Microbiology and immunology

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Unit: 1

Introduction

Outline

1 Introduction to microbiology
2 Historical background
3 Definition of terms

1 Introduction to Microbiology

- **Microbiology:-** is a science that is primarily concerned with the study of microorganisms or living organisms that are **individually too small** to be seen with the naked eye.

- The word – **Micro:-** very small
  - **bios:-** living organisms and
  - **logos:-** study of....
- Therefore, microbiology is the study of very small living organisms (microscopic size)

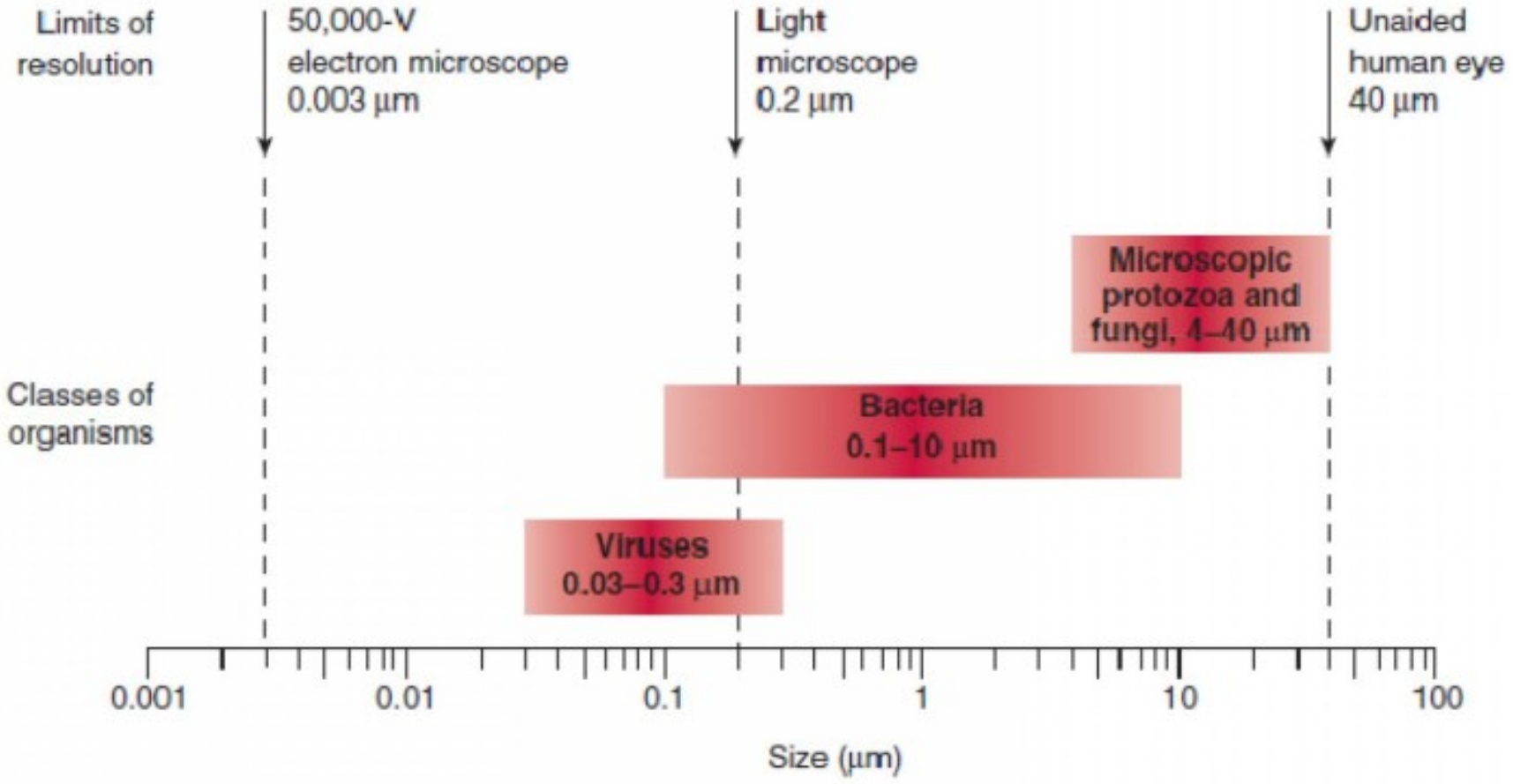
Introduction to Microbiology….

