Microbiology: it is the science that deals with study of microorganisms.

Branches of microbiology:
1- medical microbiology. 2- Industrial microbiology.
3- food microbiology. 4- soil microbiology.

Medical microbiology: it is the science that deals with study of pathogenic microorganisms including (pathogenesis, Laboratory diagnosis, treatment, epidemiology, control of infection etc).

Branches of medical microbiology includes:
1- Bacteriology: deals with study of bacteria.
2- Virology: deals with study of viruses causing infectious diseases.
3- Mycology: deals with the study of pathogenic fungi of human.
4- parasitology: deals with the study of parasites.
5- Immunology. 6- Genetics.

Historical events for discovery of microorganisms:
2- Antony Van: 1693 – could give a description of various types of bacteria, and also invented microscope.
3- Pasteur: 1857 - He introduced techniques of sterilization and he developed steam sterilization, hot air oven and autoclave.
4- Robert Koch (called father of bacteriology) He studies on the culture media and staining techniques. In 1882 he discovered the T.B, and in 1883 he discovered vibrio.
5- Neisser: 1879 - Gonococcus
6- Hansen: 1874 - Leprosy
7- Gram: 1884 - Gram stain
8- Frankel: 1886 - Pneumococcus
9- Klebs: Diphtheria
10- Loeffler: 1834 - isolated Corynebacterium
11- Escherich: 1886 - E. coli
12- Bruce - Brucella

Bacteria: are unicellular free living organisms without chlorophyll having both DNA and RNA. They are capable of performing all essential processes of life such as growth, metabolism and reproduction.

"Nomenclature of bacteria"
Bacteria have binomenclature system which consist of two words:
The first word is the name of Genus (start with capital letter),
The second word is the name of species (start with small letter)
Genus: is a group of similar species strain.
Species: is a group in which all individuals are essentially alike.
e.g. Staphylococcus aureus, Staph. citreus, Staph. albus.
  Samonella typhi
  Mycobacterium tuberculosis

“Shapes of Bacteria”
According to the shape bacteria are classified into:
1- Cocci: are spherical shape. On basis of arrangement cocci devided into:
   a- cocci in Cluster e.g Staphylococci
   b- cocci in chain e.g Streptococci
   c- cocci in pairs e.g Diplococci, Neisseria
   d- cocci in groups of four e.g Gaffkyae
   e- cocci in groups of eight e.g Sarcinae
2- Bacilli: they are rods cylindrical shape.
3- Chinese letter e.g Corynebacteria
4- Vibrio: they are comma shape (curved rods)
5- Spirilla: are spiralled non flexous rods (spirillum)
6- Spirochates: are very spirally twisted flexous filament.
7- Actinomycets: network shape.

“Structure of bacterial cell”

1- Capsule: to protect the cell wall, some spp. of bacteria can form capsule,
   It is composed of polysaccharide and some of them made of polypeptide.

2- Cell wall: it is the outer layer covering the bacterial cell. It is strong and
   rigidly which give the shape of bacteria, it is composed mucopenteptide it is
   play a role in division of bacteria, and it offers resistance to environmental
   harmful effects.

3- Cytoplasmic membrane: it is covering the cytoplasm, it is composed of lipid.
4 - **Cytoplasm**: it is a viscus liquid solution contain organic and inorganic solutes.

5 - **Nucleus**: it is along filament of DNA which not surrounded by nuclear membrane & contain uncleous.

6 - **Ribosomes**: these are ribonucleoprotein granules, they are the sites of protein synthesis.

7 - **Messosomes**: Are the sites of respirotory enzymes in bacteria.

8 - **Flagella**: all the motile species of bacteria contain flagella which are long, very fine filaments present on the outer surface of bacteria. According to the arrangement of flagella bacteria are divided into four groups:
   
   - a - Monotrichous
   - b - Lophotrichous
   - c - Amphitrichous
   - d - Peritrichous

9 - **Fimberiae** (pilli): they are filamentous short thin straight hair like. it helps in attachment to the host cell.

10 - **Spore**: some of bacteria can form spore when the condition unfavourable like drying, freezing, heat. When the condition becom favourable the spore germinate and come out of bacteria.

