جامعة الفرات الأوسط التقنية

Al-Furat Al-Awsat Technical University

Samawa Technical Institute

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The first stage - theoretical microbiology

prepared by

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الاسبوع الاول +الاسبوع الثاني

Introduction to Microbiology

Microbiology, the study of microscopic organisms, derived its name from three Greek words: **micros** ("small"), **bios**("life"), and **logos** ("science"). Taken together they mean the study of microorganisms (MOs) which are very small and cannot be seen by naked eye. They are generally 1 millimeter (mm) or less in diameter.

MOs include organisms such as protozoa, algae, fungi, bacteria and viruses (which are not technically classified as living organisms but do contain genetic material).

History of Microbiology

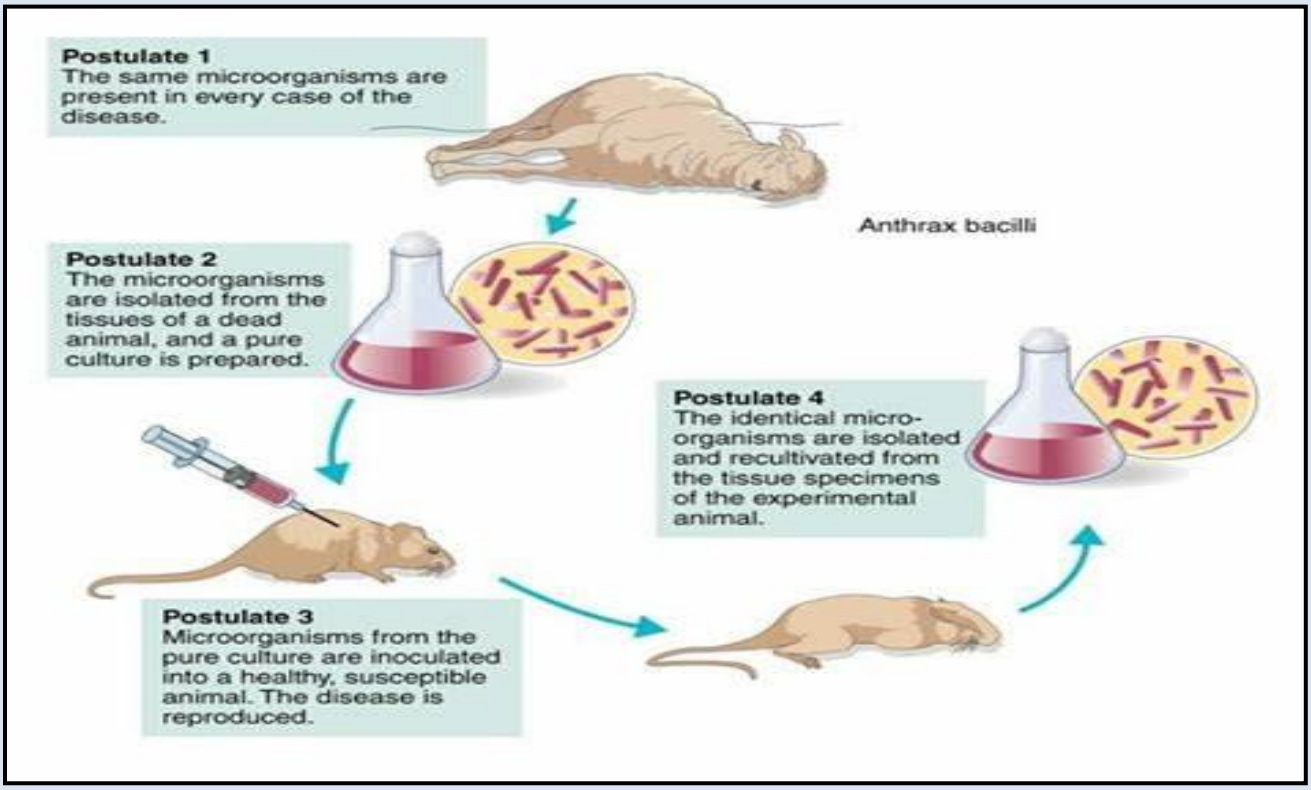
- **Antonie van Leeuwenhoek**(1632–1723) was one of the first people to observe microorganisms, using a microscope of his own design, and made one of the most important contributions to biology**.**
- **Robert Hooke** was the first to use a microscope to observe living microorganisms.
- **Lazzaro Spallanzani** (1729–1799) found that boiling broth would sterilize it and kill any microorganisms in it.
- **In 1876, Robert Koch (1843–1910) established that microbes can cause disease.**
- **Koch postulates**:

1.The suspected causative agent must be found in every case of disease.

2. The MO must be isolated from the infected individual and grown in a culture with no other types of MO.

3. When inoculation into normal healthy susceptible animal a pure culture of the agent must be producing the specific disease.

4. The same MO must be isolated from the experimentally infected host.



Microbial Taxonomy

Microbial taxonomy: is a means by which microorganisms can be grouped together. Organisms having similarities with respecting the criteria that used in the same group, and are separated from the other groups of microorganisms that have different characteristics.

Components of taxonomy

Classification is the categories of organisms with like characteristics into taxonomic groups.

Nomenclature refers to the naming of an organism by international rules according to its characteristics, using binomial system of nomenclature.

Identification is application of classification and nomenclature to assign proper name to unknown organism and place it in its proper position within classification system.

Three domains system

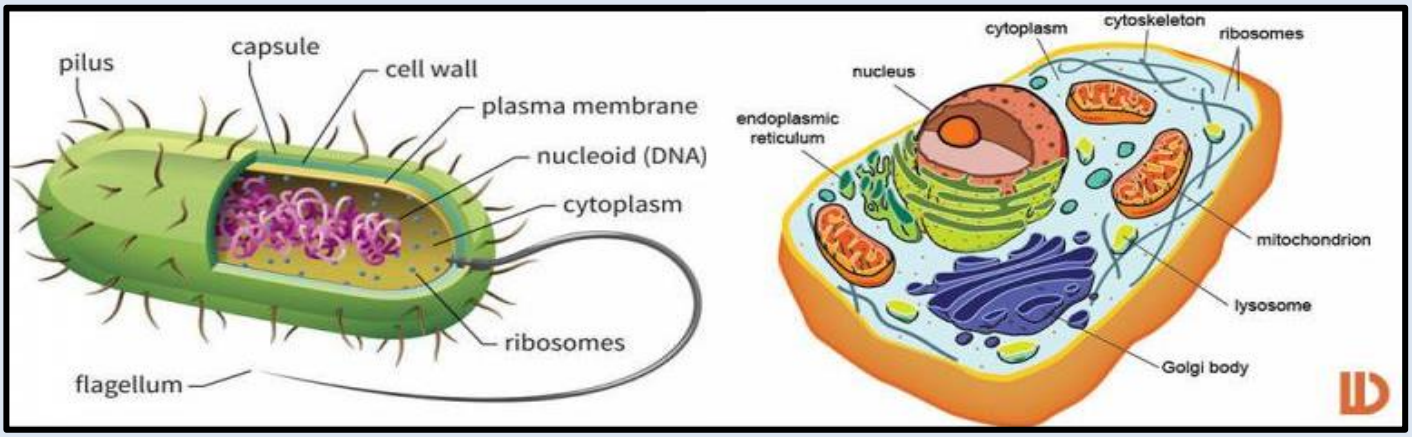
Molecular phylogeny divide all living organisms into three domains – Bacteria ("true bacteria"), Archaea (means 'ancient'), and Eukarya (eukaryotes: protists, fungi, plants and animals). These domains represent a level of classification that goes even higher than the kingdoms.

Kingdom	Types of cell	Organism
Monera	**Prokaryotes**	Bacteria
Protista	**Eukaryotes**	Protozoa
Fungi	**Eukaryotes**	fungi
Plantae	**Eukaryotes**	plant
Animalia	**Eukaryotes**	Man, animals

Protista: the kingdom of micro-organism is divided into:-

A. Higher protista : cell are Eukaryotic .example : algae , fungi , protozoa

B. Lower protista-cell are prokaryotic . example : Bacteria , blue- green algae and viruses.



	Features	Prokaryotic cell	Eukaryotic cell
1.	**Nuclear membrane**	Absent	Present
2.	**Nucleolus**	Absent	Present
3.	**Chromosome**	Single	Multiple
4.	**Cytoplasmic ribosomes**	70s*	80s*
5.	**Mitochondria**	Absent	Present
6.	**Endoplasmic reticulum**	Absent	Present
7.	**Lysosomes**	Absent	Present
8.	**Peptidoglycan**	Present	Absent

S*: Subunit

Infectiology

Infectiology: A medical specialty dealing with the pathogenicity, mode of transmission, diagnosis, prevention and treatment of infections. **Infectious diseases** mean illness caused by (bacteria, viruses, fungi…etc.) that enters the body, multiply and can cause infections.

- Some of infectious diseases are contagious that transmitted directly from one person to another.
- Other infectious disease can be transmitted by microbes carried in air, water, food or soil. They can also be transmitted by vectors, example: biting insects or animal.

