Introduction to medical microbiology

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.

Immunology, Virology, Bacteriology, Mycology, and Parasitology.

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

3- Agricultural microbiology: *This filed is concerned with Soil fertilization, nitrogen, carbon, sulfur, and phosphorous cycles, as well as plant disease.*

4- Food microbiology: *This field focuses on food poisoning, toxicity and spoilage.*

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

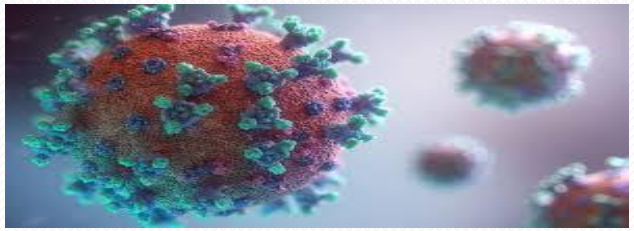
6- Sanitary microbiology: is a science based on the detection of risks associated with the production, manufacture and consumption of foods and water. It has been established that environment facts determine the survival, growing and inactivation of the microorganisms.

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, they are totally dependent on infected cells for replication. They cause intracellular infection.



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 are unicellular organisms measuring (2-20) microns.
b- Molds 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, 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) .

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.

- ✓ **Exogenous cross-infection:**
- ✓ Mainly through hands of healthcare workers, visitors, patients.

MICROBES AND HUMAN WELFARE:

The majority of Microbes Benefit human, animals and plants.

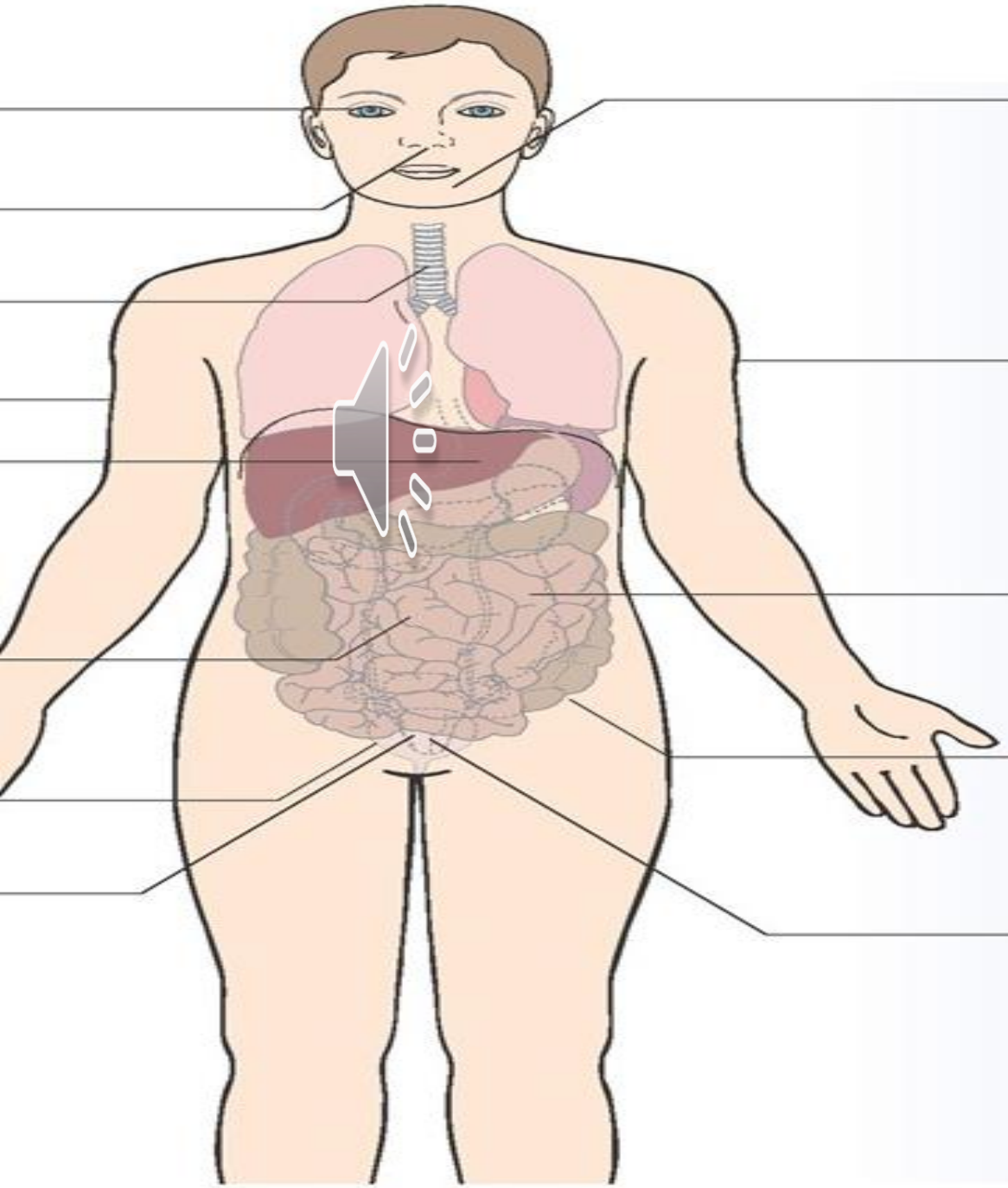
- Normal Body Flora.