   Spores classified into four groups due to their location in the cell:
   
   - a - Central spores
   - b - Treminal spores
   - c - Sub-terminal spores
   - d - Free spores
“Growth curve of bacteria”
when bacteria are cultured in appropriate fluid media, the growing bacteria are passed in 4 phases:

1- Lag phase: during this phase there occurs.
   a- Increase in size of cell.
   b- Increase in metabolic rate.
   c- Adaptation to the new environment and built up necessary enzymes and intermediate metabolites for multiplication to proceed.
   The length of lag phase depend on:
   a- Type of Bacteria.
   b- Better media decrease the time of lag phase.
   c- Size of inoculum.
   d- Enviromental factors like temperature.

2- Log phase: the cell start dividing and their number increased by geometric progression with time. during this period (log phase):
   a- Bacteria have high rate of metabolism.
   b- Bacteria are more sensitive to antibiotics.
   The control of long phase is brought about by:
   a- Nature of Bacteria.
   b- Temperature.
   c- Concentration of material in the medium.

3- Stationary phase: this phase starts when the rate of multiplication and death becomes almost equal, it may be due to:
   a- Depletion of nutrient b- Accumulation of toxic products.

4- Decline phase: during this phase population decreased due to death of cells. Factors responsible for this phase are:
   a- Nutritional exhaustion.
   b- Toxic accumulation.
   c- Autolytic enzymes are common in this phase.
“Temperature of growth”

For bacteria there is a range of temp at which growth can occur so there is:

a- Optimum temp
b- Minimum temp
c- Maximum temp

There are three groups of bacteria as regards to the temp of growth:

1- **Psychrophilic**: the organisms that growing between (0 – 25 c), these are mostly soil and water bacteria.
2- **Mesophilic**: they grow between (20- 45 c), this group including pathogenic bacteria.
3- **Thermophilic**: some organisms grow between (50 - 60 c) e.g _Bacillus_

Classification of bacteria according to O2

1- **Obligatory erobic**: require atmospheric O2 and can not grow without it e.g _Bacillus subtilis_.
2- **Obligatory anerobic**: can not grow in the presence of O2 e.g _Clostridium welchii_
3- **Facultative anerobic**: can live with or with out O2 e.g _Salmonella typhi_
4- **micro-aerophilic bacteria**: require a small quantities of O2 e.g _Haemophilus influenzae_

“Culture media”

**Media** : is the substances that used to support the growth of microorganism or other cell. On culture media we can study:

a- the characters of colony.
b- the biochemical reactions of bacteria.

**Agar** : it is a substance obtained from some sea plants (Algi), and it contains along chains of polysaccharides, small amount of protein and inorganic salt. It is used only to solidifying the media.

**Agar is Melting at 95 – 98 c and solidifying at 35 – 40 c.**
**Culture media**

- **Solid media**
  - e.g. Nutrient agar
  - Maconky agar
  - Blood agar

- **Semi-solid media**
  - e.g. gelatin media

- **Liquid media**
  - e.g. pepton water
  - Nutrient broth
  - Glucose broth

**Classification of media according to the state (solidity):**

1. **Solid media**: The concentration of agar is 1.5 - 2%. The advantages:
   - a. Characters of colony can be studied
   - b. Mixture of bacteria can be isolated

2. **Semi-solid media**: It is between solid media and liquid media, with a concentration of agar 0.2 - 0.5%. It is used for motility of bacteria.

3. **Liquid media**: No agar. The advantage is that bacteria grow faster due to the free medium.

**Types of media according to the function:**

1. **Basal (simple) media**: It is the media which contain most of the nutrient required for growth of bacteria. E.g. Nutrient agar, e.g. Nutrient broth

2. **Enriched media**: Many substances such as (blood, serum) is added to the basal media for fulfillment the growth of some microorganisms, this is known as enrich media. E.g. Blood agar.

3. **Selective media**: It is contain some chemical substances which inhibits the growth of most microorganisms other than the selective one. E.g. Lowenstein Jensens media (malachitgreen inhibits the growth of bacteria other than the Mycobacterium).