➢ Microorganisms:-

- Are living things that can not be seen with our naked eye.
- They include:
  - **Bacteria** (singular, bacterium)
  - **Viruses** (singular, virus)
  - **Fungi** (singular, fungus)
  - **Protozoa** (singular, protozoon)
- Based on their size

  Viruses < Bacteria < Fungi< Parasites

Introduction to Microbiology….



Relative sizes of microorganisms

Introduction to Microbiology….

➢ Distribution of microorganisms

- Cosmopolitan (wide) distribution depending on availability of
  - **Nutrition**
  - **Temperature**
  - **Moisture**

❖ Soil

- contains relatively large amount of microorganisms
- Non-pathogenic unless the soil is contaminated with human waste.
- E.g. ***Bacillus anthracis* , *Clostridium* species**

Introduction to Microbiology….

❖Water

- Water contains microorganisms which are derived from soil.
  - *Salmonella* species
  - *Vibrio cholera*
  - Polio virus

❖Air

- Air contains few amount of microorganisms.
- Usually out door air contains few amounts of microbes in comparison to indoor air since it is exposed to UV of sunlight.

❖Animal and human body

- 87% of microorganisms is useful
- 10% opportunistic
- 3% pathogenic

Introduction to Microbiology

➢ Scope of Microbiology

- Division of Microbiology
  - ✓ **Medical Microbiology**
  - ✓ General Microbiology
  - ✓ Agricultural Microbiology
  - ✓ Industrial Microbiology
  - ✓ Food Microbiology
  - ✓ Soil Microbiology
  - ✓ Plant Microbiology
  - ✓ Environmental Microbiology etc…

Scope of Microbiology….

- **Medical Microbiology**: - a branches of medical sciences that deal with microorganisms that cause **infectious diseases** of **human beings**.

- It Involves the study of
  - ✓**Pathogens**
  - ✓**Disease** caused by them and
  - ✓The body **defences against disease.**

Scope of Microbiology….

- **Medical microbiology** is also concerned with
  - ✓Epidemiology
  - ✓Transmission of pathogens
  - ✓Disease prevention measures
  - ✓Aseptic techniques
  - ✓Laboratory diagnosis
  - ✓Treatment of infectious diseases
  - ✓Immunology
  - ✓The production of vaccines to protect against infectious disease

Scope of Microbiology….

- Sub-division of Medical Microbiology
  - Medical Bacteriology
  - Medical Virology
  - Medical Mycology
  - Medical Parasitology
  - Clinical Immunology

Why we study microbiology?

I → Research

II→ In applied Science

- Agriculture
- Industry
- **Medicine**
- Ecology(environmental science)
- Food and drink production
- Pharmaceutical industry
- Genetic engineering

1 Historical background

❑Early history

- In some ancient civilization, disease was believed to be a **punishment** sent from the God for human wrong doing.

- Many philosophers during early period believe that disease was transmitted by **invisible animals**.

- **Hippocrates (460 - 377BC)** (father of medicine) observed that ill**ness** resulted due to **changes** in air, winds, water, climate, food, nature of soil and habits of people.

History of Microbiology….



➢ Antoni Van Leeuwenhoek (1632-1723 G.C.)

- Microbiology emerged as a science after the discovery of **microscope**.
- Father of Microbiology, observed "animalcules" using simple microscope with one lens.
- He was the first who properly described the different shapes of bacteria.
- He examined pond water and discovered an invisible creature called "Animalclues" small animals. They were everywhere in water droplets, particle of soil etc.

History of Microbiology….

