MICROBIOLOGY

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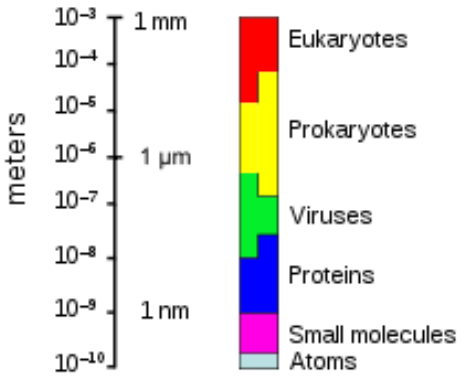
INTRODUCTION TO MICROBIOLOGY

(From Greek micro = small, bios = life)

Microbiology is the science dealing with study of very small organisms that can not be seen with naked eye these organisms are called microorganisms.

and require a microscope to be seen. This includes fungi and parasite (eukaryote), and bacteria (prokaryote), and viruses .Size is one of major criteria in differentiating microorganisms. The basic unit of measurement is the micrometer ($\mu = 10^{-3}$mm) .The sizes of bacteria are (0.5- 15).



The science of microbiology was developed with inclosing of other science development basically the progressing of the different science such as medicine cytology ,cell physiology ,genetic ,enzymology ,biochemistry ,ecology , etc.

Microbiology includes the study of many types of cells, it is concerned with viruses, protozoa, bacteria, fungi, as infectious agents with emphasis on their structures and products and that allow them to cause disease.

The field of microbiology includes the followings:

Microbial physiology: The study of microbial growth, microbial metabolism and microbial cell structure.

Microbial genetics: The study of the genetic information in microorganisms.

Cellular microbiology: Study of cell biology.

Medical microbiology: The study of microbial pathogenesis, epidemiology, and immunology.

Veterinary microbiology: The study of the role of microbes in animal medicine.

Environmental microbiology: The study the function and diversity of microbes in their natural environments.

Industrial microbiology: include industrial fermentation, waste-Water treatment. And brewing .

Food microbiology: The study of microorganisms causing fermentation , food spoilage and foodborne illness .

Other fields.. Existence of microorganisms was hypothesized for many centuries before their actual discovery . The science of microbiology was born with the discovery of the simple microscope (with single lens) by Antoine Van Leeuwenhoek (1676) . He was the first to observe microorganisms in saliva and in material around the teeth . He is considered as the father of bacteriology .

The name " bacterium" was introduced by Ehrenberg (1828) and derived from Greek meaning "small stick ". The field bacteriology founded by Ferdinand Cohn (1828- 1898), whose studies on algae and photosynthetic bacteria . Cohn was also the first to formulate a scheme for the taxonomic classification of bacteria .

MICROSCOPY BEGINNING:-

The human eye cannot see the things that has a diameter less than 100 Mm the eye can not also differentiate between the separate particles when the distance between them less than 100 Mm.

The diameter of most tissues cells are not more than 50 Mm the bacteria 15 Mm and viruses 0.25 Mm.

THERE ARE MANY TYPES OF MICROSCOPES

1-light optical microscopes includes

a-Bright –field has a resolving power one half of wave length of the lights equal to 0.2 Mm ,can not be seen .the using of ocular lens 10 magnification power and coupled with oil immersion lens of 100 magnification power can magnify the specimen 1000 times .

B-Bright-field microscope is used for viewing the stained specimen's bacteria ,molecular constituents such as DNAcapsule,flagella.

c- Phase contrast microscope is based on the principle that the light passes through transparent specimen material of different dentistry or phases forms of the particles surface .

d- Fluorescent microscope can be used to detect a specimen's stain with fluorescent dye ,that absorbed the ultra violate light and emit visible wave of a great length. The microscope equipped with filters ,ultraviolet light source .it can be used for detection the microorganisms that are found in low numbers in the specimens such as tubercle bacillus ,different microorganism in dental plaque and identify a specific antigens by specific antibody.

2- ELECTRON MICROSCOPE (E.M.)

The electron microscope uses electron beams, which are shorter than visible light waves and magnets to focus the specimens instead of lenses . The resolving power of E.M. IS OF 0.01 Mm ,the magnification power n range 2000-50000 TIMES the images potentially can be increased to 1 million times.E.M. IN MICROBIOLOGY use to study not only the **morphological**

characters of the microbe and viruses ,but also the ultrastructure's of microbial cytoplasm .

TYPES OF E.M

1- Scanning EM

Especially designed to examine the surface structures of thee specimens

2- Transmission EM (TEM).

