no.1

Microbiology

Doctor 2017 | Medicine | JU

Sheet Slides

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Contributed in the Scientific Correction

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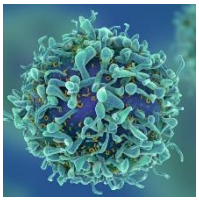
Introduction to microbiology

Let's start!

As you might have concluded, microbiology is the study of all organisms that are too small to be seen with the naked eye, Ex: bacteria, viruses, fungi, prions, protozoa and archaea. (**micro-organisms = microbes**)

The problem of this definition:

1- *all organisms*, since viruses aren't actual organisms, because if you examine them they are at the edge of life, meaning by that they have no real cellular structure, no metabolic activity
2- most importantly they can only replicate after they infect the cell and do not follow a common pattern of reproduction. (Prokaryotes: binary fission and Eukaryotes: sexual and asexual reproduction)



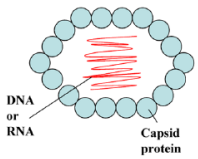
An Overview of Microbes – as covered in the lecture-

- ***viruses***: as we discussed above they're at the edge of life.

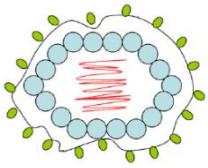
Features of Viruses:

1) They affect a wide variety of organisms (micro: bacteria, protozoa and even other viruses -as mentioned in the book- and macro: plants, animals and humans).
2) They fall on the nanometer range (10^{-9}m),
   - You should know that there are some exceptions: as some viruses are large -even larger than a bacterium- like: *Mimivirus* that infects the acanthamoeba -living soil amoeba- with a size of (400- 500) nm.
3) They have extremely simple structures.

- Further details:
   - All viruses have a nucleic acid whether single stranded or double stranded RNA or DNA
   - The nucleic acid is surrounded by a protein coat, called the capsid.
   - Some viruses are enveloped (such: HIV), and others are not AKA naked viruses.



Non-enveloped virus


Enveloped virus

Notes:

- Viruses can't produce a lipid membrane, so they take it from the host cell as they leave the host cell.
- The protein envelope is significant due to it providing specific host-virus interactions.
- As mentioned before viruses can infect all organisms but they are specific because of the interaction.

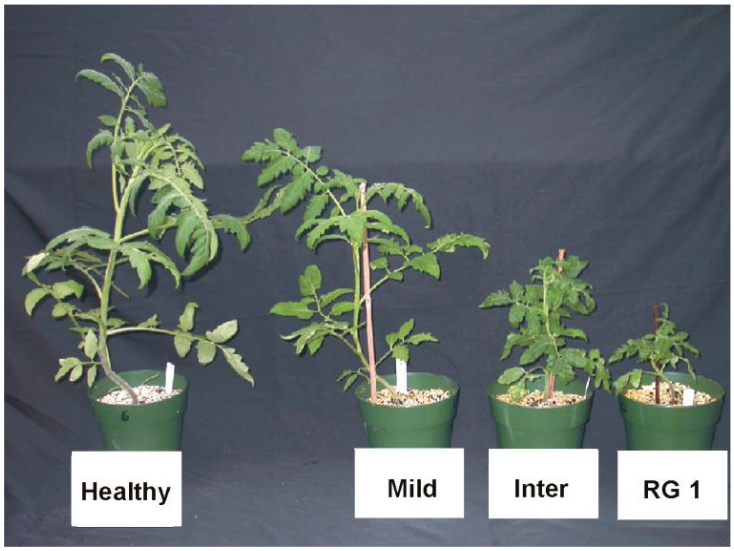
So, the steps of **internalizing a virus** -as follows-:

1- Interaction between the virus and the host occurs.
2- Glycoproteins in the virus' capsid attach to the membrane of the host then the penetration is achieved.
3- the virus starts creating proteins needed for its replication using the host's machinery (like: enzymes, ribosomes and amino acids).
4- many viral particles are formed
5- eventually, these particles are liberated by one of the following: lysis, exocytosis or budding out and taking some of host's membrane.

