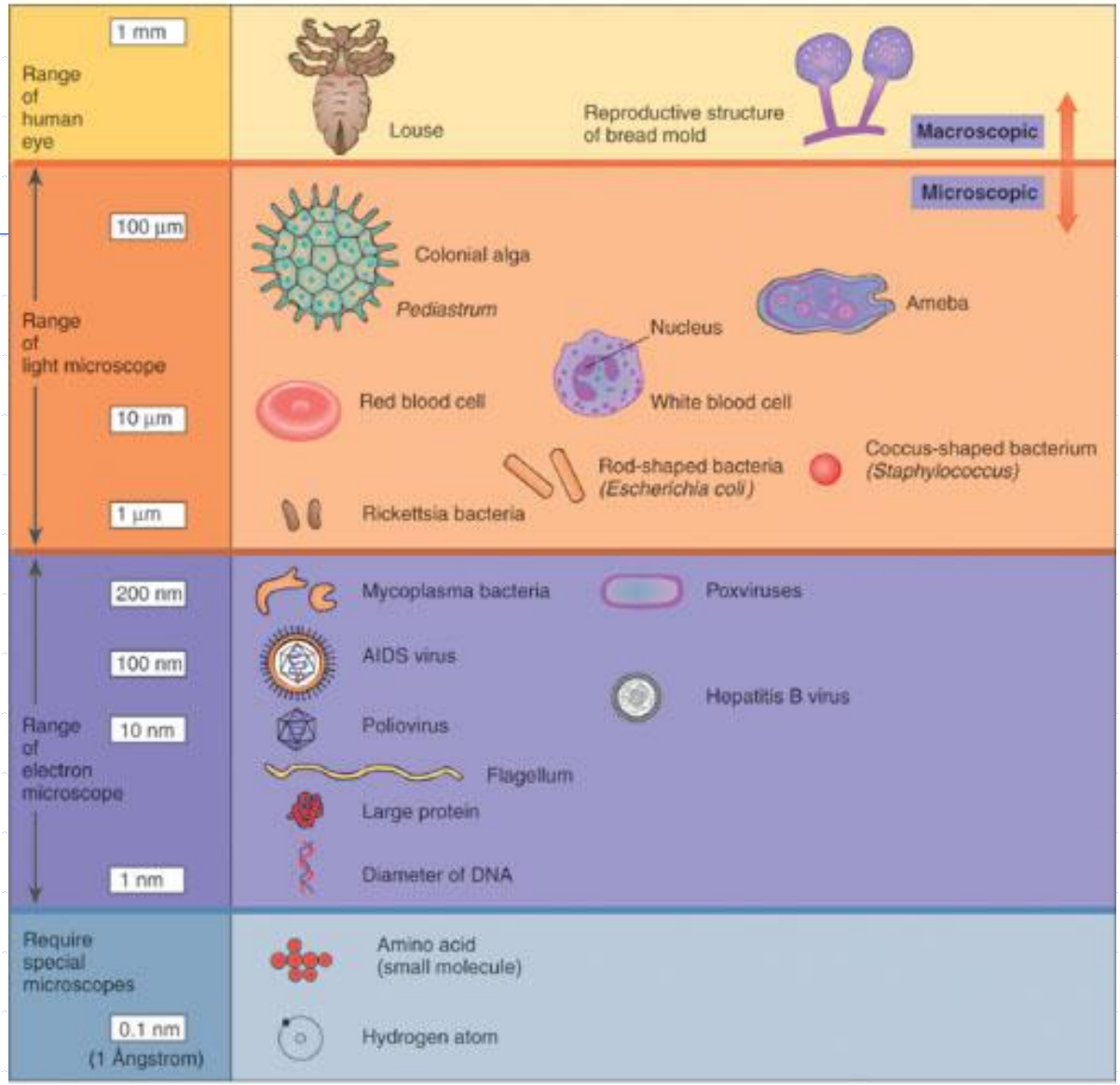
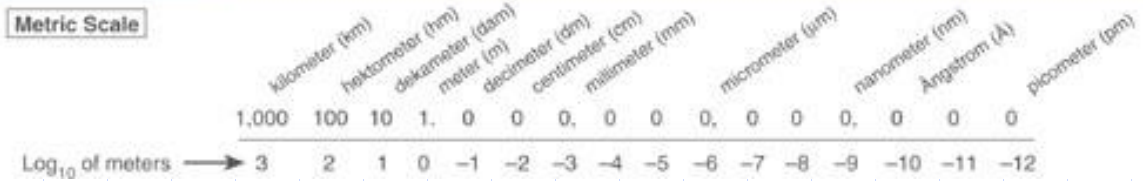
Introduction & historical perspective of Microbiology

What is Microbiology?

