

DOCTOR 2020 | JU



# MICROBIOLOGY

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## ملاحظات مهمة :

- هذا الشيت من دفعة 019 وهو مطابق لما شرحته الدكتوراة في محاضراتنا وأضاف جملة واحدة هي:-

**"Normal Flora maybe one of the Primary deffence in the Immune system"**

- الأسماء اللي على الجسم بصفحة ٢ حفظ.
- أسماء العلماء وانجازاتهم حفظ والتواريخ لأ.
- آخر صفحة ونص الدكتوراة ما شرحتهم لسا.

**بالتوفيق**

**Medical Microbiology:** is a science of studying micro-organisms that are associated with human disease **The topic of the course**

## **FIELDS OF Microbiology :**

1) **Medical microbiology:** This field focuses on pathogens, diseases, and body defenses. Immunology, Virology, Bacteriology, Mycology علم الفطريات, and Parasitology علم الطفيليات .

2) **Industrial microbiology:** This field focuses on the production of alcohol, enzymes, vitamins, and antibiotic.

3) **Agricultural microbiology:** This field is concerned with Soil fertilization, the role of microorganisms in natural cycles of important elements such as nitrogen, carbon, sulfur, and phosphorous cycles, as well as plant disease because of microbes infections.

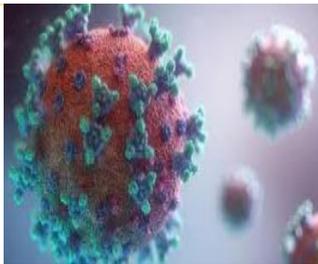
4) **Food microbiology:** This field focuses on food poisoning, toxicity and spoilage, we will focus in part of the course on some microorganisms and their toxicity in food

5) **Molecular microbiology:** deals with molecular mechanisms and physiological processes of microbes and utilization in production of biotechnology products such as vaccines, and antibodies.

6) **Sanitary microbiology:** is a science based on the detection of risks associated with the production, manufacture and consumption of foods and water. It has been established that environment facts determine the survival, growing and inactivation of the microorganisms.

7) **environmental microbiology:** is the study of the composition and physiology of microbial communities in the environment.

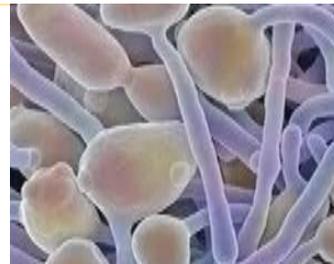
## **Four classes of organisms that can cause disease:**



**1- Viruses:** Their size < 0.3 microns in diameter, they are totally **dependent** on infected cells for replication. They cause intracellular infection. They can't replicate unless it infect a cell, and ruins its metabolic mechanism.



**2- Bacteria:** Usually measure about one micron or more, multiply by binary fission (انشطار ثنائي), and they can cause intercellular or extracellular infection.



**3- Fungi,** these can be of two varieties:  
**a- Yeasts (خمائر)** are unicellular organisms measuring (2-20) microns.  
**b- Mold (عفن)** are large multicellular organisms.



**4- Parasites:** these can be of two classes:  
**a- Protozoa,** these are unicellular organisms that vary in size, some are very small (about 3 microns) and can cause intercellular infection. Others are large (80 microns) and cause extracellular infection.  
**b- Helminthes (metazoa),** these are multicellular and can reach several meters in lengths.

## Portal of entry

Microorganisms that cause disease are said to be pathogenic.