4. **Differential media**: The media which containing substance or indicator which will differentiate some spp. of microorganisms from other spp. E.g. Maccokey agar in which the lactose fermenter spp. show as red colonies while non lactose fermenter spp. as pale colonies.
“Sterilization”

Sterilization: Is the term that means killing of all forms of life of environment.

There are two methods of Sterilization:

i- Physical methods
ii - Chemical methods

### Physical methods

#### A- Heat

1- Dry heat
2- Moist heat

#### B- Radiation

#### C- Filtration

### 1- Dry heat: This includes:

a- Red heating: it is mostly used for sterilization of inoculation wires loop, forceps, by holding them into the flame bensin burner till it becomes red.

b- Flaming: mostly used to sterilization the mouth of culture tube and slide.

c- Hot air oven: it is mostly required temp of 160 C for 1 hour or 180 C for 1/2 hour. This is the best method to sterilizing the dry glass ware like petridish, test tube, pipettes.

### 2- Moist heat: This includes:

a- Tem below 100 C: pasturisation of milk either at temp 63 C for 30 min (Holder method) or at 72 C for 15-20 C min (flahs method).

b- Tem at 100 C: Boiling water is killed all vegetative bacteria within 10 min. Tyndalization of culture media which containing sugar and gelatin media. The material is exposed to steam of boiling water at atmospheric pressure (Arnold sterilizer) for 30 min on 3 successive days:

- at the first day → steam is killing all vegetative form bacteria.
- at the second day → steam is killing all the germinated spores.
- the third day → is for appreciation to make sure that all bacteria are killed.
c- Temp above 100°C (by autoclave): This method is the most widely used for sterilization of culture media, in this apparatus the material for sterilization are exposed to steam under pressure (120°C under pressure 15 pound per inch square) for 15-20 min.

B - Radiation:

1- Non-ionizing radiation: this includes:
   a - Ultra violet radiation:
      sterilizing bacteria in water, and on contaminated surfaces.
   b - Infra red radiation:
      sterilizing a large number of disposable syringes in a short time.

2- Ionizing Radiation: e.g. x-rays

C - Filtration methods: used for sterilizing liquids that will be damaged by heat such as serum and antibiotic solutions. e.g Asbestos disc.

ii - Chemical methods: by using some chemical agents.

   Antiseptic agent: is a chemical substance that prevents growth either by inhibiting or destroying microorganisms and is used for topical application of living tissue. e.g 70% alcohol, stavelone, Halogens (iodine), used for skin.
   - Bacteriostatic material: act by inhibiting growth of bacteria.
   - Bacteriocidal material: act by killing bacteria.

   Dias infectant agent: is a chemical agents that used for sterilisation of nonliving or inanimate objects. e.g phenols, formaldehyde.
   - phenol: used in 30% solution for sterilizing surgical instruments.
   - formaldehyde: used in sterilizing bacteria vaccine.

"stains and staining methods"

Bacteria are so transparent when they are examined in the living condition, therefore it is necessary to stain them with dyes to make it visible in order to identify and classify them.

staining methods of bacteria are divided into two groups:
A- Posative stains.
B- Negative stains.
**Simple stain methods:** are the techniques in which we used only one stain or (dye), the resulting smear will be stained uniformly for all spp. with the same color. e.g. methylene blue, safranine, crystal violet.

**Differential stain methods:** are the techniques in which more than one stain are used, then we can differentiate the groups of bacteria. e.g: Grams stain method, and Ziehl-Neelsen stain method (acid fast stain).

**Grams stain technique:** is differentiate bacteria into two groups:
- (Gr +ve) Gram positive bacterial → appear violet color.
- (Gr -ve) Gram negative bacteria → appear red or pink color.

Stains and chemical solutions which used in Gram stain technique:
- a - Basic stain → Crystal violet → 1 min
- b - Iodine solution → 1 min
- c - Decolorizer solution → 95% Ethanol
- d - Counter stain → Safranine → 1/2 min

**Ziehl-Neelsen stain (Acid fast stain) technique:**

It is differentiate bacteria into two groups:
- Acid fast bacteria (Mycobacterium) → appear red or pink color.
- Non acid fast bacteria → appear blue color.