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.

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.



NORMAL FLORA

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

SKIN
- Staphylococci
- Streptococci
- Corynebacteria
- Proprionibacteria
- Yeasts

UPPER BOWEL
- Enterobacteriaceae
- Enterococci
- *Candida*

LOWER BOWEL
- *Bacteroides*
- Bifidobacteria
- *Clostridium*
- Peptostreptococci

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

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, Clostrium 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, Staphlyococcus 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 , Staphyloccous epidermidis , Pseudomonas aeruginosa , Propionibacterium, ,peptococcus and Corynebacterium species(diphtheroids),
Urethra:- Less Important Organisms:- Staphyloccous epidermidis Corynebacterium(diphtheroids),Various streptococci ,Various gram negative rods, e.g. E.coli
Conjunctiva:- Haemophilus species
Nose:- Staphyloccous 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. (Bioremediation)
- Fermentation of some products, in food industry.
- Antibiotics production

MICROBES AND HUMAN WELFARE:

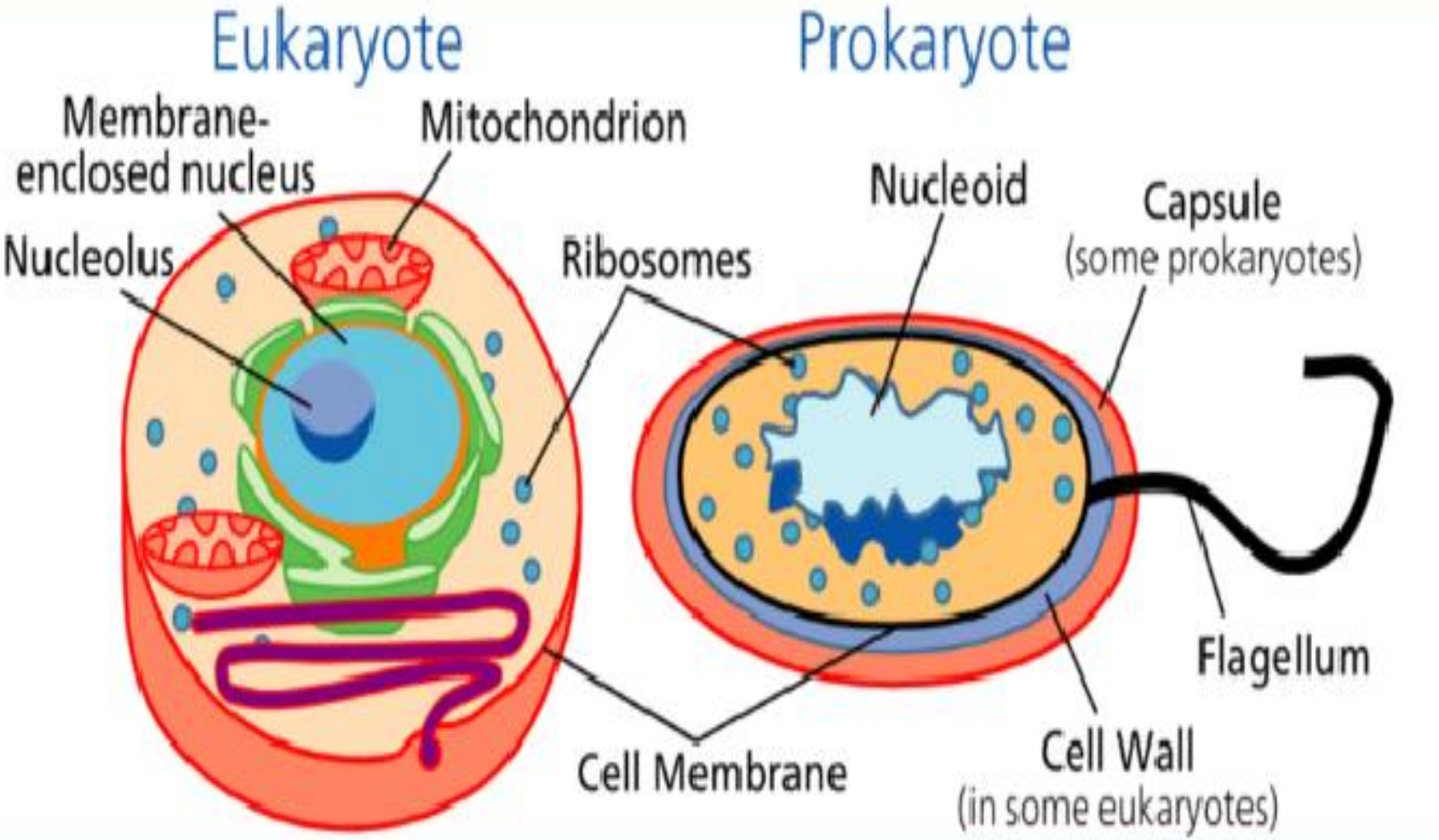
Microorganisms are used in insect pest control: (viruses, bacteria and fungi) or their bioactive agents can be used as active substances and therefore are referred as Microbial Pest Control Agents (MPCA)

- 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.

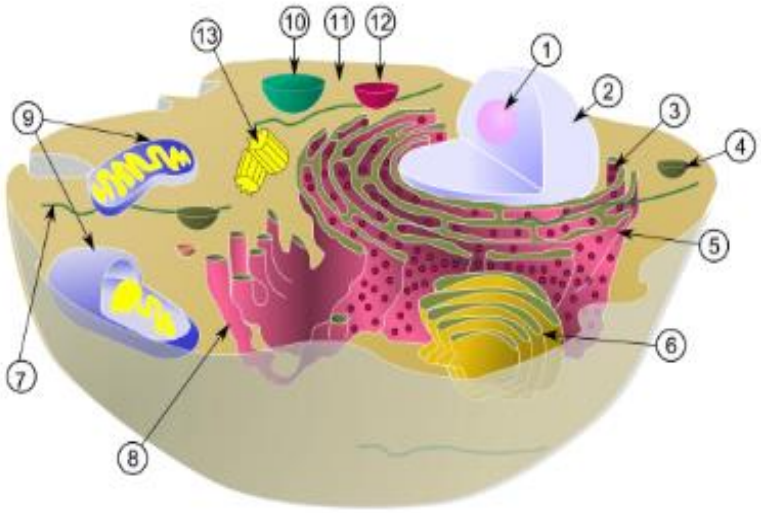
Microorganisms can be eukaryotic, prokaryotic or subcellular:

- 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.


