

Wood lamp



PRIMARY ANTI FUNGAL AGENTS

1- Polyene derivatives -- Nystatin

2- Azoles --- Ketoconazole - Fluconazole

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Principles of Microbiology

Lec-8 **Mycoplasma**

Prof. Dr. Mohammed A. Fayyadh

Mycoplasma

General characteristics :

***Group of bacteria that are the smallest free living bacteria in nature and can also be grown on laboratory media.**

***They lack a cell wall around their cell membranes . Their cell membrane (plasma membrane) is rich in cholesterol and other lipids.**

***Their size are (~100 nm), mycoplasma are undetectable by light microscopy.**

***At least 16 of these species are of human origin ; others have been isolated from animals and plants.**

***Among mycoplasmas, *Mycoplasma Pneumoniae* and *Ureaplasma organisms* are the most important human pathogens particularly in respiratory tract and urogenital tract respectively.**

Because of the absence of cell walls in mycoplasma:

1-They do not stain with the Gram stain although they are Gram negative bacteria (Giemsa and Dienes stains are used).

2-They are more pleomorphic with no fixed shape or size. The absence of a rigid cell wall and small size makes Mycoplasma able to cross filters that are otherwise permeable only to viruses.

3-They are resistant to antibiotics that interfere with the synthesis of cell wall (Penicillins , Cephalosporins) but susceptible to antibiotics that interfere with synthesis of protein such as Tetracycline, Erythromycin.

Morphology

*Mycoplasma are pleomorphic smallest living organism, also known as Pleuropneumonia like organism (PPLO).

*Mycoplasma are Gram-negative not stained with Gram stain ,but stain well with Giemsa stain.

*On Giemsa stain, mycoplasma appear as tiny pleomorphic cocci, short rods, short spirals , and sometimes as hollow ring forms.

*They do not posses spores, flagella or fimbria

Culture of mycoplasma

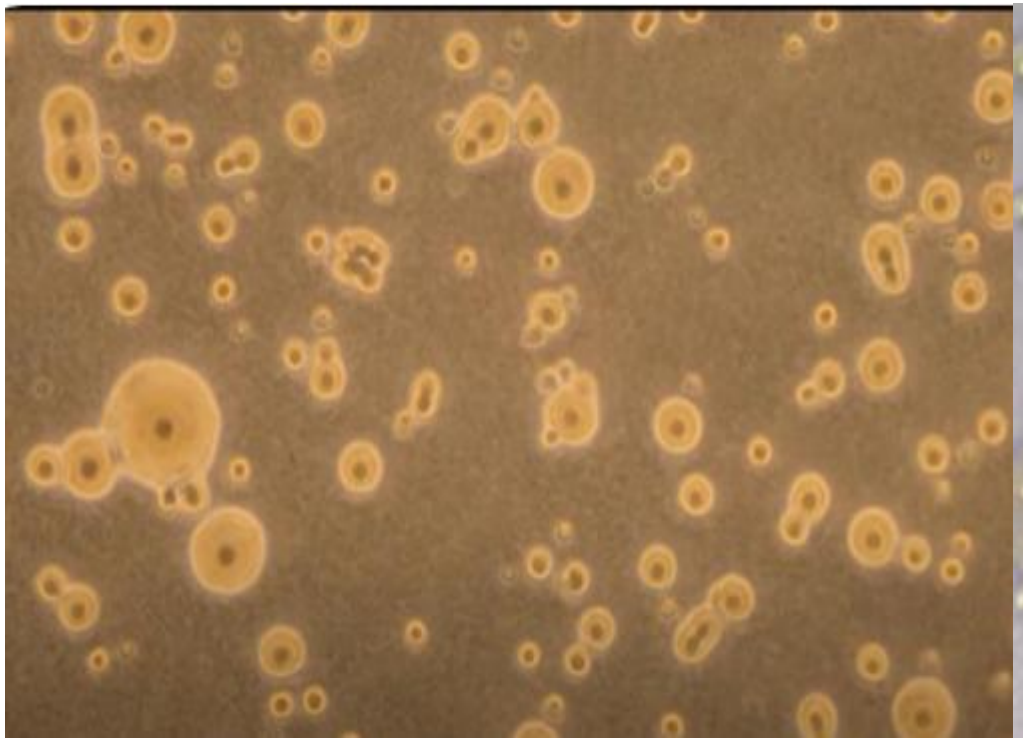
*Mycoplasma needs special culture media rich in cholesterol such as Eaton agar

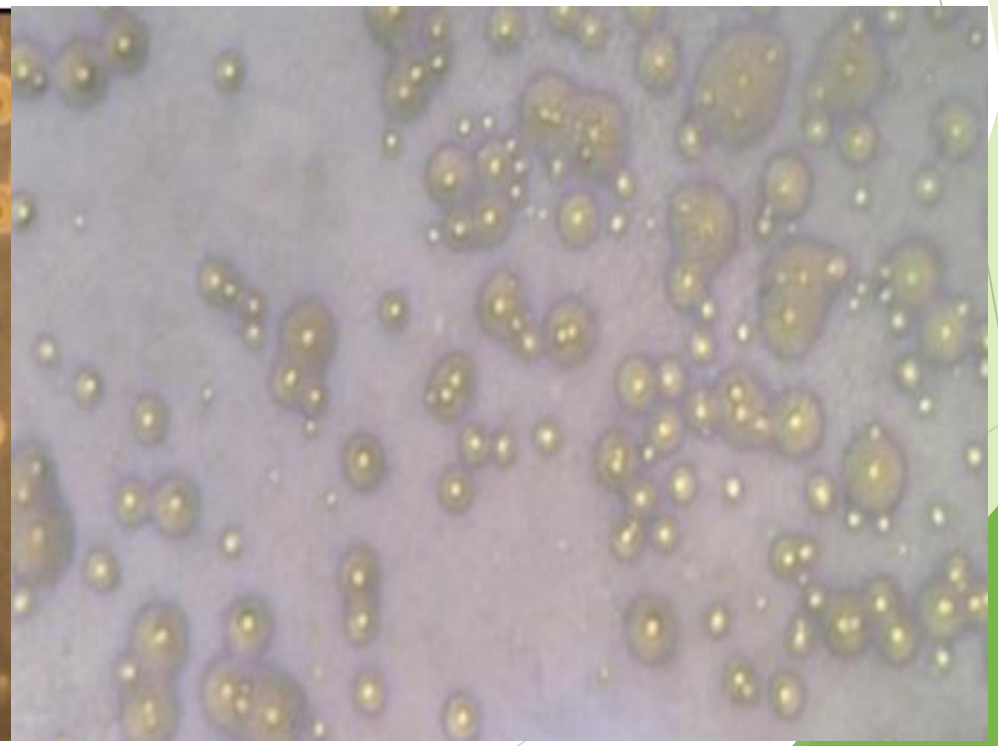
*They are aerobic or facultative anaerobic microorganisms ,but usually grow better in an aerobic condition supplemented with 5% CO_2

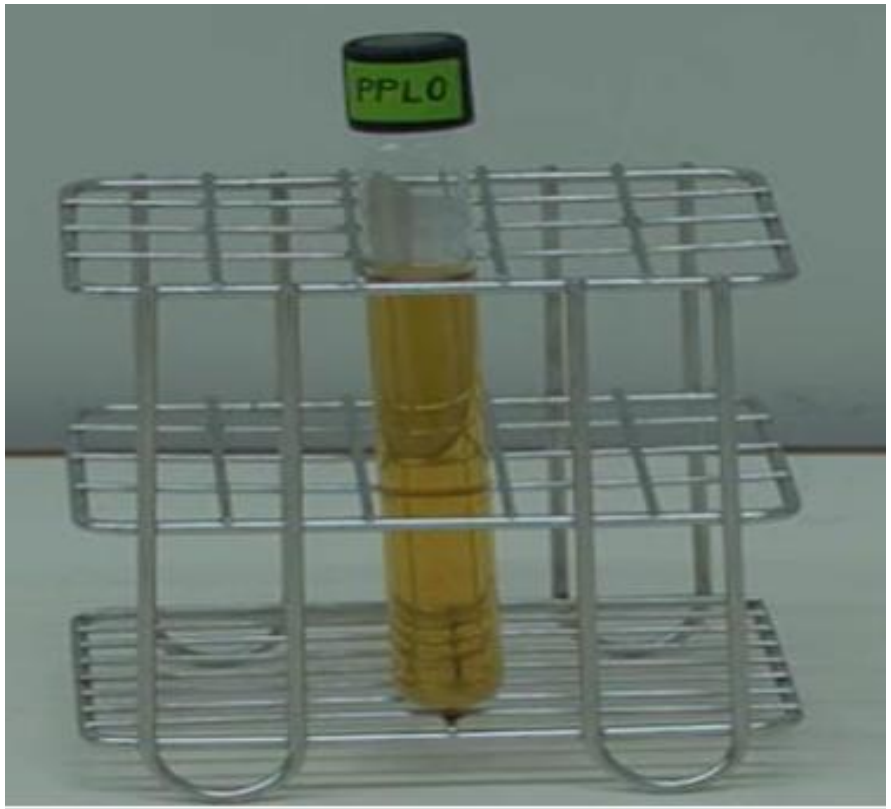
*They grow slowly on culturing (2–3 weeks incubation at 370C), especially on first isolation.

*Mycoplasma colonies are small and can only be observed under magnification or after Dienes staining

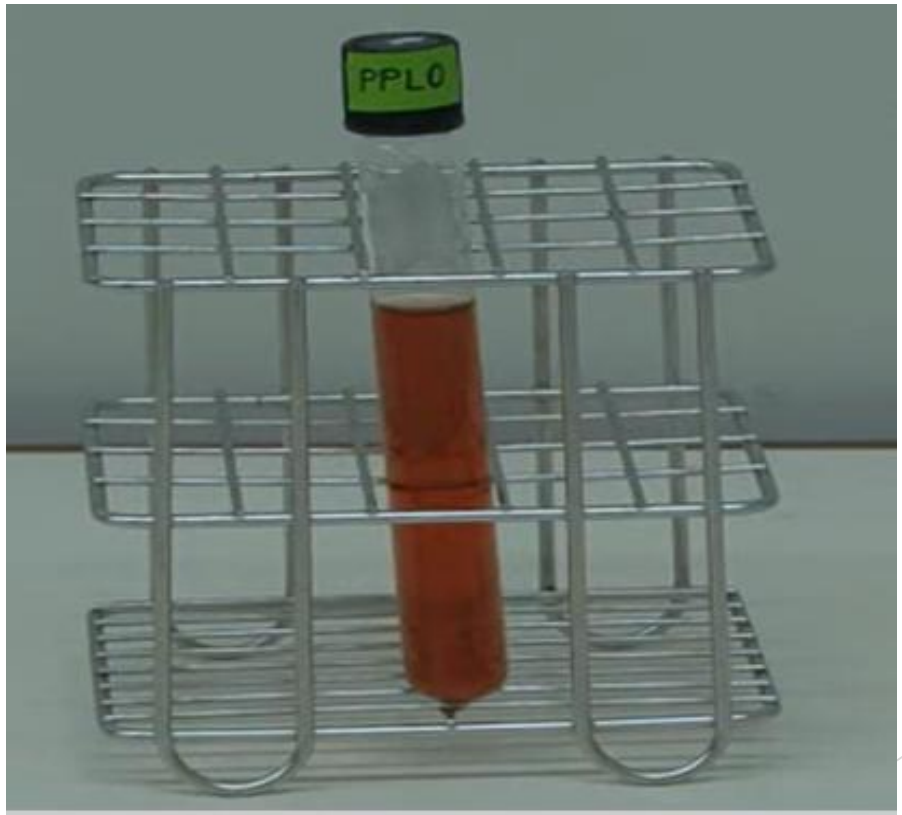
Colonies on agar have an opaque center zone of growth and a transparent outer zone on the top, giving them a fried egg look (except mycoplasma pneumoniae which shows granular colonies (mulberry).







Positive broth culture of mycoplasma



Negative broth culture of mycoplasma

Diseases caused by mycoplasma:

Mycoplasma pneumoniae **: causes respiratory disease ranging from tracheobronchitis to atypical pneumonia.**

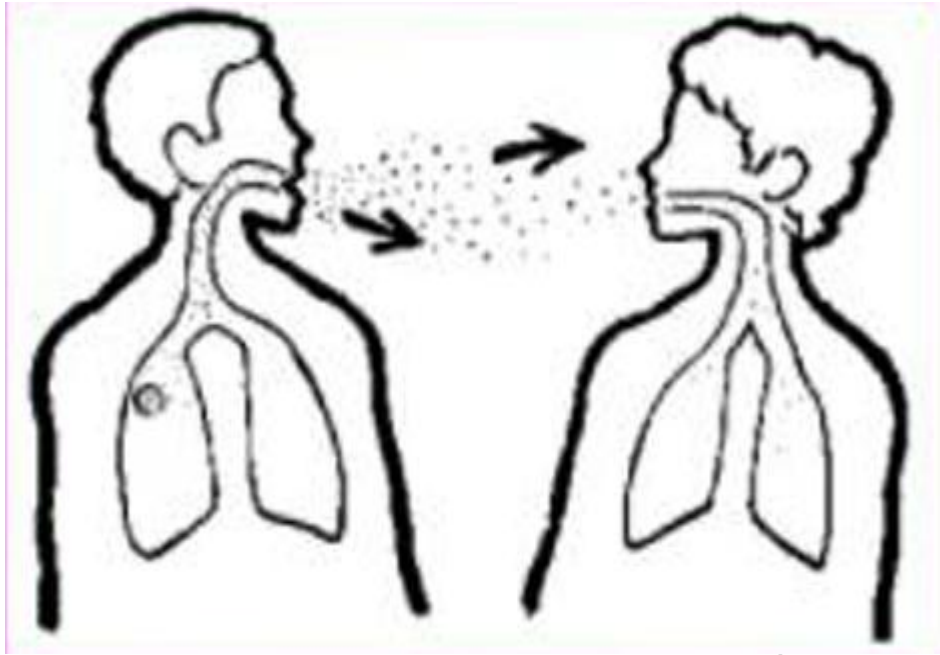
Ureaplasma urealyticum**: one of the causes of non gonococcal urethritis.**

Mycoplasma pneumoniae is the classic cause of atypical pneumonia .(Walking pneumonia)

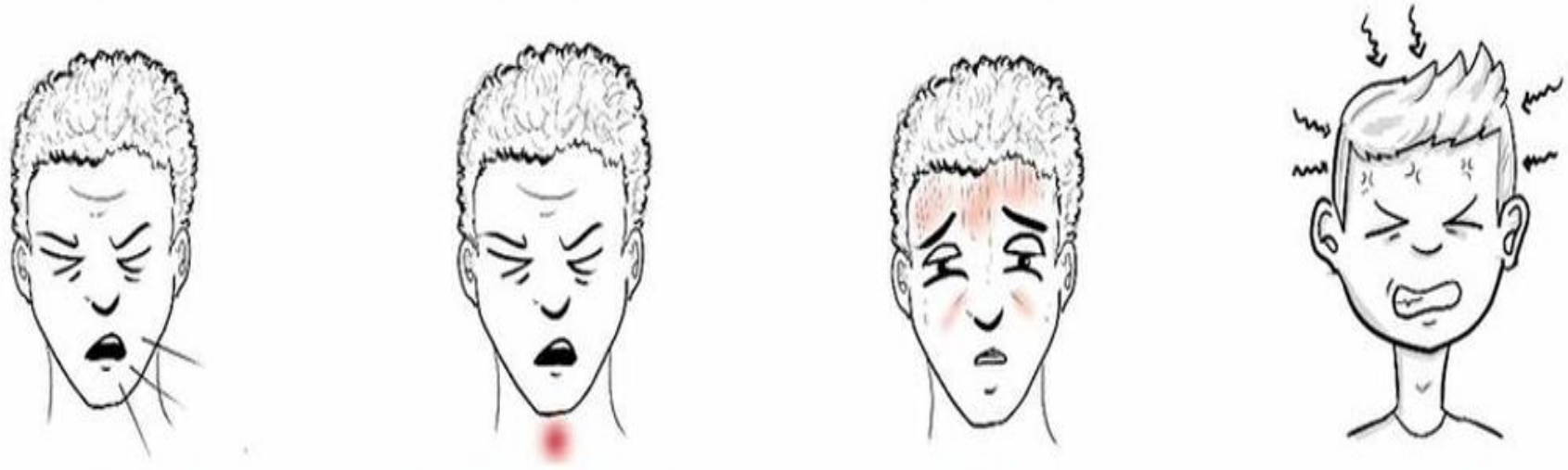
Atypical :means the disease dose not resemble the regular pneumococcal pneumonia or the causative bacteria cannot be isolated on routine culture media.

Walking pneumonia: nonmedical term means that the disease is not severe enough to require bed rest or hospitalization.

Transmission from person to person through respiratory droplets The disease occurs frequently in young adults, and in crowdy environments such as military recruits, prisons and colleges.



- The ONSET of SYMPTOMS is GRADUAL, TYPICALLY BEGINS with NON-PRODUCTIVE COUGH and SORE THROAT



Laboratory Diagnosis of Mycoplasma pneumoniae

A-Culture:

-Primary isolation of Mycoplasma requires complex media (both solid or liquid media). They are very slow under both aerobic and anaerobic conditions.

-Colonies of *M. pneumoniae* are small and have a homogeneous granular appearance (Mulberry shaped).

B-Serology :

-ELISA and Immunofluorescence.

C--Molecular Technique:

-Polymerase chain reaction is the best choice to diagnose *M. pneumoniae* infection.

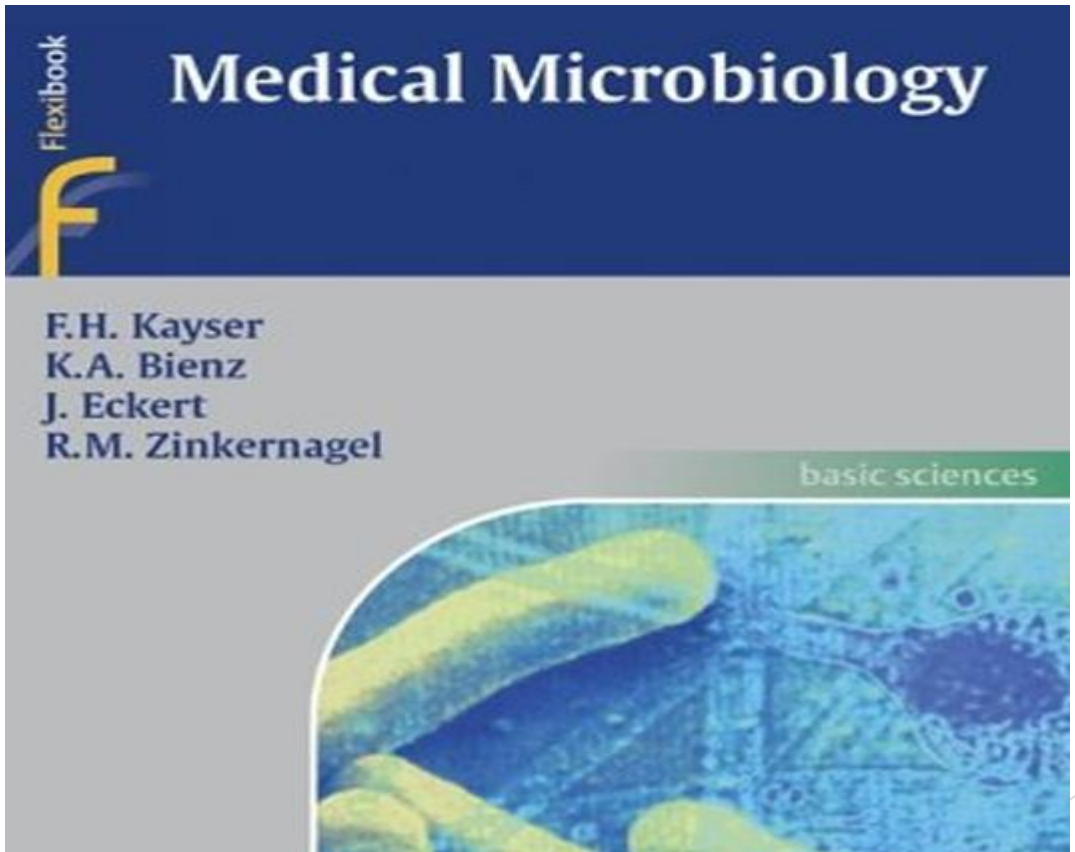
- PCR assay can detect the presence of *M. pneumoniae* DNA in single specimen and will be positive earlier than serological test.

