



Introduction to medical microbiology

كتابة وتدقيق: -منذر بويطل -الحارث حسن

Medical Microbiology: is a science of studying micro-organisms that are associated with human disease.



FIELDS OF Microbiology :

1- Medical microbiology:

This field focuses on pathogens, diseases, and body defenses.

Microbiology includes Virology, Bacteriology, Mycology, and Parasitology and connected to immunology.




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

3- Agricultural microbiology: *This field is concerned with Soil fertilization, **in addition to role of microorganisms in process of recycling the most important elements in nature such as** nitrogen, carbon, sulfur, and phosphorous cycles, as well as plant disease **caused by microorganism**.*

4- Food microbiology **(how food could be contaminated through microorganism it self or from toxins come from it):** *This field focuses on food poisoning, toxicity and spoilage **such as spoilage of vegetable caused by fungi**.*

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.

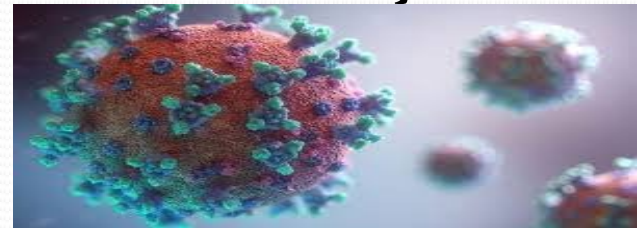
7- environmental microbiology: is the study of the composition and physiology of microbial communities in the environment.

**** There are four classes of organisms that can cause disease:**

1- Viruses:

Their size < 0.3 microns in diameter (**very small**), they are totally dependent on infected cells for replication (**they can't do replication outside the cell**). They cause intracellular infection.

1 micron =1 micrometer



2- Bacteria:

Usually measure about one micron or more, multiply by binary fission, and they can cause intercellular or extracellular infection.



3- Fungi, these can be of two varieties:



a- **Yeasts** (الخمائر) are unicellular organisms measuring (2-20) microns.

b- **Molds** (العفن) 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.
- Alimentary (GIT): by ingestion.
- Genital tract: sexual contact.
- Skin: abrasions, bites...
- Others: Conjunctiva, blood transfusion, injections and organ transplants.
- Congenital infections (vertical transmission)
moves from the mother to her embryo .

Infection with microorganisms can be

- ✓ **Endogenous infection:**

- ✓ When normal patient flora change to pathogenic bacteria because of change of normal habitat, damage of skin and inappropriate antibiotic use.

-antibiotic can cause infection by killing the normal flora which are describe to be the first line of defense in the body.

- ✓ **Exogenous cross-infection:**

- ✓ Mainly through hands of healthcare workers, visitors, patients.

-Such as nosocomial infection that come to patient from hospital due to contamination.

MICROBES AND HUMAN WELFARE:

The majority of Microbes Benefit human, animals and plants.

- Normal Body Flora (**First line of defense**).

it is used to describe the various bacteria and fungi that are permanent residents of certain body sites especially the skin, colon, oropharynx and vagina (**if there location change they become a pathogen**).

The members of normal flora vary in both number and kind from one to another site

MICROBES AND HUMAN WELFARE:

- 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.

All this examples are
for memorizing ☹

NORMAL FLORA

NASOPHARYNX

- *Streptococci*
- *Haemophilus*
- *Neisseria*
- Mixed anaerobes
- *Candida*
- *Actinomyces*

SKIN

- *Staphylococci*
- *Streptococci*
- *Corynebacteria*
- *Propionibacteria*
- *Yeasts*