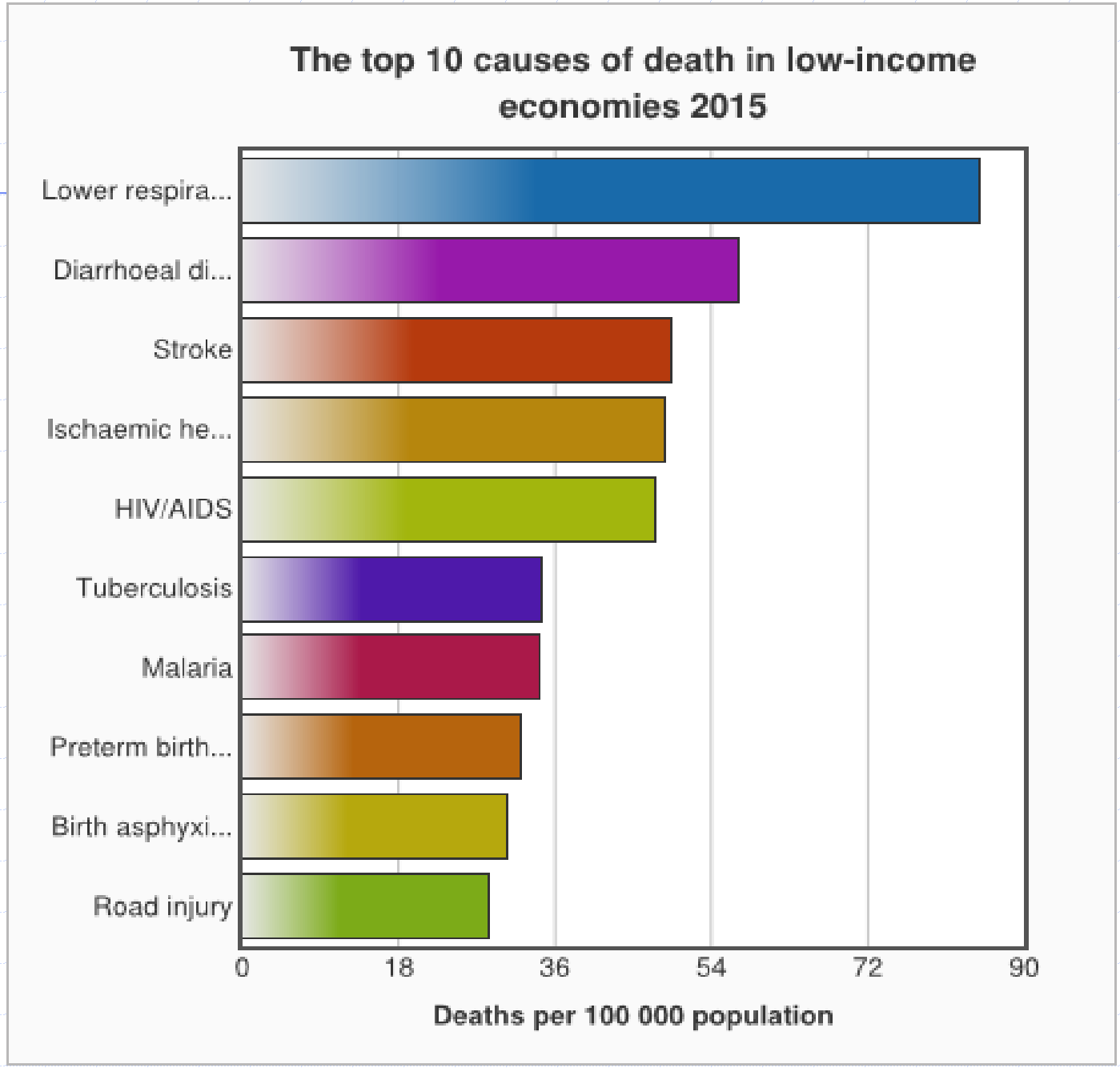
- Study of micro-organism (organism which can not be seen by naked eye)
- Includes study of
  - Viruses — Virology
  - Bacteria — Bacteriology
  - Fungi — Mycology
  - Parasites — Parasitology

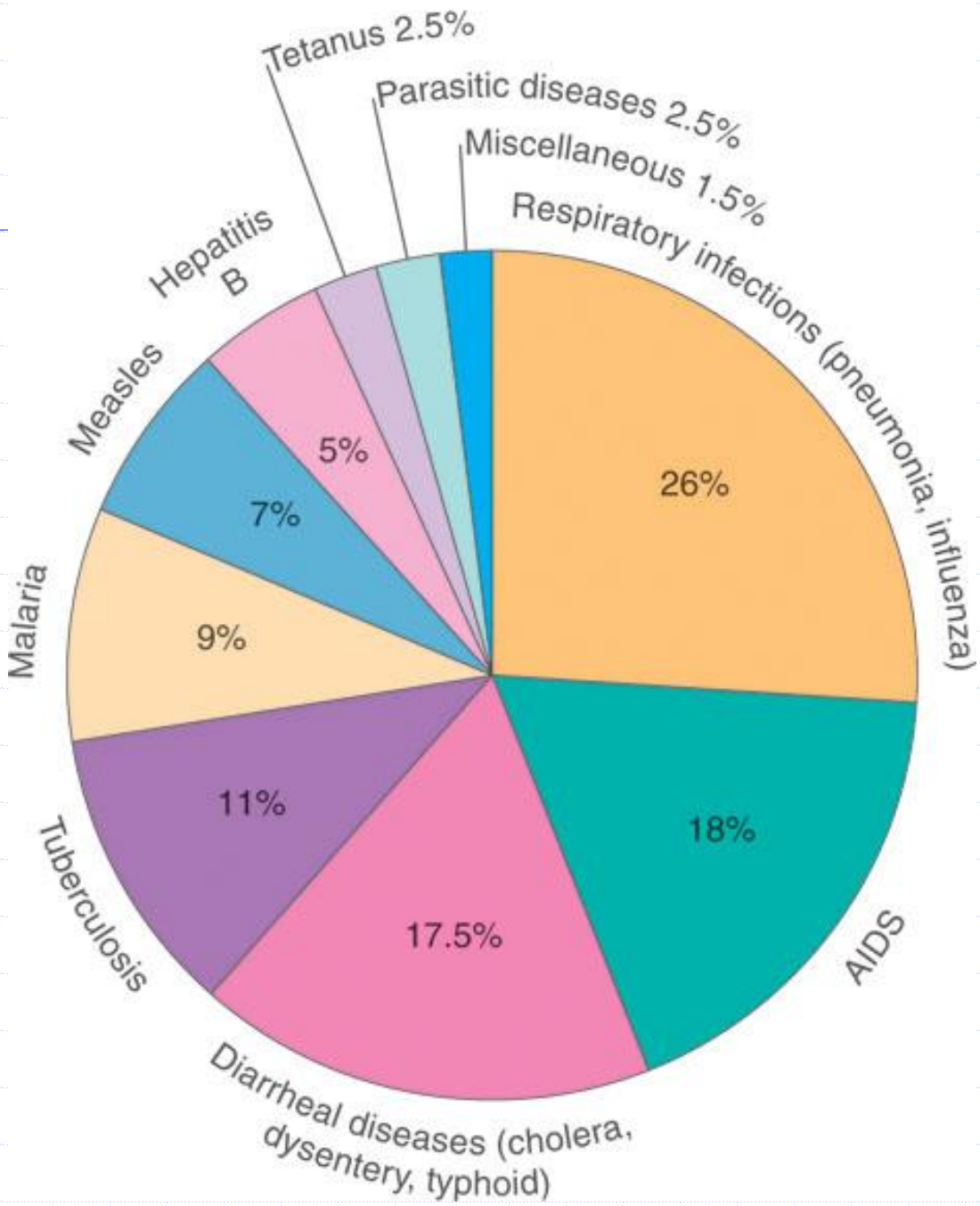




Impact of pathogens

- Nearly 2,000 different microbes cause diseases
- 10 B infections/year worldwide
- 13 M deaths from infections/year worldwide