- Respiratory: via inhalation.  
الاستنشاق
- Alimentary (GIT): by ingestion.
- Genital tract: sexual contact.
- Skin: abrasions, bites... خدوش، عضات
- Others: Conjunctiva الملتحمة, blood transfusion, injections and organ transplants.
- Congenital infections عدوى خلقية (vertical transmission), transferred from the mother to the fetus

## Infection with microorganisms can be

**Endogenous infection:** some bacteria and fungi live normally in human bod; they are useful; called normal flora, unless their location is changed, then it transforms from normal flora to pathogenic bacteria because of change of normal habitat, damage of skin and inappropriate antibiotic use which kills normal flora; which is a defensive line (further explanation next lecs)

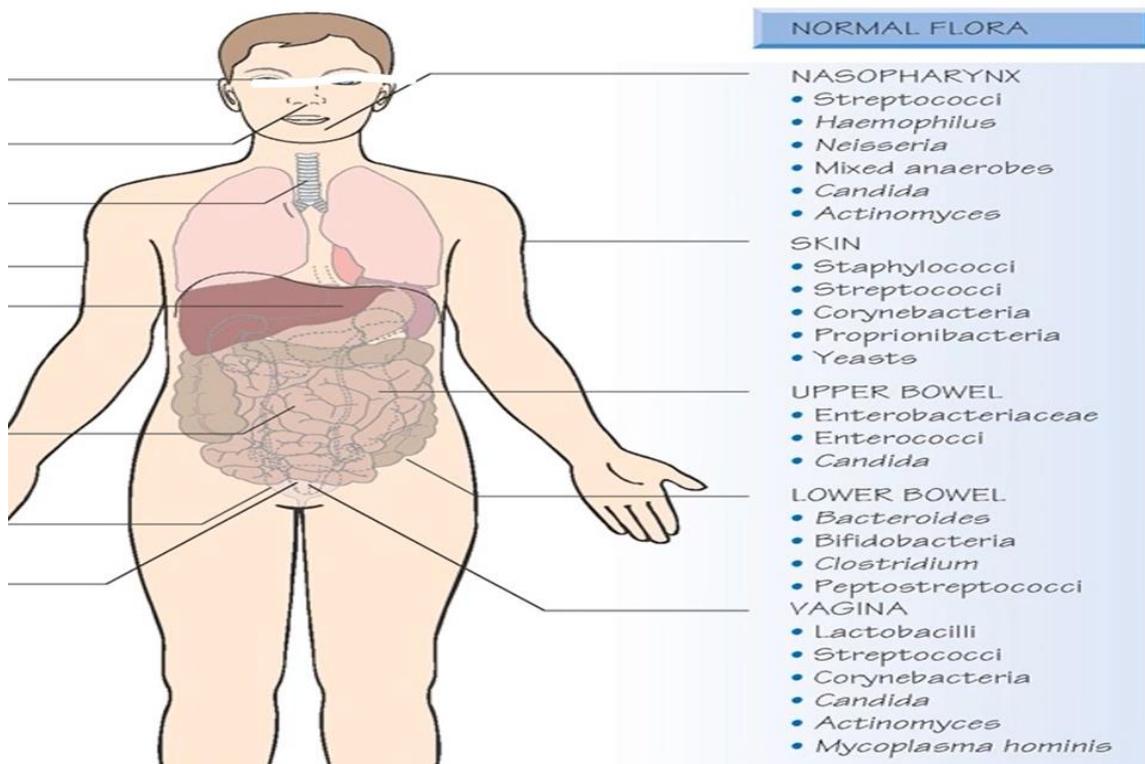
## Exogenous cross-infection:

Mainly through hands of healthcare workers, visitors, patients.

- ❖ A microbe causes a disease = pathogen, while microbe has a benefit for another organism= normal flora
- ❖ The majority of Microbes Benefit human, animals and plants.
- ❖ One microbe can be a normal flora an a pathogen, how? If a normal flora changes its location, then it can be a pathogen

**Microbes and human welfare:** most of the following are repeated.. just smile

- **Normal Body Flora.** it is used to describe the various bacteria and fungi that are permanent residents of certain body sites (maybe two sites at the same time) especially the **skin, colon, oropharynx and vagina**. The members of normal flora vary in both number and kind from one to another site. Although the normal flora extensively populates many areas of the body, the internal organs usually are sterile such as CNS, blood, lower bronchi, alveoli, liver, spleen, kidney and bladder are free of all but the occasional transient organisms. (sterile معقمة )