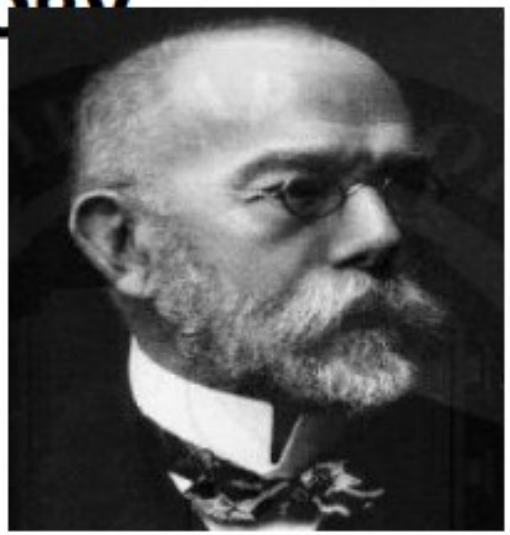
❑The golden age of Microbiology (1870-1890)



➢Louis Pasteur (1822-1895 GC)

- **Major contribution of Louis Pasteur**
  - Microbial theory of **fermentation**.
  - **Disproved** the theory of spontaneous generation.
  - Principles and practice of sterilization and **pasteurization**.
  - Development of **vaccines** against anthrax and rabies.
  - Discovery of streptococci

History of Microbiology



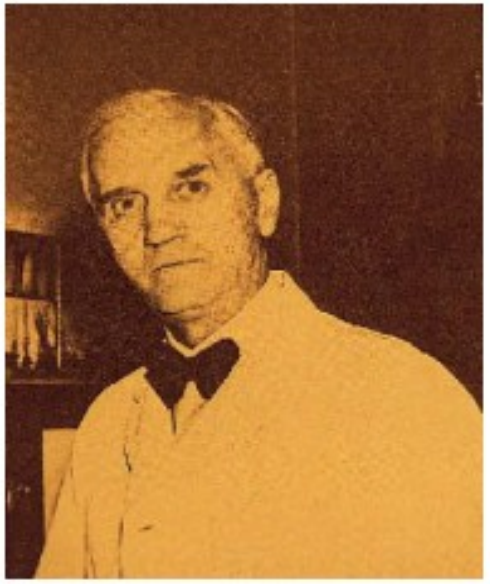
1843 - 1910

➢ **Robert Koch** (1870s)

- Known as the father of modern bacteriology.
- Introduced
  - ✓ Staining techniques
  - ✓ Pure culture medium
  - ✓ Isolation of bacterial colonies using of agar
- Developed Koch's Postulates
  - ✓ which are a sequence of experimental steps for directly relating a specific microbe to a specific disease.
- Koch discovered:
  - ✓ *Bacillus anthracis*
  - ✓ *Mycobacterium tuberculosis*
  - ✓ *Vibrio cholera*

History of Microbiology….

➢ Alexander Fleming (1928s)



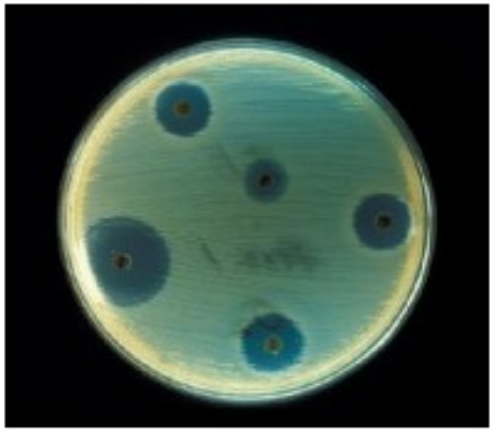
(1881 - 1955),

- Alexander Fleming a Scottish biologist and pharmacologist, observed bacterial staphylococci colonies disappearing on plates contaminated with mold.

- Fleming discovered that a mold accidentally growing on one of his Petri dishes had anti-bacterial activity.

History of Microbiology….