L-Form Bacteria

- ***L-form bacteria**, also known as cell wall deficient bacteria, are a phase of bacteria that are very small and lack cell walls.
- ***Thus far, researchers have identified over 50 different species of bacteria capable of transforming into the L-form the most important are :-*Bacillus anthracis*, *Helicobacter pylori*.**
- ***It differs from mycoplasma in its ability to restore its cell wall structure.**

Important Reference

-Kayser, Medical Microbiology © 2005 Thieme



MCQ

1-Mycoplasma are characterized by:

a-Lack of a cell wall ; b) presence of a rigid cell wall ; c)large size compared to other bacteria .

2-which of the following diseases is commonly caused by Mycoplasma pneumonia:

a) Tuberculosis ; b)Pneumonia ; c)Tetanus

3-Mycoplasma species are resistant to which of the following antibiotics ?

a) Streptomycin ; b) pencillin ; c) Tetracyclin

4-The diagnosis of Mycoplasma infection is often confirmed by:

a)Gram staining ; b)Microscopic examination of sputum ; c) PCR and serological tests.

I wish you all the Best

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كلية العلوم –قسم التحليلات المرضية

Principles of Microbiology

Lec-8- Bacterial Diseases

Prof. Dr. Mohammed A. Fayyadh

Bacterial Diseases

- Pathogen: A microorganism capable of causing disease.

- **Non-pathogen:** A microorganism that does not cause disease. It may be part of the normal flora.

- **Opportunistic pathogen:** An agent capable of causing disease only when the host´s resistance is impaired (e.g. the patient is immunocompromised).

Virulence Factors of Infectious Disease

#-Pathogenicity – Ability of a microorganism to cause disease

#- Virulence - Degree of pathogenicity

-Virulence factors contribute to an organisms virulence are :-

***Adhesion factors**

***Biofilms**

***Extracellular enzymes**

***Toxins**

***Antiphagocytic factors**

Bacterial Enzyme and Toxins

Extracellular Enzymes -Enzymes secreted outside the cells of the pathogen (bacteria) .

##- Dissolve structural chemicals in the body.

##- Help pathogen maintain infection, invade further, and avoid body defenses .

Bacterial Toxins

- **Bacterial toxins are low molecular weight of proteins** capable **to harm tissues in human body**
- **There are two types of Bacterial Toxins:-**

  – **Exotoxins (botulinum toxin** produced by *Clostridium botulinum*)

  – **Endotoxins (**Lipopolysaccharide **produced by** (*Pseudomonas* and *Klebsiella*)

Examples of some Pathogenic Bacteria (Staphylococcus)

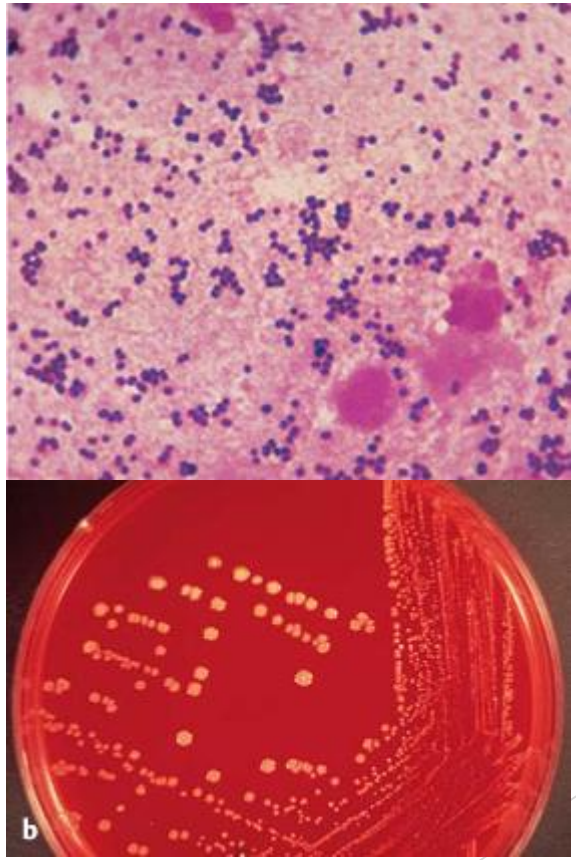
Staphylococcus is :-

-Gram positive +

-Catalase +ve (Convert H2O2 to H2O and Oxygen)

Species : *Staphylococcus aureus*

- * Gram-positive cocci
- * Non motile
- * Facultative anaerobes
- **-Cells occur in grapelike clusters**



Transmission of Bacterial infection

+ contaminated soil or animals

+Eating or drinking contaminated food or water

+ Breathing in droplets from an infected person

+ Touching dirty surfaces and then touching your eyes, nose, or mouth

Staphylococcal Diseases

1-Noninvasive Disease

Food poisoning from the ingestion of enterotoxin-contaminated food

2-Cutaneous Disease : Various skin conditions including

* **scalded skin syndrome. متلازمة الجلد المحروق**
* **Impetigo. (دمامل) قرحة الجلد**
* **Folliculitis. التهاب بصيلا الشعر**

3- Systemic Disease :• **Toxic shock** - **Bacteremia بكتريا الدم** - **Endocarditis(التهاب شغاف القلب**

and **Pneumonia التهاب رئوي**

Staph infection

The most important pathogenic bacteria

Bacteria	Disease
1-*Vibrio cholera*	Cholera
2-*Cornybacterium diphtheriae*	Diptheria
3-*Streptococcus pneumoniae*	pneumonia
4-*Mycobacterium tuberculosis*	Tuberculosis
5-*Shigella dysenteriae*	Dysentry
6-*Salmonella typhiae*	Typhoid
7-*Bacillus anthracis*	Anthrax
8-*Clostridium tetani*	كزاز Tetanus
9-*Neisseria meningitidis*	سحايا Meningitis
10-*Pasteurella pestis*	طاعون plague

Q1) Which of the following is considered a major bacterial virulence factor that enables bacteria to adhere to host tissues?

A) Exotoxins B) Flagella C) Pili D) Endotoxins

Q2) **1. Which of the following is the most common species of *Staphylococcus* that causes human infections?**

A) *Staphylococcus saprophyticus* B) *Staphylococcus epidermidis* C) *Staphylococcus aureus* D) *Staphylococcus lugdunensis*

Q3). *Staphylococcus aureus* can produce which of the following toxins that contribute to food poisoning?

A) Exfoliative toxin
B) Enterotoxins
C) Hemolysins
D) Leukocidins

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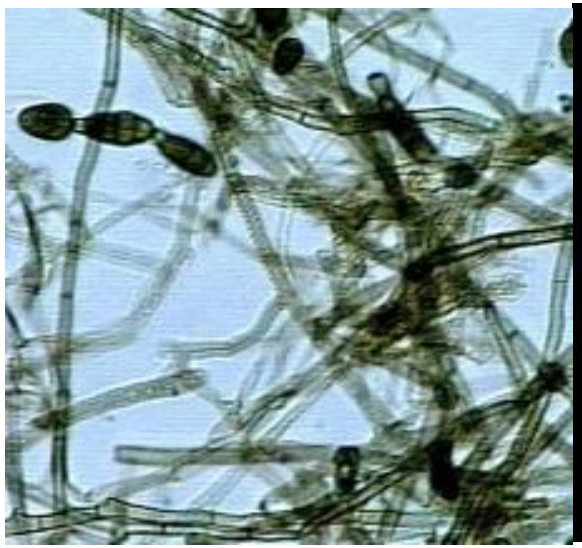

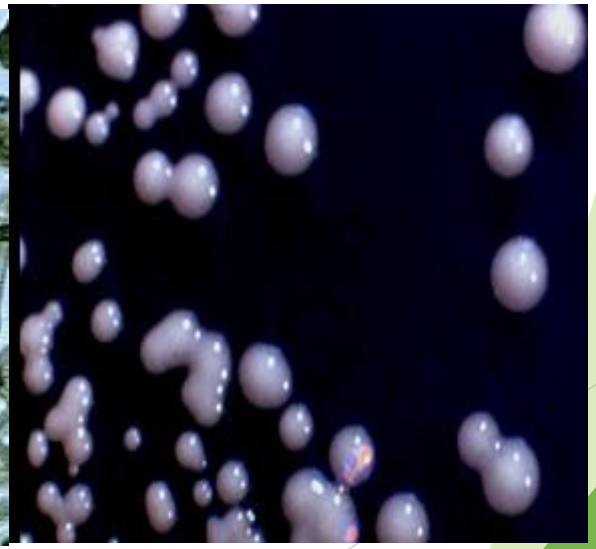

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B:-Mycoses . It refers to infections caused by the fungus itself. Most fungal infections occur on the skin, hair, and nails.

Types of fungal infection (Mycoses)

Fungal infections are classified into three main categories:

A-Superficial

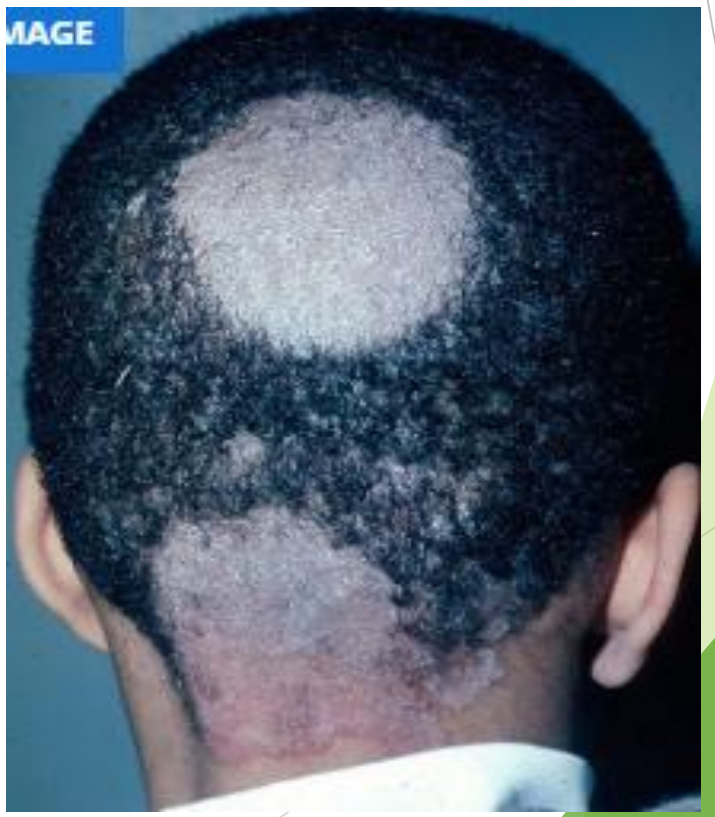
B-Subcutaneous

C-Systemic

A- Superficial Fungal Infections

1-Tinea capitis(Ringworm) Dermatophyte fungi

caused by *Trichophyton tonsurans*



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Trichophyton rubrum : As example for **Subcutaneous infection**

Severe nail infection with *Trichophyton rubrum* in a 37-year-old male AIDS patient.

Example for Sever Subcutaneous Infections.

Pathgen:- *Fonescaea pedrosi*

C:- Systemic(infection) Mycoses

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Caused by:-

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Opportunistic mycoses

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- **AIDS and cancer patients**
- **Individuals treated with broad spectrum antibiotics**
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Examples for Opportunistic mycoses

A- Aspergillosis: (داء الرشاشات) Inhalation of *Aspergillus fumigatus* spores. That cause aspergillosis --- severe allergic reaction .

B- yeast Infections or Candidiasis(داء المبيضات) :Caused mainly by *Candida albicans* . Part of normal mouth, esophagus, and vaginal flora.

C- Mucormycosis (Zygomycosis): (الفطر الاسود)is a rare but serious fungal infection that can affect many parts of human body such as eyes, sinuses, brain, lungs, gastrointestinal tract or skin.

Human Viruses

Virology: the science which deals with study of viruses as causative agents of very important diseases that occurs in human, animals, plants and other living organisms (insects, bacteria , fungi…….).

Viruses: are subcellular entities, **Ultramicroscopic**, obligate intracellular parasites that contain protein and only one type of nucleic acid, either **RNA** or **DNA .**

(**Ultramicroscopic**=It can only be seen with an electron microscope.)

General characters of viruses

1-Virus particles are very so small that they can only be seen with an electron microscope.

2-contain only one type of nucleic acid, either DNA or RNA, Surrounded by coat protein.

3- possess no enzymatic energy-producing system and no protein-synthesizing apparatus.

4- force infected host cells to synthesize virus particles

5- The virus dose not contain any organelles (ribosomes, mitochondria , metabolic enzymes, etc).

Classification of Viruses

Viruses are classified (A) according to the type of nucleic acid and the number of strands in the nucleic acid into:

1-Double stranded DNA (dsDNA)

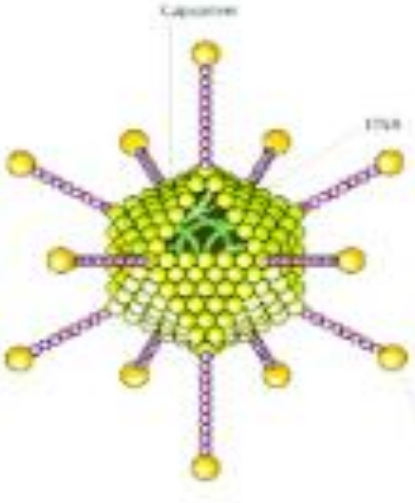
2- Single-stranded DNA (ssDNA)

3-Double-stranded RNA (dsRNA)

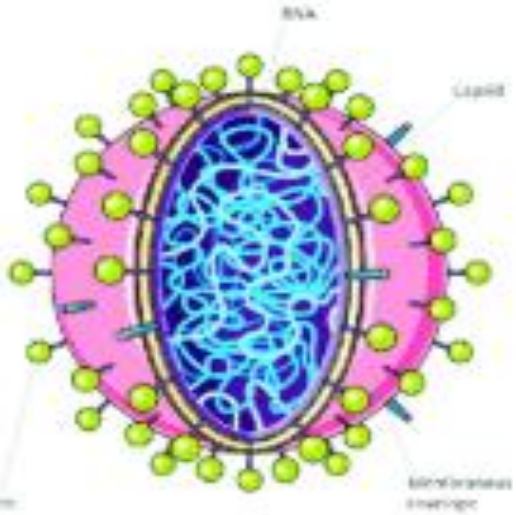
4- Single stranded RNA (ssRNA)

(B) according to their Shape

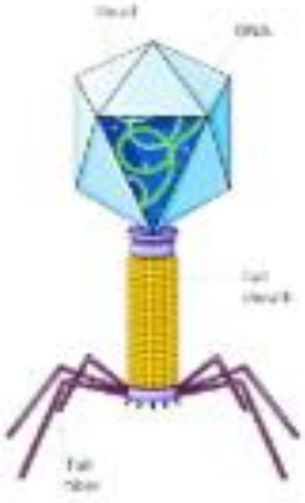
Rod shape



Polyhedral



Spherical



Complex

Examples of some important Viruses

1-Influenza virus .

2-Measles (الحصبة).

3-Human immunodeficiency virus infection / acquired immunodeficiency syndrome (HIV/AIDS).

Review Q

Q1) Fill in the blank with suitable term .

1) The---------- **lack a cell wall around their cell membranes and resistant to penicillin .**

2) According to their morphology , fungi are classified in to:-1----------,2---------- --- 3----------

3) The harm caused by fungi to humans is divided into two main categories:- 1---------- ---- 2----------

4) Infection caused by fungi that are generally harmless unless individual has weakened defenses is called----------

5) All viruses composed of ----------and one type of nucleic acid ----------or ---------

5) According to the type of nucleic acid and the number of strands in the nucleic acid into:-

a-

b-

c-

d-

Thank you for your attention

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Principles of Microbiology

Lec-7 Bacterial Diseases

Prof. Dr. Mohammed A. Fayyadh

Bacterial Diseases

Basic terms frequently used in describing aspects of pathogenesis:

- **Pathogenicity:** The ability of an infectious agent to cause disease.
- **Virulence:**
  - The quantitative ability of an agent to cause disease.
  - Virulent agents cause disease when introduced into the host in small numbers.
  - Virulence involves invasiveness and toxigenicity.

▫ **Toxigenicity:** The ability of a microorganism to produce a toxin that contributes to the development of disease.

 Invasion: The process whereby bacteria, parasites, fungi and viruses enter the host cells or tissues and spread in the body.

- **Pathogen:** A microorganism capable of causing disease.
- **Non-pathogen:** A microorganism that does not cause disease. It may be part of the normal flora.
- **Opportunistic pathogen:** An agent capable of causing disease only when the host´s resistance is impaired (e.g. the patient is immunocompromised).
- An agent capable of causing disease only when spread from the site with normal bacterial microflora to the sterile tissue or organ.

Virulence Factors of Infectious Disease

#-Pathogenicity – Ability of a microorganism to cause disease

#- Virulence - Degree of pathogenicity

-Virulence factors contribute to an organisms virulence are :-

***Adhesion factors**

***Biofilms**

***Extracellular enzymes**

***Toxins**

***Antiphagocytic factors**

An understanding of medical microbiology requires knowledge not only of the different classes of bacteria but also of their Ability to causing disease.

Bacteria are divided into two groups according to their ability to cause disease:-

****Strict pathogens:** *Mycobacterium tuberculosis* ; *Neisseria gonorrhoeae* ; *Francisella tularensis*.

****Opportunistic pathogens:** e.g. bacteria that are typically members of the human ´s normal microflora (*Staphylococcus epidermidis* , *Escherichia coli* and other)

Bacterial Enzyme and Toxins

Extracellular Enzymes -Enzymes secreted outside the cells of the pathogen (bacteria) .

##- Dissolve structural chemicals in the body.

##- Help pathogen maintain infection, invade further, and avoid body defenses .