The top 10 causes of death in low-income economies 2015
Lower respira...
Diarrhoeal di...
Stroke
Ischaemic he...
HIV/AIDS
Tuberculosis
Malaria
Preterm birth...
Birth asphyxi...
Road injury
0
18
36
54
72
90
Deaths per 100 000 population

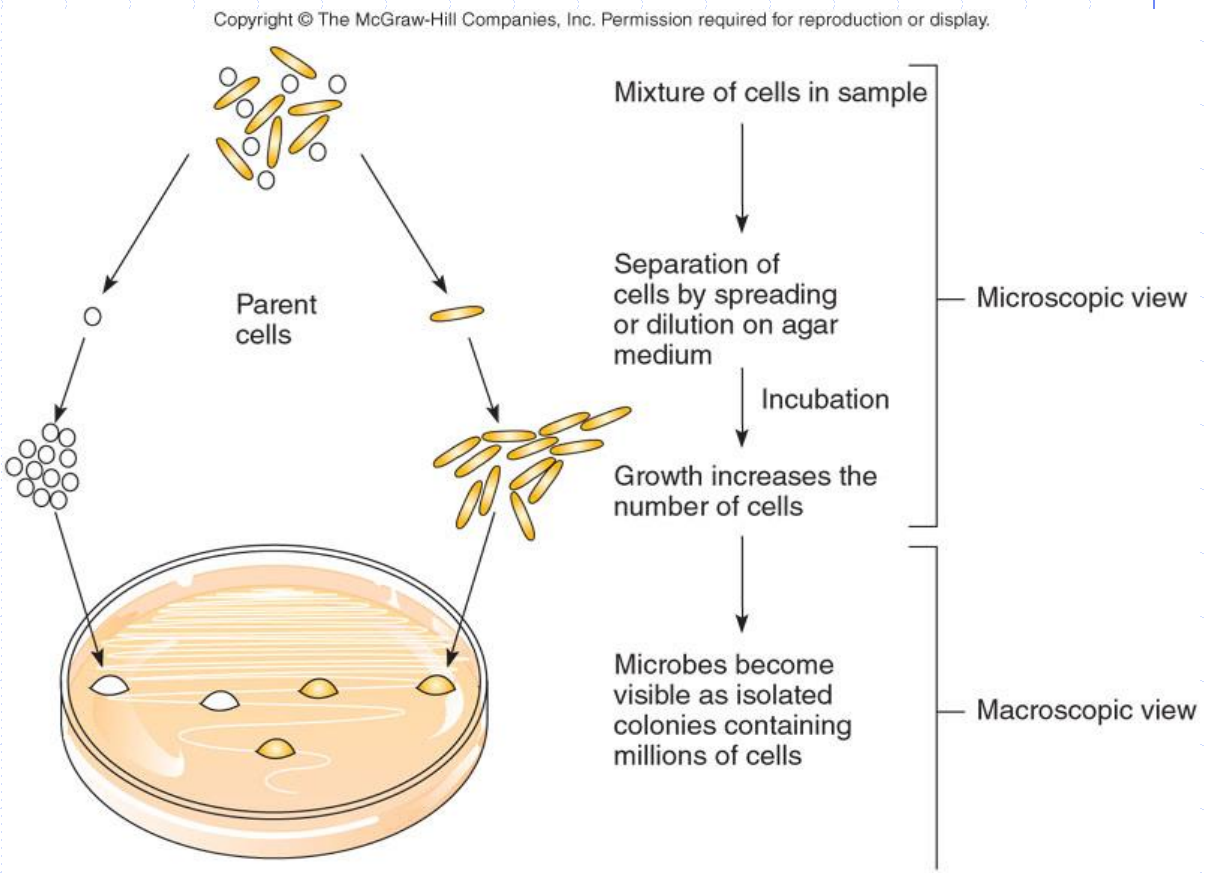


Significance of Microbes:

- Decompose organic waste
- Produce industrial chemicals such as ethyl alcohol and acetone
- Produce fermented foods such as vinegar, cheese, and bread
- Production of drugs – antibiotics & vaccines
- Nowadays – used as vectors for cloning and sequencing of DNA in genetic engineering

Key words

- culture
- agar
- colony
- broth
- virulence
- attenuation



History of Microbiology

Role of Scientist:

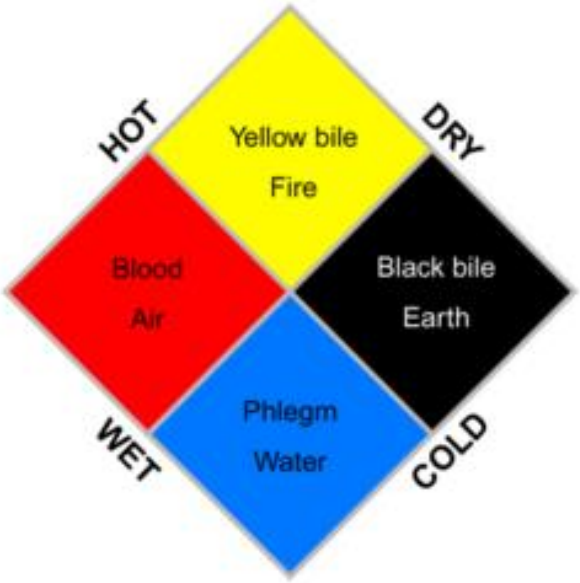
- Antony Van Leuwenhowk
- Louis Pasteur
- Robert Koch
- Joseph Lister

