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Introduction to Microbiology

29/9/2015

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**Introduction to microbiology :**

**Microbiology** : (Literally mīkros, "small";  bios, "[life](https://en.wikipedia.org/wiki/Life" \o "Life)"; and [logia](https://en.wikipedia.org/wiki/-logy" \o "-logy)) is a part of biology that studies microscopic organisms, such as bacteria, viruses, archaea, fungi, algae and protozoa . here , we usually use a MICROscope to study these MICRO organisms , there are many types of microscope like **light microscope** , **dissecting microscope** , **phase-contrast microscope and electron microscope** .

Its sub-divided into :

* **[Virology](https://en.wikipedia.org/wiki/Virology" \o "Virology)** : the study of [viruses](https://en.wikipedia.org/wiki/Virus" \o "Virus)
* **[Mycology](https://en.wikipedia.org/wiki/Mycology" \o "Mycology)** : the study of [fungi](https://en.wikipedia.org/wiki/Fungus" \o "Fungus)
* **[Parasitology](https://en.wikipedia.org/wiki/Parasitology" \o "Parasitology)** : is the study of [parasites](https://en.wikipedia.org/wiki/Parasite" \o "Parasite) (worms and others )
* **[Bacteriology](https://en.wikipedia.org/wiki/Bacteriology" \o "Bacteriology)**: the study of [bacteria](https://en.wikipedia.org/wiki/Fungus" \o "Fungus)

Ok , we already know that Microbiology is the study of microorganisms ( microbes ) , what are these microorganisms ?

* Bacteria
* Fungi (فطريات)
* Algae (طحالب)
* protozoa(الأوليات)
* Parasites

Helminths (worm-like organisms), EX : Ascaris , Taenia , bilharzia , etc …

10:00

* Viruses : not considered as true microorganisms ..

These microbes can be classified according to their lifestyle into :

* Free living : these microorganisms live freely , not depending on other living organism to get their energy , so they are not harmful , we found them usually free in the nature .
* Commensals : Living in a relationship in which one organism derives food or other benefits from another organism without hurting or helping it. Commensal bacteria are part of the normal flora in the mouth , another example is *Staphylococcus epidermidis* that live in our skin and cause body odor *.*
* Pathogenic (parasites) :simply , it's any microbe that harm other organism.

NOTE : parasites is a group of microorganisms that belongs to eukarya , but sometimes we use this term to describe any pathogenic microorganism , so don’t get confused between these two different terms .

Usually , these microbes are beneficial . However , Few species cause harmful effects ( 3% of them )

Microorganisms are unicellular cell, too small to be seen with the naked eye, recognized by light microscope. Bacteria, fungi & parasites, size above > 0.1 um , only microbes that are smaller than 0.1 um and their sizes are measured in nm are viruses .h

The order of microorganisms according to their sizes:

Viruses < bacteria < unicellular fungi and unicellular protozoa (Approximately they have the same size )

* Helminth can be seen by the naked eye.
* The smallest microorganism is virus

viruses are not considered as real microorganisms . they better described as infectious agents or particles , but why ?

1. Viruses sizes **< 0.01um**
2. Composed of only **DNA** or **RNA**.
3. Grow only in living cells/tissue culture.

20:00

1. Their presence structures can be seen only with electron microscope

Most microbes capable of grow & existence as single organism or together with others. Widely distributed in human, animal, plants and nature.

**Microbiology** has many areas of specialization including Bacteriology, Mycology (fungi), Virology, Medical microbiology, clinical microbiology, diagnostic microbiology, Immunology, Food microbiology, Biotechnology (Genetic engineering ) , Microbial genetics, Industrial microbiology, Agriculture Veterinary .

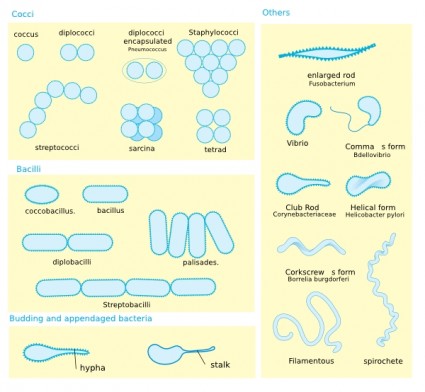
**Bacteria (bacteriology)**

**Bacteria**:  constitute a large [domain](https://en.wikipedia.org/wiki/Domain_(biology)" \o "Domain (biology)) of [prokaryotic](https://en.wikipedia.org/wiki/Prokaryotic" \o "Prokaryotic) [microorganisms](https://en.wikipedia.org/wiki/Microorganism" \o "Microorganism).

So what do we mean by [prokaryotic](https://en.wikipedia.org/wiki/Prokaryotic" \o "Prokaryotic)  ?

**prokaryote** : (Literally Pro, "before" and karyon "[nucleus](https://en.wikipedia.org/wiki/Cell_nucleus" \o "Cell nucleus) ") is a [single-celled](https://en.wikipedia.org/wiki/Unicellular" \o "Unicellular) [organism](https://en.wikipedia.org/wiki/Organism" \o "Organism) that lacks a [membrane](https://en.wikipedia.org/wiki/Biological_membrane" \o "Biological membrane) bound [nucleus](https://en.wikipedia.org/wiki/Cell_nucleus" \o "Cell nucleus) (karyon), [mitochondria](https://en.wikipedia.org/wiki/Mitochondrion" \o "Mitochondrion), or any other membrane-bound [organelle](https://en.wikipedia.org/wiki/Organelle" \o "Organelle) .