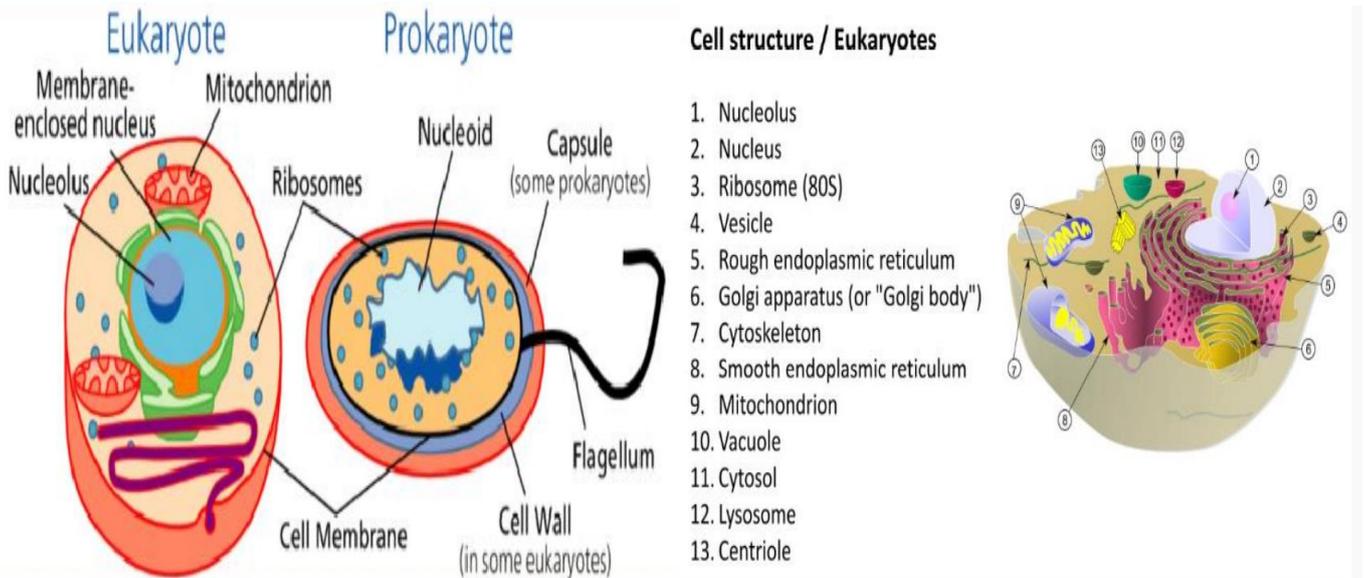
# Summary of the members of normal flora and their anatomic location

## Summary of the members of normal flora and their anatomic location

<p><b>Colon:-</b> Bacteroides species, Clostridium species, Enterococcus faecalis, Escherichia coli, coliforms, lactobacillus species, Pseudomonas aeruginosa, Bacteroides fragilis, Escherichia coli</p>
<p><b>Throat:-</b> Viridans streptococci</p>
<p><b>Vagina:-</b> Bacteroides species, Candida albicans, Corynebacterium species (diphtheroids), Escherichia coli, coliforms, Gardnerella vaginalis, lactobacillus species, Staphylococcus epidermidis, group B streptococci</p>
<p><b>Nasopharynx:-</b> Corynebacterium species (diphtheroids), Haemophilus species, Neisseria species, Viridans streptococci</p>
<p><b>Mouth:-</b> Candida albicans, lactobacillus species, Neisseria species, Viridans streptococci</p>

<p><b>Skin:-</b> Candida albicans, Staphylococcus epidermidis, Pseudomonas aeruginosa, Propionibacterium, peptococcus and Corynebacterium species (diphtheroids),</p>
<p><b>Urethra:-</b> Less Important Organisms:- Staphylococcus epidermidis Corynebacterium (diphtheroids), Various streptococci, Various gram negative rods, e.g. E. coli</p>
<p><b>Conjunctiva:-</b> Haemophilus species</p>
<p><b>Nose:-</b> Staphylococcus epidermidis, staphylococcus aureus</p>
<p><b>Dental plaque:-</b> Streptococcus mutans</p>
<p><b>Gingival crevices:-</b> Various anaerobes, e.g. Bacteroids, Fusobacterium, streptococci, Actinomyces</p>