Bacterial Toxins

-Chemicals that harm tissues or trigger host immune responses that cause damage

-Toxemia refers to toxins in the bloodstream that are carried beyond the site of infection

There are two types of Bacterial Toxins:-

– **Exotoxins (botulinum toxin** produced by *Clostridium botulinum*)

– **Endotoxins (**Lipopolysaccharide **produced by** *Staphylococcus aureus*)

	Exotoxins	Endotoxin
Source	Mainly Gram-positive and Gram-negative bacteria	Gram-negative bacteria
Relation to bacteria	Metabolic product secreted from living cell	Portion of outer (cell wall) membrane released upon cell death
Chemical nature	Protein or short peptide	Lipid portion of lipopolysaccharide (lipid A) of outer (cell wall) membrane
Toxicity	High	Low, but may be fatal in high doses
Heat stability	Typically unstable at temperatures above 60°C	Stable for up to 1 hour at autoclave temperatures (121°C)
Effect on host	Variable depending on source; may be cytotoxin, neurotoxin, enterotoxin	Fever, lethargy, malaise, shock, blood coagulation
Fever producing?	No	Yes
Antigenicity[a]	Strong: stimulates antitoxin (antibody) production	Weak

Antiphagocytic Factors

Certain factors prevent phagocytosis by the host's phagocytic cells

– Bacterial capsule

* Often composed of chemicals found in the body and not recognized as foreign

*Can be slippery making it difficult for phagocytes to engulf the bacteria

– Antiphagocytic

***chemicals Some prevent fusion of lysosome and phagocytic vesicles**

***Leukocidins directly destroy phagocytic white blood cells**

Examples of some Pathogenic Bacteria (Staphylococcus)

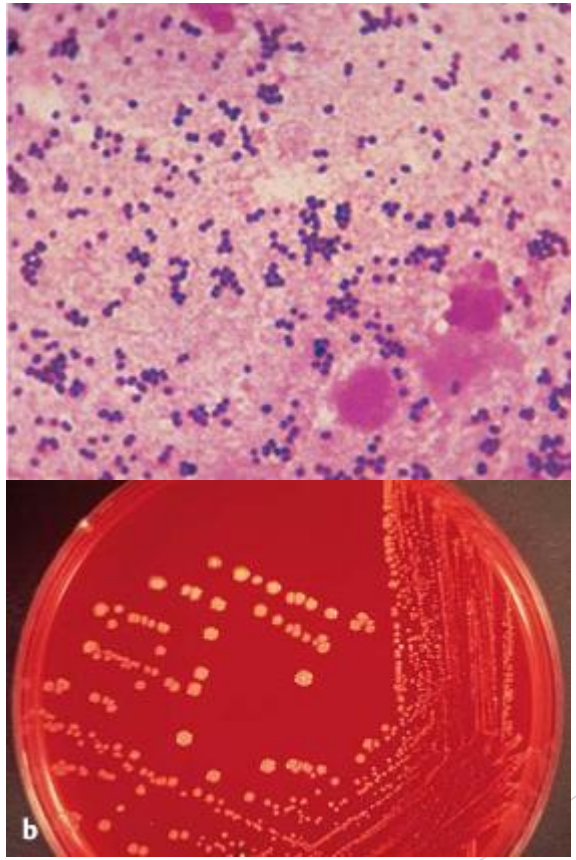
Staphylococcus is :-

-Gram positive +

-Catalase +ve

Species : *Staphylococcus aureus*

- * Gram-positive cocci
- * Non motile
- * Facultative anaerobes
- **-Cells occur in grapelike clusters**



Order: Caryophanales

Family:Micrococcaceae

Genus :Staphylococcus

Species:aureus

Scientific name: *Staphylococcus aureus*

Pathogenicity

***•Pathogenicity results from 3 features :**

- Structures that enable it to evade phagocytosis. **(capsules)**
- Production of enzymes. **(Coagulase.)**
- Production of toxins. **(Enterotoxins)**

Transmission of Bacterial infection

+ contaminated soil or animals

+Eating or drinking contaminated food or water

+ Breathing in droplets from an infected person

+ Touching dirty surfaces and then touching your eyes, nose, or mouth

Staphylococcal Diseases

1-Noninvasive Disease

Food poisoning from the ingestion of enterotoxin-contaminated food

2-Cutaneous Disease : Various skin conditions including

* **scalded skin syndrome.**
* **Impetigo.**
* **Folliculitis.**

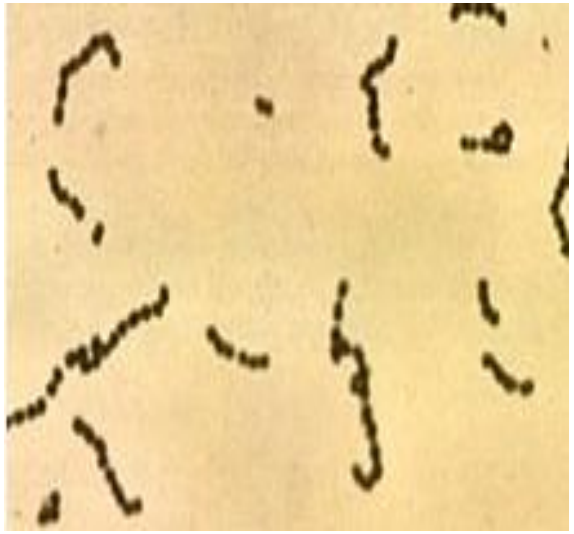
3- Systemic Disease :• **Toxic shock** - **Bacteremia** - **Endocarditis** and **Pneumonia**

Staph infection

Streptococci

- facultative anaerobe .
- Gram-positive.
- chains or pairs .
- catalase negative.

(staphylococci are catalase positive)



Shigella and Salmonella

Order: Enterobacterales

Family: Enterobacteriacea

Genus : Shigella

Species:dysenteriae

Shigella dysenteriae

It is the causative agent of human shigellosis.

Important Properties:

Shigellae are:-

- short Gram-negative rods.

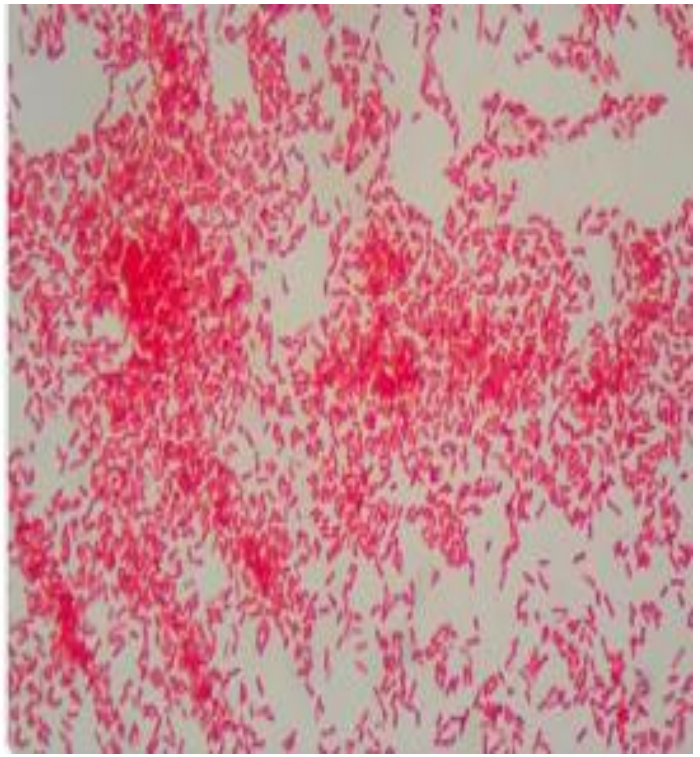
- non–lactose-fermenting.

-Resistant to bile salts.

-non spore forming

- **Shigella can be distinguished from salmonellae by three criteria:**
- **• They produce no gas from the fermentation of glucose**
- **• They do not produce H2S**
- **• They are non-motile.**


SHIGELLA
On MacConkey agar



The most important pathogenic bacteria

Bacteria	Disease
1-*Vibrio cholera*	Cholera
2-*Cornybacterium diphtheriae*	Diptheria
3-*Streptococcus pneumoniae*	pneumonia
4-*Mycobacterium tuberculosis*	Tuberculosis
5-*Shigella dysenteriae*	Dysentry
6-*Salmonella typhiae*	Typhoid
7-*Bacillus anthracis*	Anthrax
8-*Clostridium tetani*	كزاز Tetanus
9-*Neisseria meningitidis*	سحايا Meningitis
10-*Pasteurella pestis*	طاعون plague

Q1) Which of the following is considered a major bacterial virulence factor that enables bacteria to adhere to host tissues?

A) Exotoxins B) Flagella C) Pili D) Endotoxins

Answer:

C) Pili

Q2) **1. Which of the following is the most common species of *Staphylococcus* that causes human infections?**

A) *Staphylococcus saprophyticus* B) *Staphylococcus epidermidis* C) *Staphylococcus aureus* D) *Staphylococcus lugdunensis*

Answer: C) *Staphylococcus aureus*

Q3). *Staphylococcus aureus* can produce which of the following toxins that contribute to food poisoning?

A) Exfoliative toxin
B) Enterotoxins
C) Hemolysins
D) Leukocidins

Answer: B) Enterotoxins

Thank you for your attention

جامعة شط العرب الاهلية -كلية العلوم –قسم التحليلات المرضية

Lec-(5 -6).Reproduction and bacterial growth

Prof.Dr. Mohammed A. Fayyadh

Reproduction In Bacteria

#-Bacteria are prokaryotic organisms that reproduce asexually.

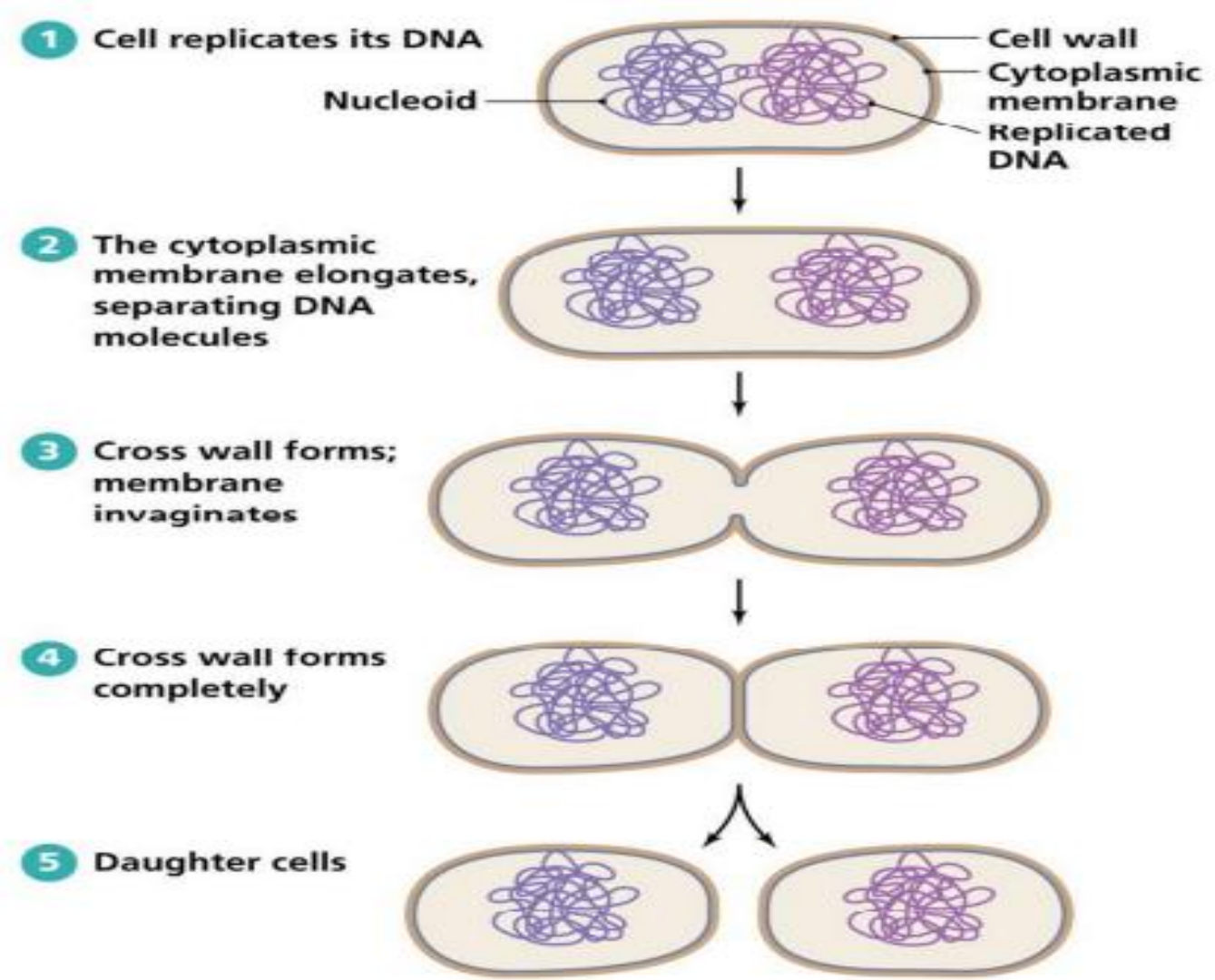
#-Most prokaryotes reproduce by binary fission.

#- Binary fission involves the division of a single cell, which results in the formation of two cells that are genetically identical.

#-In binary fission, the cell elongates, replicates its chromosome, and separates the newly formed DNA molecules so there is one chromosome in each half of the cell.

#-Finally, a septum (or cross wall) is formed at mid cell, dividing the parent cell into two progeny cells, each having its own chromosome and a complement of other cellular constituents.

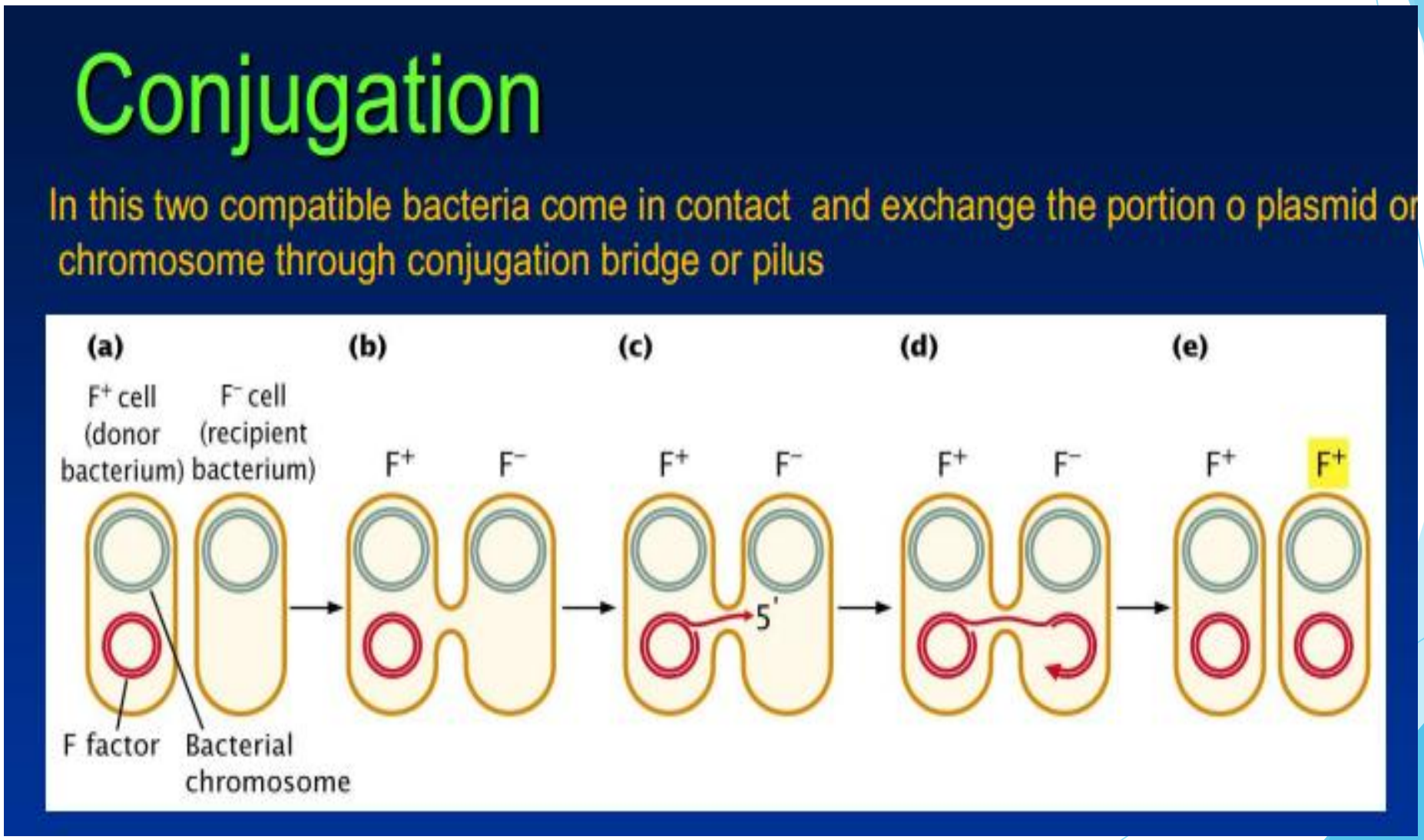
Binary fission



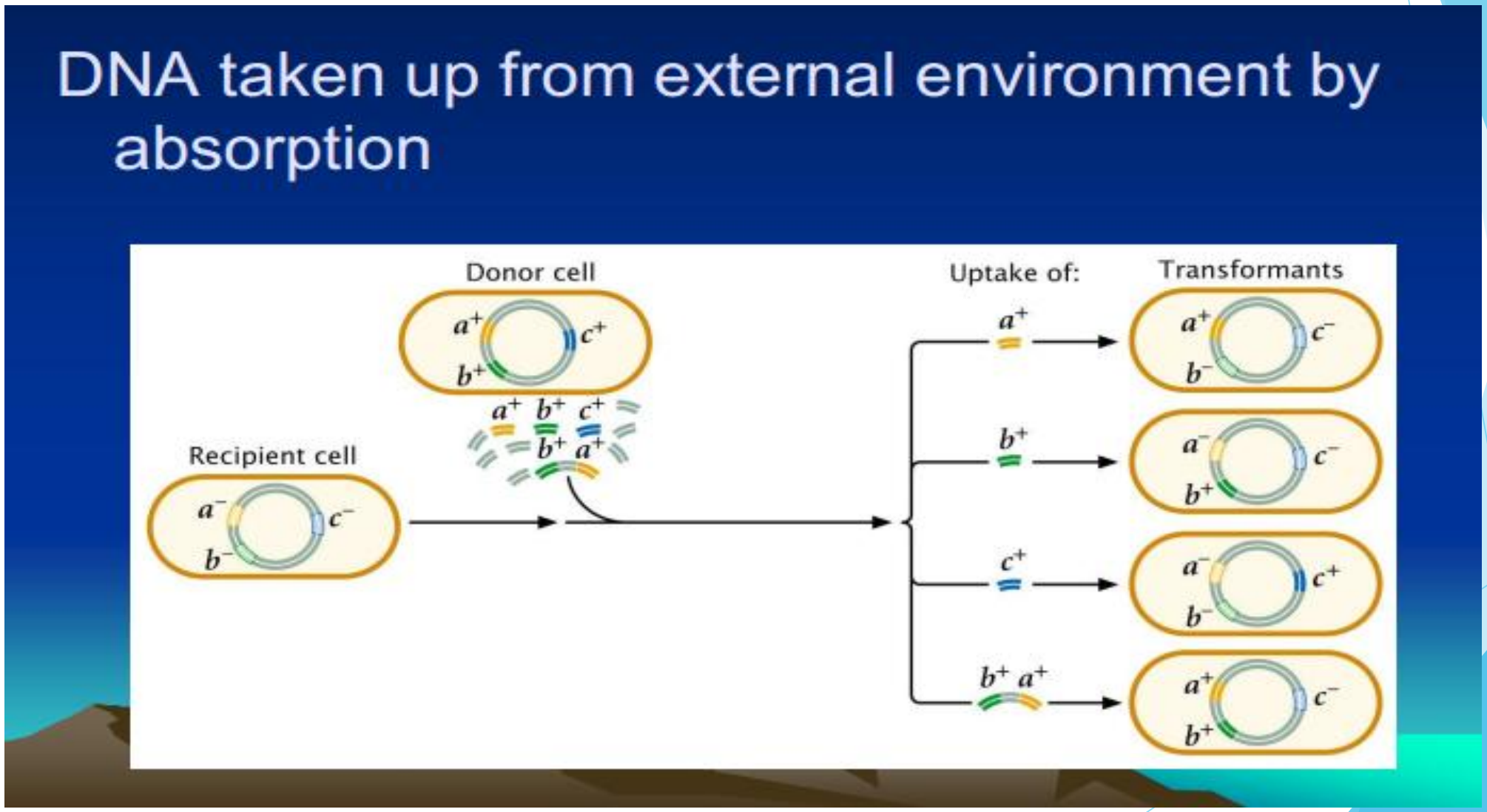
BACTERIAL RECOMBINATION

- Binary fission is an effective way for bacteria to reproduce, however it is not without problems. Since the cells produced through this type of reproduction are identical, they are all susceptible to the same types of threats, such as environmental changes and antibiotics. These hazards could destroy an entire colony. In order to avoid such perils(مخاطر), bacteria can become more genetically varied through recombination. Recombination involves the transfer of genes between cells. Bacterial recombination is accomplished through conjugation, transformation, or transduction.