- ***Viroids***

1- They fall under viruses
2- Their nucleic acid is only the single stranded RNA
3- They only infect plant cells – no recent studies have proved that viroids infect humans-.

Ex: the following picture shows 4 different states of a tomato plant infected with viroid disease (as you can see the more intense the disease is the worse the plant is.)

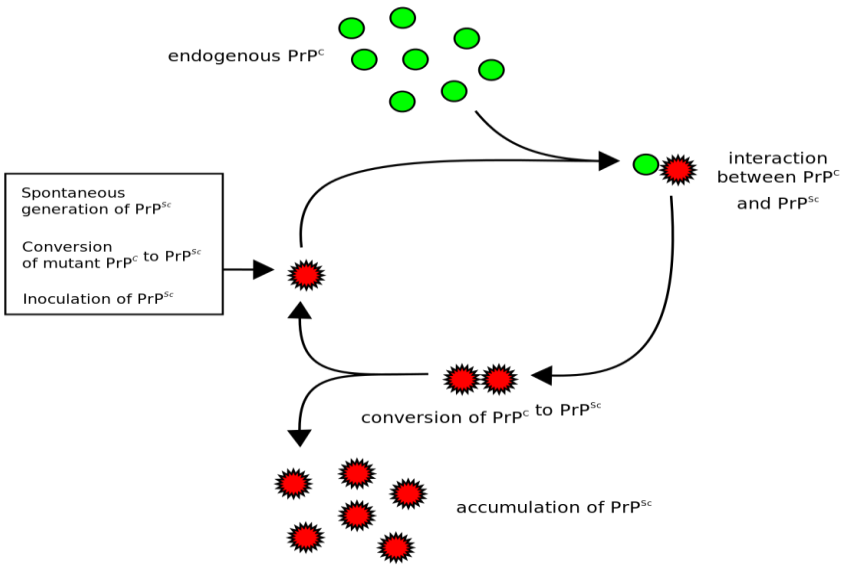


- ***Prions***

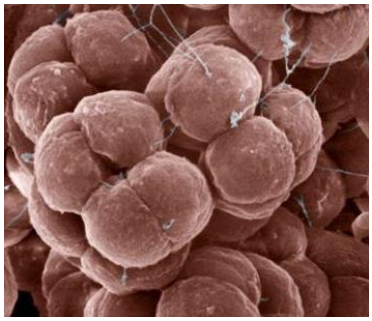
1) They are infectious misfolded pathogenic proteins.
2) They contain no nucleic acid (they're PROTEINS).
3) It starts with a normal protein interacting with a misfolded protein and ending up with 2 abnormal proteins that go interacting with other normal proteins and changing their conformation. (they become abnormal/misfolded)
4) They were first introduced from as the pathogenic agent behind the scrapie disease that infected sheep tissue (sections of abnormal brain histology were obtained then analyzed).
5) They are responsible for degenerative nervous tissue diseases in humans, including: Creutzfeldt-Jacob disease (sporadic-you don't need to be in contact with the infectious agent to develop it/ spontaneous), Fatal familial insomnia -fatal: deadly, insomnia: lack of sleep- (genetic), Kuru: -infectious, since some African tribes used to eat the brains of the dead, and these brains indeed were infected with prions.

PrP^{c} : cellular-normal prion proteins, PrP^{sc}: scrapie-abnormal prion protein.

Note for future surgeons: you must sterilize your equipment before doing surgery to avoid the risk of infecting your patient with prion disease due to your contaminated apparatus.



- ***Prokaryotes***



1) Pro: before, karyon: nucleus, so they don't have an actual nucleus (nuclear membrane) and this is the demarcation between them and eukaryotes (with actual membrane bound nucleus).
2) They are small, microscopic organisms (10^{-6}m).
3) They usually have ribosomes (to form proteins from the chromosomal DNA) and no organelles (membrane bound subcellular structures) but that's not always the case, since photosynthetic bacteria have chromatophores.