Eukaryote
Prokaryote
Membrane-enclosed nucleus
Mitochondrion
Nucleolus
Ribosomes
Nucleoid
Capsule
(some prokaryotes)
Flagellum
Cell Membrane
Cell Wall
(in some eukaryotes)

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 ≥3 µm 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

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.

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.
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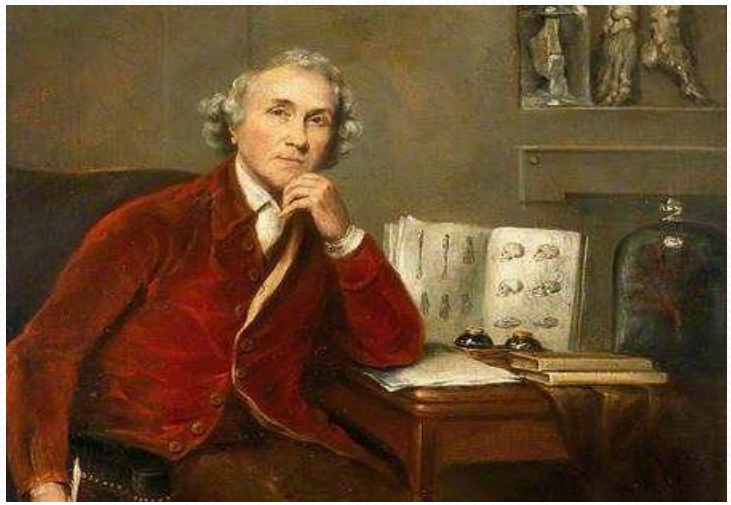
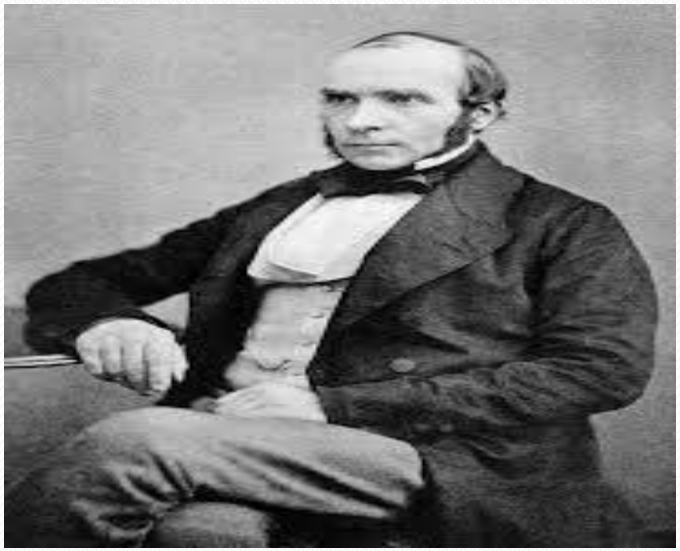
Short History:

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

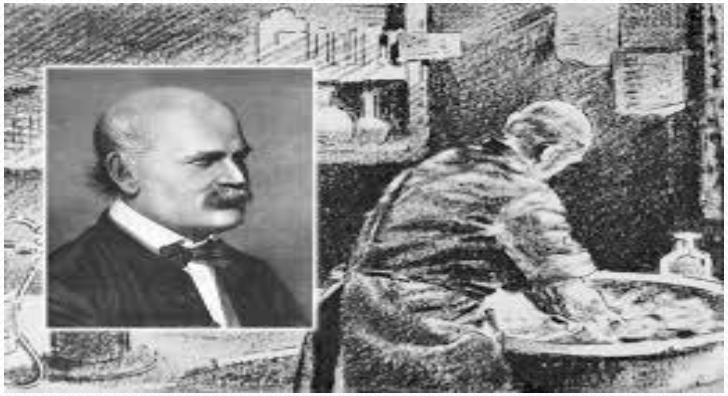


John Hunter 18th c: Scottish surgeon he was considered the leading authority on venereal diseases, and believed that Syphilis and Gonorrhea were caused by a single pathogen.