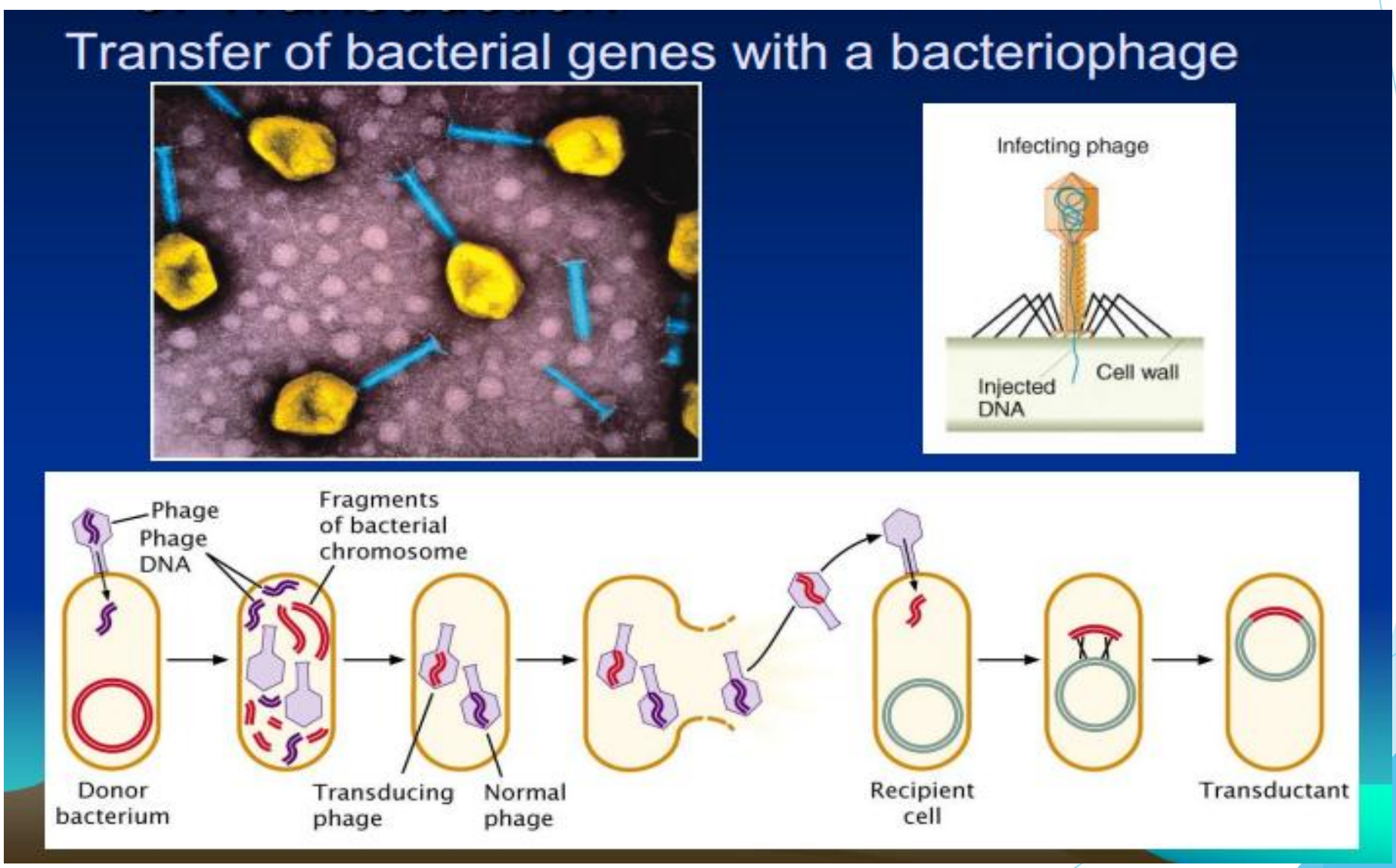
Conjugation



2-Transformation



3-Transduction



Requirements for Bacterial growth

***What do we mean by Bacterial Growth?**

Bacterial growth is an increase in all cell components, which ends in multiplication of the cell leading to an increase in population.

Factors affecting Bacterial growth

The requirements for Bacterial growth can be divided into two main categories:

A- Chemical Factors

B-Physical Factors

A- Chemical Requirements :include

- Major Elements (Macro Elements (C-N-P-S)
- Trace Elements (Iron-Copper-Molybdenum—Zinc)
- Growth Factors (Vitamins-amino acid-purines-pyrimidines)

B- Physical Factors Influencing Bacterial Growth

- Temperature
- Moisture
- pH
- Light
- Osmotic pressure

Classification of bacteria according to their need for oxygen

	a. Obligate Aerobes	b. Facultative Anaerobes	c. Obligate Anaerobes	d. Aerotolerant Anaerobes	e. Microaerophiles
Effect of Oxygen on Growth	Only aerobic growth; oxygen required.	Both aerobic and anaerobic growth; greater growth in presence of oxygen.	Only anaerobic growth; ceases in presence of oxygen.	Only anaerobic growth; but continues in presence of oxygen.	Only aerobic growth; oxygen required in low concentration.
Bacterial Growth in Tube of Solid Growth Medium					

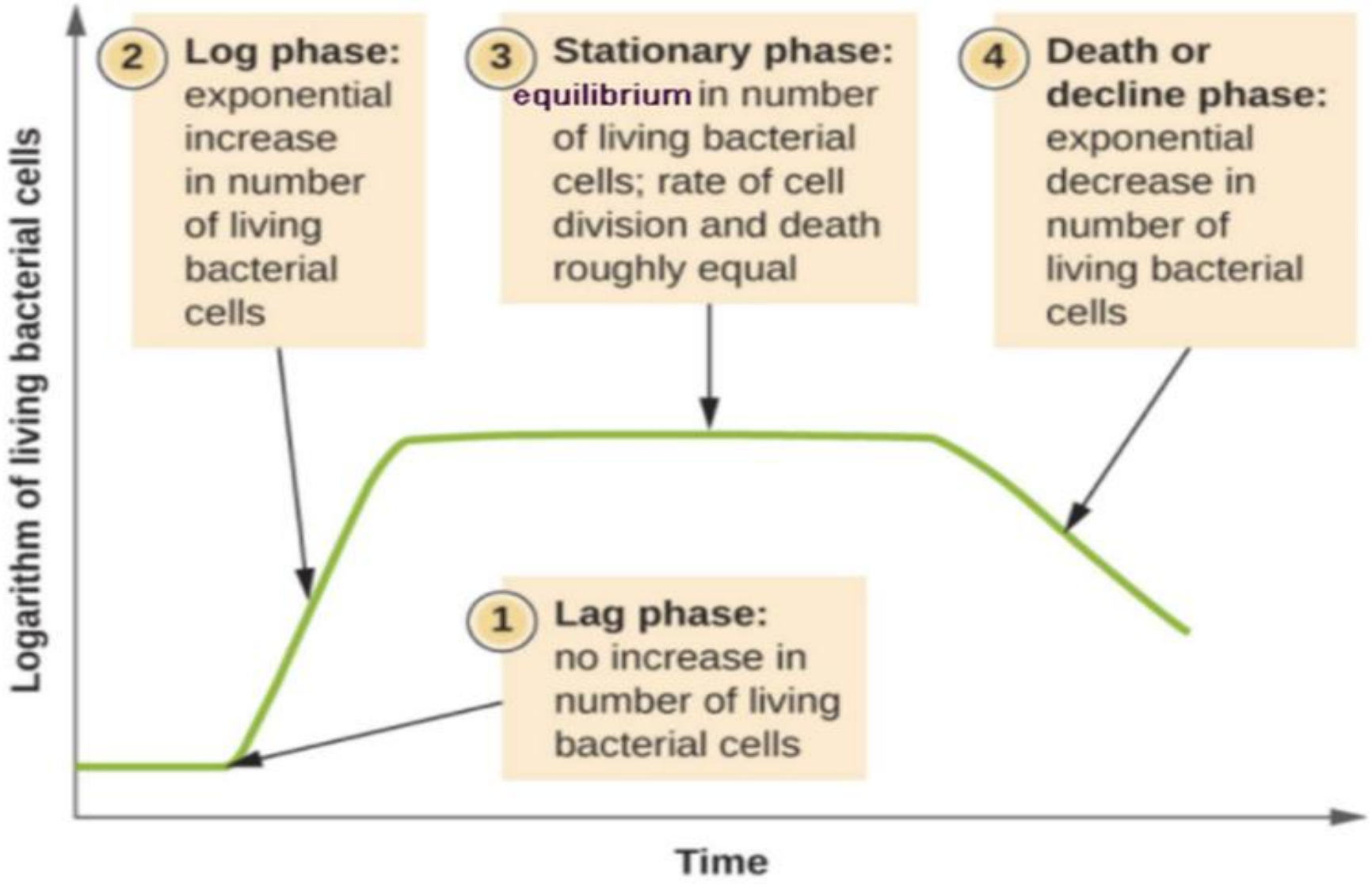
Classification of bacteria according to optimum growth temperatures

- Psychrophiles (Cold -loving microbes)0-20C (*Psychrobacter sp*)
- Mesophiles (moderate-temperature loving microbes) 20-45 C *(Escherichia coli)*
- Thermophiles (Heat -loving microbes)40-90C (*Clostridium thermosaccarolyticum*)

Bacterial Growth Curve

- The bacterial growth curve shows 4 distinct phases:
- 1-Lag phase
- 2-Log (exponential) phase
- 3-Stationary phase
- 4-Decline (Death) phase

Bacterial Growth Curve



Review Q

Q1) Choose the correct answer .

1-What is the primary method of reproduction in bacteria?
A) Binary fission
B) Budding
C) Mitosis
D) Meiosis.

2- **Which of the following is NOT a method by which bacteria can exchange genetic material?**
A) Conjugation
B) Transformation
C) Transduction
D) Binary fission

3-Which of the following processes contributes to genetic diversity in bacteria?
A) Binary fission
B) Conjugation
C) Transcription
D) Translation

4-During which phase of bacterial growth does the rate of bacterial death equal the rate of bacterial division?

A) Lag phase

B) Log (exponential) phase

C) Stationary phase

D) Death phase

5- **What term is used to describe bacteria that require oxygen for growth?**

A) Anaerobes

B) Facultative anaerobes

C) Aerobes

D) Microaerophiles.

Q2) Define the following terms:-

1-Transformation 2- conjugation 3- Lag Phase 4- Obligate aerophiles bacteria

Quiz

1-Why do gram positive bacteria retain crystal violet stain?

2- Match the following types of antimicrobials with their actions:

(a) Kills bacteria -------- Bacteriostatic

(b) Stops bacterial growth -------- Viricidal

(c) inactivate viruses ----------Sprricidal

(d) Kills bacterial spore ---------fungicidal

(c) Kills yeast and mold ----- - -- Bacteriocidal

3- Fill in the blanks with the appropriate words.

a- The type of symbiosis in which both partners benefit is called _____.

b- The gene transfer mechanism in which bacterial information is carried by a virus is called _____.

c- The process in which cell-free DNA is taken up by a cell and engages in genetic recombination is called _____.

Thanks for your attention

جامعة شط العرب الاهلية
كلية العلوم –قسم التحليلات المرضية

Lec- 4: Bacterial cell structure

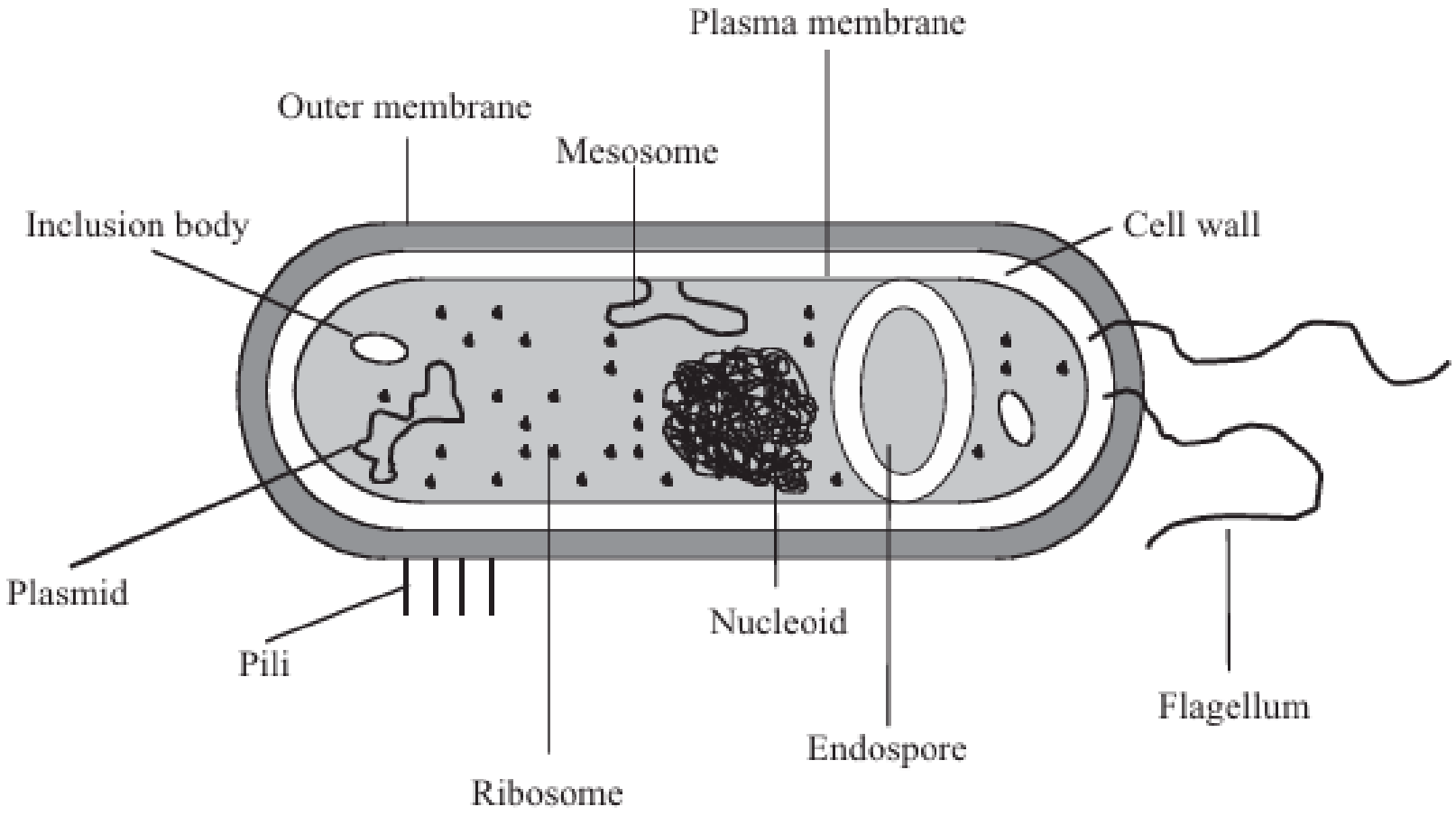
Prof.Dr. Mohammed A.Fayyadh

Bacterial Cell Structure

Basic Bacterial Structures

The structure of bacterial cells consists of basic and special structures. Basic structures include the cell wall, cell membrane, cytoplasm, nuclear material and ribosome.

Special structures, which are only found in some bacteria, include the flagellum, pilus, capsule, spore, plasmid ,etc.


Plasma membrane
Outer membrane
Mesosome
Inclusion body
Cell wall
Plasmid
Pili
Nucleoid
Flagellum
Ribosome
Endospore

Cell envelope

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

Function: To protect the organisms from hostile environments, such as extreme osmolality , harsh chemicals, and even antibiotics.