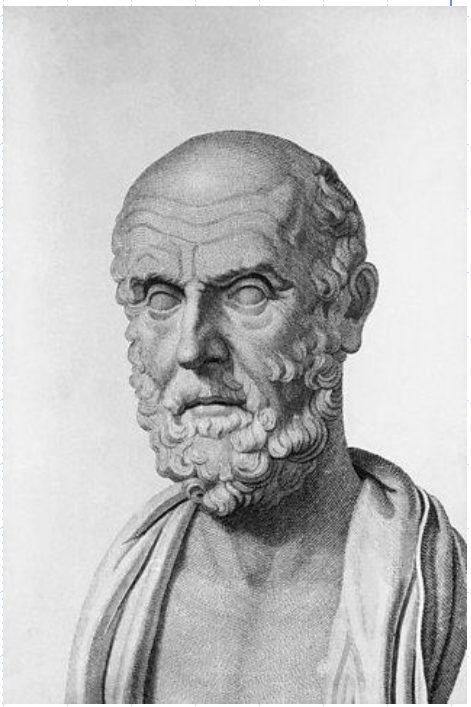
Historical background- ancient belief

- Death and diseases are known since antiquity
- Causes suggested for their occurrence
  - Supernatural causes
  - Faulty environment
  - Effect of bad bodily humors

Hippocrates – father of medicine

- Believe in 4 humors –
  - Yellow bile
  - Black bile
  - Blood
  - Phlegm





Historical background – concept of contagion

- Disease is transmitted by contact was known since biblic time – laws enacted to prevent spread of leprosy
- Vero and Columella postulated –*Animalia minuta*
- Fracastorius of Verona proposed a *contagium vivum* as a possible cause

Miasma theory

Miasma

- During the 1800s, the miasma theory of disease dominated medical thought
- It was believed that disease could be caused by the foul smells created by decomposing bodies, food, human waste, marsh gases and general filth.
- Road sweeping was one way to help clean up the streets and hopefully prevent the spread of disease.

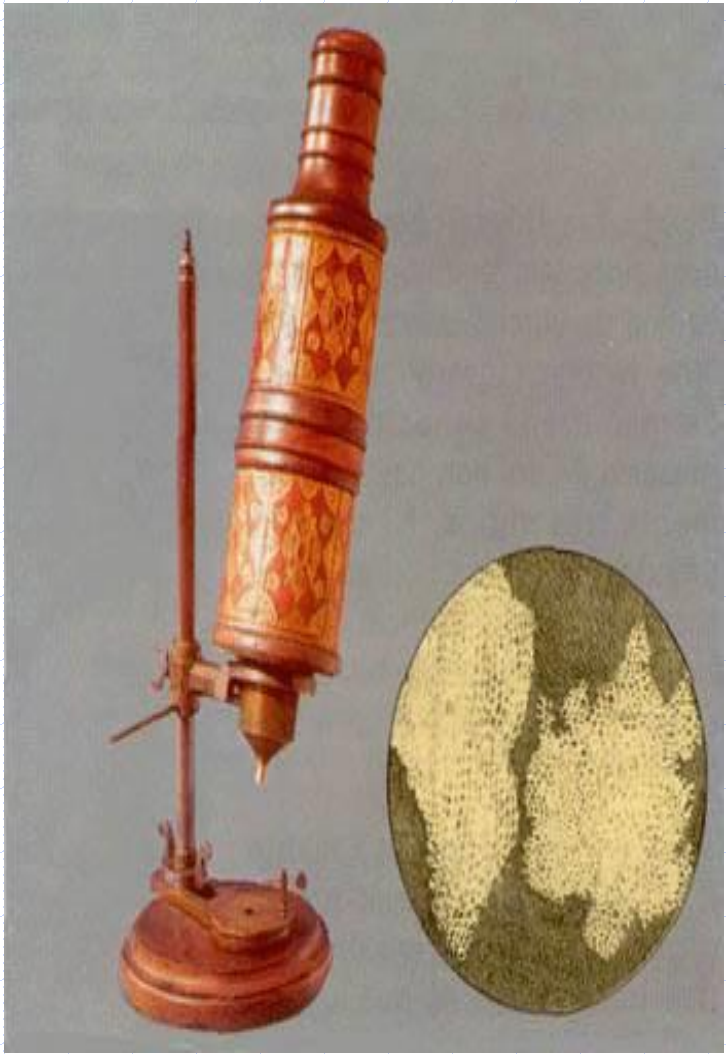
http://www.sciencemuseum.org.uk/hommedia.ashx?id=7673&size=Small

Antony Van Leeuwenhoek

History of Microbiology

The microbes were first observed in 1673 by Antony van Leeuwenhoek.

In 1665, **Robert Hooke** (Englishman) reported that living things were composed of little boxes or cells.

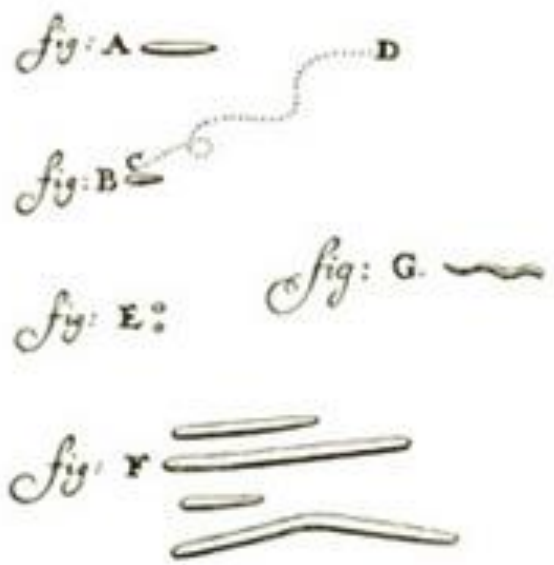


Antony van Leeuwenhoek

- Draper from Holland
- Hobby to grind glass
- 1683-Accurate description of various types of bacteria
- First to observe micro-organisms from teeth scraping & rain water
- First microscope was prepared by him