Acid fast bacteria e.g. (Mycobacterium tuberculosis) are very difficult to be stained by ordinary stains because of their waxy cell wall, therefore they require a strong basic stain (Carbol fuchsin) which resists the decolorization by strong acid solution, so they called Acid fast bacill.

Stains and chemical solutions which used in Ziehl-Neelsen stain technique:
- a - Basic stain → strong carbol fuchsin.
- b - Decolorizer solution → Acid alcohol.
- c - Counter stain → Methylene blue.

**Special stain methods:** These techniques are used for staining one of the structures of bacteria e.g. a - Capsule stain

b - Spores stain
c - Flagella stain

**B - Negative stain:** which stain the background, while leave the bacteria unstained e.g. Negrosin.
“Infection”

Infection: Is the lodgement and multiplication of the pathogenic organisms in the tissues of the host. Infection is classified into four types:

“Types of infection”

1. **Primary infection**: Is the initial infection of the host with the organism.

2. **Reinfection**: Is the subsequent infection of the host by the same organism.

3. **Secondary infection**: When the resistance (immunity) of the host become lowered by a pre-existing disease, then other organisms may set up and caused secondary infection.

4. **Cross infection**: This occurs when the patient suffering from a disease and a new infection is set up from another host or external source.

"Sources of human infection"

1. **Human**: A patient or carrier person is himself a common source of infection to the others.

2. **Animals**: Many infectious diseases are transmitted from animals to human, such diseases are called zoonosis. E.g., plague from rats.

3. **Insects**: Some insects are vectors for transmission of many diseases to human. E.g., (Anopheles) malaria.

4. **Soil**: E.g., spores of tetanus bacilli remains in soil for a long time.

5. **Water**: E.g., cholera vibrio, hepatitis virus.

6. **Food**: Contaminated food may be as a source of infection, e.g., food poisoning by (Staphylococcus).

"Methods of transmission of infection"

1. **Contact**: (Sexually) E.g., syphilis, gonorrhea.

2. **Inhalation**: E.g., Influenza, Tuberculosis.

3. **Ingestion**: E.g., colera (water), Food poisoning food.

4. **Inoculation**: Tetanus, (infection) rabies (dog).

5. **Insects**: Malaria, (dysentery and typhoid) house fly.

6. **Injection**: Laboratory infection.
Pathogenic Cocci

Gram Positive Cocci

1- Staphylococcus
2- Streptococcus
3- Diplococci (Pneumococcus)

Gram Negative Cocci

Neisseria

"Staphylococcus spp"

Morphology: spherical cell, arranged in cluster, Gram positive (Gr+ve), non motile, non sporing, aerobic, grow at 37°C on most media.

Classification: Staphylococci are classified into three species according to pigment production of their colonies on nutrient agar:
1- Staph aureus: produce golden colonies and pathogenic.
2- Staph albus: produce white colonies non pathogenic (skin normal).
3- Staph citrus: produce lemon yellow colonies and non pathogenic.

Pathogenicity: Staphylococcal infections (diseases) may be:
1- Cutaneous infection: e.g. boils, abscess, eye infection.
2- Deep infection: e.g. tonsillitis, pharyngitis, abscess of breast, and staphylococcal septicemia.
3- Staphylococcal food poisoning: when some one had taken foods (e.g. meat, fish, milk products) which are contaminated with enterotoxin produced by staphylococci, this will cause food poisoning (diarrhoea and vomiting) within (6 h) after taking contaminated food.

"Streptococcus spp"

Morphology: spherical or oval cells, arranged in chains, Gram positive, non motile, non sporing, aerobic, and sometime capsulated. They require media enriched with blood. Grow at 37°C. They are widely distributed in nature. They may be found in water, dust.