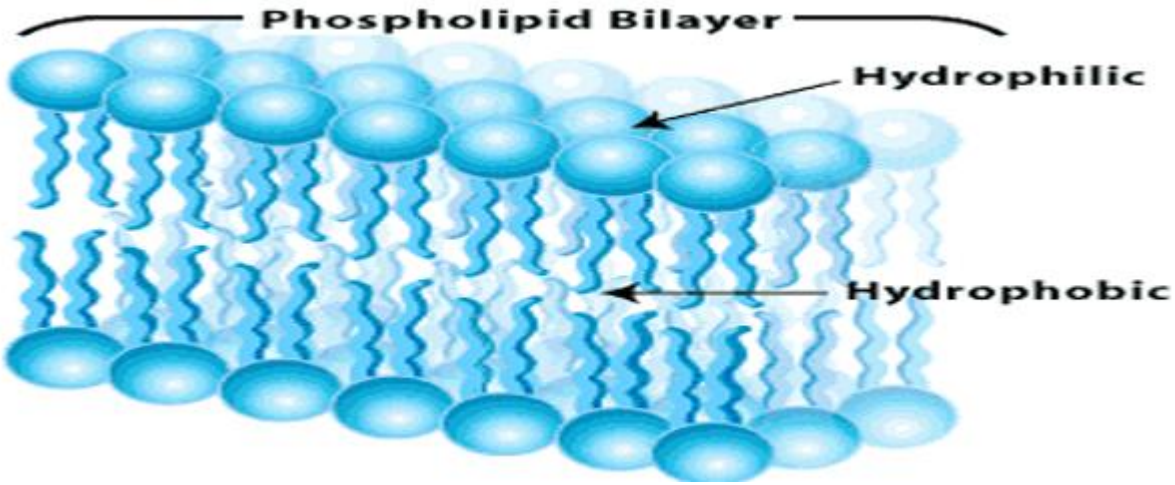
Cell Membrane

*** Often called the plasma membrane) is composed of 2 layers of phospholipids and protein .**

***Phospholipids have polar heads and non-polar tails.**

*** "Polar" implies that the heads are hydrophilic.**

*** "Non-polar" means that the tails are hydrophobic.**

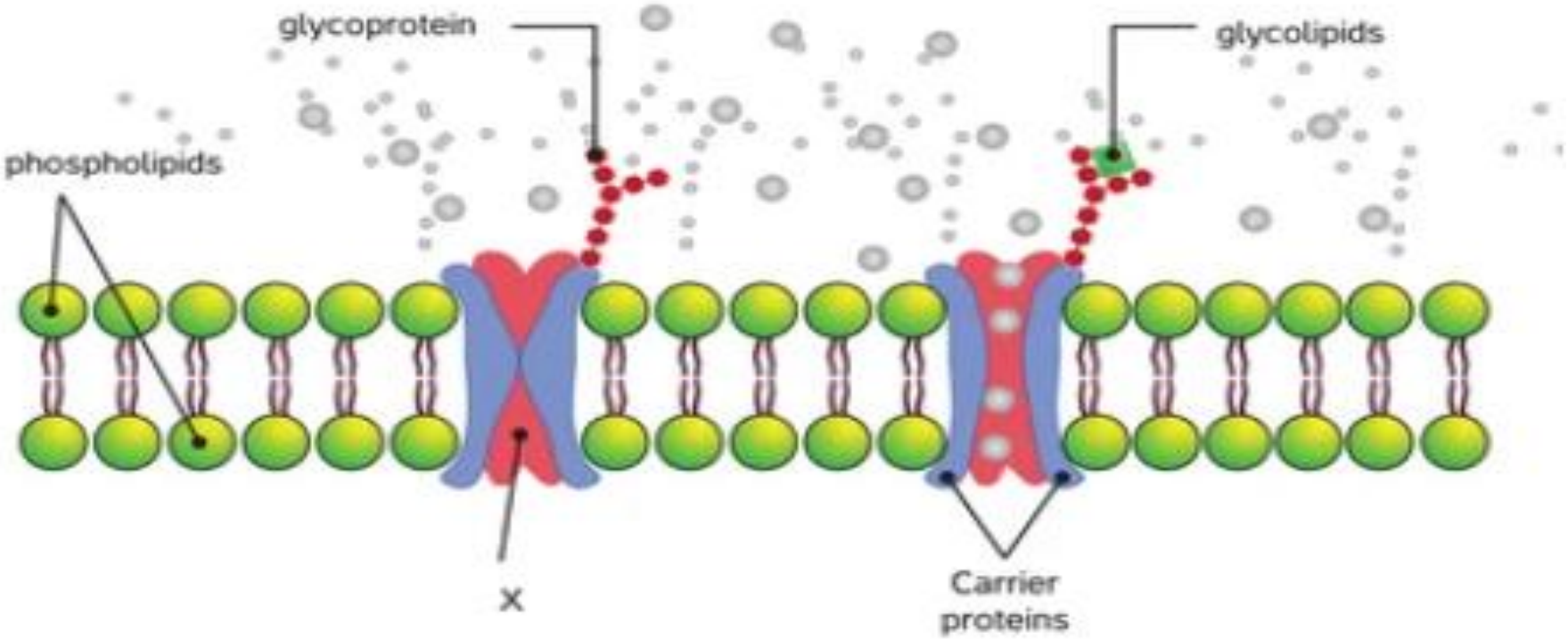


Membrane Proteins

 # Proteins account 70% of the mass of the membrane, which is a higher proportion than that of mammalian cell membranes.

 # Most are placed in the membranes so that the hydrophobic amino acids associate with the lipids in the membrane and the hydrophilic amino acids are outside the membrane interacting with the cytoplasm.

Cell Membrane



Function of plasma membrane

(1)Selective permeability and transport of solutes.

(2)Electron transport and oxidative phosphorylation

(3)Excretion of hydrolytic exo enzymes and pathogenicity proteins.

(4)Synthesis of precursors of DNA, cell wall polymers and membrane lipids.

Permeability and transport

*** Several mechanisms (transport systems) exist that enable the cell to transport nutrients into and waste products out of the cell.**

*These transport systems work against a concentration gradient to increase the nutrient concentrations inside the cell, a function that requires energy.

***There are three general transport mechanisms involved in membrane transport:**

1- Passive transport.

2- Active transport.

3- Group translocation.

Bacterial Cell wall

 # The bacteria cell wall is an important structure which is rigid, present just above the cell membrane and gives a specific shaped to the cell.

 # Because of this cell wall , bacteria can survive harshest environmental conditions like the drought, heat, chemical exposure, pressure, etc.

 # On the basis of cell wall composition, bacteria are classified into two major group ie. Gram Positive and Gram negative.

1. Gram positive cell wall

- Peptidoglycan
- Lipid
- Teichoic acid

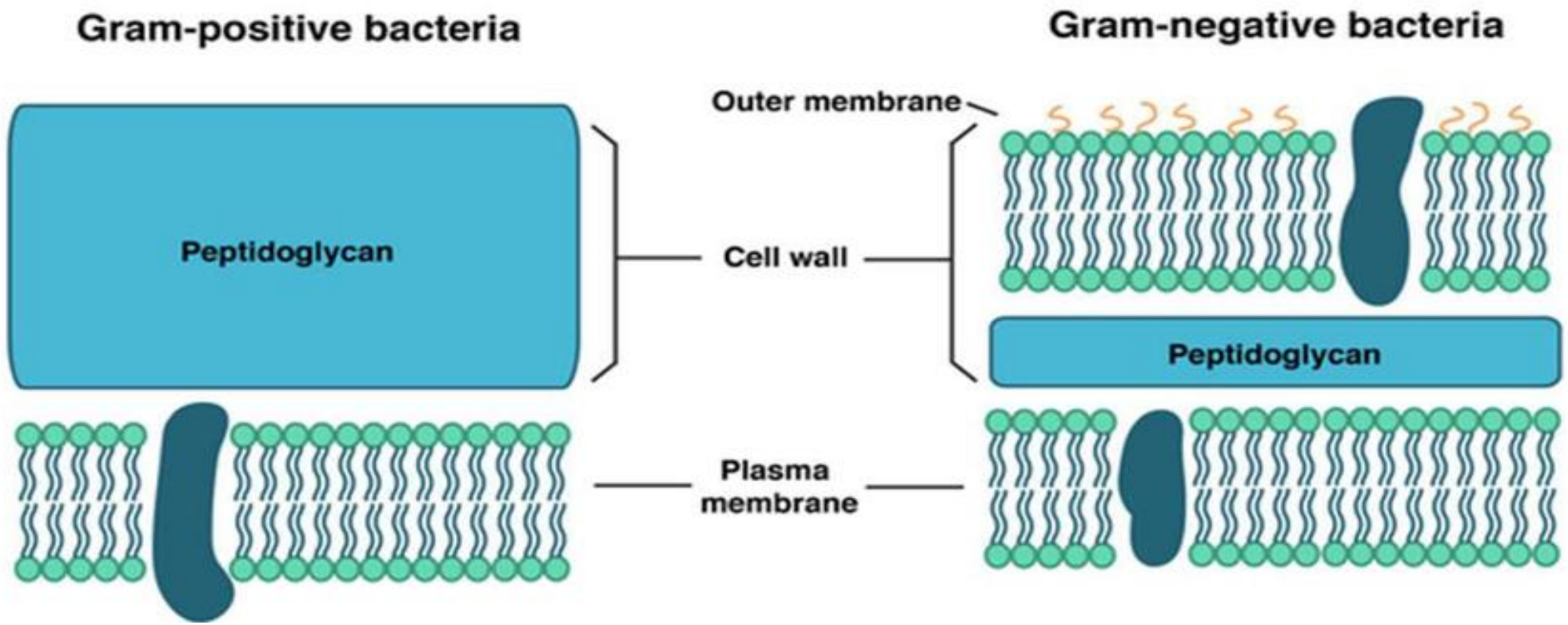
2. Gram negative cell wall

- Peptidoglycan
- Outermembrane:

1- Lipid

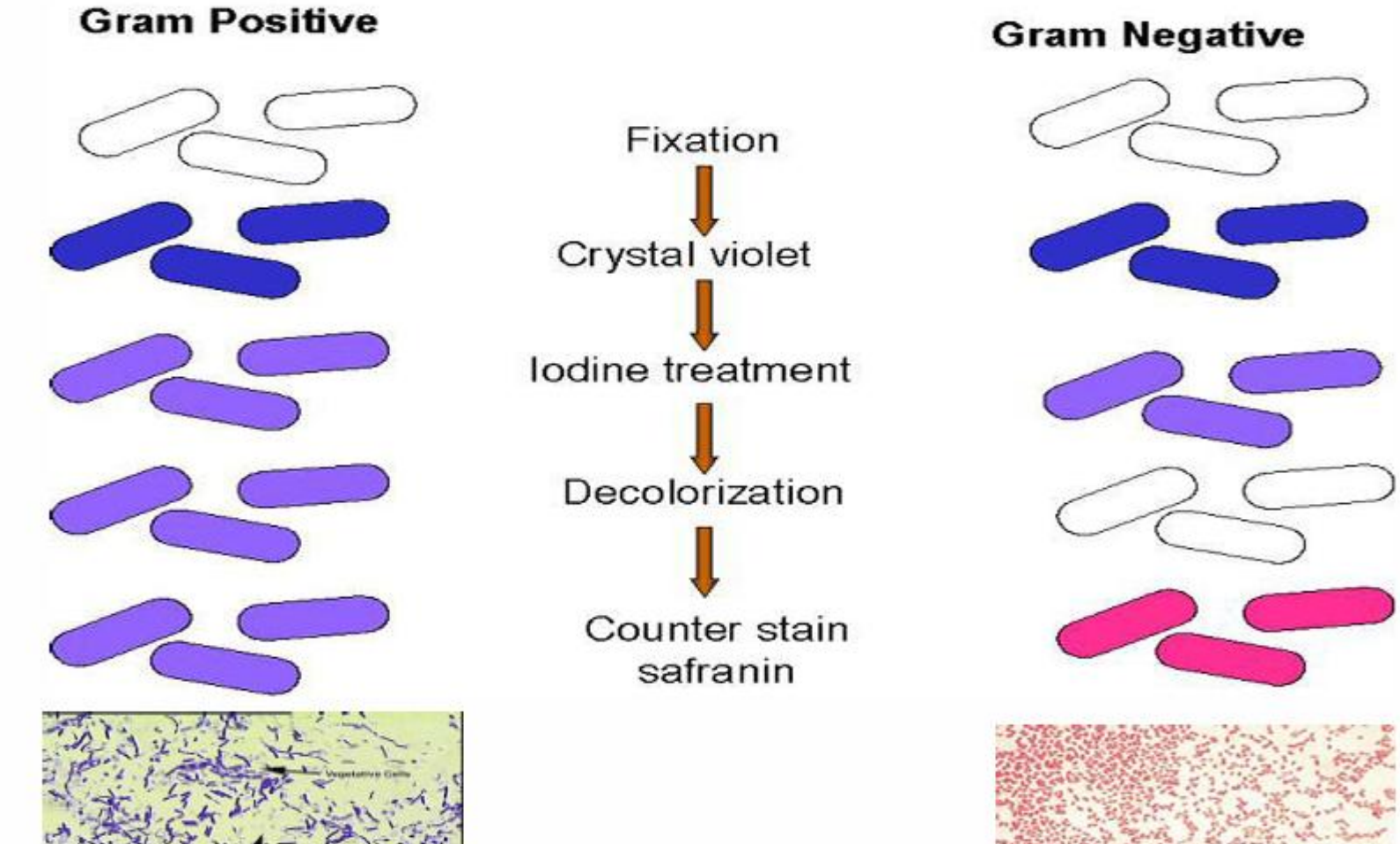
2- Protein

3- Lipopolysaccharide (LPS)



Gram Stain:

It is the most important diagnostic procedure in microbiology . It separates most bacteria into two major groups.



Cell Wall: Peptidoglycan Layer

***Peptidoglycan Polymer (amino acids + sugars)**

***Long chains of polysaccharide cross linked by short peptides (amino acid chains).**

***Unique to bacteria.**

***Provides structural support and maintains the shape of the cell.**

Cell Wall : Diaminopimelic acid

#- **It is a unique element** of bacterial cell walls.

#- It is never found in the cell walls of **Archaea or eukaryotes**.

#- Diaminopimelic acid is the immediate precursor of **lysine biosynthesis in the bacterial.**

Cell Wall: Teichoic acids

-Located in the outer layer of Gram +ve cell wall only , such as in the genera Staphylococcus , Streptococcus , Bacillus & Clostridium.

Functions of Teichoic acid

1. **Provide rigidity to the cell-wall.**

2. **Mediate the attachment of some bacterial species such as Staphylococci and Streptococci .**

3. **It is an acidic polymer and contributes negative charge to the cell wall.**

Cell Wall : Lipopolysaccharide (LPS)

*Found in the outer membrane of Gram-negative bacteria.

* Also known as endotoxins, (Fever causing)

*LPS, which is extremely toxic to animals, has been called the endotoxin of Gram-negative bacteria because it is firmly bound to the cell surface and is released only when the cells is lysed.

* Elicit strong immune responses in animals.(Cytokine storm)

Outer membrane

*It is an additional layer present in gram negative bacteria.

*It is composed of lipid bilayer , protein and lipopolysaccharide (LPS) layer .

- **Function:**

1-Structure component of gram-ve cell wall

2-LPS is an endotoxin produced by gram –ve bacteria

3- Lipid-A is antigenic.

Genetic material: The nucleoid or bacterial chromosome comprises a closed circle of double stranded DNA, many times the length of the cell and highly folded and compacted.(The bacterium *Escherichia coli* is around 3–4 µm in length, but contains a DNA molecule some 1400µm in length.

Plasmid: Its additional DNA in the form of small, self-replicating extra chromosome called plasmids. These do not carry any genes essential for growth and reproduction. and thus the cell may survive without them. They can be very important however, as they may include genes encoding **toxins or resistance to antibiotics**, and can be passed from cell to cell .

Ribosomes: Ribosomes (70s)are composed of a complex of protein and RNA, and are the site of **protein synthesis** in the cell.

Inclusion bodies: granular structures. Act as food reserves, and may contain organic compounds such as starch, glycogen or lipid.

Endospores : They are dormant forms of the cell that are highly resistant to extremes of temperature, pH and other environmental factors . Produced by certain bacteria such as *Bacillus* and *Clostridium* .

Cell Wall appendages

The most important are:-

1-Flagella (Flagellum) –used for bacterial locomotion .

2-Pili (Pilus) , short flagella –They differ from flagella in many features

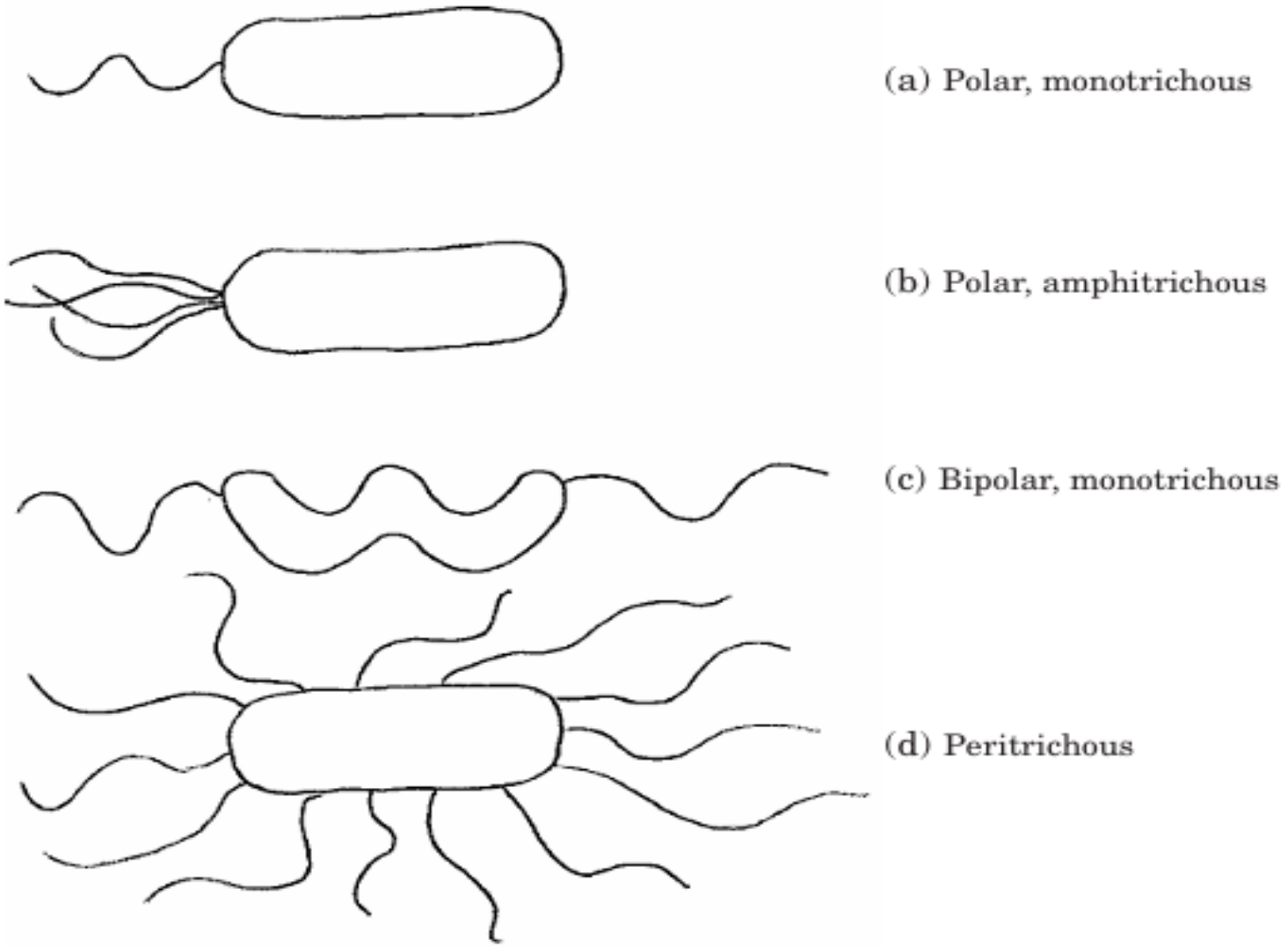
- they do not penetrate to the plasma membrane

- they are not associated with motility .

Pili function :

*** Attachment(adhesion) to host cell . * Transfer of genetic information by conjugation**

Types of Flagella



(a) Polar, monotrichous

(b) Polar, amphitrichous

(c) Bipolar, monotrichous

(d) Peritrichous

Comparison between gram positive and gram negative bacteria

Item	Gram positive	Gram negative
Peptidoglycan layer	Thick (multilayered)	Thin (single-layered)
Teichoic acids	Present	Absent
Periplasmic space	Absent	present
Lipopolysaccharide (LPS) content	Virtually none	High
Lipid and lipoprotein content	Low	High
Gram reaction	Retain crystal violet dye and stain dark violet	Can be decolorized to accept counter stain

Review Q

Q/ Compare between Gram +ve and Gram –ve cell wall?

Q/ illustrate the steps of Gram stain.

MCQ:-

1-Which of the following is not typically found in the cytoplasm of bacterial cell:

a)Ribosomes b)Nucleoid c) Endoplasmic reticulum d)Plasmid

2-The rigid outer structure of a bacterial cell that provides shape and protection is called the :

a)Capsule : b)Cell wall : c) Plasma membrane : d)Cytoplasm

3-bacterial flagella are responsible for:

a)Locomotion : b)protein synthesis : c)Energy production :d)DNA replication

4-Which of the following structure is responsible for the attachment of bacteria to host cell surface?

a)Flagella : b)Plasmid : c)Ribosome : d)Pilli

5-which of the following is found in gram-negative but not in gram-positive bacteria?

a)Pilli : b)Ribosome : c)Peptidoglycan : d)Lipopolysaccharide

I Wish You All the Best

Prof.Dr. *Mohammed A. Fayyadh*

جامعة شط العرب الاهلية
كلية العلوم –قسم التحليلات المرضية

Principles of Microbiology

Lec-3&4 **Normal Flora & Bacterial shape**

Prof. Dr. Mohammed A. Fayyadh

Normal Microflora (Flora) or Human Microbiota

Some terms should be know:-

Saprophytes:-These microorganisms are nonpathogenic; their natural habitat is dead organic matter.