4) They have a single haploid chromosome that is 1mm long (folded into 1000 folds to fit inside the membrane of the prokaryote), it's found in a specific region of the cell called: ***nucleoid***
5) They divide by binary fission and might have flagellum/ flagella for motility.

   * ***Endosymbiosis and evolution:*** studies show that mitochondria and chloroplasts in the eukaryotes were originally bacterium ingested by the cell and kept for its important function.

   ** to prove the above, we present some similarities:

i. Mitochondria and chloroplasts have circular DNA resembling the bacterial.
ii. Both are bound by membrane like the bacterial.
iii. Both replicate like bacteria through binary fission.

- ***Subgroups of prokaryotes***:

1. It's recent that prokaryotes were subdivided to 2 groups ***bacteria and archaea***, since archaea have characteristics worthy of being recognized as different from the other organisms.
2. Why was it hard to conduct a lot of studies on archaea?
   Since it was known that they only lived in extreme condition like very high or very low temperatures, pH that doesn't support life and oxygen free environment, making it hard to study in the laboratory.
3. Recently microbiologists found that archaea aren't restricted to extreme conditions, but also found within our bodies.

Classification of prokaryotes (mainly bacteria)

- Why should we classify prokaryotes?

Since it's very important for clinicians to deal with the threats of microorganisms.

- How to classify?

By using some characteristics that aren't amongst all bacteria as useful criteria, for example:

1) Structural features: like spores – structures formed by some bacteria to survive stressful environments.
2) Biochemistry: gram stain which results reflect fundamental and complex differences in the bacterial cell surfaces.
3) Genetic criteria: phylogenetic relatedness (organisms that share common ancestry or evolutionary relationship) , and how genetically bacteria are related.

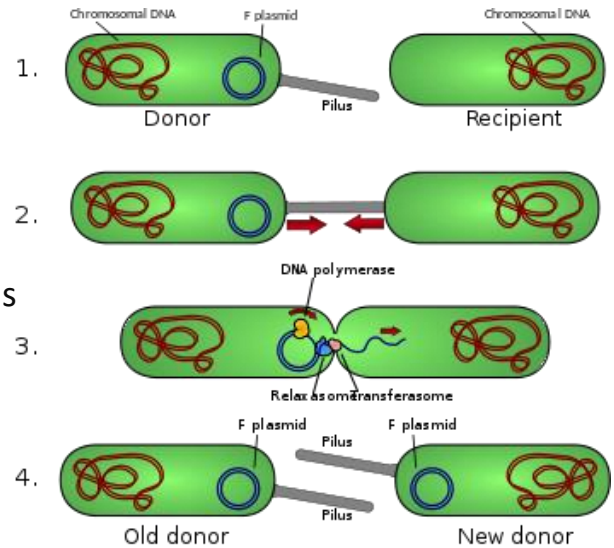
Diversity of prokaryotes:

- Have you wondered why bacteria have a single chromosome carrying few and limited number of genes?

It's because they live in various environments, so they should adapt by producing certain proteins suiting their surrounding which leads to high genetic variability and diversity.

- Lateral gene transfer – road to diversity:

1) This process needs plasmid (circular transmissible piece of DNA) that is used to exchange and transfer genetic traits between bacteria themselves and other organisms.
2) This happens as follows: 2 bacterial cells meet, and one extends a pilus to the other then the plasmid is shared and replicated giving the recipient a new trait like antibiotic resistance.