(b) Microscope replica

PLATE XXIV



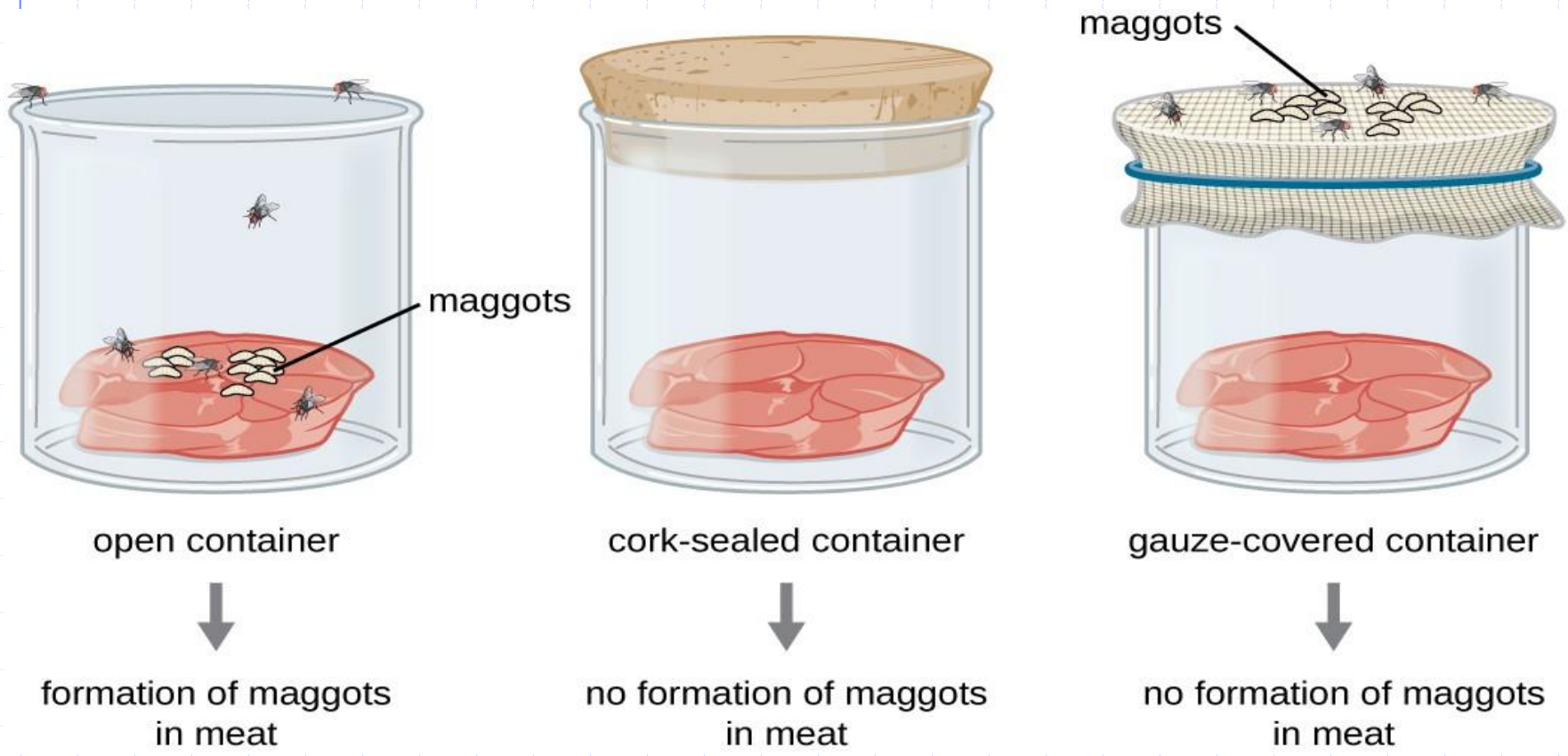
LEEUWENHOEK'S FIGURES OF BACTERIA FROM THE HUMAN MOUTH
(Letter 39, 17 Sept. 1683)
Enlarged (× 1¼) from the engravings published in *Arc. Nat. Det.*, 1695.

Fig. A, a motile *Bacillus*.
Fig. B, *Selenomonas sputigena*. C . . . . D, the path of its motion.
Fig. E, Micrococci.
Fig. F, *Leptothrix buccalis*.
Fig. G, A spirochæte—probably "*Spirochæta buccalis*," the largest form found in this situation.

Controversies over evolution of life

- Spontaneous generation theory
  - Aristotle
  - John Needham
- Biogenesis theory
  - Francesco Redi
  - Rudolph Virchow
  - Lazzaro Spallazani
  - Louis Pasteur