* The smallest bacterium is Mycoplasma ( 0.3 um )



As seen in figure above , Bacteria Have a variety of shapes :

* Coccus (Plural : cocci ) : spherical
* Bacillus(Plural :bacilli ) :Rods
* Coccobacilli : in between
* Spiral forms- spirochetes
* Vibrios (ex:colira) comma shaped bacteria

Individual cells may be arranged in *pairs or clusters or chains* , as seen in figure above ( you should be familiar with these shapes )

We also classify these bacteria according its Growth patterns & metabolic characteristics .

* Growth patterns : does it grow slow , fast or in between ? , some of them need CO2 , O2 , N , S , some of them resist dryness , some of them need 25C to grow , others 70 , others -6 , etc ..
* Metabolic characteristics : What they need for nutrition , some of them need N , cystine , egg yolk , oval albumin , beef , etc …

Sometimes they need NOTHING to grow , they only need minerals to synthesis their own food , such as *pseudomonas* . it can grow only with agar and some minerals *.*

30:00

### Bacteria Nomenclature : [Genus](https://www.google.jo/url?sa=t&rct=j&q=&esrc=s&source=web&cd=3&cad=rja&uact=8&ved=0CDgQFjACahUKEwjc2ti25pzIAhVCXhoKHZDWBvQ&url=https%3A%2F%2Fen.wikipedia.org%2Fwiki%2FGenus&usg=AFQjCNFmlN_QlUeL_ZeZe811OO_TeO2N2g&sig2=IZtQZeIo0kpA9Gawwc5T2A) + Species.

### For example : staphylococcus aureus

genus species

We have another criteria to classify bacteria , by Gram-stain :

1. For any stain you must first smear the substance to be stained (sputum, pus, etc.) onto a slide and then heat it to fix the bacteria on the slide .
2. Pour on crystal violet stain (a blue dye) and wait for 35 seconds .
3. Wash off with water and flood with iodine solution and wait for 35 seconds .
4. Wash off with water and then "decolorize" with alcohol for 10 seconds
5. Finally, counter-stain with safranin (a red dye).

When the slide is studied microscopically, cells that absorb the crystal violet and hold onto it will appear blue. These are called gram-positive organisms. However, if the crystal violet is washed off by the alcohol, these cells will absorb the safranin and appear red. These are called gram-negative organisms.

**Gram-positive = BLUE**

I'm positively BLUE over you!!

**Gram-negative = RED**

No (negative) RED commies!!

But why this happens , what's the magic in this technique ??

To answer this question we should firstly study bacterium cell wall structure , and its general structure .

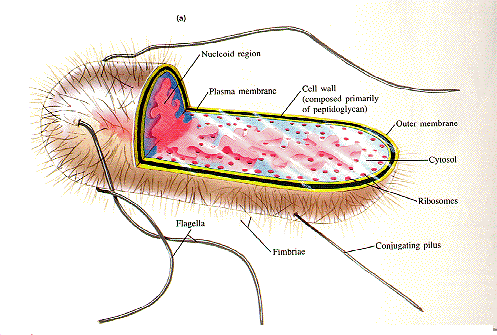
when you look at bacterial cell (as seen below ) you will find some thing projecting outward . called flagella

**Flagella:**

Organs of motility, Composed of flagellins (polymer proteins) long filament , Length up to 20 um , cells could have one , two , even dozens of flagella :

* Single polar flagellum (monotrichous)
* Several polar flagella at one, each end of the cell or covering the entire cell surface (peritrichious)

For example : flagella cover the entire cell surface of e coli bacteria



As you go deep . you will find **capsule** (protection) , **cell wall** (preserving the shape) , **plasma membrane , cytoplasm , chromosomes** (genetic material , usually circular, one chromosome ) , bacteria have an external genetic material called **plasmid** , we also have **ribosomes** (for protein synthesis) , and some **granules** .

40:00

NOTE :

* The thickness of capsule is different from one kind to another
* There are regular capsule and irregular capsule ( mucus )

NOTE : some bacteria can do cellular respiration and even photosynthesis , but without specialized organelles (Mitochondria and chloroplasts ) , and without vacuoles and any compartment .

**Cell wall** :

The cell wall is Composed of many peptidoglycan layers (carbohydrate-larger- / small peptide) :

(N-acetylglucosamine + N- acetylmuramic acid) + Pentapeptide.

The difference between peptidoglycan and peptide-carbohydrate mixture is that peptide and carbohydrate are covalently bonded in peptidoglycan.

Ok , now what's the difference between gram +ve cell wall and gram –ve cell wall ??

Gram +ve cell wall 🡪 80 layers

Gram -ve cell wall 🡪 3-5 layers

What's the magic there ?

**Gram +ve cell wall :**

* Thick cell wall composed of many layers of piptidoglycan .
* When we add crystal violet stain , the cell wall is going to absorb a huge amount of the stain .
* Then , when we add alcohol for 10 seconds to decolorize the specimen , it will not remove all the stain , because 10 seconds are not enough to remove this huge amount .
* When we add safranin stain , it will not find a place to stain , because crystal violet stain is already there ! ( the cell wall will appear Violet under L.M )

NOTE : the cell wall of gram + bacteria has Teichoic acid and Lipoteichoic acid ( Alcohol derived molecules )

**Gram -ve cell wall :**

They have different structure !

Underneath the capsule , it has a lipid bilayer called outer membrane , then we have a small cell wall ( 2 layers ) then we have a plasma membrane ..

* When we add crystal violet stain , the cell wall is going to absorb some of the stain .
* Then , when we add alcohol for 10 seconds to decolorize the specimen , it will remove all the stain , because 10 seconds are enough to remove this amount .
* When we add safranin stain , it will find a place to stain the cell wall .( the cell wall will appear red under L.M )

Note :

* there is no relation between pathogenicity and +ve or -ve gram ..
* there is no relation between the shape of bacteria and +ve or -ve gram

( for example : not all cocci bacteria are gram + bacteria or gram – bacteria )

**THE END**