Table (1): Basic Infectiological Terminology

Term	Explanation
Saprophytes	Microorganisms are nonpathogenic; their natural habitat is dead organic matter
Parasites	Unicellular or multicellular organisms living in or on a host organism of another species and gets its food from orat expense of its host
Pathogenicity	Capacity of a pathogen species to cause disease
Virulence	Degree of a pathogenicity that caused by microbes
Incubation period	Time between infection and manifestation of disease(symptoms); the incubation period can be measured in hours, days, weeks, or even years

Minimum infective dose	Smallest number of pathogens sufficient to cause an infection
Mode of infection	Method or pathway used by pathogen to invade the host
Contamination	Presence of microorganisms on objects, in the environment, or in samples of diagnosis
Infection	Invasion of a host organism by microorganisms, proliferation of the invading organisms, and host reaction

General Introduction to Bacteriology

Bacteria are single-celled prokaryotic microorganisms**Figure (1)**. They areapproximately (0.1–10) µm in size andexist in various shapes, including spheres (cocci),rods (bacilli), curves andspirals**Figure (2)**. Thesecharacteristic shapes are used to classify and identifybacteria

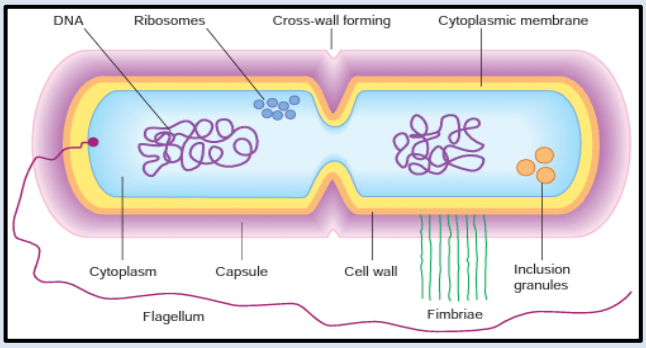


Figure (1): A section of bacterial cell

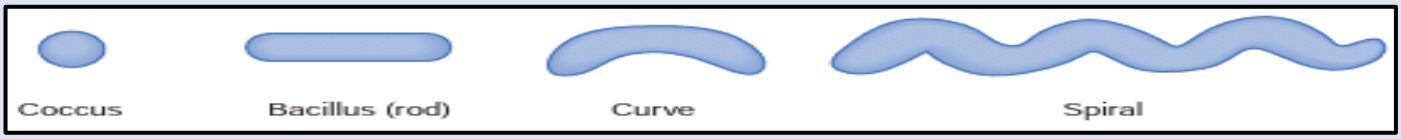


Figure (2): Bacterial shapes

الأسبوع الثالث + الأسبوع الرابع

General structure of bacteria

Bacterial structure is considered at three levels.

I.Cell envelope: Cell wall and cell membrane.

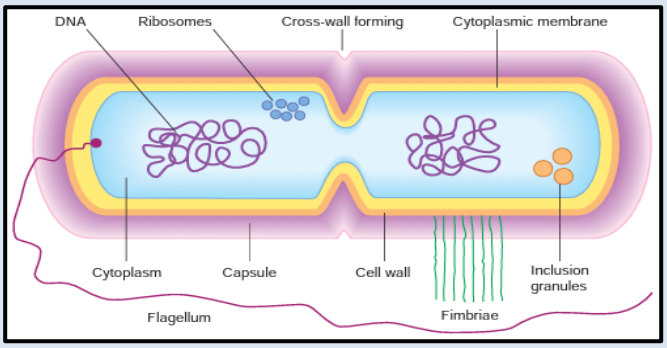


Figure (1): A section of bacterial cell

II.Cellular element enclosed with in the cell envelope: Mesosomes, Ribosomes, Nucleus, polyamine and cytoplasmic granules.

III.Cellular element external to the cell envelope: Flagellum, Pili and Glycocalyx.

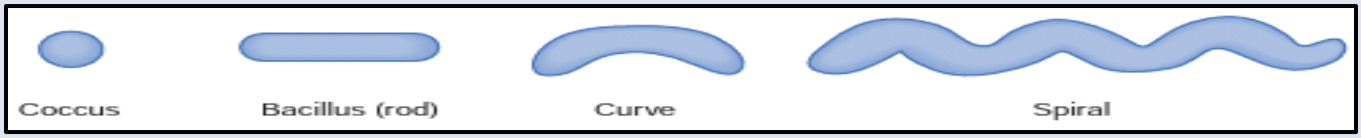


Figure (2): Bacterial shapes

I.Cell envelope

A. Cell wall:Multi layered structure, have important role in protecting of bacteriaagainst external osmotic pressureand maintain their shape. Thecell wall composition of bacteriaresults in difference in responseto the Gram stain. The bacteriawhich stain **purple/blue** are termed Gram positive**because** it is contain fewer Lipids in cell wall. Therefore it takes the first color stain (Crystal violet),**whereas** those that stain **pink/red** aretermed Gram-negativebecause contain more Lipid in cell wall; so it takes the counter stain (Safranin).

Table (1):Comparison of Gram Positive (+ve)& Gram Negative (–ve) cell walls.

No.	Characteristics	Gram Positive	Gram Negative
1.	Chemical composition	a. Peptidoglycan b. Teichoic acid	a. Peptidoglycan b. Lipoprotein c. Phospholipid d. Lipopolysaccharide
2.	Thickness	Thicker	Thinner

B.Cytoplasmic membrane (Cell membrane)

A Cytoplasmic membrane surrounds the cytoplasmof all bacterial cells and composed from protein, lipid and carbohydrate.

II.Cellular element enclosed within the cell envelope

A.MesosomesB. RibosomesC. Polyamine D. Cytoplasmic granulesE. Nucleus

III. Cellular element external to the cell envelope

A.Glycocalyx(capsule and **slime layer**)

- **Capsule**is gel firmly adherent to cell envelope, usually composed of polysaccharide and protein.
- **Slimelayer**is gel easily washed off from cell envelope.

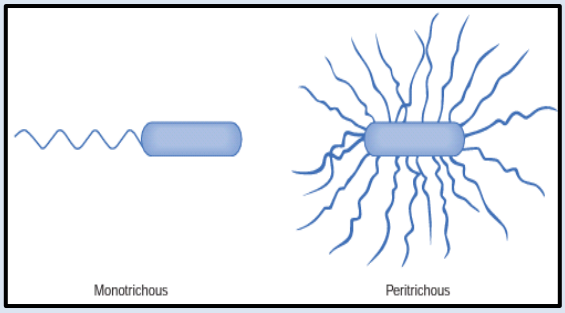
B.Pili (fimbriae): It is hair like structure composed of protein (pilin).), there are two types (Based on function)

1.Common pili: The structure for adherence to cell surface.

2.Sex pili: The structure for transfer of genetic material from the donor to the recipient during the process of conjugation.

C. Flagellum

Bacterial flagella are spiral-shaped filamentsconsisting mainly of the protein (flagellin).They are attached to the cell envelope as single (Monotrichous) or multiple (Peritrichous) forms. Flagella facilitate movement (motility) in bacteria.**Figure (3): Bacterial Flagella Forms**



- **Spores**

Bacterial spore is smooth walled and oval or spherical in shape. Capable of surviving under adverse environmental conditions like heat, drying, freezing, action of toxic

chemicals and radiation.The location of spores is variable, but is constant in any one bacterial species.

There are two types of bacterial spores

1. **Endospores:**located inside the bacteria cells. The shape and site of the spore different according to the species of bacteria:

Figure (4): Bacterial Spores

The endospores has highly resistance for dry, dyes, radiation, temperature and boiling becauseLow content of water and High content of Dipicolinic acid (DPA).

2. **Exospores:** from extracellular, less resistance than endospores due to low content of (DPA).

Environmental conditions are affected on the growth of bacteria

Many factors affect the generation time of the organism like temperature, oxygen, carbon dioxide, light, pH, moisture, salt concentration.

1-Nutrition: For growth and multiplication of bacteria, the minimum nutritional requirement is water, a source of carbon, nitrogen and some inorganic salts.

- **Bacteria can be classified nutritionally**, based on their energy requirement and on their ability to synthesize essential metabolites:

a-Phototrophsbacteria : obtain their energy from sunlight.

b-Chemotrophs bacteria: obtain energy from chemical reactions.

c-Autotrophs bacteria: can synthesize all their organic compounds.

d-Heterotrophs bacteria: unable to synthesize their own metabolites.

2-Oxygen: Bacteria may be classified into four groups accordingto their O_2 requirements:

a. **Obligate aerobes**: grow only in the presence of oxygen.

b. **Microaerophilic bacteria**: grow best in low oxygen concentrations.

c. **Obligate anaerobes**: grow only in the absence of free oxygen.

d. **Facultative anaerobes**: grow in the presence or absence of oxygen.

3-Carbon Dioxide: Bacteria require small amounts of carbon dioxide for growth. A few bacteria like *Neisseria meningitides* require additional levels of carbon dioxide.

4- Temperature: Bacteria vary in their requirement of temperature for growth. Most of pathogenic bacteria grow best at 37 °C.

5- Moisture and Drying: Water is an essential ingredient of bacterial protoplasm and hence drying is lethal to cells. The effect of drying varies in different species.

6-Light: Bacteria **except** phototrophic species grow well in the dark. They are sensitive to ultraviolet light and other radiations. Cultures die if exposed to light.

7- PH concentration: Each species has a pH range. Majority of pathogenic bacteria grow best at slightly alkaline **pH (7.2 –7.6)**

Stages of Bacterial Growth

When bacteria is grown in a suitable liquid medium and incubated its growth follows process. If bacterial counts after inoculation and in relation to time, a growth curve is obtained.