- Bacteria is used in sewage treatment, recycling water. (Bioremediation)
- Fermentation of some products, in food industry, yeast is used in pastries and bread.
- Antibiotics production; penicillin from fungi is used to treat some bacterial infections
- Microorganisms are used in insect pest control: (viruses, bacteria and fungi) or their bioactive agents can be used as active substances and therefore are referred as Microbial Pest Control Agents (MPCA)
- Bacteria is used now in modern biotechnology such as genetic engineering, insulin, enzymes, vitamins production.
- Bacteria participate in recycling vital elements in the environment such as nitrogen, carbon, oxygen, sulfur, phosphorus, etc.



**Microorganisms can be eukaryotic (eu: حقيقي , karyot: نواة) prokaryotic ( pro: بدائي) or subcellular (viruses):**

Prokaryotes and eukaryotes are distinguished on the basis of their cellular characteristics. For example, **prokaryotic cells** lack a nucleus and other organelles, but may have flagellum, cell wall and capsule. They include **bacteria, blue-green algae.**

while **eukaryotic cells** have both a nucleus and organelles. They include such microorganisms as **fungi, protozoa, and simple algae.**

Both have **plasma membrane**, use **DNA** for their genetic information and have **ribosomes**, but 80S (found in eukaryotes) ribosomes are bigger than 70S ribosomes (found in prokaryotes)

**Viruses** are considered neither prokaryotes nor eukaryotes because **they lack the characteristics of living things, except the ability to replicate** (which they accomplish only in living cells)

**Size and shape**

Prokaryotes are probably the **smallest living organisms**, ranging in size from 0.15 μm (mycoplasmas) to 0.25 μm (chlamydiae) to 0.45 μm (rickettsiae) to about **2.0 μm (many of the bacteria).**

Eukaryotic cells are generally larger and more complex than prokaryotic cells. **Size ≥3 μm in diameter**

Prokaryotes vs Eukaryotes ribosomes:

prokaryotes have smaller ribosomes, this property is used to target bacterial protein synthesis with antibiotics( some antibiotics inhibit bacteria by inhibiting 70S ribosomes only; further explanation next lectures also)

## Prions (infectious agent)

→ The term "prion" is derived from **proteinacious infectious particle** and refers to the pathogen that causes transmissible spongiform encephalopathies (TSEs).  
 → This small infectious particle is a disease-causing form of a protein called **cellular prion protein (PrPc)**.  
 → PrPc is mainly found on the **surface of cells in the central nervous system**, but it is also located in other bodily tissues.

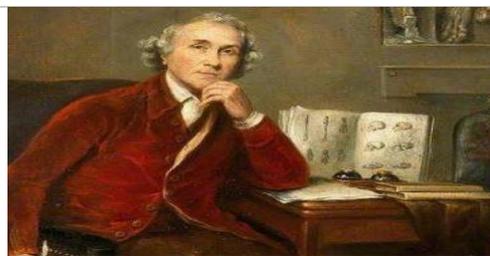
Characteristics	Viruses	Bacteria	Fungi	Protozoa and Helminthes
Cells	No	Yes	Yes	Yes
Approximate diameter (µm)	0.02-0.2	0.5-2	3-10	15-25
Nucleic acid	Either DNA or RNA	Both DNA and RNA	Both DNA and RNA	Both DNA and RNA
Type of nucleus	Non	Prokaryotic	Eukaryotic	Eukaryotic
Ribosome	absent	70S	80S	80S
Mitochondria	Absent	Absent	Present	Present
Nature of outer surface <small>Further explanation next</small>	Protein capsid and lipoprotein envelope	Rigid wall containing peptidoglycan	Rigid wall containing chitin	Flexible membrane
Motility	None	Some	None	Most
Method of replication	Not binary fission	Binary fission	Budding or mitosis	Mitosis