- Fleming extracted the compound from the mold responsible for destruction of the bacterial colonies.
- The mold was producing **Penicillin**.
- This was the first antibiotic discovered.
- The product of the mold was named penicillin, after the **Penicillium** mold from which it was derived.
- Nobel Prize in Physiology of Medicine in 1945.



History of Microbiology….

➢Joseph Lister

- Used a **chemical disinfectant** to prevent surgical wound infections after looking at Pasteur's work showing microbes are in the air, can spoil food, and cause animal diseases.



1827 - 1912

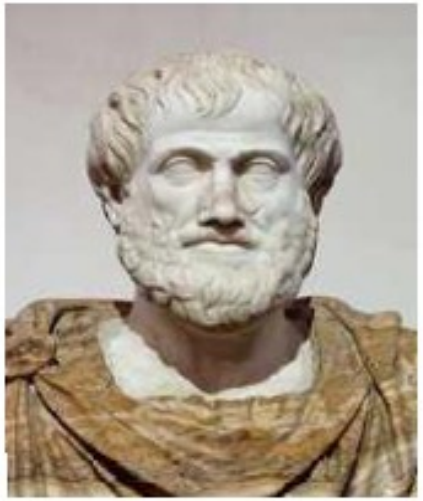
Some important discoveries

Year	Investigator (s)	Discovery
1684	Antoni van Leeuwenhoek	Bacteria
1798	Edward Jenner	Smallpox vaccine
1864	Louis Pasteur	Discredited SG
1867	Joseph Lister	Antiseptic
1882	Robert Koch	Cause of TB
1884	Robert Koch	Koch's postulates
1884	Christian Gram	Gram staining
1885	Louis Pasteur	Rabies vaccine
1908	Paul Ehrlich	Chemotherapeutic agents
1929	Alexander Fleming	Penicillin
1931	Ernst Ruska	The first Electron microscope
1977	W. Gilbert and F. Sanger	Method to sequence DNA
1983	Luc Montagneir	HIV, the cause of AIDS
1988	Kary Mullis	PCR

Theories of origin of microorganisms

1) Spontaneous generation (Abiogenesis)

- This was the theory of **Aristotle** and his followers.
- Aristotle (384-322 BC): The founder of a theory spontaneous generation.
- He observed spontaneous existence of fishes from dried ponds, when the pond was filled with rain.



Aristotle: 384 – 322 B.C.

Spontaneous generation.....

- This is a theory that says life comes from non living nature.
  - ✓**Snake** emerged from horse hair
  - ✓**Maggots** emerged from rotten meat
  - ✓**Flies** from fresh and rotting fruit
  - ✓**Frogs** emerged from slime mud

➢ Key to developing the germ theory of disease was a refutation of the concept of spontaneous generation.

Theories of origin of microorganisms

2. Biogenesis

- This theory says life comes from pre-existing cells.
- Different individuals did a lot to prove this theory

➢ **Francisco Redi - 1665**

- He is the scientist who first tried to set an experiment to disprove spontaneous generation.
- He did an experiment in 1665, with covered and uncovered meat showing that maggots developed only in meat that flies could flesh to lay eggs on he proved that living things are comes from pre-existing living things.