Parasites:-Unicellular or metazoan organism living in or on an organism of another species (host) on the expense of the host.

Pathogen:- any organism can cause disease to human, animals and plants .

Opportunistic pathogen : An agent capable of causing disease only when the hosts resistance is impaired(when the patient is immunocompromised). these are frequently germs of the normal flora or occasionally from the surrounding environment, animals, or other germ carriers.

- **Symbiosis**: it is the relationship between two dissimilar organisms that are adapted to live together.
- **There are three types of symbiosis:**

1.Mutualism: close relationship in which the parasite and the host depend on each other to survive. It's beneficial for both of them .E.g.: the **protozoa** in the digestive tract of **termites.**

2. Commensalism: It's beneficial for the parasite, at the same time it's harmless for the host . E.g.: *E. coli* .

3. Parasitism: The parasite is harmful to the host.E.g.: *Entamoeba histolytica, Giardia lamblia.*

Adherence (adhesion, attachment);- The process by which bacteria stick to the surface of host cell, it’s a major initial step in infection process.

Invasion :- The process whereby bacteria ,animal parasite, fungi , and viruses enter host cell or tissue and spread in the body.

Toxigenicity:- The ability of a microorganism to produce a toxin that contributes to the development of disease.

-Normal flora:- **are microorganisms that exist naturally on or in the body of a living organism without causing any apparent harm.**

-However, under certain conditions, such as low immunity, these organisms can cause disease in humans.

-Normal flora are bacteria, fungi, and protozoa that reside naturally in the skin, gastrointestinal tract, mucous membranes, and genitourinary tracts, where they provide a stabilizing balance.

-Bacteria are the predominant component of the normal flora.

-The count of bacteria per gram of intestinal content is 10^1–10^5 in the duodenum, 10^3–10^7 in the small intestine, and 10^{10}–10^{12} in the colon.

-The bacteria present in the average human gut weigh about 1 kg, and a human adult will excrete his or her own weight in fecal bacteria each year.

Normal Microbial Flora in Humans

Microorganisms	Microbiotopes				
	Skin	Oral cavity	Intes-tine	Upper re-spiratory tract	Genital tract
Staphylococci	+++	+	+	++	++
Enterococci			++		+
α-hemolytic streptococci	+	+++	+	+	+
Anaerobic cocci		+	+		+
Pneumococci		+		+	
Apathogenic neisseriae		+		+	+
Apathogenic corynebacteria	++	+	+	+	+
Aerobic spore-forming bacteria	(+)				
Clostridia			+++		(+)
Actinomycetes		+++			+
Enterobacteriaceae	(+)	(+)	+++	(+)	+
Pseudomonas			+		
Haemophilus		+		++	(+)
Gram-neg. anaerobes		+++	+++	+++	+++
Spirochetes		++		+	(+)
Mycoplasmas		++	+	+	++
Fungi (yeast)	++	+	+	+	+
Entamoeba, *Giardia*, *Trichomonas*		+		+	

+++ = numerous, ++ = frequent, + = moderately frequent, (+) = occasional occurrence

Significance of the Normal Flora:-

-Normal microbiota , provides a first line of defense against microbial pathogen- assist in digestion –play a role in toxin degradation.

-According to its location in the human body, the natural flora is divided in to:-

-Skin Flora:-Staphylococci, Micrococci

-Oral and Upper Respiratory Tract Flora:- *Neisseria*, , *Corynebacterium*, and *Streptococcus*

-Gastrointestinal Tract Flora:-Clostridia :Enterococci

-Urogenital Flora:-*Candida spp*

-Conjunctival Flora:-*Staphylococcus*

What is a Bacterial cell?

- **Bacteria** is Prokaryotic microorganisms are a single-celled microscopic organisms that lack nuclei and other organized cell structures.
- Several bacterial species are pathogenic (capable of causing disease), most are non-infectious, and many have critical roles in decay, fermentation, nutrient recycling, and nitrogen fixation.
- Bacteria are usually classified as Gram positive or Gram-negative based on a basic microbiological staining procedure called the Gram stain.
- They come in a variety of shapes and sizes

The Bacterial Shape

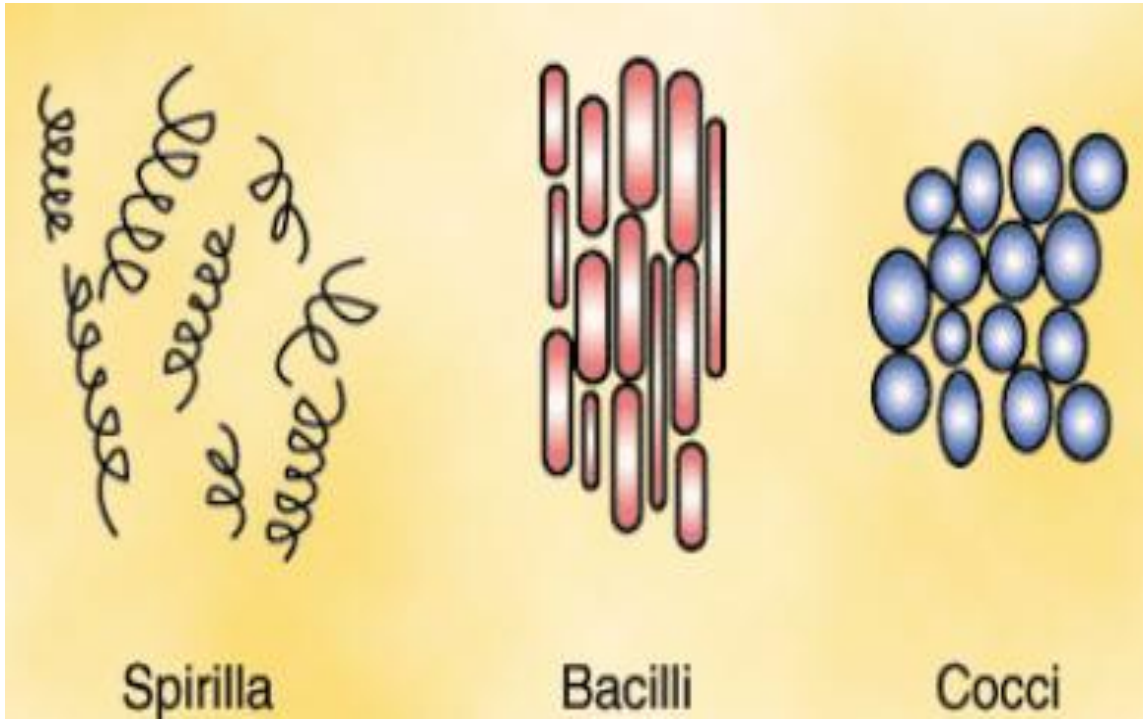
- There are three basic shapes of bacteria: **coccus**, **bacillus**, and **spiral**.
- Based on planes of division, the coccus shape can appear in several distinct arrangements: diplococcus, streptococcus, tetrad, sarcina, and staphylococcus.
- The bacillus shape can appear as a single bacillus, a streptobacillus, or a coccobacillus.
- The spiral shape can appear in several forms: vibrio, spirillum, and spirochete.
- The metric unit micrometer (1/1,000,000 or 10^{-6} of a meter) is used to measure bacterial size.

Basic shapes of bacteria

* Spherical (cocci)

*Rod-shaped(bacilli)

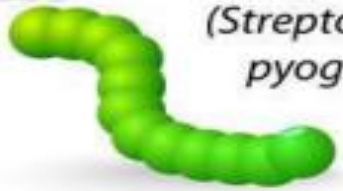
*Spiral-shaped



SHAPES OF BACTERIA

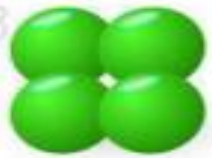
COCCI

Diplococci
(Streptococcus pneumoniae)



Streptococci
(Streptococcus pyogenes)

Tetrad



Staphylococci
(Staphylococcus aureus)

Sarcina
(Sarcina ventriculi)

BACILLI

Chain of bacilli
(Bacillus anthracis)

Flagellate rods
(Salmonella typhi)

Spore-former
(Clostridium botulinum)

OTHERS

Vibrios
(Vibrio cholerae)

Spirilla
(Helicobacter pylori)

Spirochaetes
(Treponema pallidum)

Spherical (cocci) bacteria

1.Micrococci

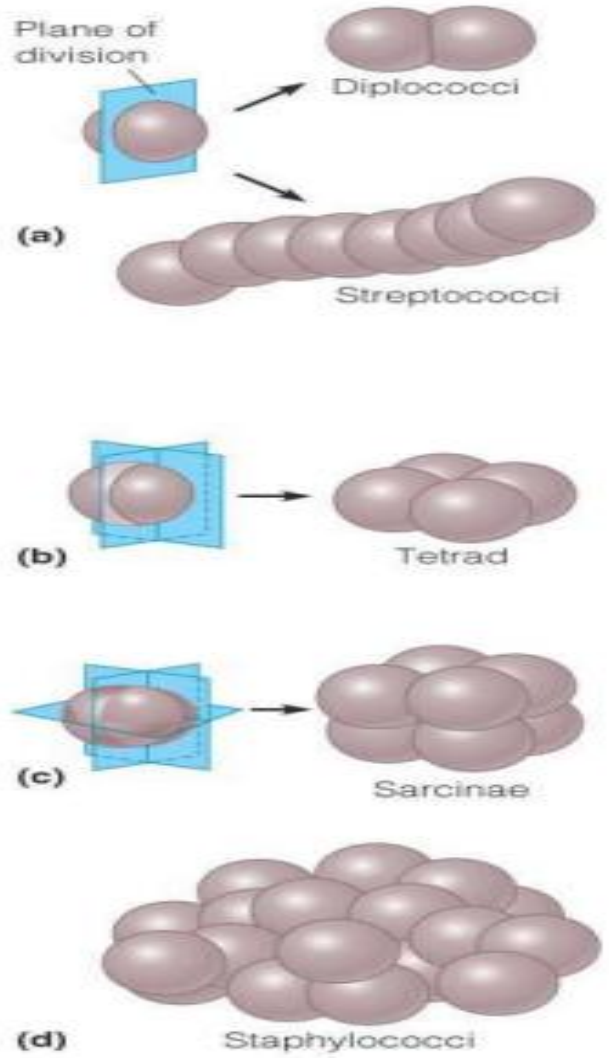
2. Diplococci

3. Streptococci

4. Tetracocci

5. Sarcinae

6. Staphylococci



Review Q.

Q1) Define the following terms :-

a-Opportunistic pathogen b- parasite c- Toxigenicity d-Invasion

Q2)Choose the correct answer.

1-If the relationship between host and parasite is beneficial to both of them ,it is called:-

a-Mutualism b- Parasitism c-Commensalism d-Symbiosis

2-Predominat component of the Normal flora is :-

a- Fungi b-Protozoa c-Bacteria d- Viruses

3-If the bacteria are spherical in shape, they are called :-

A-Bacilli b-Coicci c- Spirilla d- Vibrio

Thanks

I wish you a happy time

prof Dr. Mohammed A Fayyadh

جامعة شط العرب الاهلية
كلية العلوم –قسم التحليلات المرضية

Principles of Microbiology

Lec-2- Types of Pathogenic Microorganisms

Prof. Dr. Mohammed A. Fayyadh

Types of Pathogenic Microorganisms

Infectious diseases have been known for thousands of years, although accurate information on their etiology has only been available for about a century.

There are Three reasons for the delay in knowing the causes of diseases: - The prevalence of spontaneous generation theory - Religious doctrine that prohibit experiments - The small size of microbes.

Classification of Microorganisms

living things is classified in the three domains Bacteria , Archaea, and Eucarya. in this system, each domain is subdivided into kingdoms:

Bacteria. This domain includes the kingdom of the heterotrophic eubacteria and includes all human pathogen bacteria. The other kingdoms, for instance that of the photosynthetic cyanobacteria, are not pathogenic. It is estimated that bacterial species on Earth number in the hundreds of thousands, of which only about 5500 have been discovered and described in detail.

Archaea. The earlier term for the archaea was archaebacteria (ancient bacteria), and they are indeed a kind of living fossil. . This domain includes forms that live under extreme environmental conditions, including Thermophilic- Hyperthermophilic- Halophilic- and Methanogenic microorganisms. . Thermophilic archaea thrive mainly in warm, moist biotopes such as the hot springs. The hyperthermophilic archaea, a more recent discovery, live near deep-sea volcanic plumes at temperatures exceeding 100 C.

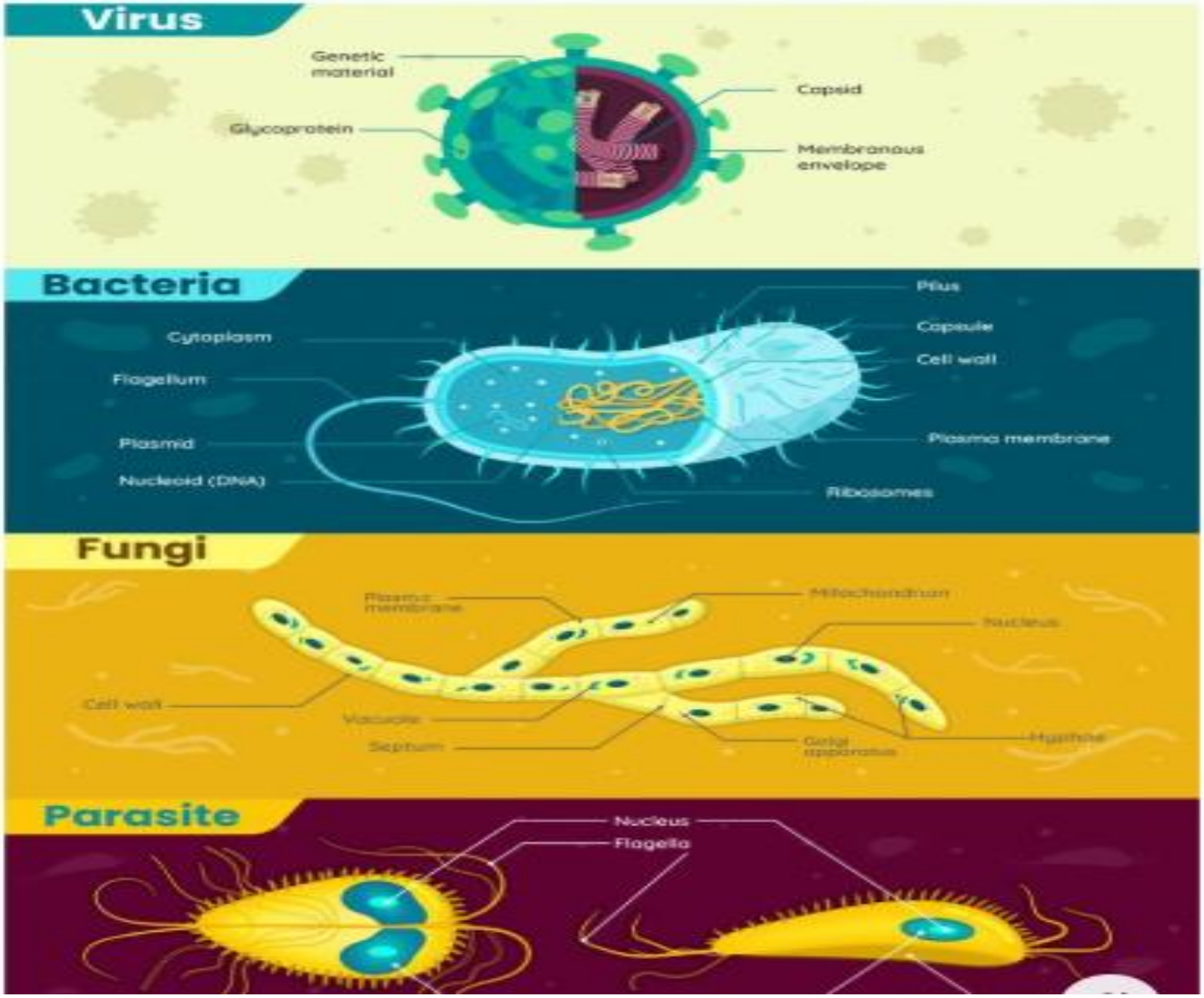
Eucarya. This domain includes all life forms with cells possessing a genuine(True) nucleus. The plant and animal kingdoms (animales and plantales) are all eukaryotic life forms. Pathogenic eukaryotic microorganisms include fungal and protozoan species.

Types of Pathogenic microorganisms

Subcellular biological entities	Prokaryotic microorganisms	Eukaryotic microorganisms	Animals
Prions (infection proteins)	Chlamydiae (0.3–1 µm)	Fungi (yeasts 5–10 µm, size of mold fungi indeterminable)	Helminths (parasitic worms)
Viruses (20–200 nm)	Rickettsiae (0.3–1 µm)	Protozoa (1–150 µm)	Arthropods
	Mycoplasmas		
	Classic bacteria (1–5 µm)		

Units of Length Commonly Used in Microbiology

Metric Unit	Meaning of Prefix	Metric Equivalent
meter (m)	—	1 m = 10^{0} m
decimeter (dm)	1/10	1 dm = 0.1 m = 10^{-1} m
centimeter (cm)	1/100	1 cm = 0.01 m = 10^{-2} m
millimeter (mm)	1/1000	1 mm = 0.001 m = 10^{-3} m
micrometer (μm)	1/1,000,000	1 μm = 0.000001 m = 10^{-6} m
nanometer (nm)	1/1,000,000,000	1 nm = 0.000000001 m = 10^{-9} m


Virus
Genetic material
Glycoprotein
Capsid
Membranous envelope
Bacteria
Cytoplasm
Flagellum
Plasmid
Nucleoid (DNA)
Pilus
Capsule
Cell wall
Plasma membrane
Ribosomes
Fungi
Cell wall
Vacuole
Septum
Mitochondrion
Nucleus
Hyphae
Parasite
Nucleus
Flagella

Bacteria(Prokartotes)

&- Classic bacteria. These organisms reproduce asexually by binary transverse fission. They do not possess the nucleus typical of Eucarya. The cell walls of these organisms are rigid (with some exceptions, e.g., the mycoplasma). **It can be grown on culture media.**

&- Chlamydiae. These organisms are obligate intracellular parasites that are able to reproduce in certain human cells only and are found in two stages: the infectious, nonreproductive particles called elementary bodies (0.3 µm) and the noninfectious, intracytoplasmic, reproductive forms known as initial (or reticulate) bodies (1 µm).

&- Rickettsiae. These organisms are obligate intracellular parasites, rodshaped to coccoid, that reproduce by binary transverse fission. The diameter of the individual cell is from 0.3–1 µm

&-Mycoplasmas. Mycoplasmas are bacteria without rigid cell walls. They are found in a wide variety of forms, the most common being the coccoid cell (0.3–0.8 µm). Threadlike forms also occur in various lengths

Fungi and Protozoa (Eukaryotes)

&- Fungi. Fungi (Mycophyta) are nonmotile eukaryotes with rigid cell walls and a classic cell nucleus. They contain no photosynthetic pigments and are carbon heterotrophic, that is, they utilize various organic nutrient substrates (in contrast to carbon autotrophic plants). of more than 150 000 fungal species(The number of fungal species in nature is estimated at between 1-2 million), only about 300 are known to be human pathogens. Most fungal infections occur as a result of weakened host immune defense.