Classification: Streptococci divided into three groups according to their haemolytic activities on blood agar:
1- Alpha haemolytic streptococci (∞): produce a partial haemolysis of the red blood cells on blood agar, which resulting in a greenish brown discoloration surrounding the colony.
   e.g. Streptococcus viridans, Streptococcus pneumonia
2- **Beta haemolytic streptococci** : produce a complete hemolysis of red blood cell on blood agar, which resulting in a completely clear zone surrounding the colony.  
   e.g **Streptococcus pyogenes**

3- **Gamma haemolytic (Non haemolytic) streptococci** : they have no effect on red blood cells and produce no haemolysis.  
   e.g **Streptococcus faecalis**

**Pathogenicity of Streptococcus spp:**

<table>
<thead>
<tr>
<th>Streptococcus pyogenes</th>
<th>Pathologic sites</th>
</tr>
</thead>
<tbody>
<tr>
<td>1- Respiratory infection</td>
<td>Sore throat (tonsilitis)</td>
</tr>
<tr>
<td>2- Scarlet fever</td>
<td>Erythrogenic rash.</td>
</tr>
<tr>
<td>3- Skin infection</td>
<td>Wounds, burns.</td>
</tr>
<tr>
<td>4- Rheumatic fever</td>
<td></td>
</tr>
<tr>
<td>5- Genital tract</td>
<td>Puerperal sepsis</td>
</tr>
<tr>
<td>6- Other infection e.g abscess of organs such as lungs, liver, kidney, brain</td>
<td></td>
</tr>
</tbody>
</table>

| Strep viridans | Subacute bacteria (endocarditis) |
| Strep faecalis | Urinary tract infection |

“ Diplococcus (Strept. pneumoniae) “

**Morphology:** they are gram positive, lanceolate diplococci occur in pairs. Capuslated, non motile, non sporing, they require enrichment of media with blood or serum, they grow best at 37 c and at PH 7.6, and they are aerobic and facultative anaerobic.

**Pathogenicity:** cause many diseases such as:

1- Lobar pneumonia  
3- Pneumococcal meningitis.  
4- Otitis media.  
5- Sinusitis.

" Neisseria "

**Morphology:** they are gram negative cocci arranged in pairs, oval or spherical, non motile, non capsulated, aerobic. Grow best in atmosphere containing (5-10%) of CO2 on heated blood agar (chocalat agar). The colonies after 48 hr incubation are creamy and transperant, non pigmented, non haemolytic.

**Pathogenicity:** there are 2 pathogenic spp:

1- **Neisseria gonorrhoea** cause gonorrhea urithritis.  
2- **Neisseria meningitidis** cause meningitis.
"Mycobacterium"

**General characters**: they are acid fast bacilli, slender rod, aerobic, non motile, non capsulated, non sporing. Can not grow on ordinary media, then they require enrichment media e.g. Lowenstein Jensen's medium, and they incubation for 4-8 week at 37 c, colony looks is rough and creamy color.

**Pathogenic species are**:

1. **Mycobacterium tuberculosis** causes tuberculosis in human.
2. **Mycobacterium leporea** causes leprosy in human.
“Corynebacterium “

**Morphology**: Gr +ve bacilli, appear as chinease letters, metachromatic granules are present seen by Albert or Neisser's stain. they require enrichment media such as Loefflers- serum agar and Blood Tellurite agar.

**Pathogenecity**: 
1- **Corynebacterium diphtheriae** pathogenic, caused diphtheria in children.
2- **Corynebacterium diphtheroid** non pathogenic, present as commensal organisms in mouth and throat.

"Bacillus"

**Morphology**: they are gram positive bacilli, occurring in chains, thick, with convex end, aerobic, motile, central spore, present in air, water. the colonies on nutrient agar are dry, irregular, opaque, grayish white. On blood agar → No haemolysis

**Pathogenecity**: 
1- **Bacillus subtilis** → non pathogenic
2- **Bacillus cereus** → caused food poisonin
3- **Bacillus anthracis** → pathogenic, caused anthrax disease in human and animals.