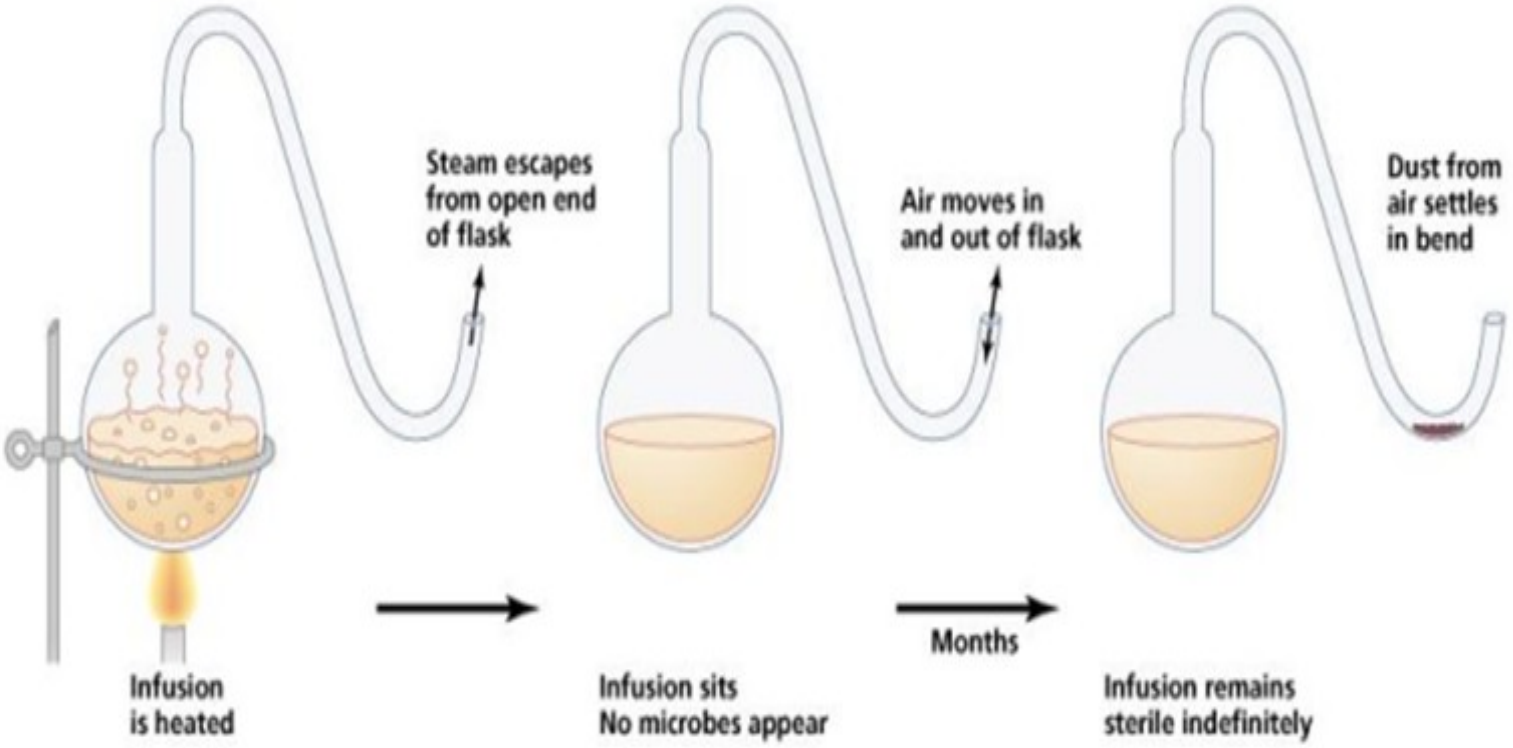
Francesco Redi, Italian physician, naturalist & poet, 1626 – 1697.