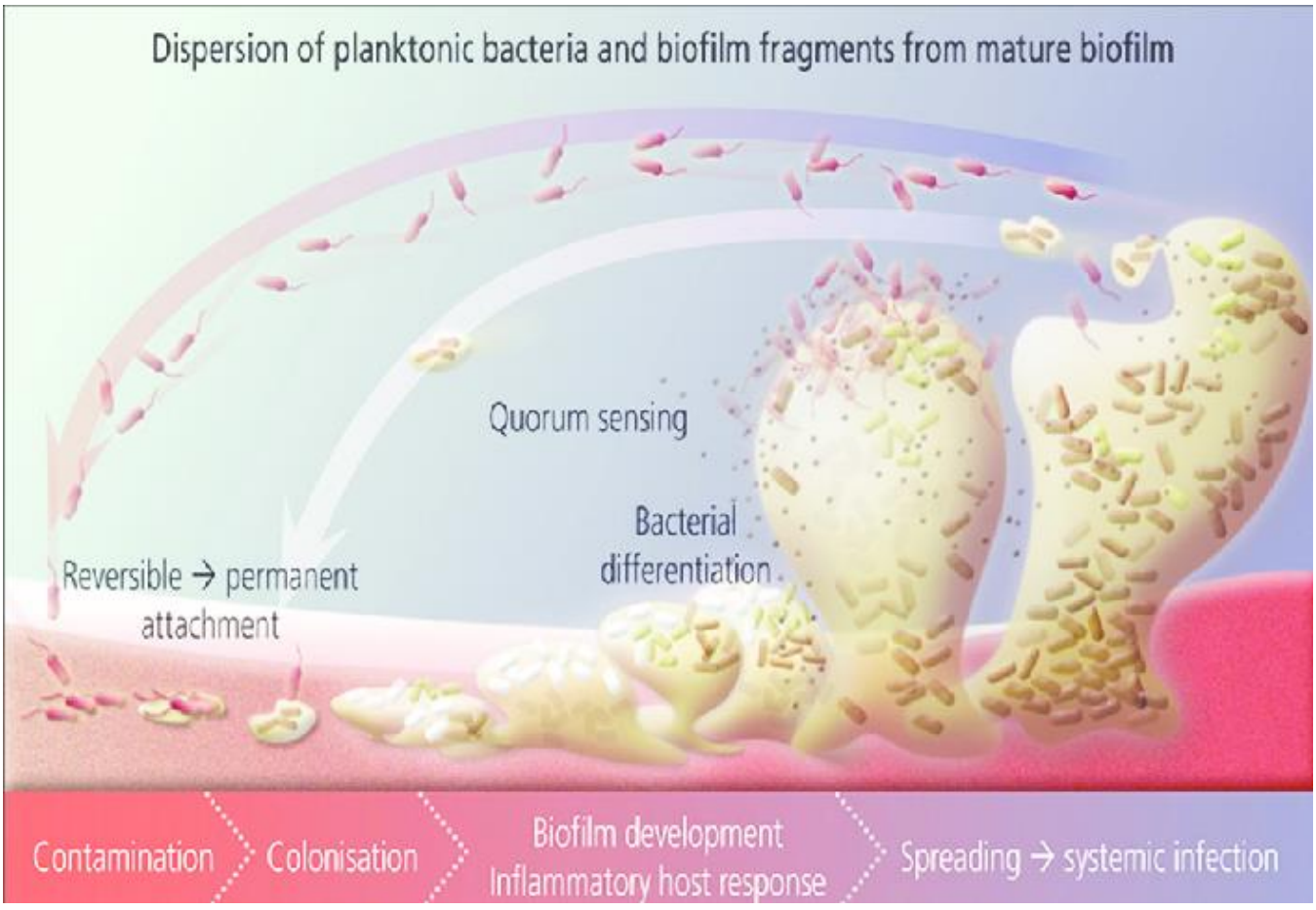


* ***Pilus: hair like appendage on the surface of many bacteria.***

- ***Communities of Prokaryotes***:

1) It was thought that individual bacterium was similar in characteristics to the bacteria colonies.
2) It was found that they are quite different
3) Biofilm production clears points 1 and 2:

i. Bacteria start to attach to any surface (let's say your skin).
ii. At first the attachment is reversible, but as the bacteria invade deeper it becomes permanent.
iii. Bacteria then colonize and initiate the biofilm production
iv. Quorum Sensing can happen as multicellular/ cell-cell communication so bacteria can control its own population density through signals and sometimes regulating the transcription of genes resulting in changing features, so the colonies can survive and grow better.



The End.