Redi filled three jars with decaying meat



The Controversy Over Spontaneous Generation

John Needham & Lazzaro Spallanzani

Needham >

Spallazani >

1713 - 1781

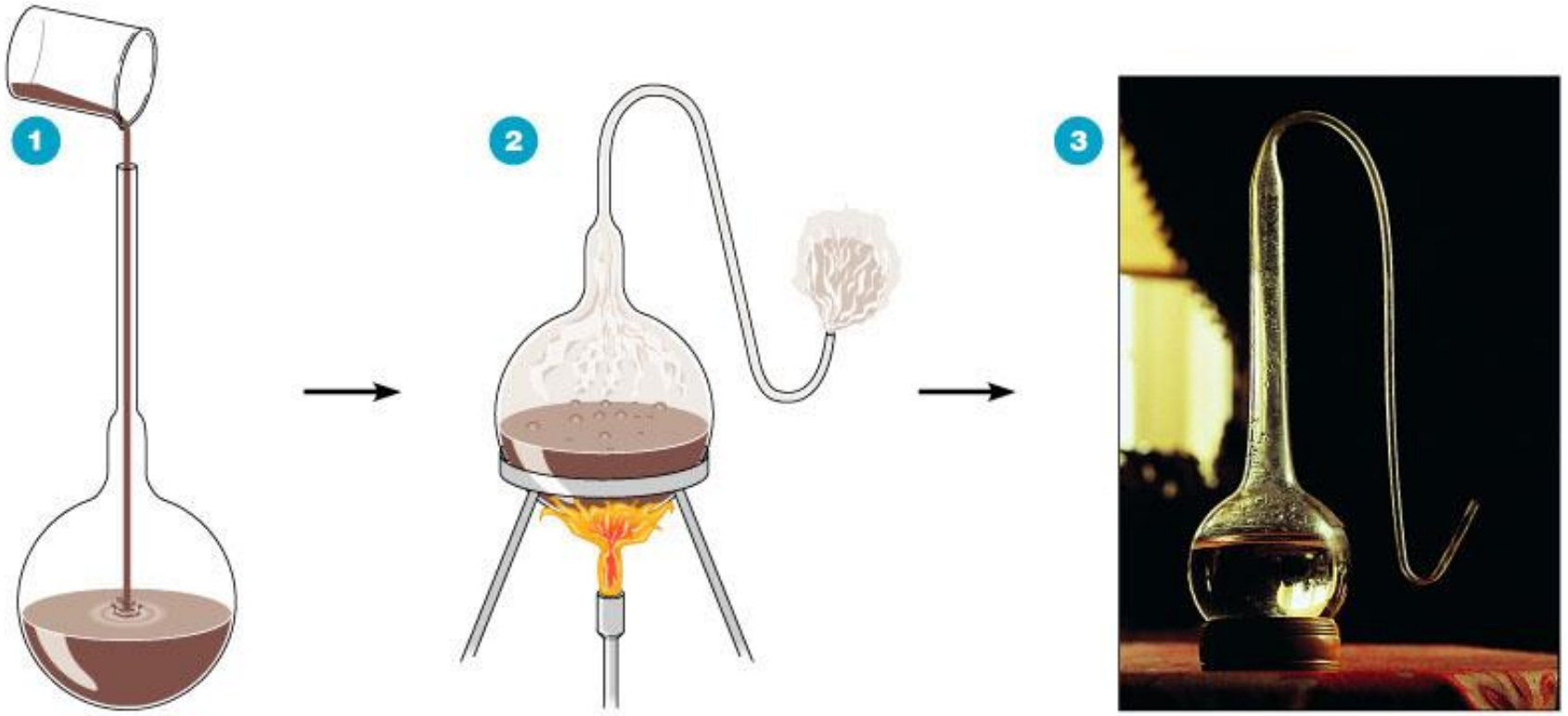
1729 - 1799

Needham's Hypothesis: Spontaneous generation.

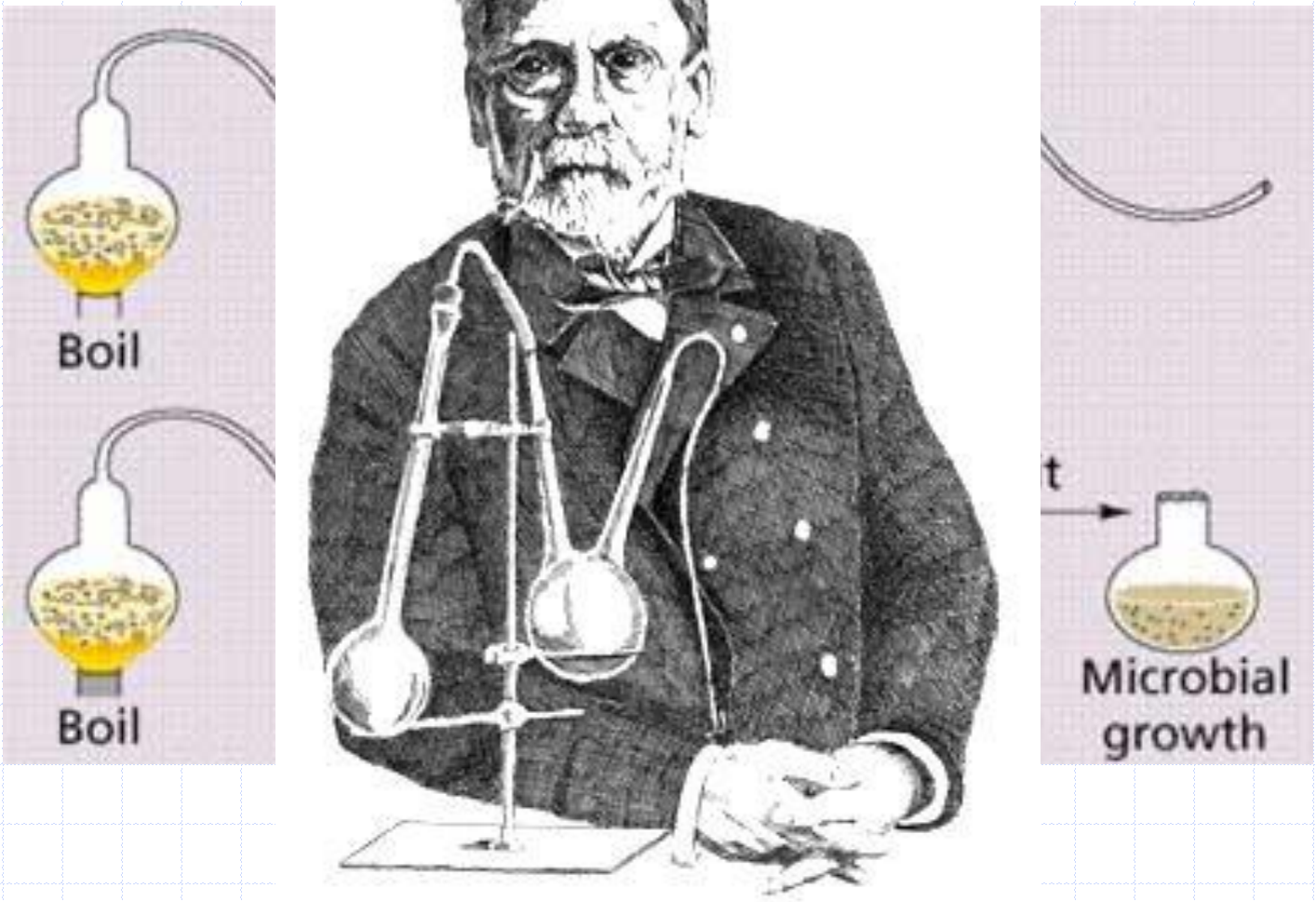
Spallazani's Hypothesis: Microbes come from the air. Boiling will kill them.