The curve shows the following phase:

(I) Lag phase(III) Stationary phase

(II) Log or exponential phase(IV) Decline Phase

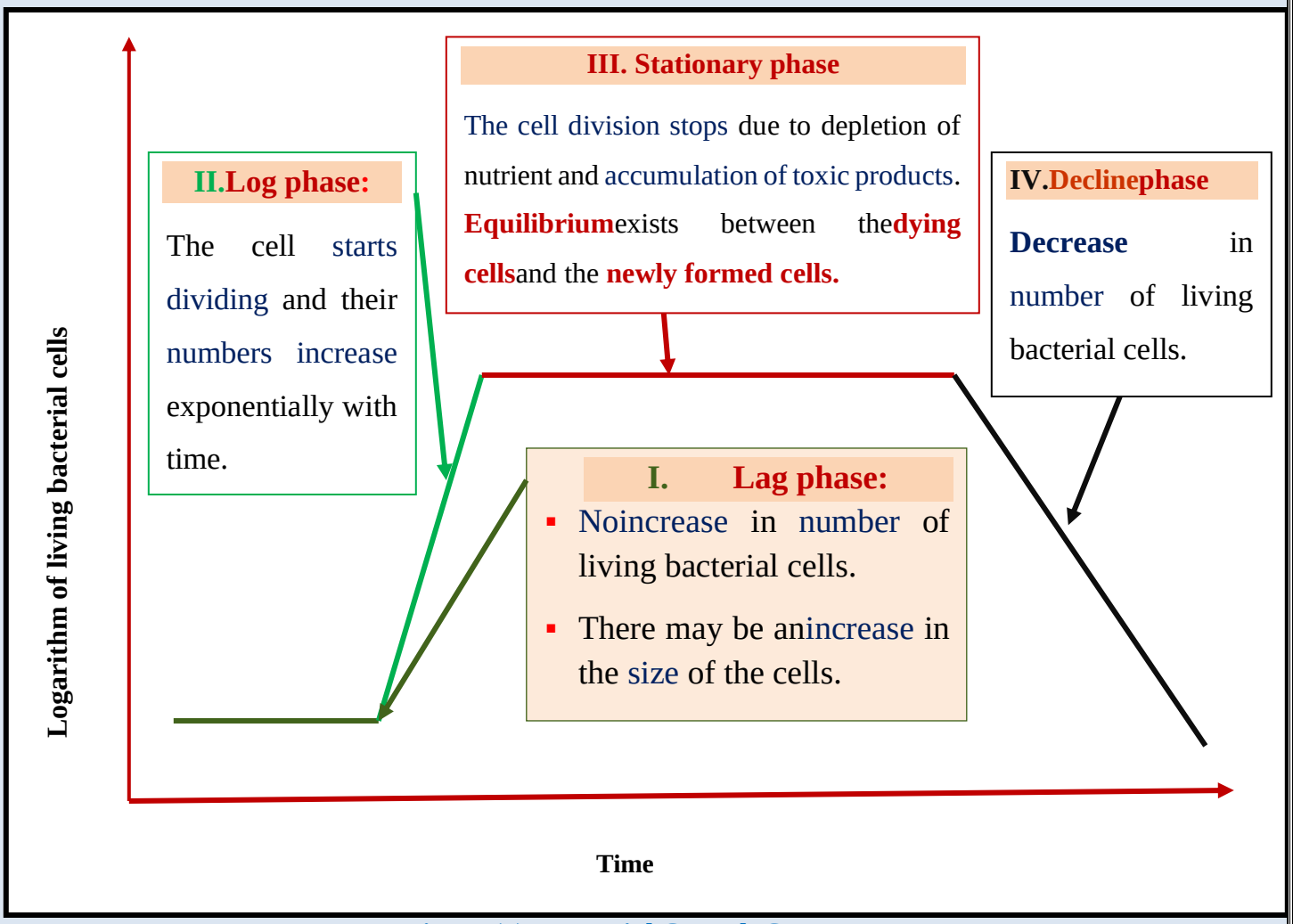


Figure (5): Bacterial Growth Curve

الاسبوع الخامس +الاسبوع السادس

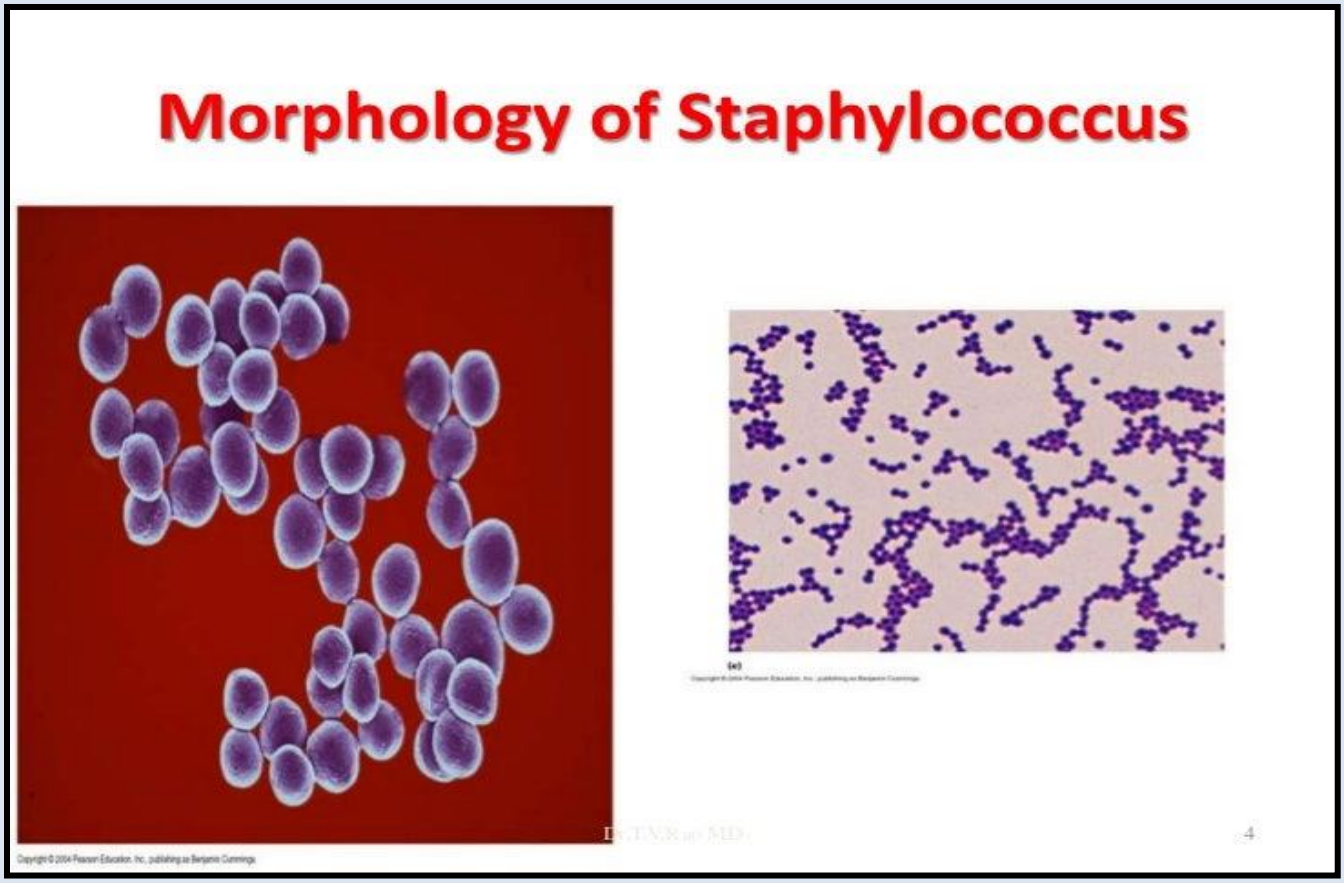
Staphylococcus

General characteristics&Structure

Gram-positive,cocci**1µm** in diameter; usually arranged in **grape like clusters**;they form clumps;non-motile; catalase positive; non-sporing; facultative anaerobic; grow on simple media.Older cultures may lose their Gram-positive character**.**

Clinical Manifestations

Staphylococci can cause many forms of infection. *S aureus* causes **superficial skin lesions** (**boils, styes**) and localized abscesses in other sites. *S aureus* causes **deep-seated infections**, such as **(osteomyelitis, endocarditis** and more serious skin infections (**furunculosis**)). *S aureus* is a major cause of hospital acquired (nosocomial) infection of surgical wounds and, with *S epidermidis*, causes infections associated with **indwelling medical devices**. *S aureus* causes **food poisoning** by releasing **enterotoxins** into food.



Streptococcus

Streptococcus pyogenes, other *Streptococci,* and *Enterococcus*

General characteristics & Structure

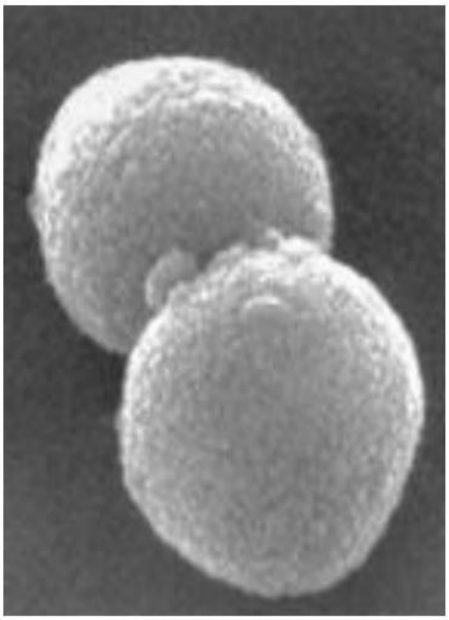
Streptococci are **Gram-positive**, non-motile, non-sporeforming, catalase-negative,cocci that occur in pairs or chains. **Older cultures may lose their Gram-positive character**. Most streptococci are facultative anaerobes, and some are obligate (strict) anaerobes. Most require enriched media (blood agar). Group A streptococci have a hyaluronic acid capsule.