&-Protozoa. Protozoa are microorganisms in various sizes and forms that may be free-living or parasitic. They possess a nucleus containing chromosome and organelles such as mitochondria (lacking in some cases),an endoplasmic reticulum , pseudopods, flagella, cilia, kinetoplasts , etc. Many parasitic protozoa are transmitted by arthropods, whereby multiplication and transformation into the infectious stage take place in the vector.

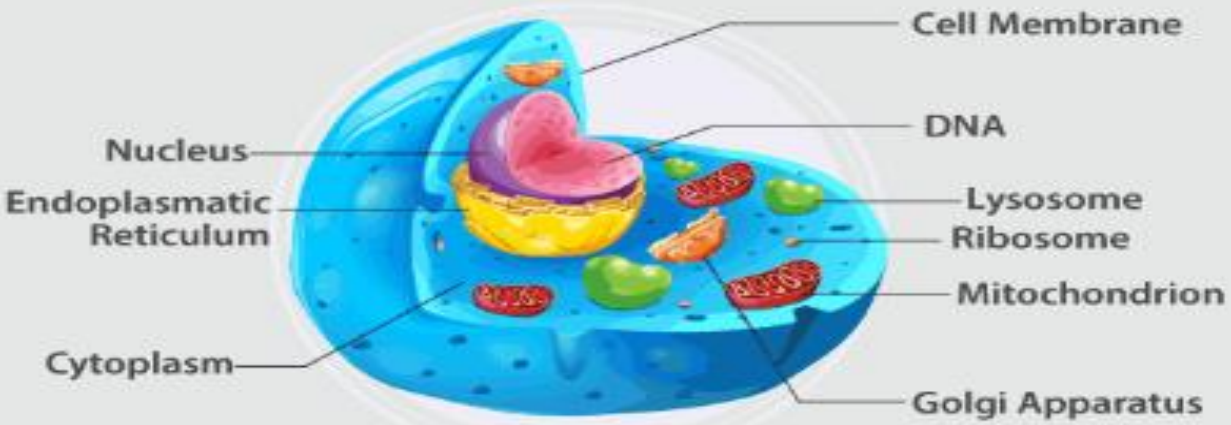
Animals

Helminths. Parasitic worms belong to the animal kingdom. These are metazoan organisms with highly differentiated structures. Medically significant groups include the trematodes (flukes or flatworms), Cestodes (tapeworms), and nematodes (roundworms). المسطحة والشريطية والخيطية

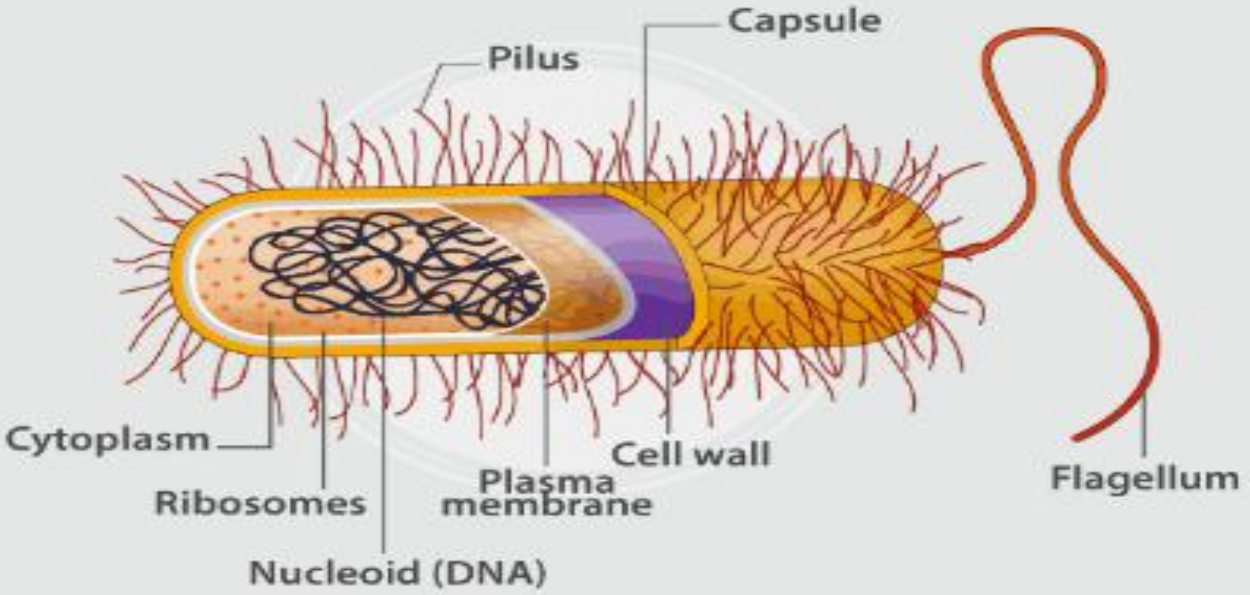
Arthropods. These animals are characterized by an external chitin skeleton, segmented bodies, jointed legs, special mouthparts, and other specific features. Their role as direct causative agents of diseases is a minor one (mites, for instance, cause scabies) as compared to their role as vectors transmitting viruses, bacteria, protozoa, and helminths

Characteristics of Prokaryotic (ClassicBacteria/Eubacteria) and Eukaryotic (Fungi, Protozoans) Microorganisms

Characteristic	**Prokaryotes** (bacteria)	**Eukaryotes** (fungi, protozoans)
Nuclear structure	Circular DNA molecule not covered with proteins	Complex of DNA and basic proteins
Localization of nuclear structure	Dense tangle of DNA in cytoplasm; no nuclear membrane; nucleoid or nuclear equivalent	In nucleus surrounded by nuclear membrane
DNA	Nucleoid and plasmids	In nucleus and in mitochondria
Cytoplasm	No mitochondria and no endoplasmic reticulum, 70S ribosomes	Mitochondria and endoplasmic reticulum, 80S ribosomes
Cell wall	Usually rigid wall with murein layer; exception: mycoplasmas	Present only in fungi: glucans, mannans, chitin, chitosan, cellulose
Reproduction	Asexual, by binary transverse fission	In most cases sexual, possibly asexual



Eukaryotic Cell



Prokaryotic Cell

Subcellular Infectious Entities

Viruses. Ultramicroscopic, obligate intracellular parasites that:

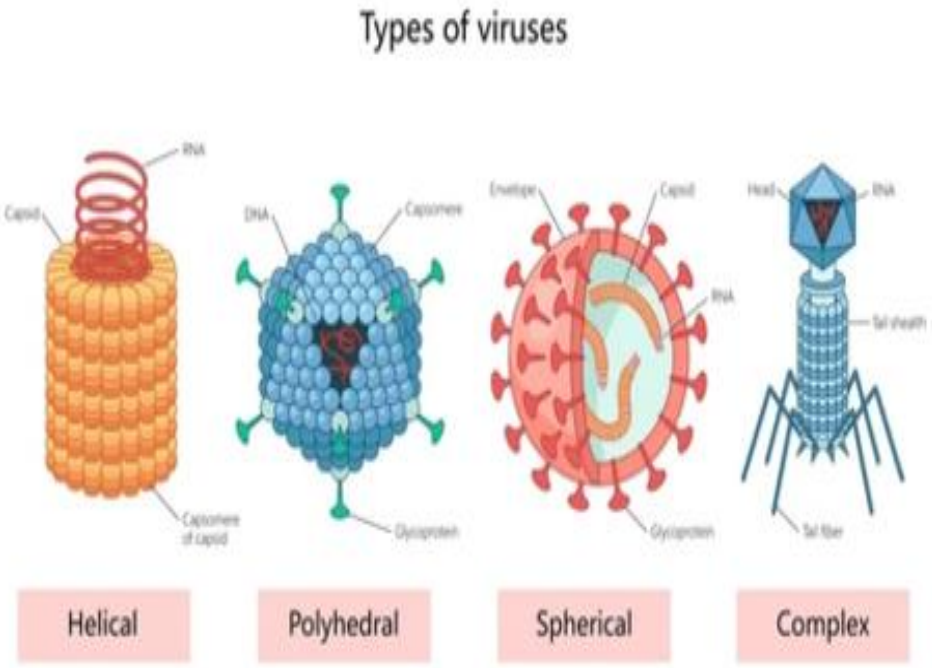
contain only one type of nucleic acid, either DNA or RNA,

possess no enzymatic energy-producing system and no protein-synthesizing apparatus.

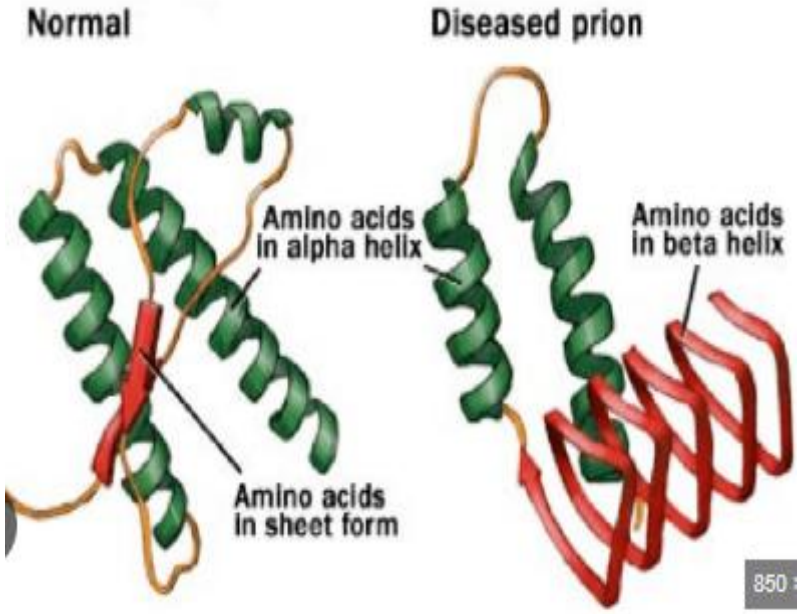
force infected host cells to synthesize virus particles

Prions (proteinaceous infectious particles). The evidence indicates that prions are protein molecules that cause degenerative central nervous system (CNS) diseases such as Creutzfeldt-Jakob disease, Kuru, scrapie in sheep, and bovine spongiform encephalopathy (BSE) (general term: transmissible spongiform encephalopathies [TSE]).

Virus shape



Prion shape



Classification of bacteria

Classification is a method for organizing microorganisms into groups or taxa based on similar morphologic, physiologic, and genetic traits. The hierarchical classification system consists of the following taxa designations: • **Domains** (Bacteria, Archaea, and Eukarya) • **Kingdom** (contains similar divisions or phyla; most inclusive taxa) • **Phylum** (contains similar classes; equivalent to the Division taxa in botany) • **Class** (contains similar orders) • **Order** (contains similar families) • **Family** (contains similar genera) • **Genus** (contains similar species) • **Species** (specific epithet; lowercase Latin adjective or noun; most exclusive taxa)

Nomenclature

Nomenclature:- Is the naming of microorganisms according to established rules and guidelines set forth in the International Code of Nomenclature of Bacteria (ICNB) or the Bacteriological Code (BC). According to Carolus Linnaeus system ,each organism has a scientific name consisting of two parts: the genus designation, in which the first letter is always capitalized, and the species designation, in which the first letter is always lowercase. The genus and species name of any organism is derived from the Latin language and is written in italics or underlined. For example, the streptococci include *Streptococcus pneumonia*.

Classification of *Escherichia coli* as EXAMPLE

Domain :- **Bacteria**

Kingdom:- **Eubacteria**

Phylum :- **Proteobacteria**

Class:-**Gammaprteobacteria**

Order:**Enterobacteria**

Family :-**Enterobacteriaceae**

Genus:-**Escherichia**

Species :-**coli**

Scientific name:- ***Escherichia coli***

Review Q

Q\ Enumerate classification of microorganism

Q\ Compare between Eukaryotic cell and prokaryotic cell.

MCQ:-

Q1- which of the following is not Domaine :-

a-Plantae b-Bacteria c- Archaea d-Eukaryota

Q2- which of the following is a prokaryotic microorganism :-

a-helminthus b-Protozoan c- Mycoplasma d-mold

Q3- which of the following is subcellular (acellular):-

a-Virus b-Bacteria c-fungus d- Prion e-a And d

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Thank you for your attention

جامعة شط العرب الاهلية

كلية العلوم –قسم التحليلات المرضية

Principles of Microbiology

Lec-1

History of Microorganism Discovery

Prof. Dr. Mohammed A. Fayyadh

lach1- History of Microorganism discovery

In this lecture we will try to answer three important questions about microbiology:-

- What is microbiology?

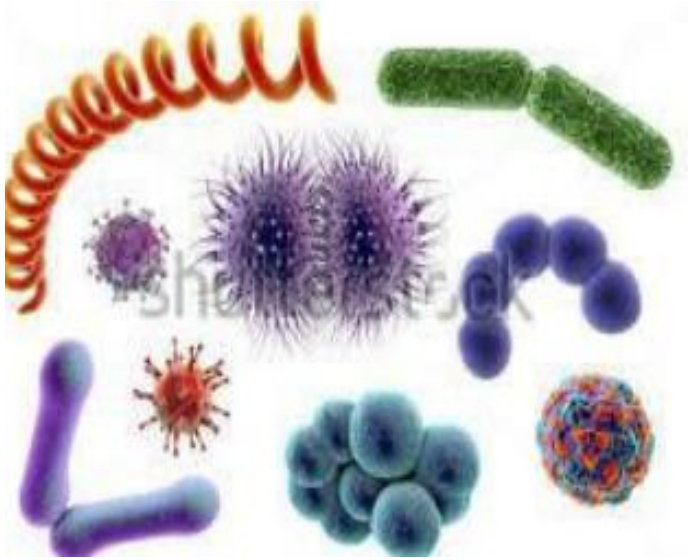
- Why is it such an important subject?

- How have we gained our present knowledge of microbiology ?

What is Microbiology?

Microbiology is the science (logos) of small (micro) life (bios),

or the study of living things so small that they cannot be seen with the naked eye.



lach1- History of Microorganism discovery

Microorganisms:- also called microbes, are organisms that require a microscope to be readily observed. It be found in every ecosystem and association with every type of multicellular organisms.

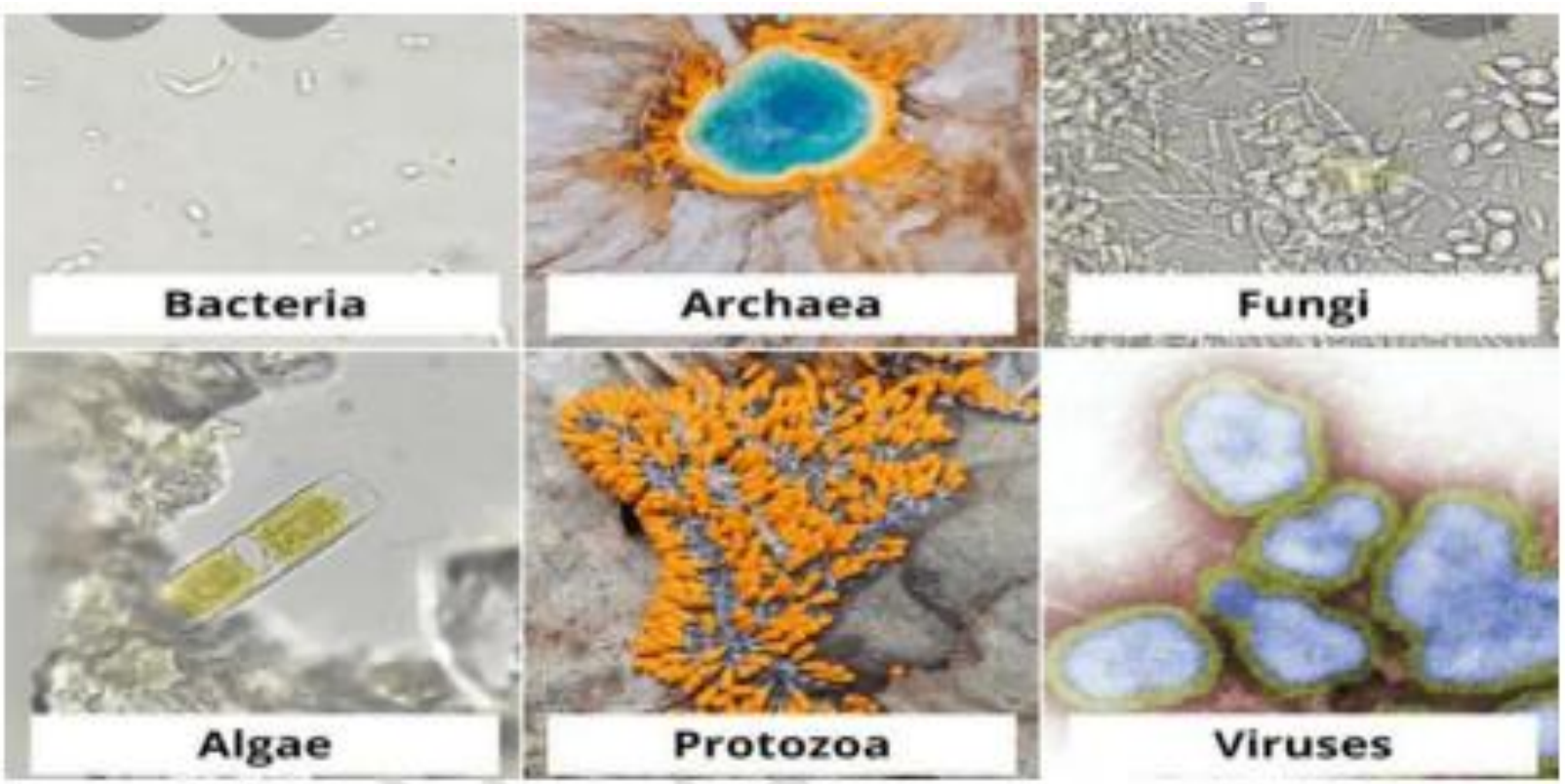
M.O are the oldest organisms, having evolved over the 4 billion years of earth's history to the modern varieties we now observe. Microbes are classified into groups according to evolutionary relationships, provided with standard scientific names, and identified by specific characteristics.

They populate the healthy human and animals body by billions as Normal flora and even participants in body functions, for ex. Bacteria play a role in the degradation in intestinal contents. These M.O consist of archaea, bacteria, viruses, fungi, protozoa, algae, and helminthes, which caused infection and spread of human diseases. Few species of M.O that harmful to human either by production toxic compounds and enzymes or direct infection by their virulence factors are characterized as pathogens .

Major Fields of Pure Sciences

Field	Some Applied Areas
Bacteriology	Study of bacteria
Mycology	Study of fungi (achlorophyllous, heterotrophic, eukaryotic with a rigid cell wall containing chitin/cellulose)
Protozoology	Study of protozoans (animal like single celled eukaryotic organisms).
Virology	Study of viruses and viral diseases.
Algology or Phycology	Study of algae.
Parasitology	Study of parasitism and parasites (include pathogenic protozoa, helminthes worms and certain insects).
Microbial ecology	Study of interrelationships between microbes and environment.
Microbial morphology	Study of detailed structure of microorganism.
Microbial taxonomy	Concerned with classification, naming and identification of microorganism.
Microbial Physiology	Study of metabolism of microbes at cellular and molecular levels.
Microbial genetics and Molecular Biology	Study of genetic material, structure and function and biochemical reactions of microbial cells involved in metabolism and growth.