This type of E.M is used to study the composition of the microbial cell wall and cytoplasmic constituents of the microbes or tissue cell

HISTORICAL REVIEW ON THE MICROBIOLOGY

1- LOUIS PASTEUR

A-confirmed the hypothesis that are the air contains microorganisms ,that are attach dust particle.

b- Designed flask with swan necked

c- Confirmed the suggestion that the heating causing killing the microorganisms and using of cotton plugs prevent the contamination of heated (sterilized)materials from the air .

d- The spoilage of wines occurred because the microorganisms .

e- The heating of the wine at temperature range 50-60 C causing microbial killing the method was called pasteurization (the sterilization of milk at temperature 63 C for 30 min.

2- JOHN TYNDALL

1- Postulate that the pasteurization method was not ideal method because the presence of spore forming microorganisms was not killed .

2- according to the above postulate he suggested that the successive heating the played containers at 100 C for a definite time 15-30 min.

The vegetative cells could be killed then the containers were being lated one day for the spores germination to form vegetation cells .

By repeating this process for three days causing complete killing of the microorganisms ,this method was called Tyndallization **.**

ROBERT KOCH

He was physician ,he had wide knowledge in human disease ,and his studies assisted and play important in the progressing of medicine and medical microbiology . He suggested four postulate on the relation between the disease and the causing agent this suggestion called Koch s four postulates:

1- The pathogenic agent must presents in ill animals and not found in the healthy animals .
2- The causative microbe must be cultivated in pure isolation outside in host body .
3- The isolated microbe must be caused the same disease –symptoms on the other health animals which inoculated with this isolated microbe .
4- The same causative microbe must be isolated from the experimented animals ,it must have a similar characters of the original isolate .

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These postulates are not applicable for the following cases when :

1- The causative is opportunistic pathogen .
2- The pathogenic agent can not be isolated outside the host body .
3- The experimental animal has immunity again pathogenic microbe .
4- The disease is caused by association of different microbes .

the progression of microbiology is in closed with other sciences such as , human ,animal and plant pathology ,immunology and vaccination

,pharmacology ,taxonomy of living organisms ,virology ,molecular biology ,physiology ,genetic ,microbial ecology ,biotechnology ,mycology ,protozoology .

Microbiology includes the study of many types of cells ,it is concerned with viruses , protozoa ,bacteria ,fungi as infectious agents with emphasis on their structure and products and that allow them to cause disease .
General description of prokaryotic cellular structure is concerned .

PROCARYOTES

Include the bacteria which have a simpler internal organization they lack the true nucleus .prokaryotic cells divided into two major kingdom ,the eubacteria and archaebacteria .

Microorganism can be classified in to major groups ,algae , bacteria and viruses ,number of m.o. intermediate between bacteria and viruses , chlamydia ,Rickttiсeae).
Bacteria ,fungi and protozoa are differentiated from animal and plants by being unicellular or relatively simple multicellular organisms .viruses are unique , a cellular ,metabolically inert organisms and therefore can replicate only within living cells ,bacteria are prokaryotic ,fungi and protozoa are eukaryotic .
The characteristic of prokaryotic cells is the absence of separate membrane enclosed organelle .

Morphology

The shape of bacteria is determined by it is rigid cell wall .

Bacteria are classified by shape in to three basic groups

- 1-cocci(spherical) , are referred as cocci they are arranged depending on plane of division and attachment after division into 1 single such as micrococcus , diplococci occur in pairs .
- Streptococcus occur in chains
- Staphylococcus occurs in grape –like clusters.
- Aerococcioccur in group of four cells .
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- 2-bacilli(rod-shaped) distinguished into single pointed at one or both end cylindrical ,long or short , singly ,pairs or remain attached to form chains or swelling at one end forming what called Drum-stick shape (Clostridium)
- 3-spirochaetes (helical) are in different groups such as short comma shape (vibrio) or wavy form referred Spirochetes (Treponema) .
- 4- FILAMENTOUS ,branched referred to as actinomycetes .
-
- the size of bacteria ranged from about 0.2 Mm to 5 Mm

STRUCTURE OF BACTERIA

1- **Surface Structure:** Beginning from the outermost structure and moving inward, bacteria have some or all of the following structures