UPPER BOWEL

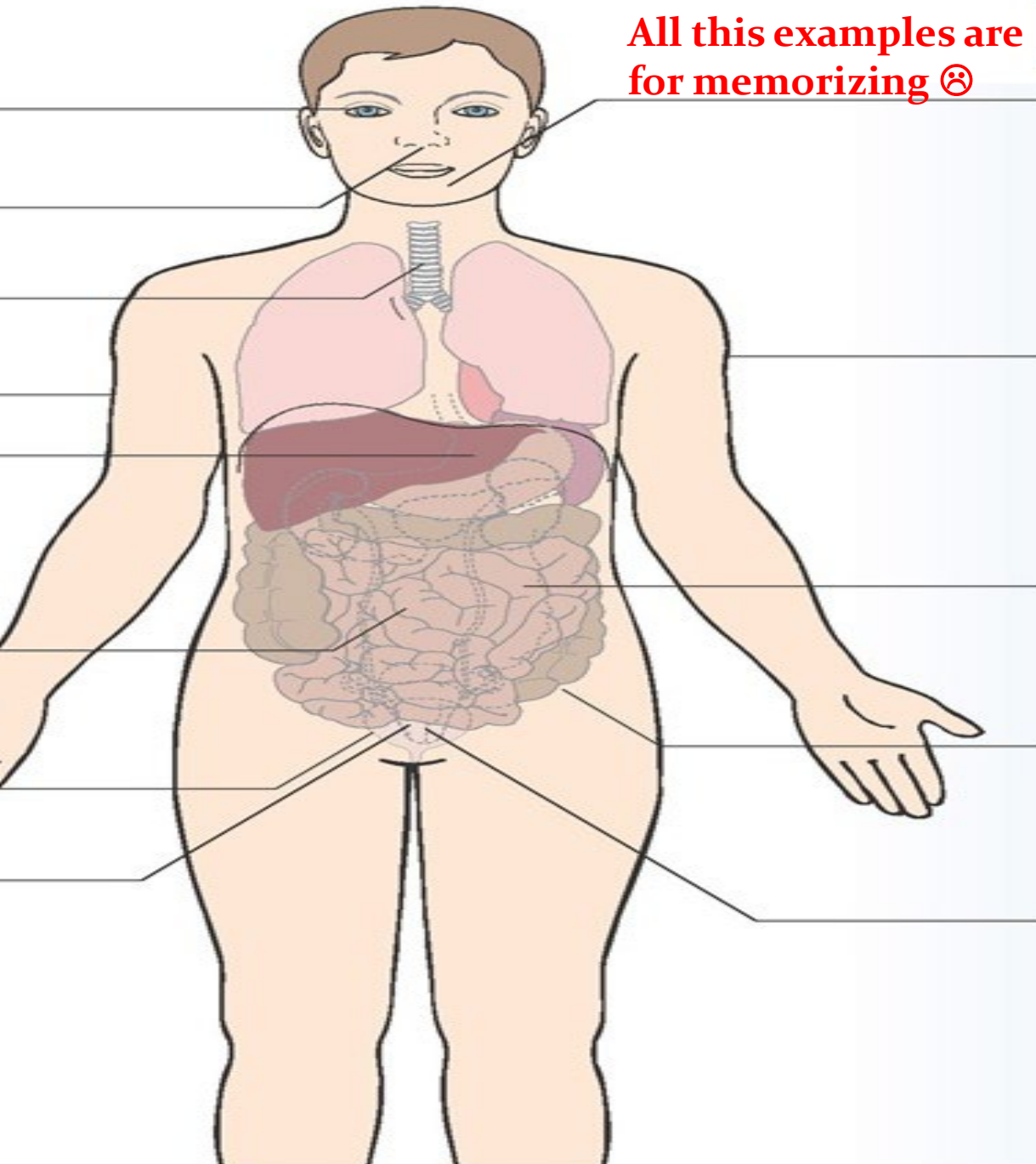
- *Enterobacteriaceae*
- *Enterococci*
- *Candida*

LOWER BOWEL

- *Bacteroides*
- *Bifidobacteria*
- *Clostridium*
- *Peptostreptococci*

VAGINA

- *Lactobacilli*
- *Streptococci*
- *Corynebacteria*
- *Candida*
- *Actinomyces*
- *Mycoplasma hominis*



COULD BE EASIER WAY TO MEMORIZE

-Nasopharynx

صحن مكة

S H N M C A

Streptococci

Haemophilus

Neisseria

Mixed Anaerobes

Candida

Actinomyces

-Lower Bowel

شبكة BBC الإخبارية

B B C + P

Bacteroides

Bifidobacteria

Clostridium

peptostreptococci

مع تحيات
الزميل حمزة
العيان

Summary of the members of normal flora and their anatomic location

Summary of the members of normal flora and their anatomic location

Colon:-

Bacteroides species, Clostridium species, Enterococcus faecalis, Escherichia coli, coliforms, lactobacillus species, Pseudomonas aeruginosa, Bacteroides fragilis, Escherichia coli

Throat:-

Viridans streptococci

Vagina:-

Bacteroides species, Candida albicans, Corynebacterium species (diphtheroids), Escherichia coli, coliforms, Gardnerella vaginalis, lactobacillus species, Staphylococcus epidermidis, group B streptococci

Nasopharynx:-

Corynebacterium species (diphtheroids), Haemophilus species, Neisseria species, Viridans streptococci