Examples of microorganisms



The general areas in which the microorganisms might be used (importance of microorganism)

Although microorganisms are important causes of diseases that affect humans, animals and plants, they are used in several useful fields:-

*medicine (therapeutic agents, antibiotics, antifungals, anticancer drugs,, antivirals, immunosuppressants, vaccines.)

*environmental science(recycling of essential elements)

* food and drink production (Bakery, alcohol and cheese industry)

* fundamental research (Genetics and biology)

- *Agriculture (Biofertilizer)
- * pharmaceutical industry (Antibiotics)

* genetic engineering.

History of our present knowledge of microbiology.

Microorganisms had been on the Earth for some 4000 million years.

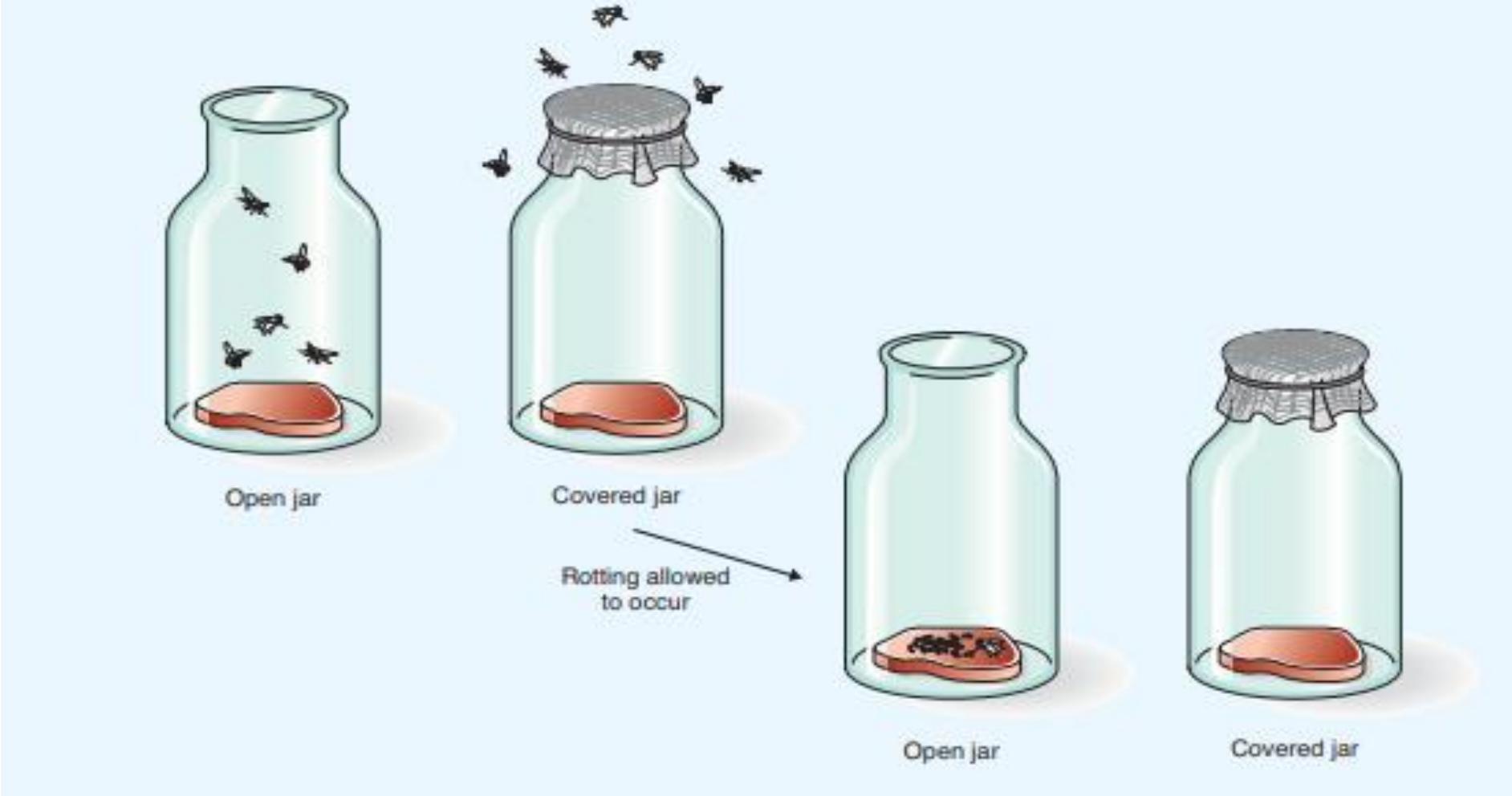
-Leeuwenhock 1673 (Discover magnifying lenses)

-Redi (1626-1697) the larvae found on putrefying meat arose from eggs deposited by flies -This can be seen as the beginning of the end for the spontaneous generation theory.

What is spontaneous generation ?

- Louis Pasteur (1822–1895).(life arises only from already existing life)-germ theory.
- Joseph Lister (1867) used Phenol to disinfect wound (first aseptic technique in surgery)
- The first proof of the involvement of bacteria in disease came from the Robert Koch. In 1876 Koch showed the relationship between the cattle disease anthrax and a bacillus which we now know as *Bacillus anthracis*.

Redi Experiment



Koch’s postulates

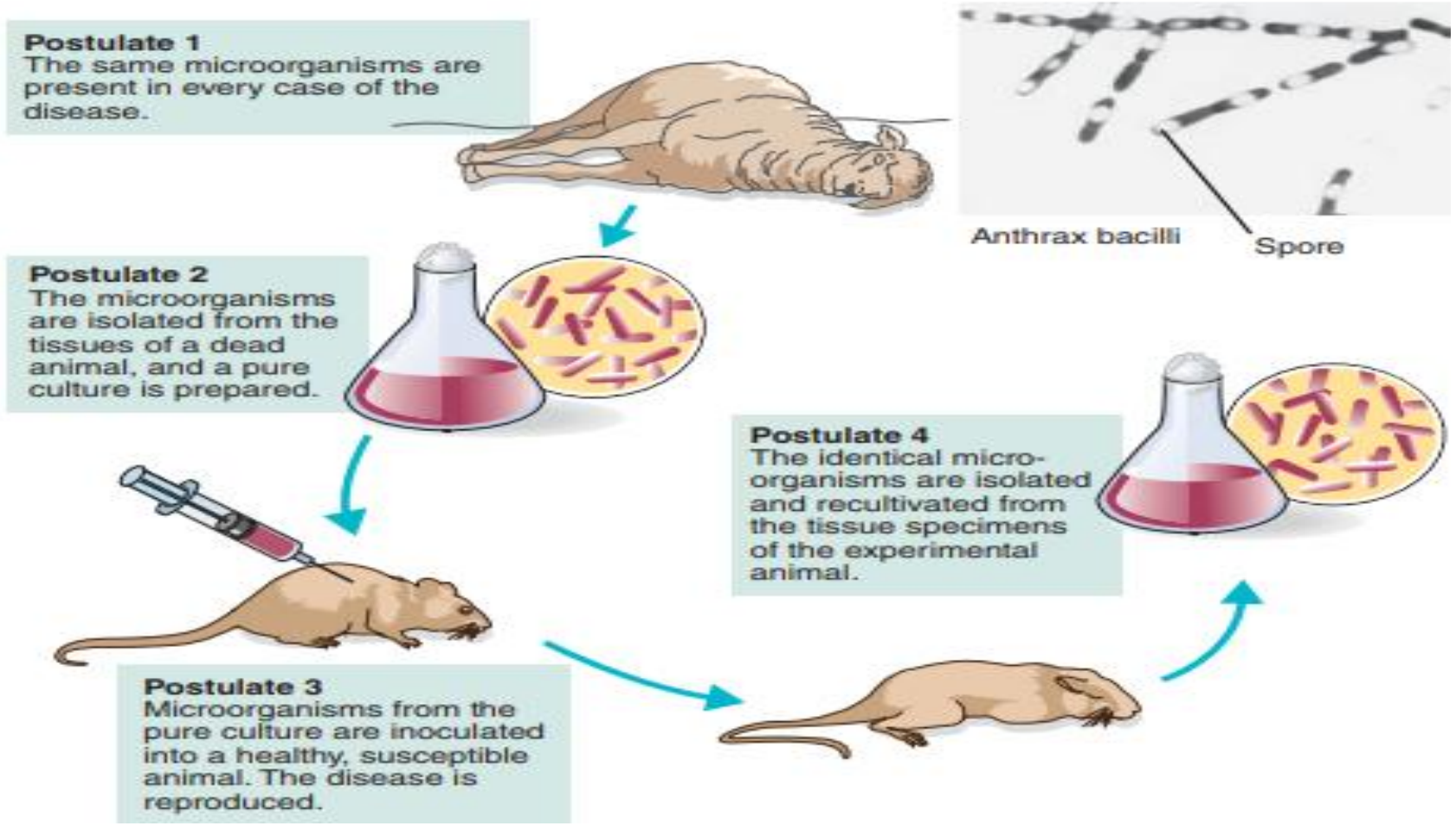
1- The microorganism must be present in every instance of the disease and absent from healthy individuals.

2 -The microorganism must be capable of being isolated and grown in pure culture.

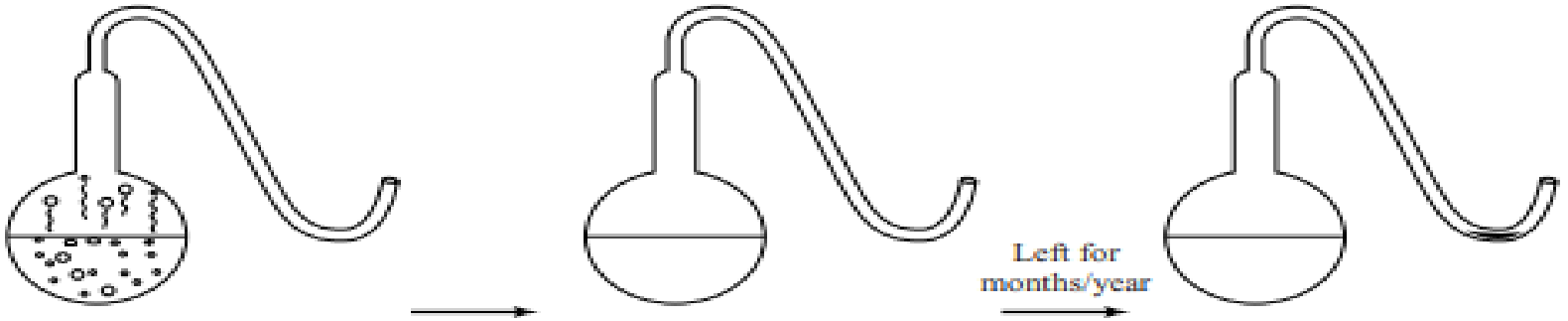
3- When the microorganism is inoculated into a healthy host, the same disease condition must result.

4- The same microorganism must be re-isolated from the experimentally infected host.

Koch's postulates



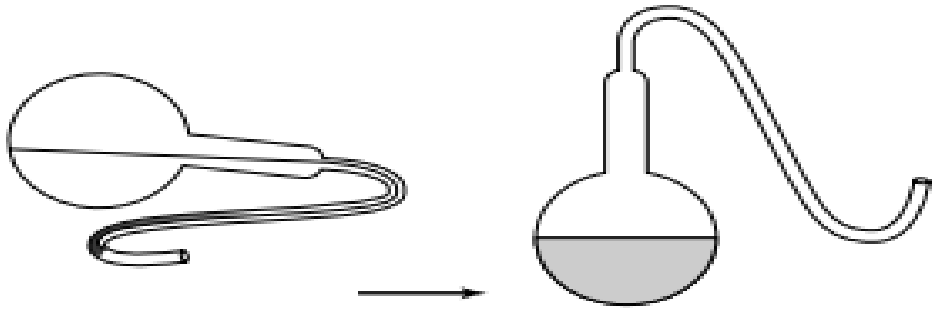
Pasteur experiment



Liquid sterilised by boiling.

Liquid allowed to cool.

Dust and microorganisms settle in bend of flask neck. Liquid remains sterile.



Flask tilted, allowing liquid to come into contact with deposit in neck.

Liquid turns cloudy due to microbial growth.

Koch’s greatest achievement was in demonstrate the identity of the causative agent of Tuberculosis, which at the time was responsible for around one in every seven human deaths in Europe.

- We now know that *Mycobacterium tuberculosis* (the tubercle bacillus) is very difficult to stain by conventional methods due to the high lipid content of the cell wall surface. Koch developed a staining technique that enabled it to be seen.
- -Many bacterial diseases had been discovered later such as Typhoid fever *Salmonella typhi* and Cholera *Vibrio cholera*

-1892 Tobacco Mosaic Disease (TMD) shown to be caused by a filterable agent. By Iwanowsky.

- 1901 Demonstration of first human viral disease (yellow fever). Reed

-1935 TMV is first virus to be crystallized. By Stanley

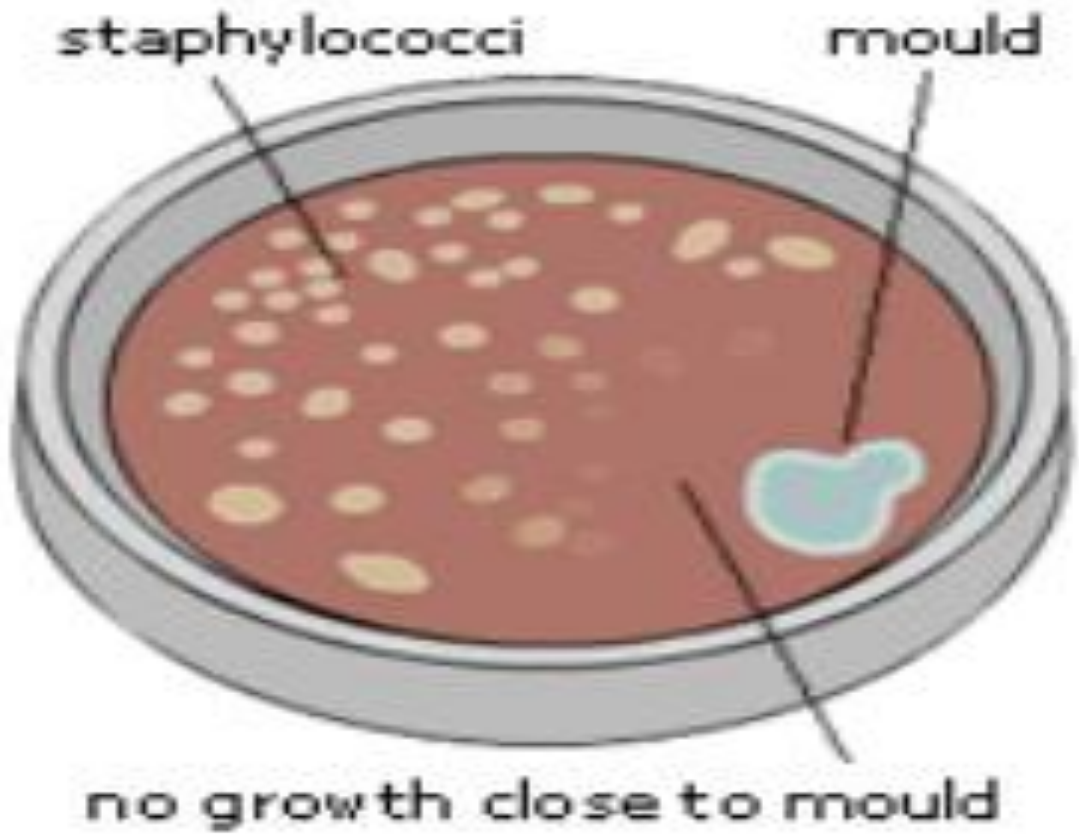
-1937 Separation of TMV into protein and nucleic acid fractions by Bawden & Pirie

-1971 Discovery of viroids By Diener

- 1997 -Discovery of prions by Prusiner

- The nineteenth century was the golden age of microbiology.

- *The twentieth century is the golden age of molecular biology.
- * 1953 Watson and Crick's discovered the structure for DNA.
- *In 1928, Alexander Fleming discovered the antibiotics Penicillin (*Penicillium notatum*)


staphylococci
mould
no growth close to mould

Advances in microbiology tools

The development of some technologies, especially light and electron microscopy technologies, staining technologies, and molecular biology technologies, has helped in the development of microbiology.

Microscopes:- produce magnified images of microorganisms, human cells and tissues, and many other types of specimens too small to be observed with the naked eye.

Stains and dyes:- are used to add color to microbes so they can be better observed under a microscope.. Some stains only work on certain types of microbes because of differences in their cellular chemical composition.

Growth media:-A growth medium provides nutrients, including water, various salts, a source of carbon (like glucose), and a source of nitrogen and amino acids (like yeast extract) so microorganisms can grow and reproduce.

Electron microscopy:-The electron microscope is able to achieve greater magnification and resolution because it uses a high voltage beam of electrons, whose wavelength is very much shorter than that of visible light.

Molecular Techniques:-

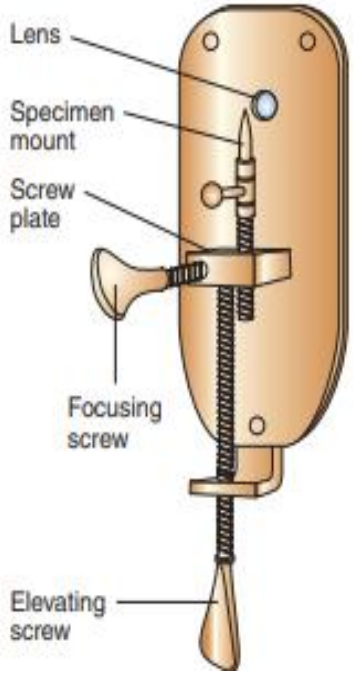
Gel Electrophoresis

Enzyme Linked Immunosorbent Assay (ELISA)

Polymerase Chain Reaction (PCR)

Pioneer in Microbiology

Van Leeuwenuoek
1676 first observation of Bacteria (Animalcules)



Louis Pasteur (1822-1895) germ theory of disease

Pioneers of Microbiology

- Joseph Lister, UK (1867)
- Used phenol (carbolic acid) to disinfect wounds
- First aseptic technique in surgery

Pioneers….

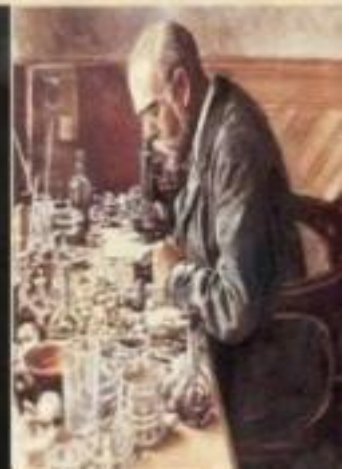
- 1929 Discovery of Penicillin (first antibiotic) Alexander Fleming

Pioneers….

1953 Structure of DNA Revealed by Watson & Crick

Pioneers….

Robert Koch



Test your self:-

Q1\ What is the meaning of microbiology and microorganism

Q2\ Microorganism consist of

……,……,……,……,……,…….

Q3/Choose the correct answer

1-Magnifying lenses were invented by: a- stanly b-leeuwenhock c-Koch

2-Pasteur contributed to the development of: 1- Germ theory 2- The theory of spontaneous generation 3-The foundations of classification of living things

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Thanks

I wish you a happy time

prof Dr. Mohammed A Fayyadh