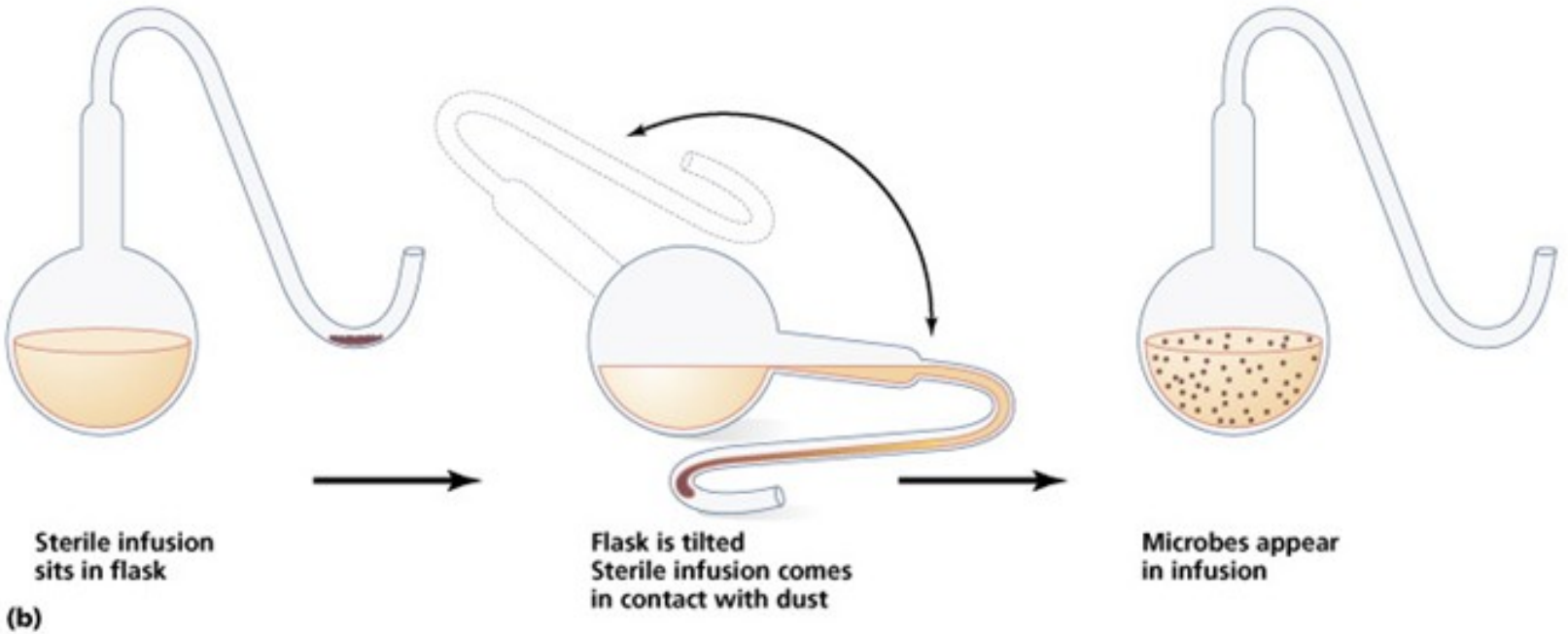
Theories of origin of microorganisms

➢ Louis Pasture – 1858

- Louis pasture (1822- 1895) was the scientist who disproved the theory of abiogenesis once and for all.
- He proved the controversy between the two theories in 1859.
- Performed experiment to disprove Theory of spontaneous generation.
- He designed a large curved flask/swan-necked (pasture goose neck flask) and placed a sterile infusion broths.

* In ‘A’ air freely moved through the tube, but dust particles were trapped in the curved portion of the flask. And no microbial growth was observed.





Therefore, Pasteur proved that microorganisms entered to the broth with the air and micro organisms did not evolve spontaneously

Germ theory of disease

- Germ theory of disease explains about microbes can **spread** through the population and causes a **specific disease**.
  - **L. Pasture** discovered that microbes can cause disease.
  - **Joseph Lister** a surgeon who explained sepsis and discovered antiseptics so called the father of antiseptic surgeon.
  - **Robert Koch** Explained and proved microorganisms can be isolated and can cause a specific disease. He studied anthrax in his experiment.