Mouth:-

Candida albicans, lactobacillus species, Neisseria species, Viridans streptococci

Skin:-

Skin:-

candida albicans , Staphylococcus epidermidis , Pseudomonas aeruginosa , Propionibacterium , peptococcus and Corynebacterium species(diphtheroids),

Urethra:-

Less Important Organisms:-

Staphylococcus epidermidis

Corynebacterium(diphtheroids), Various streptococci , Various gram negative rods, e.g. E.coli

Conjunctiva:-

Haemophilus species

Nose:-

Staphylococcus epidermidis, staphylococcus aureus

Dental plaque:-

Streptococcus mutans

Gingival crevices:-

Various anaerobes , e.g. Bacteroids, Fusobacterium, streptococci, Actinomyces

MICROBES AND HUMAN WELFARE:

- Bacteria participate in recycling vital elements in the environment such as nitrogen, carbon, oxygen, sulfur, phosphorus, etc.
- Bacteria is used in sewage treatment, recycling water (we can use this water to Irrigate crops).
(Bioremediation)
- Fermentation of some products, in food industry.
- Antibiotics production such as penicillin which comes from fungi.

MICROBES AND HUMAN WELFARE:

- 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.

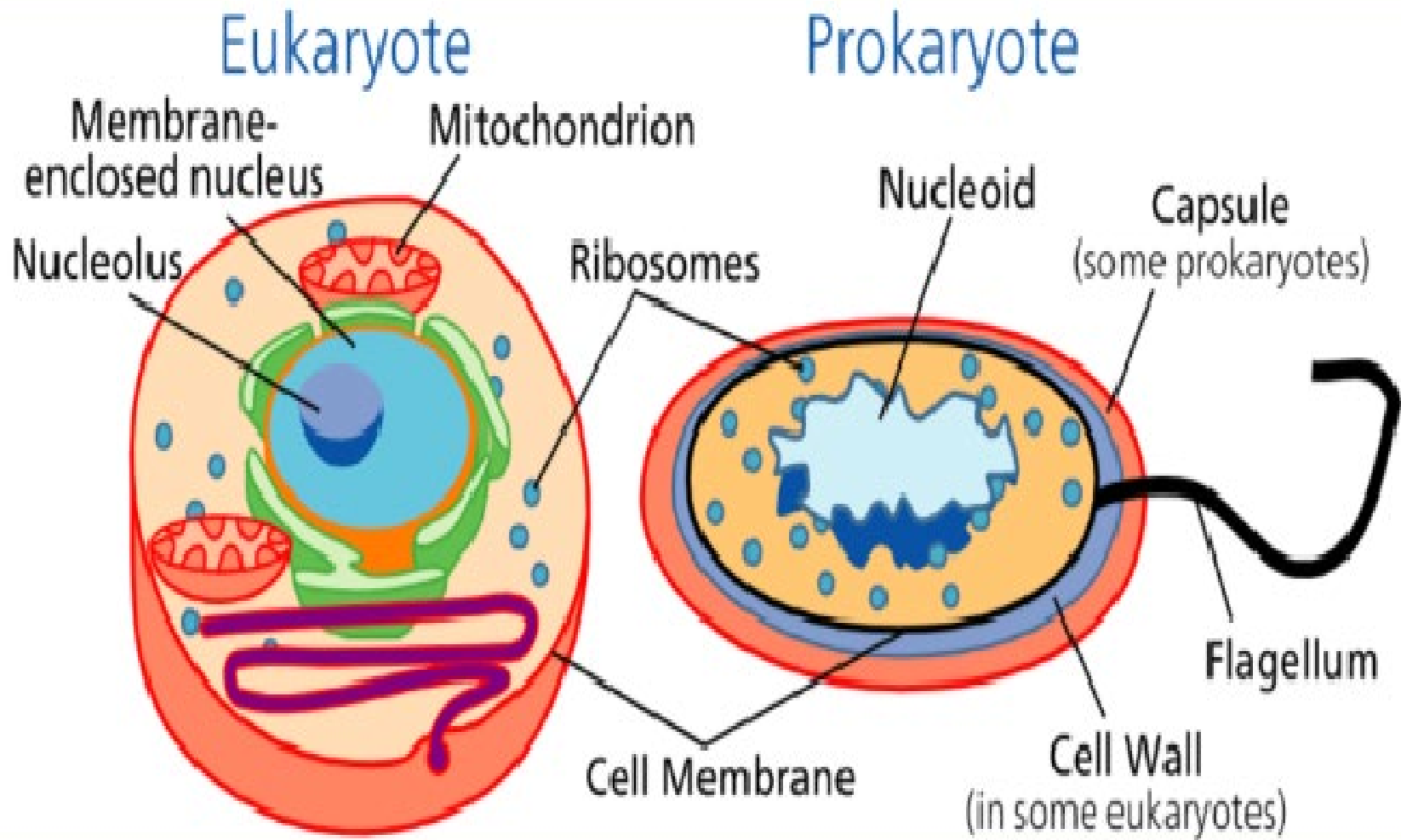
Micro-organisms are abundant in our environment, not all are harmful, and indeed some are useful.