Prof. Dr. Ghada Fahmy Helaly

- A prion is composed of **abnormally folded protein** that causes progressive neurodegenerative conditions, with two of the most notable being **Bovine spongiform encephalopathy (BSE or mad cow disease)** seen in cattle, and **Creutzfeldt-Jakob disease (CJD)** seen in humans.
- Transmitted by **ingestion**. Sometimes **iatrogenic route** (relating to illness caused by medical examination or treatment) e.g. blood transfusion, reuse of needles or IV sets, also drugs may cause side effects which can lead to iatrogenic disease.



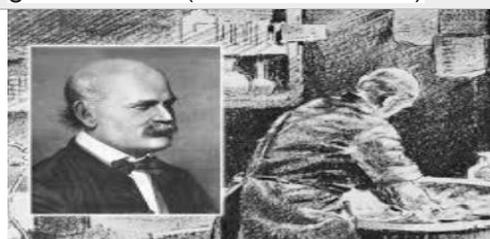
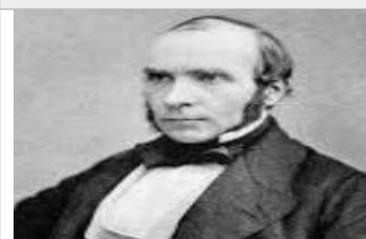
**Antony van Leeuwenhoek** 7<sup>th</sup> c: Dutch microscopist who was the first to observe live microorganisms in water mud and saliva



**John Hunter** 8<sup>th</sup> c: Scottish surgeon he was considered the leading authority on venereal diseases (تناسلية), and believed that Syphilis and Gonorrhea were caused by a single pathogen. But later on it was discovered that what causes syphilis is *Treponema pallidum*, while what causes Gonorrhea is *Neisseria gonorrhoeae* (both are bacteria)



**Edward Jenner** 18<sup>th</sup>-19<sup>th</sup> c: An English physician and scientist who pioneered the concept of vaccines including creating the smallpox vaccine, the world's first vaccine.



**John Snow** 19th c: An English physician, known for locating source of cholera outbreak in London (thus establishing the disease as water-borne) "انتقال المرض عبر الماء", also he is considered one of the founders of modern epidemiology



**Ignaz Semmelweis** 19th c: A Hungarian physician and scientist, known as early pioneer of antiseptic procedures. Described as the "savior of mothers", he discovered that the incidence of Puerperal sepsis (حمى النفاس) can be prevented if the attending nurses apply hygienic measures. Hand washing stops infections

**Robert Koch** 19th c: Developed microbiological media & streak plates for pure culture (so we could get the microbe pure from its culture; further explanation later). Previously, it was believed that the disease occurs by itself, not because of a microbe.

**Germ theory (Koch's postulates):**

- Microorganism must be present in every case of the disease.
- Organism must be grown in pure culture from the diseased host. If we cultured the infected part, there must be the microbe in it
- Inoculation of above into host must give same disease.
- Organism must be recovered from experimentally infected host.

\* remember first lec in immune\*

**Louis Pasteur** 19th c: French biologist, microbiologist, and chemist.

1. Discovered the principle of Fermentation of alcohol by microorganisms.
2. Invent a technique of treating milk and wine to stop bacterial contamination, a process called pasteurization (will talk about it later)

3. Created the first Vaccines of rabies (داء الكلب), Bacillus anthrax (الجمرة الخبيثة)

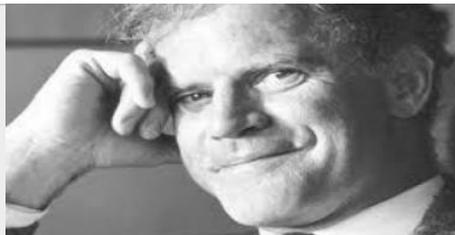
**Louis Pasteur and the germ theory**

Louis Pasteur worked in the middle and late 1800s. He performed numerous experiments to discover why wine and dairy products became sour, and he found that bacteria were to blame. Pasteur called attention to the importance of microorganisms in everyday life and stirred scientists to think that if bacteria could make the wine "sick," then perhaps they could cause human illness.