Capsule	**This layer of polysaccharide (sometimes proteins) protects the bacterial cell and is often associated with pathogenic bacteria because it serves as a barrier against phagocytosis by white blood cells.** **Macrocapsule is an extracellular polysaccharide such as glycan (dextran) or fructan (levan) or protein**

saccharides ,it is probably originated as a secretion from the cell membrane ,and is excreted through the cell wall ,forming highly viscous slime material surrounds the cell wall of certain bacteria , Avery thin layer close to the outer part of cell wall is called microcapsule capsule has numerous characters and function among of them are :-

- **a- protect the cell from desiccation**
- **b- protect the bacterial cell from phagocytosis**
- **c- may prevent the phage tail from coming in contact with bacteria receptors .**
- **d- associated with virulence**
- **e- capsule has antigenic characters because of their chemical composition ,therefore it play a role in immunological specify**

serve as a osmotic barrier

Flagella and Pili

flagellum

Flagella are small hair like structure 12-15 nm in diameter and several times the length , of the cell ,originated at cytoplasmic membrane . aflagellum is composed of protein 98% with trace of carbohydrate and fat .the formation of flagella are genetically controlled and differed ,therefore ,the antigenic specifity is used for diagnosis and classification of different

species of bacteria .

Flagella are associated with motility .various arrangement and numbers of flagella are characterized of different species ,there are four arrangement basis on their location .

1- **monotrichous ,presence of one at one end point on the cell .**
2- **lophotrichous ,presence of numerous flagella at one end (pollar) .**
3- **amphitrichous ,presence of atuft of flagella at both polars of cell .**

peritrichous , presence of flagella surrounding the bacterial cell

PILI

Pili are extremely appendages ,about one half of the thickness of the flagella .these structure surround the cell and vary in number between 100-200 per cell composed of protein called piling originated from cytoplasmic membrane

Pilli play an important role in :-

1- **adhesive or attachment and may agglutinate RBC.**
2- **Receptors of bacteriophage**
3- **Transfer of genetic materials referred as to sex or F type pili in conjugation between two adjacent bacterial cells .**

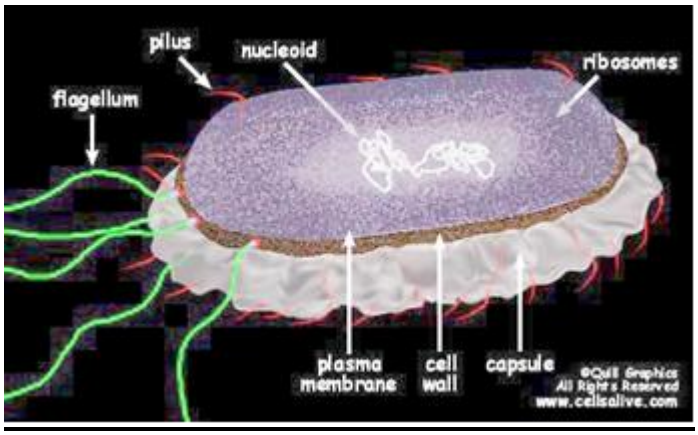
outer membrane	This lipid bilayer is found in Gram negative bacteria and is the source of lipopolysaccharide (LPS) in these bacteria. LPS is toxic and turns on the immune system of , but not in Gram positive bacteria.
cell wall	It is strong , rigid and includes several layers . The chemical companions of the cell wall differ between different bacterial species , the basal composition is the peptidoglycan (PG) (protein + polysaccharides)), The function of the cell wall : (1) maintains the overall shape of a bacterial cell. The three primary shapes in bacteria are coccus (spherical), bacillus (rod-shaped) and spirillum (spiral). Mycoplasma is bacteria that have no cell wall and therefore have no definite shape. (2) Responsible for the strength and rigidity of the cell (3) Protect the bacteria against a variety Of chemical agents (bactericidal) (4) It possesses selective permeability because of porous (porosity = 1-2 nm). (5) The cell Wall plays important part in cell division.
periplasmic space	This cellular compartment is found only in those bacteria that have both an outer membrane and plasma membrane (e.g. Gram negative bacteria). In the space are enzymes and other proteins that help digest and move nutrients into the cell.
plasma membrane	This is a lipid bilayer much like the cytoplasmic (plasma) membrane of other cells. There are numerous proteins moving within or upon this layer that are primarily responsible for transport of ions, nutrients and waste across the membrane.

2-

f- .