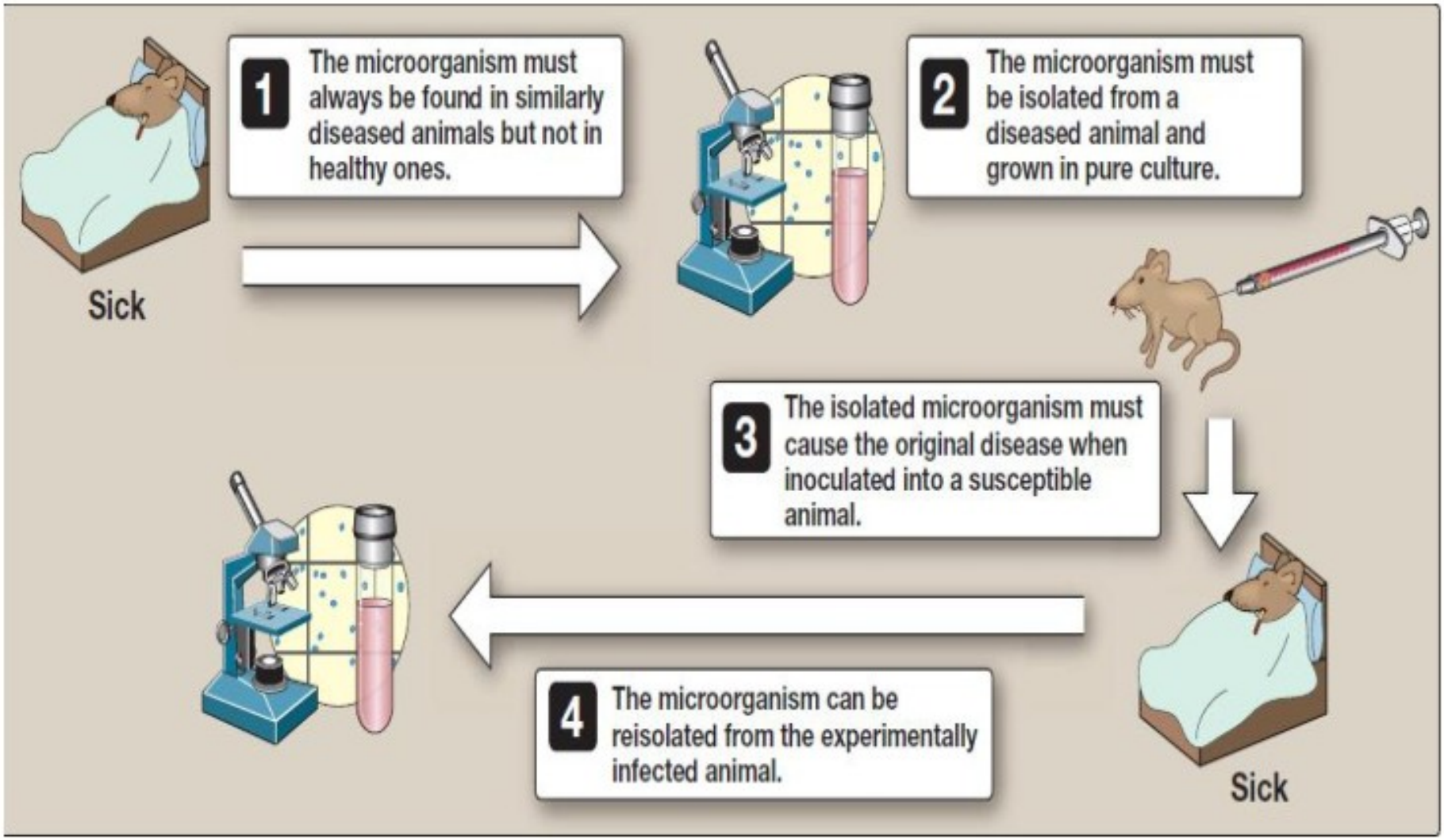
Germ theory of disease…

- A **definite proof** of the germ theory of disease was offered by **Robert Koch**.

- **Foundation of modern medicine.**

- Germ theory of disease is the single most important contribution to medical science and practice ever.

Germ theory of disease…



Germ theory of disease…

- **From this experiment Koch formulated the following postulates:**

1) Diseased animal contains the **causative organism** of that disease.
2) The organism can be **isolated** and grown on pure culture media.
3) Pure culture can **produce disease** when inoculated into susceptible animal.
4) It is possible to **obtain the organism** on culture from experimental infected animal.

Germ theory of disease…

➢ Exception/ Limitation to Koch's postulates

a) Many healthy people carry pathogens, but do not exhibit symptoms of the disease, the carriers'

- E.g. **HIV, typhoid fever**

b) Some microbe are very difficult or impossible to grow in the laboratory on artificial media

- E.g. **Virus, *M. leprae* , *T. palladium*** etc...

c) Certain disease develops only when an opportunistic pathogen invades a weak (susceptible) host.

d) Many species of microbes are species specific e.g. ***Brucella aborutus*** cause abortion in animals but not in humans.