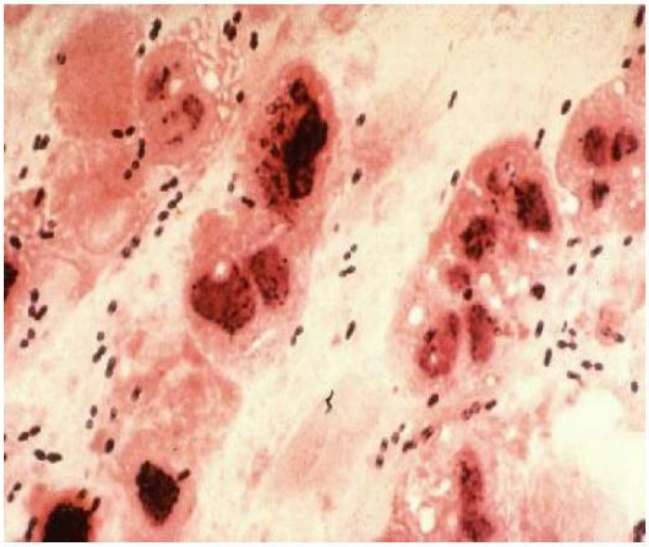
Clinical Manifestations

Acute *Streptococcus pyogenes* infections may take the form of pharyngitis, scarlet fever (rash), impetigo, and cellulitis. **Invasive infections** can result in necrotizing

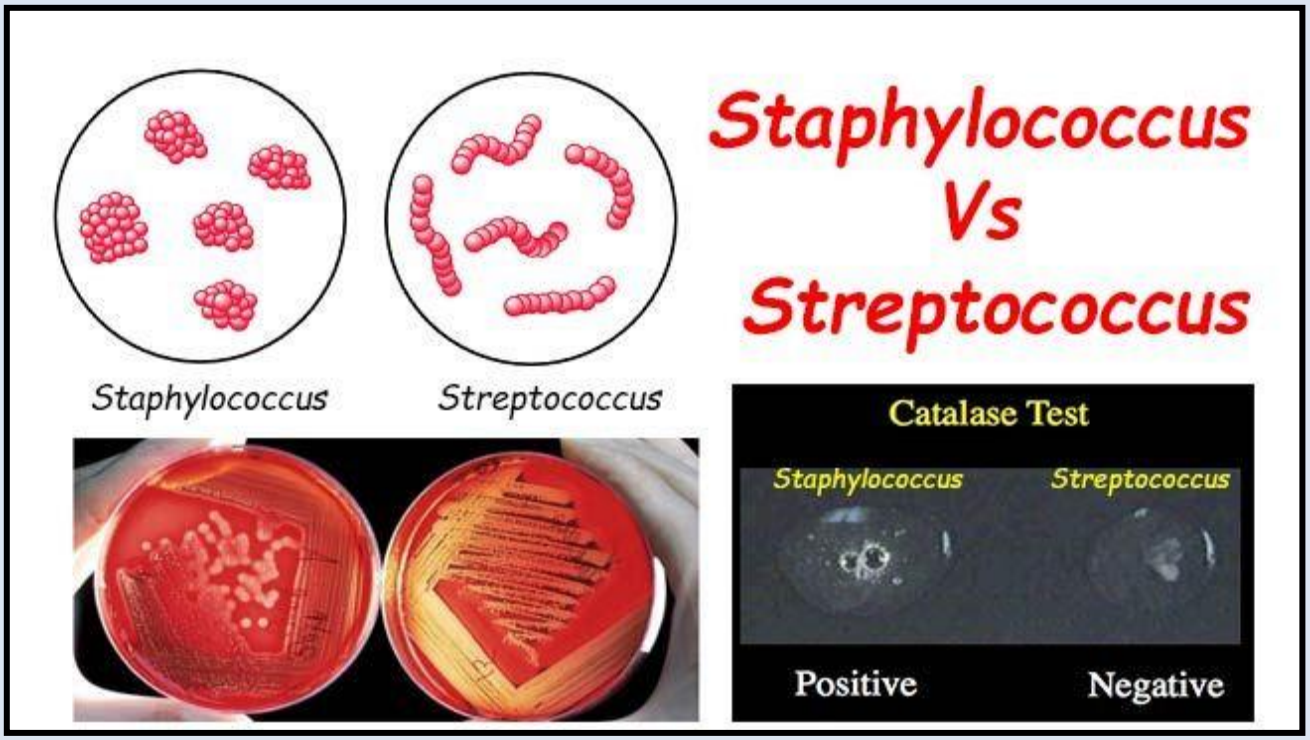
fasciitis, myositis and streptococcal toxic shock syndrome. Patients may also **develop immune-mediated sequelae** such as (**acute rheumatic fever** and **acute glomerulonephritis**). *S agalactiae* may cause (**meningitis**, **neonatal sepsis**,**and pneumonia in neonates**); **adults** may experience (**vaginitis**, **puerperal fever**, **urinary tract infection**, **skin infection**, **and endocarditis**). **Viridans streptococci** can cause **endocarditis**, and ***Enterococcus*** is associated **with urinary tract and biliary tract infections**. **Anaerobic streptococci** participate in **mixed infections** of the **abdomen**, **pelvis**, **brain**, and **lungs**.

Streptococcus pneumoniae





Differences between Staphylococcus and



Streptococcus

Staphylococcus and ***Streptococcus*** are both Gram **positive** and cocci in shape. They are **Non-motile**, **Non-Spore forming** and **Facultative anaerobes**. **But they possess some of the differences which are as follows:**

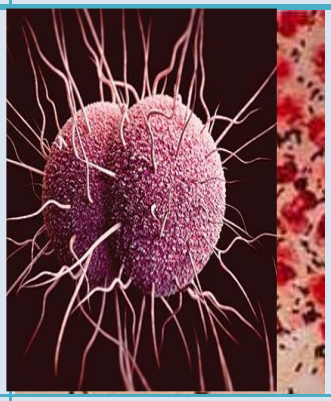
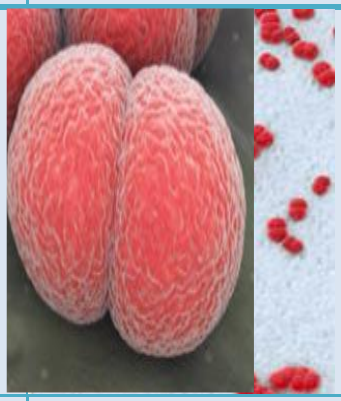
Characteristics	Staphylococcus	Streptococcus
Arrangement	**Grape-like clusters**.	A **chain** of round cells.
Division	Staphylococci divide in **various directions** (**multiple axes**).	Division occurs in **one linear direction** (**single axis**).
Catalase Test	Positive (Catalase is an enzyme to converts hydrogen peroxide to water and oxygen gas).	Negative

Enriched Media	Staphylococci **do not** need **enriched media** (**not fastidious).**	Streptococci **need enriched media** (**fastidious**).

Genus: Neisseria

Gram-negative, cocci and includes two important humanpathogens: ***N. meningitidis*** (meningococcus)and***N. gonorrhoeae*** (gonococcus).

Comparison between*N.gonorrhoeae*&*N.meningitides*

Characteristics	*N. gonorrhoeae*	*N. meningitidis*
		
General Characteristics	**Gram-negative**, **kidney-shapedcocci**, **aerobic**.	**Gram-negative**, **kidney-shaped cocci**; **aerobic**.
Arrangement	pairs (diplococci)	pairs (diplococci)
Capsule	Absent	Present
Disease	**Urethritis**, **cervicitis**, **Epididymitis**, **Arthritis**, **Pelvic inflammatory disease**, Neonatal ophthalmia **Bloodstream** infection	**Meningitis** **Bloodstream** infection
Diagnosis	**Specimens** from **various sites** (depending uponthe infection): **cervix**, **urethra**, **rectum**, **conjunctiva**,**throat** and **synovial fluid should be rapidly transported to the laboratory because gonococci die readily on drying**. Clinical	**Specimens:cerebrospinal fluid (CSF)** or **pus** for Microscopical examination and culture. **Nasopharyngeal swabs**: can determine carriageof meningococci.

	samples are cultured on **enriched selective media**.	

الاسبوع السابع + الاسبوع الثامن

Genus: Mycobacteria

General characteristics

Gram-positive bacilli; acid-fast; obligate aerobes; non-capsulated; non-motile; grow slowly on **specialized media**; **cell walls have high lipid content**.

Mycobacteria stain **poorly by Gram stainbecause ofcell-wall mycolic acid**. **Therefore;** they are **recognized by the Ziehl–Neelsen (ZN) stain**.