Microorganisms can be eukaryotic, prokaryotic or subcellular:

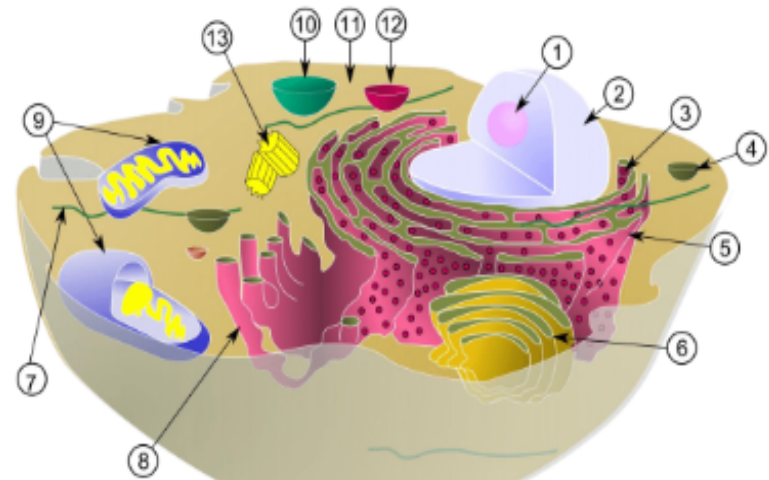
- Prokaryotes and eukaryotes are distinguished on the basis of their cellular characteristics. For example, prokaryotic cells lack a nucleus and other organelles, while eukaryotic cells have both a nucleus and organelles.




- Ribosomes in prokaryote are different from ribosome in eukaryote.
- Ribosomes in prokaryote become a target for antibiotics because if you stop ribosome from working you stop protein synthesis in the cell which will kill it.

Cell structure / Eukaryotes

1. Nucleolus
2. Nucleus
3. Ribosome (80S)
4. Vesicle
5. Rough endoplasmic reticulum
6. Golgi apparatus (or "Golgi body")
7. Cytoskeleton
8. Smooth endoplasmic reticulum
9. Mitochondrion
10. Vacuole
11. Cytosol
12. Lysosome
13. Centriole





-Prokaryotic and eukaryotic cells are similar in several ways. Both types of cells are enclosed by cell membranes (plasma membranes), and both use DNA for their genetic information.

-Prokaryotes include bacteria, blue-green algae.

-Eukaryotes include such microorganisms as fungi, protozoa, and simple algae.

-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 $\geq 3 \mu\text{m}$ in diameter
- **Prokaryotes vs Eukaryotes ribosomes:**
Prokaryotes have smaller ribosomes, this property is used to target bacterial protein synthesis with antibiotics.

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	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

-extra note(from google☺) S: sedimentation unit of ribosomes which is (svedberg). Is the measure used to differentiate the ribosomes which called the sedimentation coefficient .It helps to measure the particle's size based on the sedimentation rate (time taken by a particle of given size and shape settles to the bottom of a solution)

Prions (infectious agent)

- The term "prion" is derived from proteinacious infectious particle and refers to the pathogen that causes transmissible spongiform encephalopathies (TSEs) (الاعتلال الدماغى الإسفنجى (جنون البقر)).
- 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.

Prions

- 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.