History of Microbiology

Next experiment, Pasteur's S-shaped flask kept microbes out but let air in. These experiments form the basis of aseptic technique



Pasteur's Swan-Necked Flasks



Louis Pasteur(1822-95)

- French chemist
- Father of Microbiology
- Opposed theory of spontaneous generation
- Role in fermentation industry
- Introduces techniques of sterilsation, developed
  - Hot air oven
  - Steam sterilizer
  - Autoclave
- Discovered process of attenuation - vaccines

Role of Pasteur in fermentation

- *Fermentation – process of conversion of sugar to alcohol*
- Era of chemist – Chemical instability of bonds
- Theodore Schwann and others – 1837 proposed – **yeast cells** are responsible for fermentation
- **controversy** *– Oh not again !!*

- 1856, M.Bingo – industrialist of Lille, France called Pasteur to solve problem of sour wines
- His business – to produce ethanol from beet sugars
- Pasteur – demonstrated that yeast was replaced by bacteria (acidic fermentation)


PASTEUR DÉCOUVRE LA LOI DES FERMENTS

History of Microbiology

Pasteur demonstrated that these spoilage bacteria could be killed by heat that was not hot enough to evaporate the alcohol in wine. This application of a high heat for a short time is called **pasteurization**.

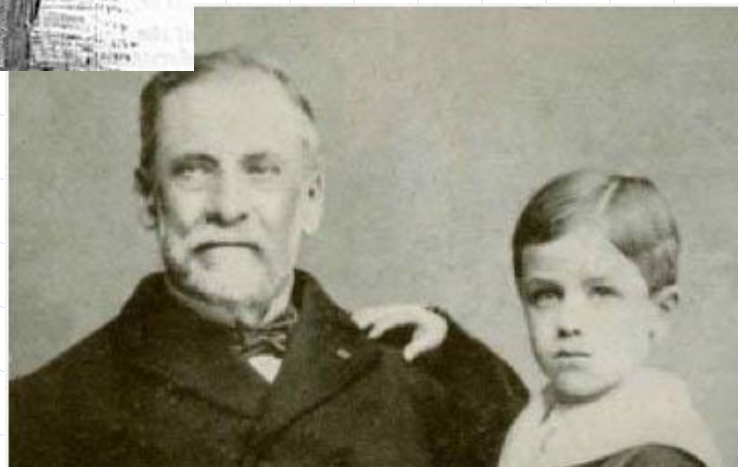
Louis Pasteur (Contd.)

- Discovered process of attenuation and developed live vaccines of
  - Anthrax, chicken cholera and rabies
- Described various techniques of attenuation-
  - Incubation at high temperature-Anthrax
  - Incubating for long periods-Chicken cholera
  - Treating with chemicals like formaldehyde-Rabies

Role in vaccine preparation

- During study on chicken cholera –accidently kept plate on bench & left – injecting this culture into chicken – no disease produced
- In a public farm – he showed these chickens were not infected later on even by wild strains
- Coin term *Vaccine* – for such attenuated strains
- "Vaca" (cow) in honor of Edward Jenner (who used cowpox material to immunize against smallpox)

Development of rabies vaccine



Development of Pasteur institute

The Golden Age of Microbiology 1857-1914

Beginning with Pasteur's work, discoveries included the relationship between microbes and disease – germ theory of disease

- Role of Robert Koch & Joseph Lister

History of Microbiology

The Germ Theory of Disease

1835: **Agostino Bassi** showed a silkworm disease was caused by a fungus.

1865: **Pasteur** believed that another silkworm disease was caused by a protozoan.

1840s: **Ignaz Semmelwise** proved role of hands in transmission of puerperal infection in pregnant patient & advocated hand washing to prevent transmission of puerperal fever

History of Microbiology

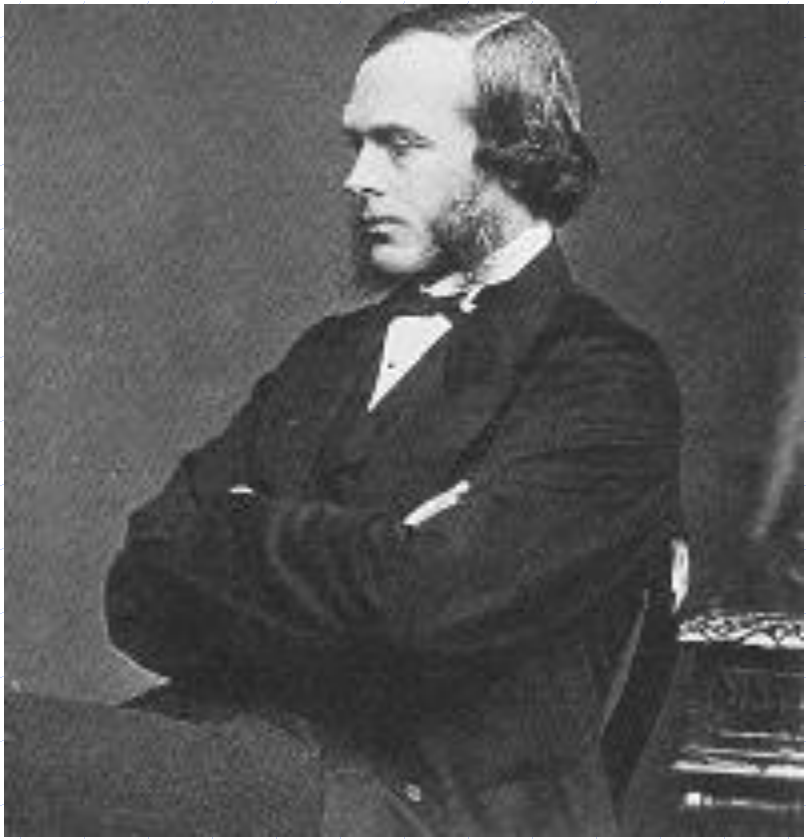
The Germ Theory of Disease

- 1860s: **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.