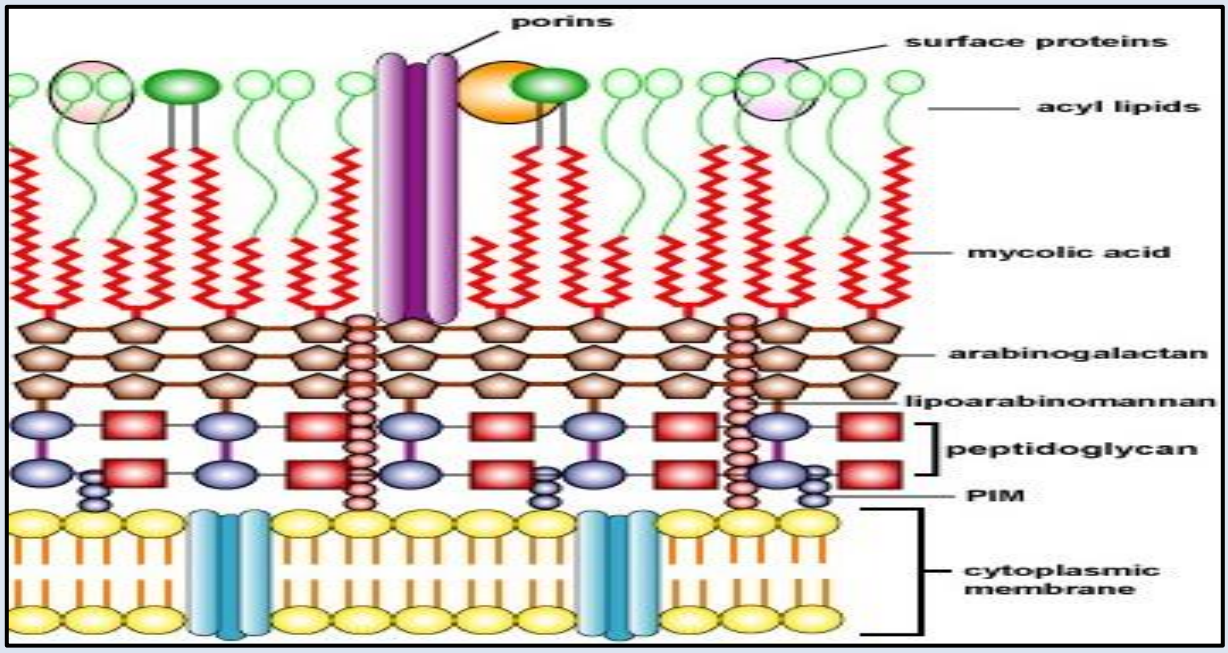
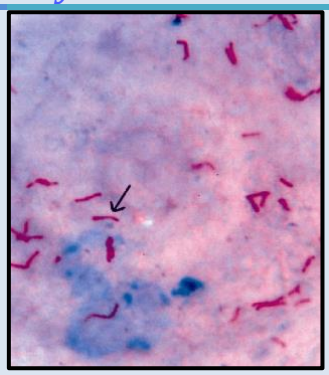
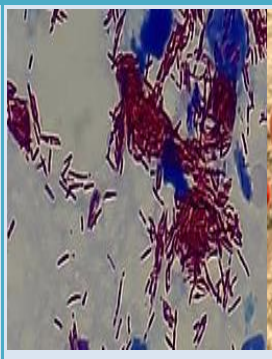


Figure: Cell-wall of Mycobacteria contain of mycolic acid

Mycobacteria grow slowly; visible colonies appearon solid media after 1–12 weeks dependingon the species.

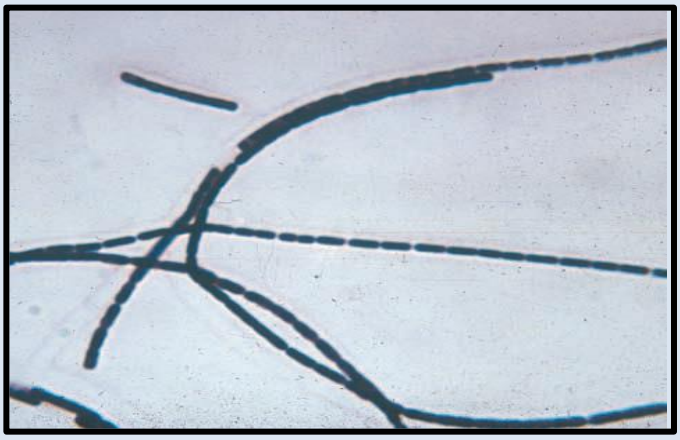
Comparison between
Mycobacteriumtuberculosis&*Mycobacteriumleprae*

	Mycobacteriumtuberculosis	*Mycobacteriumleprae*
		
Characteristics	***Mycobacterium tuberculosis***	***Mycobacterium leprae***
General characteristics	Gram-positive bacilli; acid-fast; **obligate aerobes**; **non-capsulated**; **non-motile**; grow slowly on **specialized media**; **cell walls have high lipid content**.	Gram-positive bacilli; acid-fast; **obligate aerobes**; **non-capsulated**; **non-motile**; grow slowly on **specialized media**; **cell walls have high lipid content**.
Staining	Stain**poorly by Gram stainbecause ofcell-wall mycolic acid**. **Therefore;** they are **recognized by the Ziehl–Neelsen (ZN) stain**.	Stain**poorly by Gram stainbecause ofcell-wall mycolic acid**. **Therefore;** they are **recognized by the Ziehl–Neelsen (ZN) stain**.
Disease	Causative agent for**Tuberculosis (TB).**	Causes**Leprosy**.
Diagnosis	**Microscopy of specimens**, including **sputum**, **bronchoscopy material**, **pleural fluid**, **urine**, **joint fluid**, **biopsy tissue** and **cerebrospinal fluid**. **Culture on special media** for **up to 12 weeks**, e.g. **Lowenstein–Jensen medium**, which contains egg yolk, glycerol and mineral acids plus inhibitors to reduce growth of other bacteria.	**Microscopy of scrapings** from **skin** or nasal mucosa,or **skin biopsies**, examined by ZN staining.

Treatment	Combinations of up to four anti-mycobacterial drugs (e.g. **rifampicin**, **isoniazid**, **ethambutol,**and **pyrazinamide)** However, multiple drug resistant strains of *M. tuberculosis* (MDRTB) are now emerging.	combination of **dapsone** plus **rifampicin** and/or **clofazimine**

Genus: Bacillus

Gram-positive, **spore-forming**; therefore**they can survive in the environment for many years**, **bacilli**,**aerobes**, There are a few species, however, that causeimportant diseases in humans. *Bacillus anthracis*cause Anthrax; ***Bacillus cereus*** and ***Bacillus thuringiensis*** cause **food poisoning**and occasionally **eye** or other **localized infections**.



Bacillus anthracis

Gram-positive, the cells, 1 × 3–4 µm, have **square ends**and are **arranged in long chains**; **spores are located in the center** of the **non-motile bacilli**.

Disease

Anthrax is primarily in animals. Humans become infected by contact with infected animals or their products. **In animals**, Spores from contaminated soil find easy access when ingested with irritating vegetation. **In humans**, the infection is usually acquired by the **entry of spores through injured skin (cutaneous anthrax)** or

rarely **the** **mucous membranes (gastrointestinal anthrax)** or by **inhalation of spores into the lung (inhalation anthrax)**.

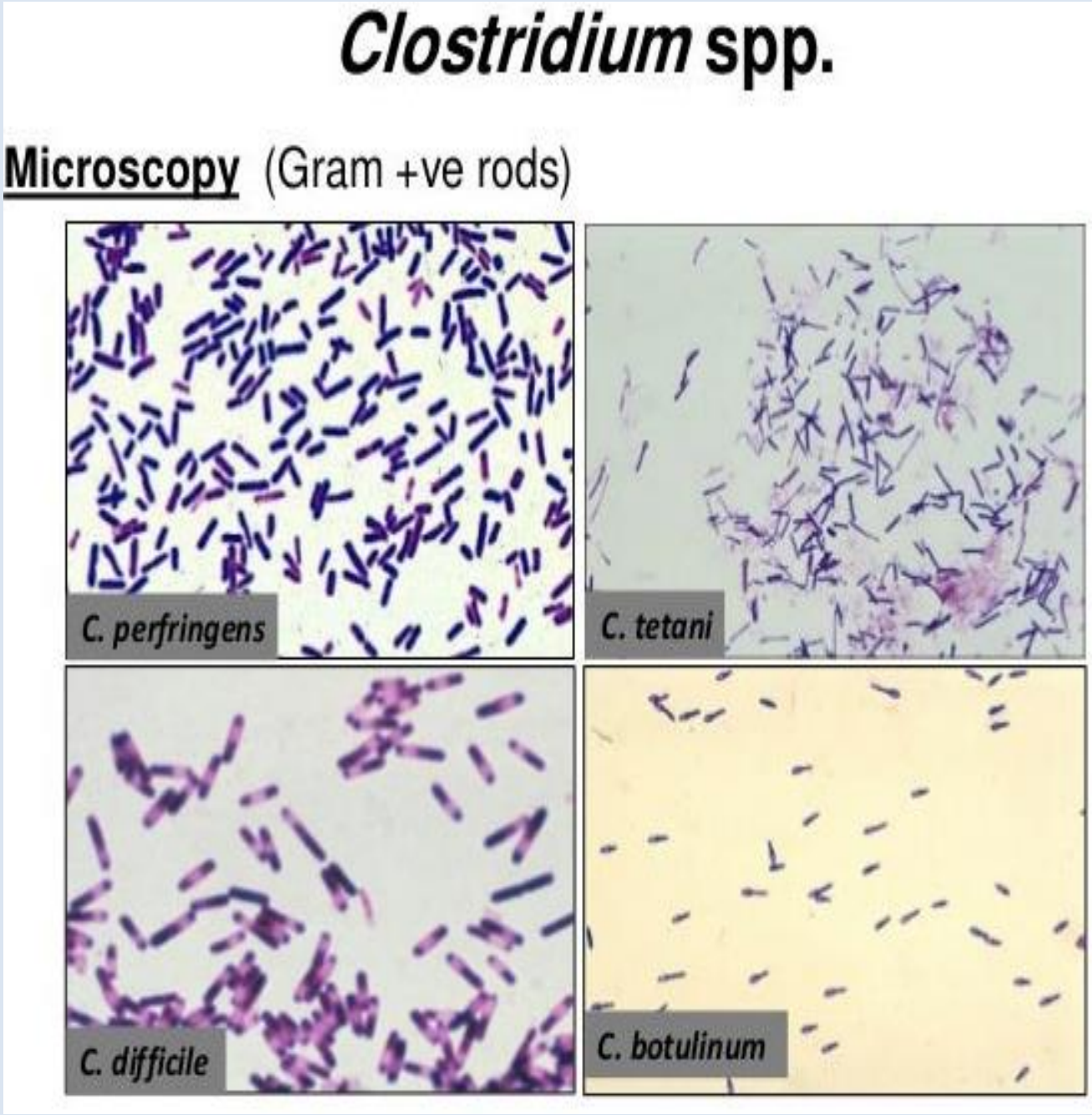
Treatment

Many antibiotics are effective against anthrax in humans,but treatment must be started early. **Ciprofloxacin** is recommended for treatment; **penicillinG**, along with **gentamicin** or **streptomycin** used to treat anthrax.