Short History:



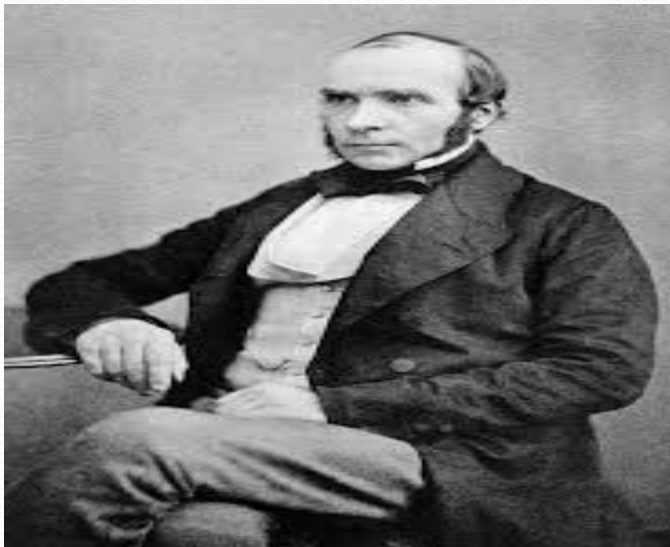
Antony van Leeuwenhoek 17th c: (father of microbiology), Dutch microscopist who was the first to observe live microorganisms in water mud and saliva.



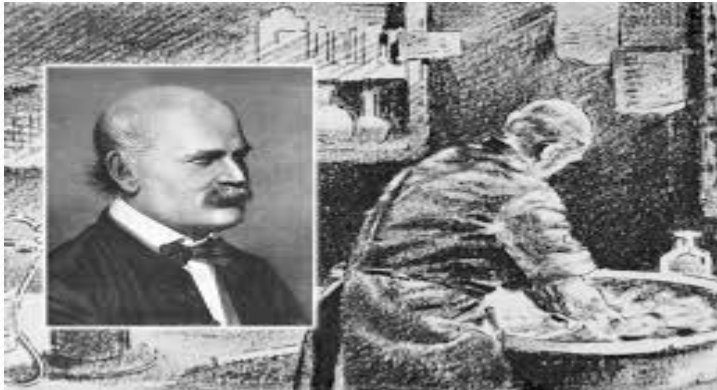
John Hunter 18th c: Scottish surgeon he was considered the leading authority on venereal diseases (**because there is microorganisms**), and believed that Syphilis and Gonorrhea were caused by a single pathogen **But later scientists discovered that there is a type of bacteria called Treponema pallidum that causes syphilis, while Gonorrhea is caused by a bacteria called neisseria gonorrhoeae..**



Edward Jenner 18th-19th c: An English physician and scientist who pioneered the concept of vaccines (**whether produced from dead microorganisms or from attenuated microorganisms**) 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), 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 can be prevented if the attending nurses apply hygienic measures. Hand washing stops infections



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.
3. Created the first Vaccines of *rabies*, *Bacillus anthrax*.



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. However, the German scientist **Robert Koch** provided the proof by cultivating anthrax bacteria apart from any other type of organism.



Robert Koch 19th c:

Developed microbiological media & streak plates for pure culture.

Germ theory (Koch's postulates):

- Microorganism must be present in every case of the disease **whether animal or human**.
- Organism must be grown in pure culture from the diseased host.
- Inoculation of above into host must give same disease.
- Organism must be recovered from experimentally infected host.



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 (**Human Papilloma Virus**).

Common terms

- Incubation period (فترة الحضانة) : the time between acquisition of the organism & the beginning of symptoms, it varies from hours to days to weeks. (the period between the appearance of the microorganism until the appearance of symptoms)
- Period of communicability (infectious period)(فترة العدوى) : the time during which the infectious agent may be transferred directly or indirectly from an infected person to another person. There are many people who have recovered but are still infectious to others (some but not all diseases) or it can be asymptomatic, but it is a source of infection and is called a carrier of the disease.
- Incidence rate (معدل الإصابة) : “is a measure of the disease risk” refers to the number of new cases of a disease within a time period .

Common terms

- Prevalence (نسبة الانتشار) : “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.

Measures of disease

MEASURES OF DISEASE

incidence (rate) = $\frac{\text{\# new cases}}{\text{\# people @ risk in a given time frame}}$

— how fast (RISK)

prevalence (proportion) = $\frac{\text{\# cases}}{\text{\# total people}}$

— how much (BURDEN OF DISEASE)

Common terms

- Mortality rate (معدل الوفيات) : is a measure of the frequency of occurrence of death in a defined population during a specified interval.
- Case fatality rate (نسبة وجود المرض) : “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.

Common terms

- 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”



-These slides talk about how the hand can be a source of infection.

-Also about the importance of washing hands, which helps to stop the spread of infection, before and after dealing with patients:

Before: In order to protect the patient

After: In order to protect myself and other patients

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.





**We and our Hands must be Part of Infection
control**

Hands are dangerous!

**Wash your hands ! Before and after each clinical
contact!**

Do not wear wrist watch , rings, or ties?