Pasteur's attempts to prove the germ theory were unsuccessful.



**Alexander Fleming** – 1928 – A Scottish physician and microbiologist, his best known discovery the world's first broadly effective antibiotic (Penicillin G) from the mould *Penicillium rubens* in 1928.



**Kary Mullis** 1986: An American biochemist, invent Polymerase Chain Reaction (PCR) technique.



**Zur Hausen** : A German virologist, He has done research on cancer of the cervix, where he discovered the role of papilloma viruses, This research directly made possible the development of a vaccine HPV

## Common terms

- ❖ **Incubation period** وقت الحضانة: the time between acquisition of the organism & the beginning of symptoms, it varies from hours to days to weeks according the type of microbe.
- ❖ **Period of communicability** فترة العدوى (infectious period): the time during which the infectious agent may be transferred directly or indirectly from an infected person to another person. Asymptomatic, carrier, an origin of infection to others
- ❖ **Mortality rate:** is a measure of the frequency of occurrence of death in a defined population during a specified interval.

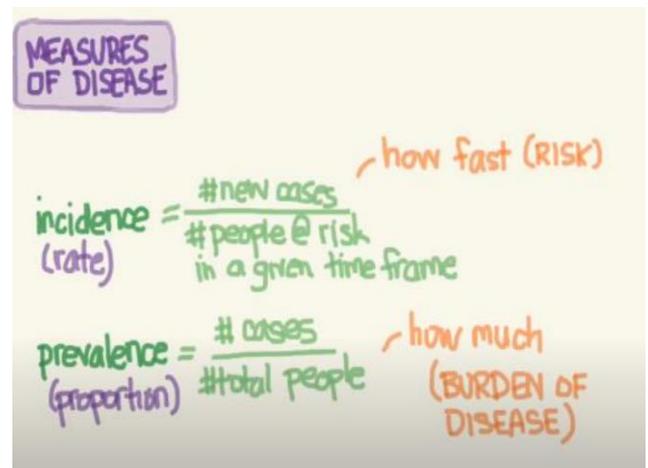
- ❖ **Incidence rate:** “is a measure of the disease risk” refers to the number of new cases of a disease within a specific time period.

Rate, how fast the risk is, looking to the number of new cases in specific period of time

- ❖ **Prevalence:** “is a measure of the disease burden” a statistical concept referring to the number of cases of a disease that are present in a particular population at a given time.

Proportion( percentage) how much burden is the disease, no time frame, how much the disease is there in a population, how many are sick ans how many we have to care for.

- ❖ **Case fatality rate:** “is a measure of the severity of the disease” , is the proportion of deaths from a certain disease compared to the total number of people diagnosed with the disease for a particular period.
- ❖ **Endemic infection:** a disease that exists permanently in a particular region or population. Malaria is a constant worry in parts of Africa.
- ❖ **Epidemics:** is the rapid spread of disease to a large number of people in a given population within a short period of time.
- ❖ **Pandemic:** when an epidemic spreads throughout the world, “has spread across a large region, for example multiple continents or worldwide”



Nurses, doctors and other healthcare workers can get 100s or 1000s of bacteria on their hands by doing simple tasks, such as:

- pulling patients up in bed
- taking a blood pressure or pulse
- touching a patient's hand
- rolling patients over in bed
- touching the patient's gown or bed sheets
- touching equipment like bedside rails, over-bed tables, IV pumps

Culture plate showing growth of bacteria 24 hours after a nurse placed her hand on the plate.

To control any disease, keep washing your hands  
 Doctors and nurses have highly risk of getting microbes on their hands