الاسبوع التاسع + الاسبوع العاشر

Clostridia

The clostridia are Gram-positive bacilli,large anaerobic, motile rods, and **spore-forming**. **Clostridia have spores that are resistant to heat**. **They are able to survive for years in the environment.** The shape of the cell and location of the spore varies with the species, but the spores themselves are rarely seen in clinical specimens. Among the pathogens are the organisms causing botulism, tetanus, gas gangrene, and pseudomembranous colitis.

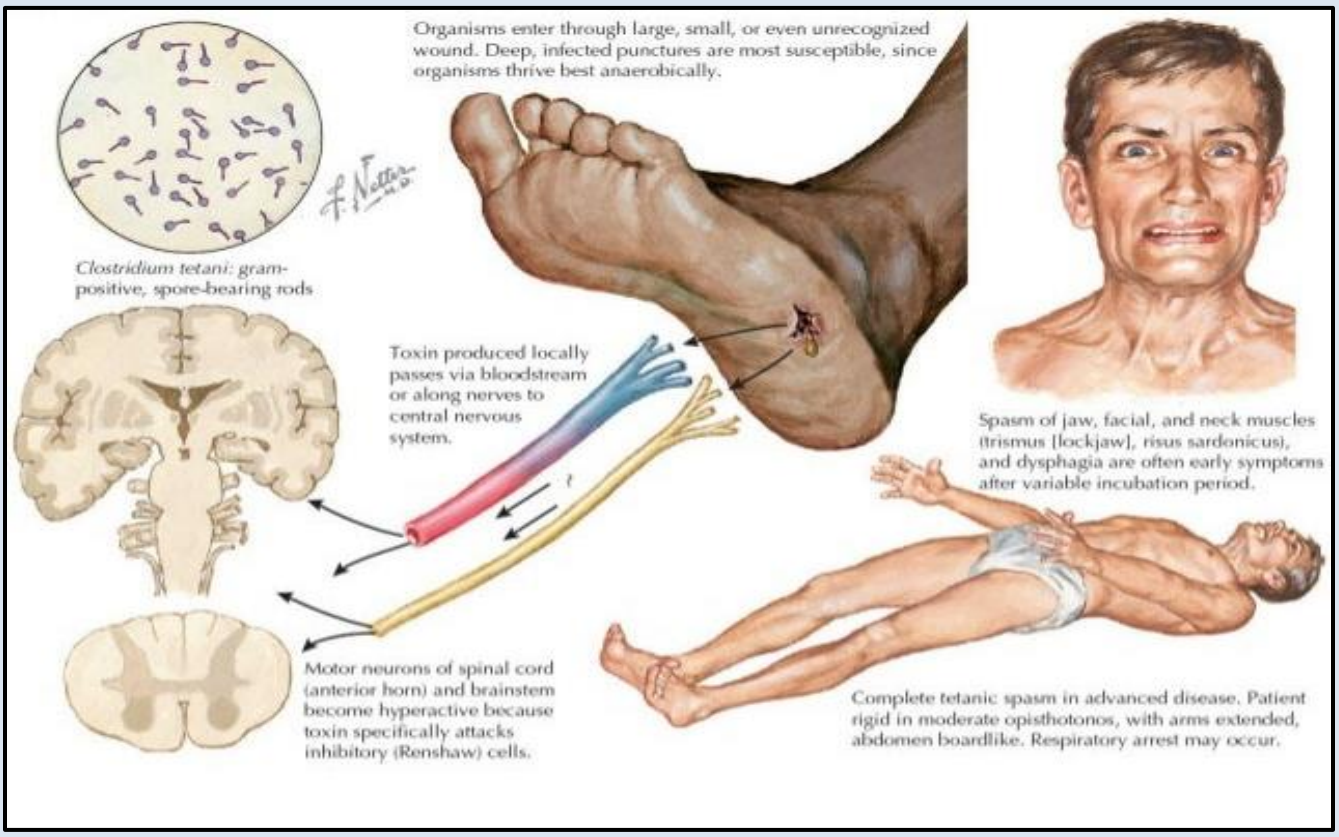


Clostridium tetani

These bacteria form endospores that are able to survive long periods of exposure to air and other adverse environmental conditions.

Tetanus

Infection generally occurs through wound contamination. There are several forms of tetanus: generalized, local and neonatal. **Diagnosis** of tetanus is based primarily on the **patient's clinical symptoms** (muscle cramps, painful back muscle spasms, and generalized contractions of the arcuate curvature of the body) as well as on microbiological diagnosis.



Treatment and prevention

Treatment includes administration of human tetanus immunoglobulin and benzylpenicillin ormetronidazole. Surgical debridement and cleansingof wounds is important in successful treatment.**Prevention** includes administration of thetetanus toxoid vaccine.

Clostridium perfringens

Clostridium perfringens is an anaerobic **gram-positive** spore-forming bacillus associated with acute gastrointestinal infections ranging in severity from diarrhea to necrotizing enterocolitis and **myonecrosis** in humans. This pathogen possesses an arsenal of toxins responsible for disease pathogenesis and can form spores resistant to environmental stress.

Gas gangrene: Severepolymicrobial wound infection. It is caused by various clostridial anaerobic microflora in association with pathogenic facultative anaerobic bacteria (staphylococci, streptococci, gram-negative rods, etc.)

Pathogenesis and Clinical Findings in Gas Gangrene

Clostridia stay in the intestine of animals and humans (as sources of infection) and discharge outside with feces. Spores of clostridia are constantly present in the soil. Hence, any contact with dust and soil particles results in contamination of skin and mucosal tissues with clostridial spores.Gas gangrene is associated with war wounds, and motorcycle accidents and septic abortions (endometritis) .Organisms grow in traumatized tissue (especially muscle) and produce a variety of toxins. Themost important is alpha toxin (**lecithinase**), which damages cell membranes, including thoseof erythrocytes, resulting in hemolysis. **Degradation enzymes** produce gas in tissues.

Treatment

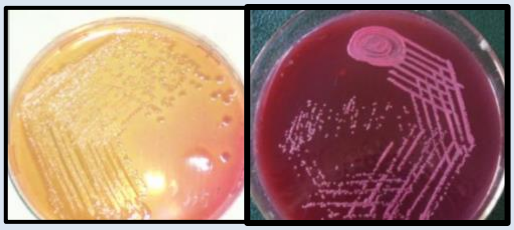
Gas gangrene: surgical debridement, immediate antibiotic therapy with high dose benzylpenicillin and/or metronidazole and supportive measures. Co-infecting microorganisms may be present;therefore additional antibiotics may be required.

الاسبوع العاشر + الاسبوع الحادي عشر

Enterobacteriaceae

General characteristics

They are Gram-negative bacilli, which are foundas commensals in the intestinal tract of mammals.They are also referred to as entericbacteria. Aerobic and facultatively anaerobic growth; optimal growth normally at 37 C; grow readily onsimple media; ferment wide range of carbohydrates;oxidase-negative; some are motile; bile-tolerantand grow readily on bile-salt-containing media, e.g. MacConkey's agar.Salmonella, Shigella, and Proteus do not ferment lactose and form pale colonies on

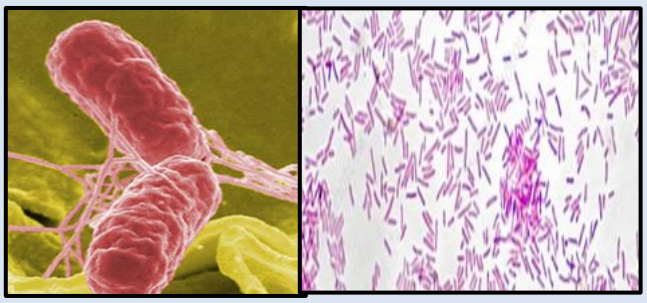


Non-lactose fermenting(pale colonies)Lactose fermenting(pink/red)colonies on

Include the following genera: Escherichia, Enterobacter ,Klebsiella, Proteus, Serratia, Shigella, Salmonella and Yersinia.

Salmonella spp.

Gram-negative bacilli, motile, contains a large number ofspecies (more correctly, serotypes). Salmonellaserotype Typhi and Salmonella serotype Para-typhicause enteric fever (typhoid or paratyphoid); othersalmonellae cause enteritis.



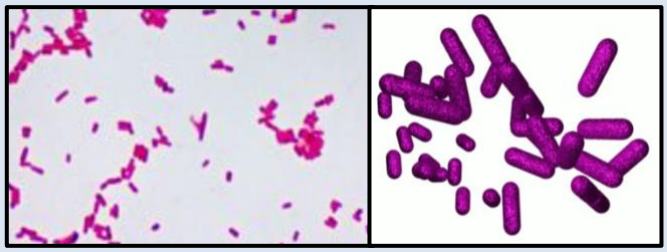
Food Poisoning: Most food poisoning caused by the bacterium Salmonella. The common serotypes are *S. typhimurium*(typhoidal) and *S. enteritidis* (non-typhoidal). Transmission of bacteria is commonly through food and egg, including the egg shell.

Symptoms: Painful abdominal cramps, diarrhea, fever, vomiting, body ache, headache

Treatment: Enteric fever: **ciprofloxacin** (though resistance isincreasing).

Shigella spp.

Gram-negative bacilli,non-motile (they have no flagella).They are resistant to sodium deoxycholate andgrow on deoxycholate agar. They are non-lactose or late lactose fermenters.