"Clostridium"

**General characters**: are gram positive bacilli, anaerobic, forming spores.

**Pathogenecic species**: 
1- **Clostridium tetani**: caused tenanus disease, making alpha-haemolysis on blood agar medium, forming spore which is terminal and projecting outside the bacilli (dram stick appearance).
2- **Clostridium perfringens** and **Clostridium welchii**
   These are caused gas gangrene disease, beta-haemolysis on blood agar, growing on cooked meat medium at 37 c, forming oval subterminal non projecting spore.
3- **Clostridium botulinum**: caused botulism disease (food poisoning), forming oval, central and projected spore. Incubation period 12-36 hour.
“Enterobacteriaceae”

General characteristics: Is the family of bacteria (several genus) which present in the intestine of human. All of them are gram (-ve) bacilli, motile with peririchate flagella or non motile, non sporing, they are grow on simple medium like N. Agar and macconkey agar and ferment carbohydrates like lactose, glucose, sucrose, mannitol. Enterobacteriaceae include:

1- “Escherichia coli”

Morphology: G-ve Bacilli, non capsulated, non sporing. Lactose fermenter → pink colonies on macconkey agar. The presence of E. coli in water is an indicator of water pollution by human faecal materials.

Pathogenicity:
1- urinary tract infection → cystitis pyelonephritis.
2- Gastroenteritis → summer diarrhoea in children.
3- pyogenic infection → wounds infection and abscess.

2- “Klebsiella”

Morphology: G-ve bacilli, non motile, capsulated, lactose fermenter on macconkey agar. They produce mucoid colonies on N. agar.

Pathogenicity:
1- Klebsiella pneumoniae → cause pneumoniae.
2- Klebsiella aerogenes → cause urinary tract infection.

3- “Salmonella”

Morphology: G-ve bacilli, motile with peririchous flagella, non lactose fermenter on macconkey agar.

Enrichment media → selenite broth and tetrahtinate broth.

Pathogenic species: Salmonella spp. which can infect human are caused typhoid fever (entric fever): e.g:
1- S. typhi
2- S. paratyphi A
3- S. paratyphi B
4- S. Para typhi C

Salmonella spp. which can infect animals are caused food poisoning, gastor enteritis and septicaemia e.g 1- S. typhimurium, 2- S. enteritides.

Serological test (Widal test)
O (somatic antigen) and H (flagella antigen)
4- "Shigella"

**Morphology**: G-ve bacilli, non motile, non capsulated, non lactose fermenter on macconkey agar (except *S. sonnei* which can ferment lactose and form pink colonies).

Selective media → Deoxychoate citrate agar (D.C.A)

**Serological test**: only (O) antigen and no (H) antigen.

There are 4 species on the basis of (O) antigen:

1- *Sh. dysenteriae* → cause bacillary dysentry.
2- *Sh. Flexneri*
3- *Sh. boydii*
4- *Sh. sonnei*

5- "Proteus"

**Morphology**: G-ve bacilli, non motile, non lactose fermentmer, grows on simple media like N.agar and macconkey agar. Spreading of the colonies called swarming.

*P. vulgaris* (swarming)
*P. morganii* non swarming case urinary tract infection and wounds infection.

6- "Pseudomonas"

**Morphology**: G(-ve) bacilli, non capsulated, motile, non sporlings. it gives musty or earthy smell. On N.agar colonies show green colour due to the production of pyocyanin pigment by the bacteria. Oxidase test (+ve) positive. Precent in soil and water. The only pathogenic spp. is:

*Pseudomonas aeroginose* or (*P. Pyocyanea*) → wound infection, U. T. I, otitis media

7- "Vibrio"

**Morphology**: G(-ve), comma shaped, motile by polar flagellum, non lactose fermenter, oxidase test (+ve), on macconkey agar has colourless colony. Enrichment media → Alkaline peptone water PH 8.6 (T.C.B.S) media → thiosulphate citrate bromothymole blue and sucrose is widely used.

E.g *vibrio cholerae* → cause cholera
"Coccobacilli"

Are a group (family) of bacteria. All are Gr (-ve) coccobacilli. These include:

1- Yersinia:

Bipolar non motile, non sporing, with rounded end and convex sides.
- On N. agar ➞ transparent colony become opaque on continued incubation.
- On blood agar ➞ dark brown colony due to absorption of haemin pigment.
- On macconkey agar ➞ colourless colony.
E.g Yersinia pestis ➞ cause plague

2- Bordetella:

E.g Bordetella pertussis ➞ cause whooping cough.
Culture ➞ Bordet – gengou – glycerine potato blood agar meddia.