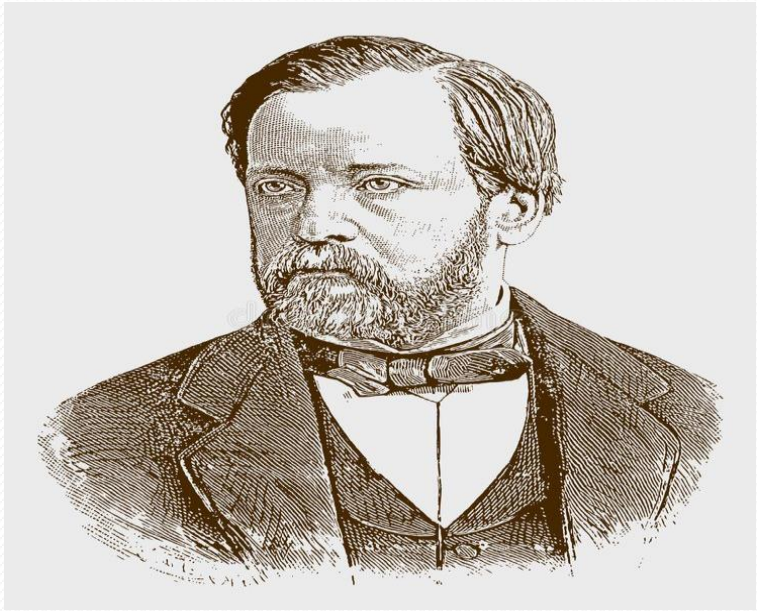
Edward Jenner 18th-19th c: An English physician and scientist who pioneered the concept of vaccines including creating the smallpox vaccine, the world's first vaccine.



John Snow 19th c: An English physician, known for locating source of cholera outbreak in London (thus establishing the disease as water-borne),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.

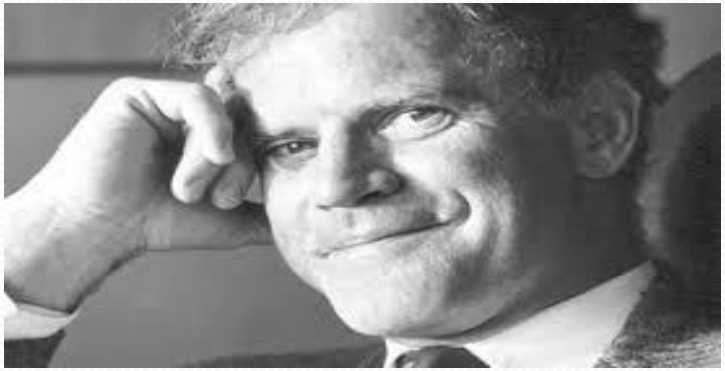
Robert Koch 19th c:

Developed microbiological media & streak plates for pure culture.

Germ theory (Koch's postulates):

- Microorganism must be present in every case of the disease.
- 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 Chin 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: the time between acquisition of the organism & the beginning of symptoms, it varies from hours to days to weeks .

- Period of communicability (infectious period): the time during which the infectious agent may be transferred directly or indirectly from an infected person to another person.

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

Common terms

- 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.

Measures of disease

Common terms

- Mortality rate: is a measure of the frequency of occurrence of death in a defined population during a specified interval.

- 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.

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”


Flu?
Diarrhoea?
Colds?
Tummy bugs?
MRSA?
Food poisoning?
If you could see the germs, you'd wash your hands.
Many germs can be spread by hand contact. Just wash your hands regularly with soap and warm water, and you're more likely to stay healthy. For more information visit www.washyourhandsofthem.com
Germs. Wash your hands of them.

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?