**Microbiology lecture #1
Recommended references** :

1)medical microbiology for greenwood (this book is easy to read)
2)Medical microbiology for Jared siliga? (harder to understand its language)

We actually live in an environment which is full of all kinds of microorganisms ,these microorganisms are in nature ,water,soil & everywhere.

Not all microorganisms are bad,the large majority of microorganisms are good & beneficial for the environment ,uses:

1) produce antibiotics
2)act on the soil and reduce organic material to inorganic material to be available for absorption by plants
3)production of drugs  & vaccines
4)genetic engineering (hepatitis B vaccine is a genetically engineered vaccine)
In the old days they used to take the vaccine from the virus itself so it was really dangerous that you might have remnants of viruses ,nowadays it's produced by yeast ,yeast is a fungus ,so the surface antigens hepatitis b or hbs is genetically engineered products of yeast.
At the end of the list ,they actually cause diseases so we mainly concern ourselves mostly with these pathogenic diseases.

Microorganisms in our bodies that are useful for us.
they are located in :

 1)skin

2) mouth

3) gastrointestinal tract.

these microorganisms are not really bad because they are beneficial to us they don't harm us

"pathogenic microorganisms" : Microorganisms that cause diseases,they produce disease(pathology).

"non-pathogenic microorganisms" :Microorganisms that don't cause diseases.

Microorganisms that are located on & in our bodies are called "normal flora"

normal flora are  really useful because by being there ,they prevent pathogenic microorganisms from multiplying & causing disease.

Pathogenic microorganisms are there trying  to take any opportunity to produce disease in our body ,they use our body as a culture region and they can multiply & spread to cause disease

**Microbiology** is the study of the pathogenic microorganisms ,how to diagnose them ,how to treat the infections & so on.

There are 4 main groups of microorganisms that cause diseases to humans :
1)Bacteria

 2)viruses.

3)fungi

4)parasite (Protozoa & helminth)
The largest group is the parasites .
**Helminth** can be very big which reach 10 um
**Protozoa** have a uni-cellular structure ,smaller than helminth ,they only measure few microns.

in this term ,we are going to talk about bacteria ,the rest will be discussed next semester.

Slides which talk about the history of bacteria weren't discussed during the lecture ,for those who are interested ,you can read them at your leisure.

# branches of microbiology :
Bacteriology : the study of bacteria
 Mycology  is the study of fungi
Parasitology  :the study of parasite
Virology : the study of viruses

Chemotherapy will be discussed in immunology.

Bacteria are differentiated from other organisms ,in that they're really unique in structure of the cell.

Bacteria are known as prokaryotic cells.

|  |  |
| --- | --- |
| **Eukaryotes** | **Prokaryote**  |
| No cell wall | Has a cell wall  |
| Has a nuclear membrane  | Has no nuclear membrane (dna is in the cytoplasm) |
| Has golgi apparatus or endoplasmic reticulum | Has no golgi apparatus or endoplasmic reticulum |

Prokaryote cell wall size (0.2 microns to 2.0 microns) which is smaller than the eukaryote cell wall.

Both of them have ribosomes

mesosomes are artifacts in bacteria.

In bacteria we have :

1)cell wall (peptide and glycan)
2)Plasma membrane (lipid bilayer) ( which is the same in mammals & bacteria) phospholipids

Outside of plasma membrane ,we have the cell wall which has peptidoglycan and teichoic acid which is present in bacteria & not in mammalian cell ,mainly in gram + bacteria.

Lps :lipopolysaccharides which is part of the outer membrane of the gram – bacteria.

Endospores are not true spores .

In some bacteria,they can actually become dormant and form spores which are really resistant and can last for many many years ,like-seed can last for centuries and when conditions are right they can pulp and become bacteria again.

Endospores are part of the bacteria .don't confuse them with fungi,fungi has spores but are really used for reproduction so they are different from the bacterial Endospores.

bactrial endospores are non-reprodctive.
Endospores are called so because they are inside bacteria.

In addition to chromosomes ,we can have bits and pieces of DNA in the cytoplasm in separate of chromosomes ,which known As plasmid ,not all bacteria have it.

Plasmid : extra DNA

in Bacteria figure slide ,as you can see in the middle we have nucleoid which is circular but it maybe elongated .

Cytoplasm has:
 1)ribosomes

2) inclusion bodies

3)mesosomes which look like mitochondria but they're most likely artifacts.

-Plasma membrane is a typical lipid bilayer (hydrophobic inside & hydrophilic outside).

Out of plasma membrane ,we've cell wall (peptidoglycan)

out of the plasma membrane ,some bacteria may have polysaccharides layer which is known as capsule .

In some bacteria we may find appendages (flagella for motility).
Sometimes you may find some hair-like structures (pili & fimbria)

Fimbria is hair-like appendages used for adhesion & attachment of bacteria to the surrounding surface.
Pilli are used for multiplying & conjugation to exchange DNA from one bacteria to another.