3- Brucella

They are strict anaerobes, with addition of 10% CO2. Temp is 37c. Incubation period is (4-30) days.
E.g Brucella abortus ➞ cause brucellosis (malta fever or indulent fever) which transmitted from animals (cows) to human.
Laboratory diagnosis: 1- Serological test 2- Blood culture

4- Haemophilus:

E.g Haemophilus influenzae

Non motile, Gr(-ve) coccobacilli, infected human and animals. They are characterized by their requirement for one or both of two accessory factors called (X-factor and V-factor) present in Haemophilus species.

X-factor: present in blood, it is necessary for the synthesis of catalase and other enzymes necessary for aerobic respiration.

V-factor: present in red blood cells, it is synthesis by some fungi and bacteria (staph aureus). It is appear to acts as hydrogen acceptor in the metabolism of cell, this is called (satellism phenomena).

Satellism: Staphylococcus is streaked across blood agar plate on which Haemophilus influenzae has been inoculated. At 37c over night incubation we will find large, and well developed colonies of Haemophilus influenzae along side the streaked of staph aureus, and smaller colonies further a way. This is called satellism.

Pathogenicity: It is present normally in nasopharynx and tonsillar region, and may be caused ➞ meningitis, otitis media, pneumonia, endocarditis.
“Viruses”

**Virus:** Is unicellular, ultramicroscopic microorganism (particle). Contains either RNA or DNA. Reproducing only inside the living cells.

**General characters:**
1- Do not possess cellular organization.
2- Contain only one type of nucleic Acid either RNA or DNA (never both).
3- Lack necessary enzymes for protein and nucleic acid synthesis.
4- Can multiply only inside the living cells by complex process called replication (not by binary fission).
5- Unaffected by antimicrobial or antibiotics.
6- Sensitive to the interferons which is a chemical substances that give resistance to the immunity system.

**Morphology**

**Size of Viruses:**
Viruses are varied in their size, The largest virus is the (Pox Virus) which measuring about 300 nm. The smallest virus is the (Foot And Month)Virus measuring about 20 nm.

**Shape of Viruses:**
Viruses are also varied in their shape e.g. Rabies Virus has bullet shape, Pox Virus has brick shape, Influenza Virus Has spherical shape, and the Bacteriophage virus has a head, neck, and tail.

**Structure of Virus:**
1- The virus has a central core of nucleic acid which is either RNA or DNA.
2- Then nucleic acid is covered with protein coat called capsid.
3- The capsid is composed of number of Sub-units called nucleocapsid.
4- The virion may be inclosed by envelope.(sometimes non-enveloped ).
5- Protein sub-units may seen as a projecting on the surface of the envelop and are called peplomers.

Some Viral Diseases :
1. Influenza Virus. 2. Measle Virus. 3. AIDS Virus. 4. Mumps Virus.
“Mycology”

**Mycology**: Is the science which deals with the study of fungi. The diseases by fungi called mycosis.

**Fungi**: Are plants that lack chlorophyll and reproduced by spores.

**General characters of fungi**

1. All species of fungi are aerobes need O₂ for growth.
2. Nutritional requirement to growth of fungi is simple e.g: saburate agar.
3. Optimum temperature for growth of fungi is 28°C, for 1 week incubation.
4. Fungi are affected by physical and chemical agents.
5. Resist spores destroyed by sterilization method and chemical antiseptic.
6. Fungi growth in PH(2-9), and grow best in acidic PH(6).
7. Treatment of fungal diseases by using antifungal material e.g Nystatin.
8. Fungi may reproduced sexually or asexually or by both methods.

**Classification of fungi according to morphology:**

1. **Molds**: most are consist of microscopic branching filaments called (hyphae) which are normally divided with septa into cells. Ex: (Rhizopus).
2. **Yeast**: when fungi are appear unicellular, spherical or oval shape, and reproduce by budding, generally called yeast. ex: Cryptococcus neoformans.
3. **Yeast-like fungi**: when the hyphae represents pseudo hyphae which are elongated budding cells, often linked in branching chains, and which are superficially resemble hyphae. Ex: Candida albicans.
4. **Dimorphic fungi**: a fungus which occurs in two different forms according to the environmental culture, they are appear as filaments on the culture media at 22°C and appear as yeast at 37°C and in the human body. for example some pathogenic fungi are filaments (mycelia) in culture, and yeast like in infected tissues. ex: Histoplasma capsulatum.
Reproduction of fungi

1. Sexual reproduction:
The formation of specialized structures that facilitate fertilization.
Nuclear fusion resulting in the production of specialized spores.