INTERNAL STRUCTURE IS VERY SIMPLE IN BACTERIA INCLUDE

Nucleoid	DNA in the bacterial cell is generally confined to this central region. Though it isn't bounded by a membrane, it is visibly distinct (by transmission microscopy) from the rest of the cell interior.
Ribosomes	Ribosomes give the cytoplasm of bacteria a granular appearance in electron micrographs. Though smaller than the ribosomes in eukaryotic cells, these inclusions have a similar function in translating the genetic message in messenger RNA into the production of peptide sequences (proteins).
storage granules	Nutrients and reserves may be stored in the cytoplasm in the form of glycogen, lipids, polyphosphate, or in some cases, sulfur or nitrogen.
Endospore	(not shown) Some bacteria, like Clostridium botulinum, form spores that are highly resistant to drought, high temperature and other environmental hazards. Once the hazard is removed, the spore germinates to create a new population.



<u>Bacterial Cell Wall and Gram Reaction;</u>

Gram staining is a method of differentiating bacterial species into two large groups (Gram positive and Gram negative) .It is based on the chemical and physical properties Of their cell wall.

Gram negative cell wall are more chemically complex than is the wall of Gram positive cells . In Gram positive bacteria peptidoglycan makes 90% of the thick which is the outermost of Gram positive cells, and in Gram negative bacteria peptidoglycan makes only 5- 20% 0f the cell wall , and is not the outermost layer , but it lies between the plasma membrane and an outer membrane .The outer membrane is similar to the plasma membrane , but less permeable and composed composed of lipopolysaccharide (LPS), a harmful substance classified as an endotoxin .

The outer part of the cell wall is responsible for the for the Gram staining reaction. The blue –violet stain reaction character-eristic of Gram positive cell is caused by crystal violet , the primary Gram stain dye which interacts with the iodine mordent causing the complex to adhere to the peptidoglycan . The decal-izard step dose not remove the crystal violet stain bound to the Gram positive cell wall . The safranin counter stain is much lighter than the crystal violet and even after application of the counter stain , the Gram positive cell maintains its blue-violet color.

Classification of bacteria

Bergy ' s Manual of Determinative Bacteriology has been used as standard for classifying bacteria .In this , the true bacteria and related microorganisms are placed in the kingdom Prokaryote and in the division Protophyta. The classification system in this manual, is based on the morphological nutritional , cultural , biochemical , phsiological, serological , pathologic properties , the genetic characterization, and

DNA base sequence .

The following classification of bacteria is based on the stain reaction , cell shape, and their characteristic.

Gram-negative bacteria

Cell shape	Characteristic	Genus	Family
Cocci	aerobic	Neisseria	Neisseriaceae
Coccobacilli		Brucella , Bordetella Pasteurella Haemophilus	Brucellaceae
Bacilli	Facultative anaerobic, motile with peritrich-ous flagella or immotile	Escherichia , Shigella , Salmonella, Proteus, Enterobacter, Yersinia, Erwinia , Serratia	Enterobacte-aceae
	Aerobic, motile with Peritrichous flagella or immobile	Azotobacter	Azotobacter-aceae
		Rhizobium	Rhizobiaceae
	Aerobic , motile with polar flagella	Pseudomonas other genera	Pseudomona-daceae
	Facultative anaerobic with polar flagella	Campylobacter other genera	
	Curved rods with polar flagella	Vibrio Spirillum	Spirillaceae

Gram – Positive Bacteria

Cell shape	Characteristics	Genus	Family
Cocci	Cells in irregular clusters	Staphylococcus Micrococcus Sarcina	Micrococcaceae
	Cells in chains	Streptococcus Leuconostoc	Streptococcaceae

Bacilli	Aerobic sporing	Bacillus	Bacillaceae
	Anaerobic sporing	Clostridium	
	Lactic fermentation	Lactobacillus	Lactobacillacaeae
	Propionic fermentation	Propionibacter-ium	Propioni-bacteraceae
	Oxidative , weakly Fermentative	Corynebacterium Listeria Erysipelothrix	

Other Groups

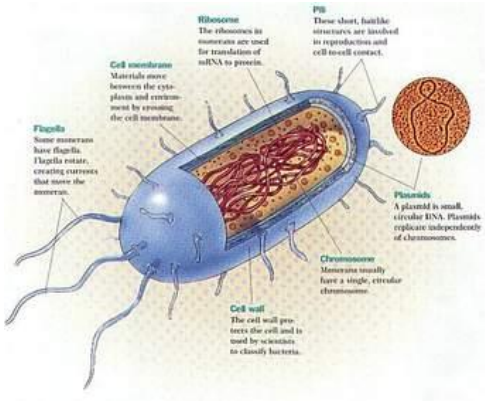
Cell shape	Characteristics	Genus	Family
Acid-fast rods		Mycobacterium	Actinomycetales
Ray-forming rods		Actinomyces Nocardia Streptomyces	
Spiral organisms	motile	Treponema Borrellia Leptospira Spirocheta	Spirochetales
Small pleomorphic	luck rigid wall	Mycoplasma	Mollicutes
Small intracellular parasites		Rickettsiae Coxiella Chlamydia	Rickttsiaceae Cladiaceae
Intracellular Parasites	bordeline with protozoa	Bartonella	Bartonellae