 **Naming of bacteria :**
We first write the genus (with capital letter) ,in every genus there are several species.

 Species are written with small letter & sometimes in italic.
For example  : E.coli  ,e for Escherichia
Genus : Escherichia    Spice : coli

Staphylococcus aureus    Or  S.aureus:
Genus : staphylococcus    Spice : aureus

**Size of bacteria :**
0.5 micron to 2.0 micron
To imagine the size ,refere to The red blood cell which is 7 microns ,so for example :
If you have staphylococcus aureus that's 1 micron ,you can put 7 of them in the diameter of the red blood cell.
Most of bacteria are 1 micron in size.
**Surface area :**
Don't bother to memorize the surface areas.

 But one thing you should remember is that the ratio of surface area to volume in bacteria is much greater than mammalian cells which is in inverse relation to the size which is really good for bacteria to absorb from the surrounding environment.

* Nutrients move to bacteria from outside by by diffusion.

We classify bacteria according to the morphology and staining properties ,we also classify it according to its shape(morphological classification)
* 1) coccus :single ,plural : cocci
2) bacillus :single ,plural :bacilli  (rods)
3) Coccobacilli: not really coccus nor it's bacili
4) comma shape:looks like a comma
* 5) Spirillum(helical)
* 6) Spirochete(helical)
7) square & star are not relevant to us,not in human.
* Most of the bacteria are coccus or bacillus in shape
* Comma-shaped bacteria are not common

Kindly Refer to slide #18 if you'd like to see the structures mentioned above.

Coccus can exist in separate bacteria ,scattered all over the place.
* Sometimes when they divide they don't move away from one another ,they stay in pairs we call them **diplococcus**
* sometimes they keep dividing without separating completely so they produce a chain called **streptococci** .
* Some divide and then spread to produce aggregations of bacteria like staphylococcus.
Staphyl means a bunch of grapes.

Now,back to the bacterial structures :

Flagella is loco-motor organ which helps bacteria to move.

Anything which helps bacteria to grow better ,move bacteria ,spread better & cause more disease is called **pathogenic factor.**

Flagella for example help bacteria to move and spread the infection so it's a **pathogenic factor**

Pilli (fimbria) factors for adhesion so the bacteria can cause disease.
Bacteria in urinary tract :

if the bacteria there has no pili it'll be flushed by urea ,but due to pili they stick to the mucosa membrane & cause disease.
Pili allow DNA move between bacteria so it can pass pathological problems to others so pilli is **a pathogenic factor.**

Cell wall ,some of its components (lipopolysaccharides & teichoic acid) are **pathogenic factors**,they produce infection.

Plasma membrane is not really a pathogenic factor ,it's there for the integrity of the bacterial cell.

In cytoplasm we have genetic material ,ribosomes & inclusions.

As we mentioned before in some Bactria we have a polysaccharides layer which is called **capsule**.

Bactria which has a capsule is usually shiny & glowy due to the polysaccharides layer.

Capsule helps in adhesion so the bacteria sticks to surfaces easily to establish infection

capsule is also anti-phagostic how?

when neutrophils & white blood cells want to engulf the bacteria capsule helps the bacteria to escape.

 So the capsule is **a pathogenic factor**.

How does The Capsule help in prevention of phagocytosis?

1) is because it got a negative charge & WBC got a negative charge too so the effect doesn't come within reach for the WBC & neutrophil to engulf the bacteria.

-a competent of the immune system is called complement

2)Complement system: is a series of protein that  are activated to produce lysis of bacteria.

 so those proteins have to get to the plasma membrane ,the capsule prevents them from going inside so prevent the complementary effect & so the bacteria survive.

**That's why the capsule is pathogenic factor.(2 explanations above)**

The capsule does not take stains so when we look at bacteria which has a capsule ,it appears as a hollow around the bacteria.(empty space)

staphylococcus  present in the mouth so it helps the bacteria to adhere to the enamel of tooth to cause carries.

The cell wall is really important ,in mammalian cells ,rigidity of the plasma membrane is due to steroids in the plasma membrane itself whereas eukaryotic cells have no steroids in their plasma membrane so the plasma membrane is rather weak.
To compensate the weakness of its plasma membane , they have a cell wall to keep the integrity of the cell & it's shape.

The cell wall is made of peptidoglycan which occurs in layers (1-70)
**Gram negative** usually has 1 or 2 layers of peptidoglycan
**Gram positive** has a thick layer of peptidoglycan up to 70

slide #27

here we have a (gram negative bacteria) in the Bottom,we have plasma membrane (lipid bilayer structure)
above it ,we have One layer of peptidoglycan so the wall is weak ,to compensate the weakness, gram negative bacteria has an extra membrane called the outer membrane.
The outer membrane is different from the proper membrane.

both gram + & gram – bacteria have two leaves (outer & inner) in their membrane(proper)

both of the layers(leaves) are **identical** in the proper membrane but layers are Different in the **outer** membrane ,inner leaf is made of phospholipids whereas the outer leaf is made of lipopolysaccharides.

So inner (proper) membrane exists in both gram positive & gram negative bacteria
Outer (extra) membrane exists only in gram negative bacteria as a compensation for the weakness of its plasma membrane.