Shigella food poisoning

Shigella food poisoning or Shigella infection (shigellosis) caused by the bacterium*Shigella spp.*

Symptoms

Diarrheal illness, dysentery (diarrhea with blood and pus, fever, abdominal pain).

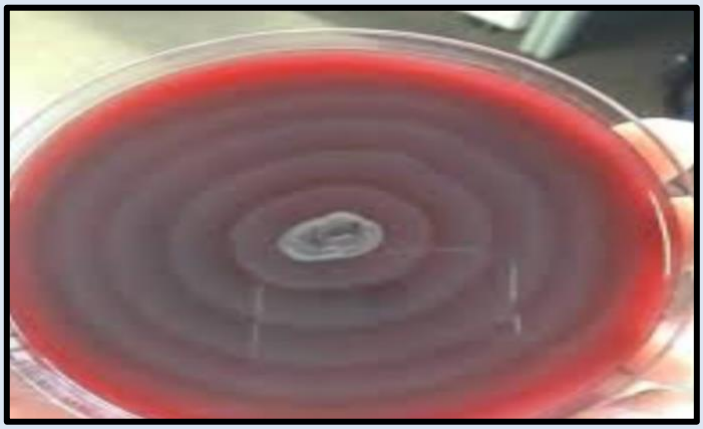
Treatment

Antibiotics (e.g. **ciprofloxacin**) reserved for severecases.

Proteus spp.

Characteristics:

Non-lactose fermenting; motile, tendency to 'swarm' on blood agar; important cause of urinary tract and abdominal wound infection.



Swarming growthof*Proteus spp.* on blood agar

Fastidious Gram-negativeBacteria

They are Gram-negative bacteria that can be difficult to culture and usually are members of the normal microbial flora of humans or animals.

Comparison between *Brucella*&*Bordetella*

	Brucella	*Bordetella*
Characteristics	***Brucella***	***Bordetella***

General characteristics	Gram-negative coccobacilli; grows slowly aerobically.	Gram-negative Small coccobacilli ; obligate aerobes.
Disease	Cause **Brucellosis**	**Cause: whooping cough**.
Diagnosis	Direct isolation from bloodcultures, CSF after prolonged incubation. Note: blood cultures are incubated for 3–7 days.	Culture of pernasal swabs on specialised agar, e.g. Bordet–Gengou (charcoal blood agar). Coloniesmay take 2–3 days to grow.
Treatment	**Prolonged treatment** isnecessary with**tetracycline**and **rifampicin(6 weeks)**. This reflectsthe intracellular location of the microorganisms.	**Erythromycin** may be given to reduce infectivity.

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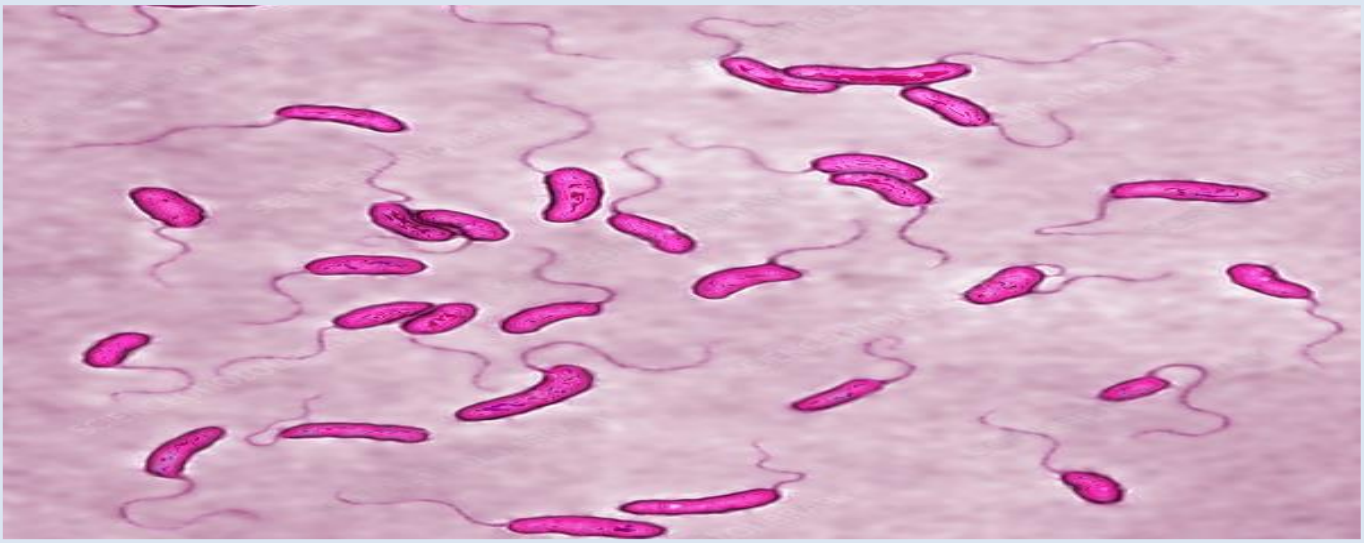
Vibrio cholerae

Gram negativecurved rod, non-spore forming,facultative anaerobic.Some strains of ***Vibrio cholerae***arepathogenic tohuman and found in coastal waters that causes the acute gastrointestinal disease, cholera. Sea foods and water is the most common vehicle for this infection in humans.



Cholera is an acute diarrheal illness caused by infection of the intestine with *Vibrio cholerae*bacteria. People can get sick when they swallow food or water contaminated with cholera bacteria. The infection is often mild or without symptoms, but can sometimes be severe and life-threatening.

A physician checking a patient for dehydration

About 1 in 10 people with cholera will experience severe symptoms, which, in the early stages, include:

- Profuse watery diarrhea, sometimes described as "**rice-water stools**"
- Vomiting
- Thirst
- Leg cramps
- Restlessness or irritability

How to Diagnose

Isolation and identification of *Vibrio cholerae*serogroup**O1 or O139** by culture of a stool specimen remains the gold standard for the laboratory diagnosis of

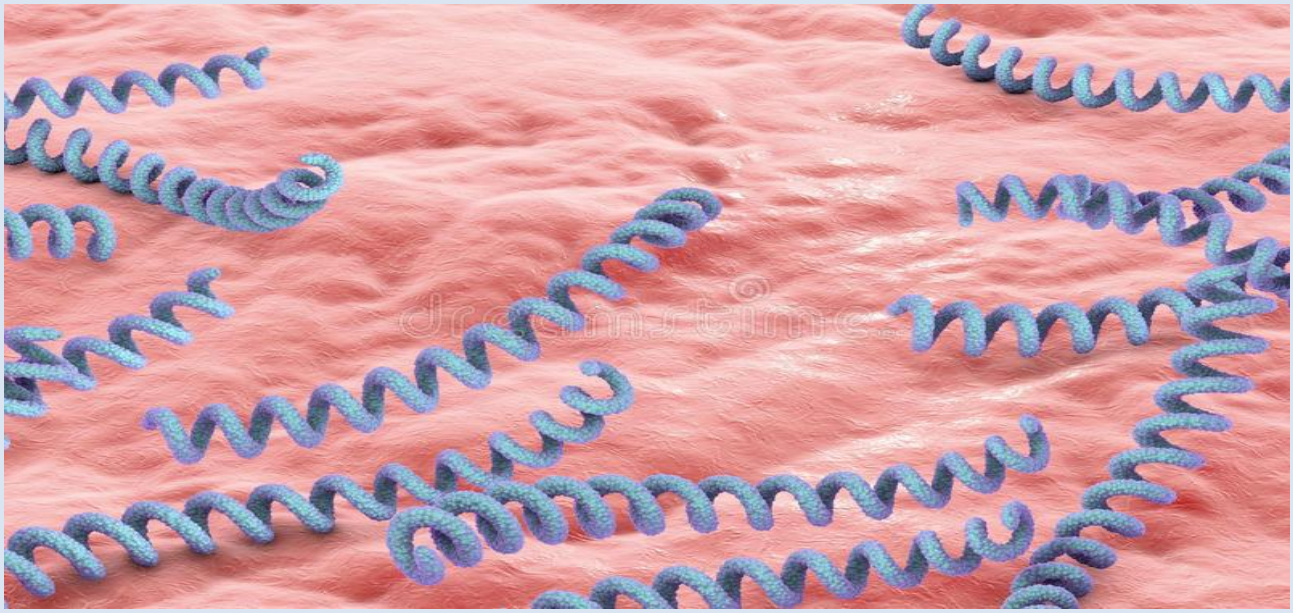
cholera.**Cary Blairmedia** is ideal for transport, and the selective **thiosulfate–citrate–bile salts agar (TCBS)** is ideal for isolation and identification.

Treatment

Patients should drink plenty of liquids to replace fluid lost through diarrhea. The choice of antibiotic should be informed by local antibiotic susceptibility patterns. In most countries, **doxycycline** is recommended as first-line treatment for adults (including pregnant women) and children. If resistance to doxycycline is documented, **azithromycin** and **ciprofloxacin** are alternative options.

Treponemes

Helically coiled, corkscrew-shaped cells. They have an outer membrane which surrounds the periplasmic flagella, a peptidoglycan-cytoplasmic membrane complex, and a protoplasmic cylinder. Multiplication is by binary transverse fission. Treponemes have not yet been cultured in vitro.



Epidemiology

Humans are the only source of treponemal infection; there are no known non-human reservoirs. Venereal syphilis caused by *Treponema pallidum* is distributed worldwide, and over the past several decades has become a significant public health problem in many underdeveloped countries.