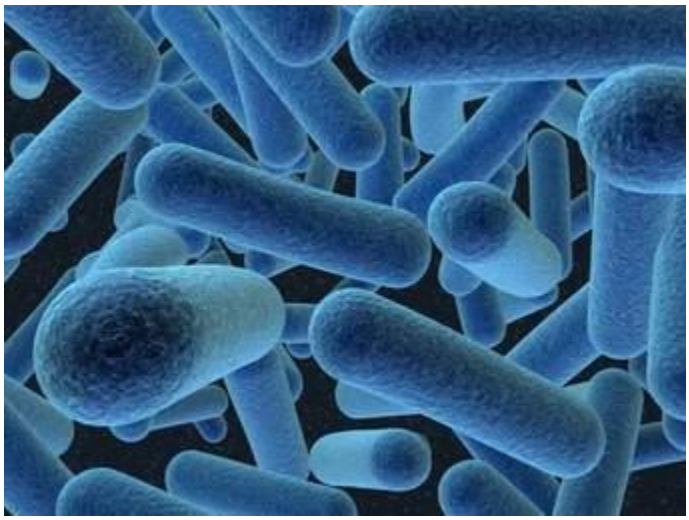
Naming of Bacteria : (Scientific name)

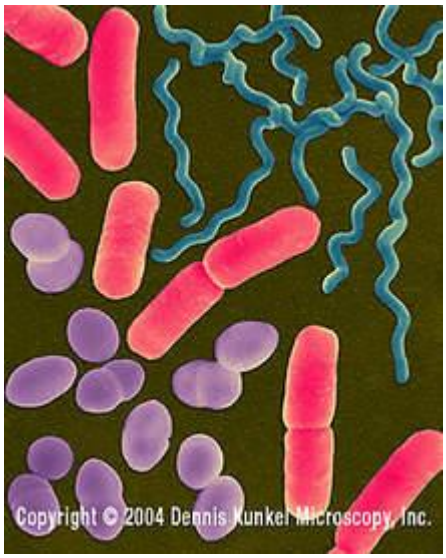
The binomial system for naming bacteria is used . The name of a bacterium is derived from a Latin or Greek word . The first word of the name of the bacterium is the generic name (genus) , the second word is the species (specific name). The first letter of the generic name always capitalized , the specific name is never .The generic name given to a bacterium is based on: based on :

the generic (1) Morphology of the bacterium ; such as the genus *Bacillus* in Latin meaning little e rod , (2) The discoverer of the organism ; such as the genus *Shigella* , the discoverer Shiga, a Latinized name for the bacterium , (3) Some distinguishing characteristic of the bacterium such as genus *Lactobacillus* , meaning a milk small rod , (4) Some generic names are of Geek origin ; such as Micrococcus , meaning coccid *Staphylococcus* is derived from meaning bundle of grapes , *Streptococcus* meaning clubbed small rod . The genus is given to a group of species that bear resemblance to one another to be considered closely related . The second name of the bacterium , the specific name (species) , should indicate some characteristic of the organism as a physiologic trait as the following examples (1). *Staphylococcus aurous* the specific name aurous ,is , derived from Latin meaning orange color . (2) *Streptococcus anguish* : *anguish* is derived from Latin , meaning blood , (3) *S. progenies* : *progenies* , means pus forming . (4) *S .salivarius* , means salivary , (5) *S . mutans :* means variation in form , such as cocci and rod shapes . The scientific name of bacterium should be italicized (written with declined letters).

THE END


Ribosome
The ribosomes in monerans are used for translation of mRNA to protein.
Pili
These short, hairlike structures are involved in reproduction and cell-to-cell contact.
Cell membrane
Materials move between the cytoplasm and environment by crossing the cell membrane.
Flagella
Some monerans have flagella. Flagella rotate, creating currents that move the moneran.
Plasmids
A plasmid is small, circular DNA. Plasmids replicate independently of chromosomes.
Chromosome
Monerans usually have a single, circular chromosome.
Cell wall
The cell wall protects the cell and is used by scientists to classify bacteria.

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