These sexual spores are produced by different ways such as:

   a. Cospores: formation and combination of spores in a structure like sacs.
   b. Zygospores: fertilized spore form after combination of the same gametes.
   c. Oospores: fertilized spore form after combination of different gametes.
   d. Basidospores: spores form on the tips of fingers-like branches.

2. Asexual Reproduction: this occurs by:
   a. Fragmentation.
   b. Budding.
   c. Fission.
   d. Formation of asexual spores.

Types of asexual spores:
1. Chlamydo spores: formed when a cell of hyphae become swell up and develops a thick resistant wall.
2. Arthro spores: formed when septation followed by fragmentation of hyphae.
3. Conldio spores: spores produced externally on a specialized hyphae.
4. Sporangio spores: spores produced on a spherical cell (sporangium) at the end of specialized hyphae called a sporangiophora.

Classification of fungi according to their sites of infection
1. Superficial Mycosis: these affect the surfaces like skin, hair.
2. Cutaneous Mycosis: skin, hair, eye and ear.
3. Subcutaneous Mycosis: nasal mycosis and smooth skin like bucal Mouth.
Antibiotics: are substances which are produced by some living microorganisms and can inhibit some other microorganisms. ex: penicillin.

**Antibiotics**

- **Bactericidal**: Killing microbes completely
  - e.g. penicillin, streptomycin

- **Bacteriostatic**: Stopping growth (non-killing)
  - e.g. tetracycline

**Antibiotic**

- **Narrow Spectrum**: Against one spp. of microbes
  - e.g. penicillin

- **Broad Spectrum**: Against many spp. of microbes

**Mode of effect Antibiotic on Microbes:**
1. Destruction of cell wall synthesis.
2. Destruction of protein synthesis.

**Sensitivity Test (Sensitivity of microbes to Antibiotic discs):**

- **(S)** is referred to sensitive Antibiotics, it shows a clear zone of inhibition on the culture medium with a diameter more than 3 mm around the Antibiotic disc.

- **(MS)** is referred to Intermediate Sensitive Antibiotics, diameter of inhibition is between 2-3 mm.

- **(R)** is referred to resistant Antibiotics, with no zone of inhibition or zone less than 2 mm.
“Animal Cells”

General Structure:

1. **Cell Wall**: It surrounds the contents of the cell. It consists of two layers of phosphoric lipids, the cell wall used in the organization of water transpiration between the inside and outside of the cell.

2. **Cytoplasm**: It is a living portion of the cell, it lies outside the nucleus and covered with the cytoplasmic membrane. It consists of water 80%, protein 15%, lipid, sugars, and salts 5%.

3. **Nucleus**: It is surrounded by the nuclear envelope and contains:
   a. Nucleoplasm.
   b. Chromatin network.
   c. Nucleolus: it consists of ribo-nucleic acid (RAN) and protein.
   d. Chromosomes: to carry deoxyribonucleic acid (RNA).

4. **Endoplasmic reticulum**: It has two types:
   a. Rough E.R.: contains ribosomes
   b. Smooth E.R.

5. **Mitochondria**: It is the center of providing the energy to the cell. It stores the energy as adenosine triphosphate (ATP) the main function of mitochondria is cellular respiration.

6. **Golgi apparatus**: It is important for:
   a. Built the complex sugars.
   b. Secretion the protein that will be leave the cell.
   c. Secretion complex sugars, protein, hormones, and enzymes.

7. **Lysosomes**: It can digest large particles like proteins and nucleic acid to smaller units.

8. **Cilia and Flagella**: Present in some aquatic motile unicellular organisms.

**Cell division**: 1. Somatic cells. 2. Germ cells or sex cells (Gametes).

**Types of division**: 1. Amitosis. 2. Somatic mitosis. 3. Meiosis.