The discovery of some major human pathogen

Year	Disease	Causative agent	Discoverer
1876	Anthrax	*Bacillus anthracis*	Koch
1879	Gonorrhoea	*Neisseria gonorrhoeae*	Neisser
1880	Typhoid fever	*Salmonella typhi*	Gaffky
1880	Malaria	*Plasmodium* sp	Laveran
1882	Tuberculosis	*Mycobacterium tuberculosis*	Koch
1883	Cholera	*Vibrio cholerae*	Koch
1883/4	Diphtheria	*Corynebacterium diphtheriae*	Klebs & Loeffler
1885	Tetanus	*Clostridium tetani*	Nicoaier & Kitasato
1886	Pneumonia (bacterial)	*Streptococcus pneumoniae*	Fraenkel
1892	Gas gangrene	*Clostridium perfringens*	Welch & Nuttall
1894	Plague	*Yersinia pestis*	Kitasato & Yersin
1896	Botulism	*Clostridium botulinum*	Van Ermengem
1898	Dysentery	*Shigella dysenteriae*	Shiga
1901	Yellow fever	Flavivirus	Reed
1905	Syphilis	*Treponema pallidum*	Schaudinn & Hoffman
1906	Whooping cough	*Bordetella pertussis*	Bordet & Gengou
1909	Rocky Mountain spotted fever	*Rickettsia rickettsii*	Ricketts

3 Definition of terms

➢Common Terminologies

❖Microbe

- Microscopic organism that can transmit disease (pathogenic bacterium).

❖Pathogen

- Harmful microorganisms that are capable of damaging their host (disease causing microorganism).

❖Colonization

- Presence and multiplication of a microorganisms without tissue invasion or damage.

Common Terminologies…..

- **Infection**
  - The entry and multiplication of an infectious agent in the body of man or animal. (colonizing organisms are now causing cellular response)
- **Sepsis**
  - the condition or syndrome caused by the presence of microorganisms or their toxins in the tissue or the bloodstream.
- **Septicemia**
  - a wide spread destruction of tissue due to adsorption of disease causing bacteria or their toxins from blood stream.
- **Bacteremia**
  - The presence of bacteria in the blood

Common Terminology….

❖Nosocomial infection

(healthcare facility acquired infection or healthcare associated infections)

- An infection acquired in healthcare facility by a patient who was admitted for a reason other than that infection.

❖Acute infection

– a disease or condition which occur/develops rapidly and can be dangerous.

Common Terminology….

- **Chronic infection**
  - long duration or one that is progressing slowly .
- **A recurrent infection**
  - appear after an earlier infection (episode) of the same disease.
- **Latent infection**
  - The condition in which the pathogen present in the body but does not show any signs. The pathogens later emerge to cause illness.

Common Terminology….

❖Normal Flora

- Are a normal inhabitant that are acquired early in life and reside in the human **intestinal** track, **skin**, **body fluid** without harming the host in normal condition.

❖An opportunistic pathogen

- Cause disease when it gains access to an **abnormal location** or when a host immune status are diminished.

Common Terminology….

- **Obligate microorganism**
  - Microorganisms that can not live or exists without their host.
- **Vector**
  - An organism (arthropods /intermediate host) that transmits disease causing microorganisms from an infected person or animal to another.
- **Incubation period**
  - Is the time during which the agent multiply/develop in the host cell before the appearance sign & symptoms of the disease.

Common Terminology….

❖Host

- An organism that harbors or nourishes another (parasites).

❖Reservoir

- Host (any person, animal, arthropod, plant, soil or substance) that carries parasites with out being affected, but capable of transmit and causing diseases to another host.

Common Terminology….

❖Contamination

- Presence of living infectious agent up on articles.

❖Carrier

- Is an infected person or animal who doesn't have apparent clinical disease but is a potential source of infection to others.