Diagnosis

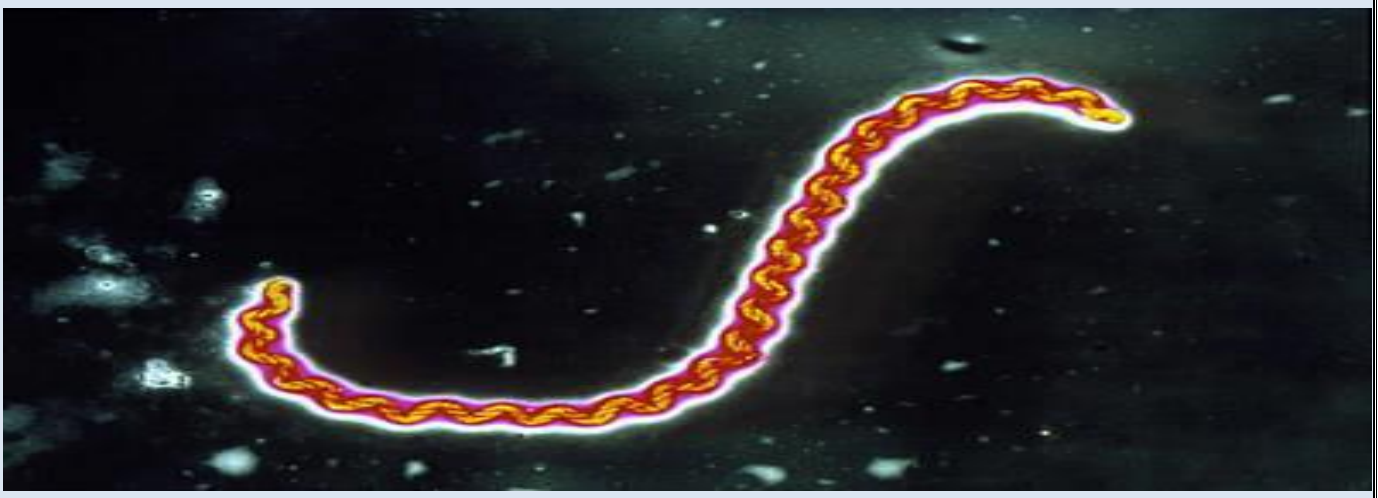
Diagnosis relies heavily on clinical manifestations. In addition, the finding of treponemes within exudative lesions and positive serology aids the diagnosis.

Control

Control of venereal and non-venereal treponematoses is based upon active surveillance and treatment of contacts. Penicillin treatment eradicates all stages, including congenital infection in pregnancy.

Leptospires

Corkscrew-shaped bacteria, which differ from other spirochaetes by the presence of end hooks. They belong to the order of Spirochaetales, family Leptospiraceae, genus *Leptospira.* Leptospires are obligate aerobes with an optimum growth temperature of 28–30°C. They grow in simple media enriched with vitamins B1 and B12. *Leptospira interrogans* causes leptospirosis, a usually mild febrile illness that may result in liver or kidney failure.



Pathogenesis

Leptospira enters the host through mucosa and broken skin, resulting in bacteremia. The spirochetes multiply in organs, most commonly the central nervous system, kidneys, and liver. They are cleared by the immune response from the blood and most tissues but persist and multiply for some time in the kidney tubules. Infective bacteria are shed in the urine. The mechanism of tissue damage is not known.

Diagnosis

Clinical diagnosis is usually confirmed by serology. Isolation of spirochetes is possible, but it is time-consuming and requires special media.

Control

Animal vaccination and eradication of rodents are important. Treatment with **tetracycline** and **penicillin-G** is effective. No human vaccine is available.

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Immunity

Latin term (Immunis = safe): Is a term that describes a state of having biological defenses to avoid infection, disease, or other unwanted invasion.

Immunity classify as:

1. Natural immunity (Innate immunity)

- Present from birth and is nonspecific.
- Include various barriers to external insults; for example; physical barriers such as: skin, mucous membranes, macrophages, monocytes, neutrophils, eosinophils, and the contents of these cells in addition Chemical barriers such as: Fatty acid, enzymes and PH.
- This innate immunity is not improved by repeated exposure to infection and does not retain a"memory" of the infection.

2. Acquired immunity(Adaptive immunity)

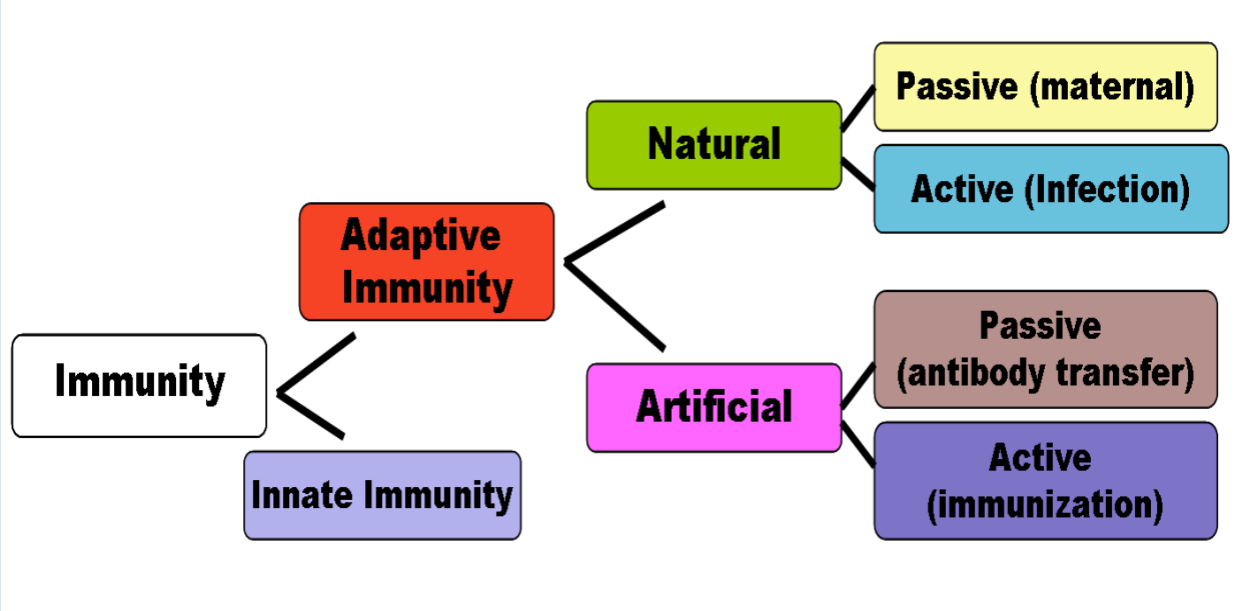
- Is expressed after exposure to a given substance and is specific.
- Involves specific receptors on lymphocytes and the participation of macrophages for its expression.
- Include **humoral immunity**, mediated by antibodies and **cell-mediated immunity**, mediated by lymphocytes.

Inflammation:L**oca**l accumulation of fluid and cells afterinjury, infection, or local immune response.

Innate Immunity (Non-specific Defense Mechanisms)		Adaptive Immunity (Specific Defense Mechanisms)
Timeline: 0 to 12 hours		Timeline: 1 to 7 Days
1st Line of Defense	2nd Line of Defense	3rd Line of Defense
• Skin • Mucous membranes • Secretions of skin • Secretions of mucous membranes	• Macrophages • Other Phagocytes (i.e. neutrophils, NK cells) • Antimicrobial proteins • The Inflammatory response (e.g. redness, fever)	• Lymphocytes (B & T Cells) • Antigen-specific • Antibodies • Memory

The 1st Line of Defense includes the skin; mucous membranes; hair within the nose; cilia in the upper respiratory tract; urine; perspiration, saliva ; stomach gastric juice; and sebum.

The 2nd Line of Defense includes an inflammatory response and white blood cells (called phagocytes) that ingest pathogens.



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Mycology

Mycology:is the study of fungi, which are eukaryotic organisms that evolved in tandem with the animal kingdom. However, unlike animals, most fungi are non-

motile and possess a rigid cell wall. Unlike plants, fungi are non-photosynthetic because lack of chlorophyll.

General characteristics of fungi

- Fungi are eukaryotic organisms.
- Nutritional fungi are heterotrophs.
- Optimum temperature of growth 28◦C.
- Most fungi are obligate orfacultative aerobic
- Growth in PH (2-9), but optimum growth in acidic PH.
- Fungi may reproduce sexually or asexually.
- Fungus's body is a unicellular or multicellular.

Classification of fungi

Fungican be classified according to the morphology into:

1. **Yeast:**Have round or oval cells that multiply by budding or growpredominantly as yeasts that bud , example: ***Candida albicans***

2. **Filamentousfungi (Mold):**Grow as hyphae (multi-celled); produceasexual spores (conidia or sporangiospores), example: ***Aspergillus spp***.

3. **Dimorphicfungi:**Have two forms of growthdepending on temperature:

filamentous at 28◦Cand yeast like at 37◦C, example: ***Penicillummarneffei***

Fungal infection types

Fungal infections (mycoses) can be divided clinically into three groups:

1. **Superficial mycosis**: Infection caused by pathogenic fungi and limited to the human hair, nails, epidermis, and mucosa, example:***Trichosporon species***.
2. **Subcutaneous mycosis:** Infectioninvolves the deeper layers of the skin (the dermis, subcutaneous tissue and even bone),example: ***Sporothrixschenckii***
3. **Systemic mycosis:**Infection affecting internal organs, example:*Histoplasmacapsulatum*

Clinical diagnosis

A. **Direct microscopy** of clinical material fromdeep or superficial sites

B. **Culture:** fungi can be grown on most routinemedia,antibiotic-containing selective media (e.g. Sabouraud's Dextrose agar), which inhibit bacterial growth, are often used. Incubation at both 37°C and 28°C.

Treatment

Depends on the site and severity of infection, include topical **imidazoles** (e.g. clotrimazole)

For systemic disease, **amphotericin-B** is given.