Recognition of microbial role in causation of diseases

- Role of Joseph Lister

Joseph Lister(1827-1912)

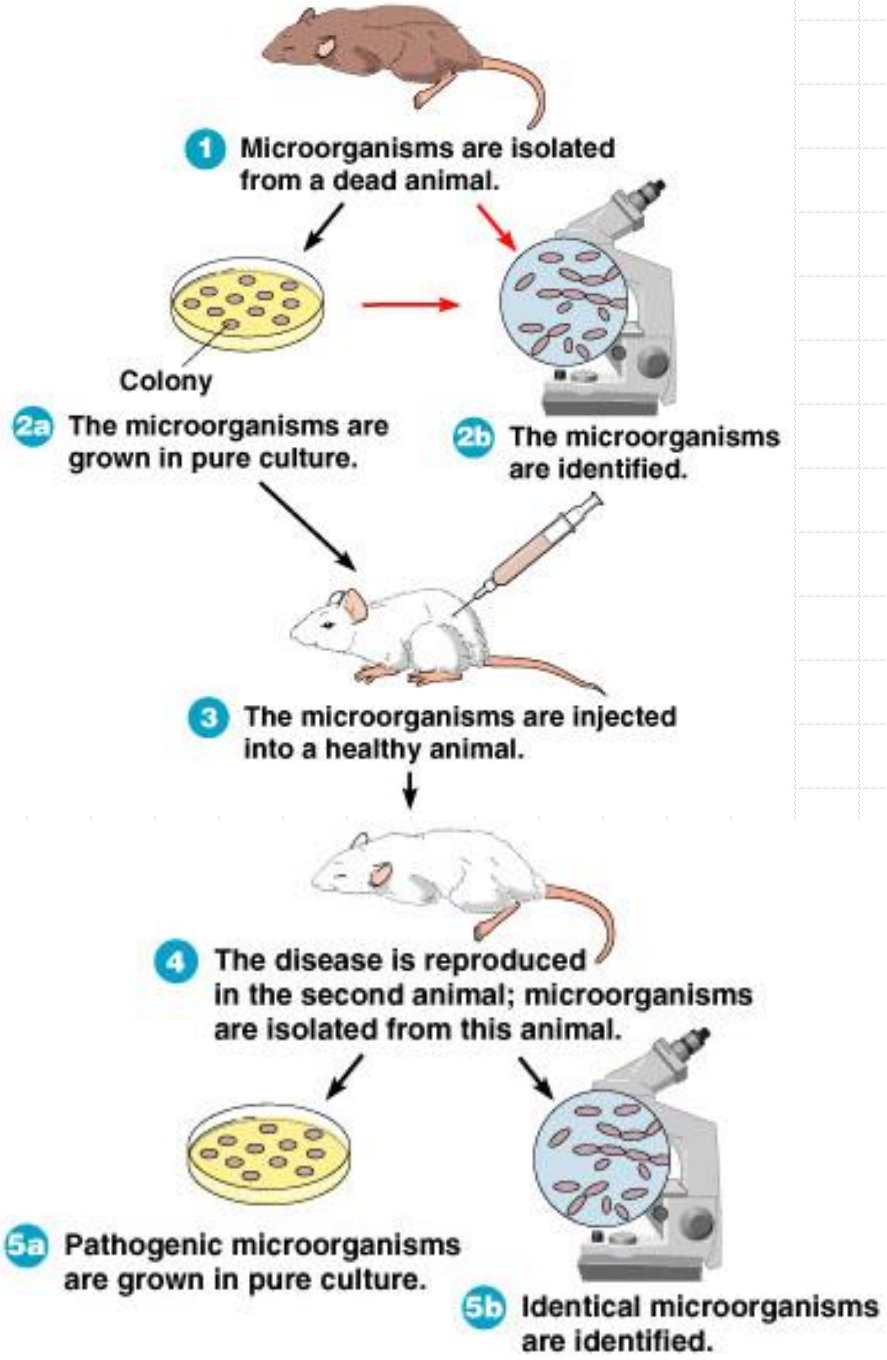


- Father of Antiseptic surgery
- Surgeon from England
- Used heat and phenol to prevent wound infection
- Developed system of antiseptic surgery

History of Microbiology

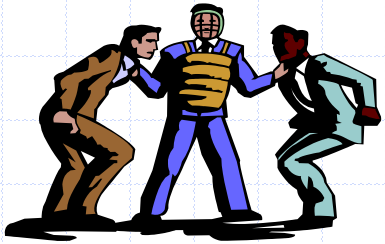
The Germ Theory of Disease

1876: **Robert Koch** provided proof that a bacterium causes anthrax and provided the experimental steps, Koch's postulates, used to prove that a specific microbe causes a specific disease.

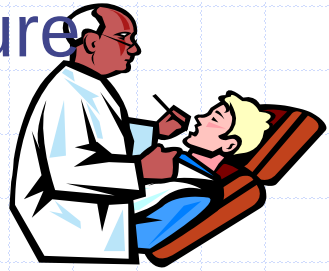

1 Microorganisms are isolated from a dead animal.
Colony
2a The microorganisms are grown in pure culture.
2b The microorganisms are identified.
3 The microorganisms are injected into a healthy animal.
4 The disease is reproduced in the second animal; microorganisms are isolated from this animal.
5a Pathogenic microorganisms are grown in pure culture.
5b Identical microorganisms are identified.

Koch's Postulates

- Organism should be constantly associated with lesion of disease

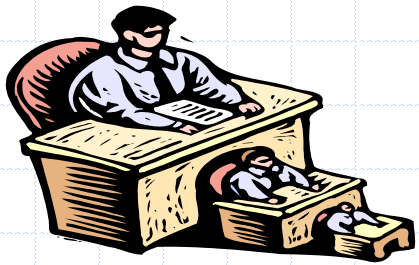


- Should be possible to isolate bacterium in pure culture

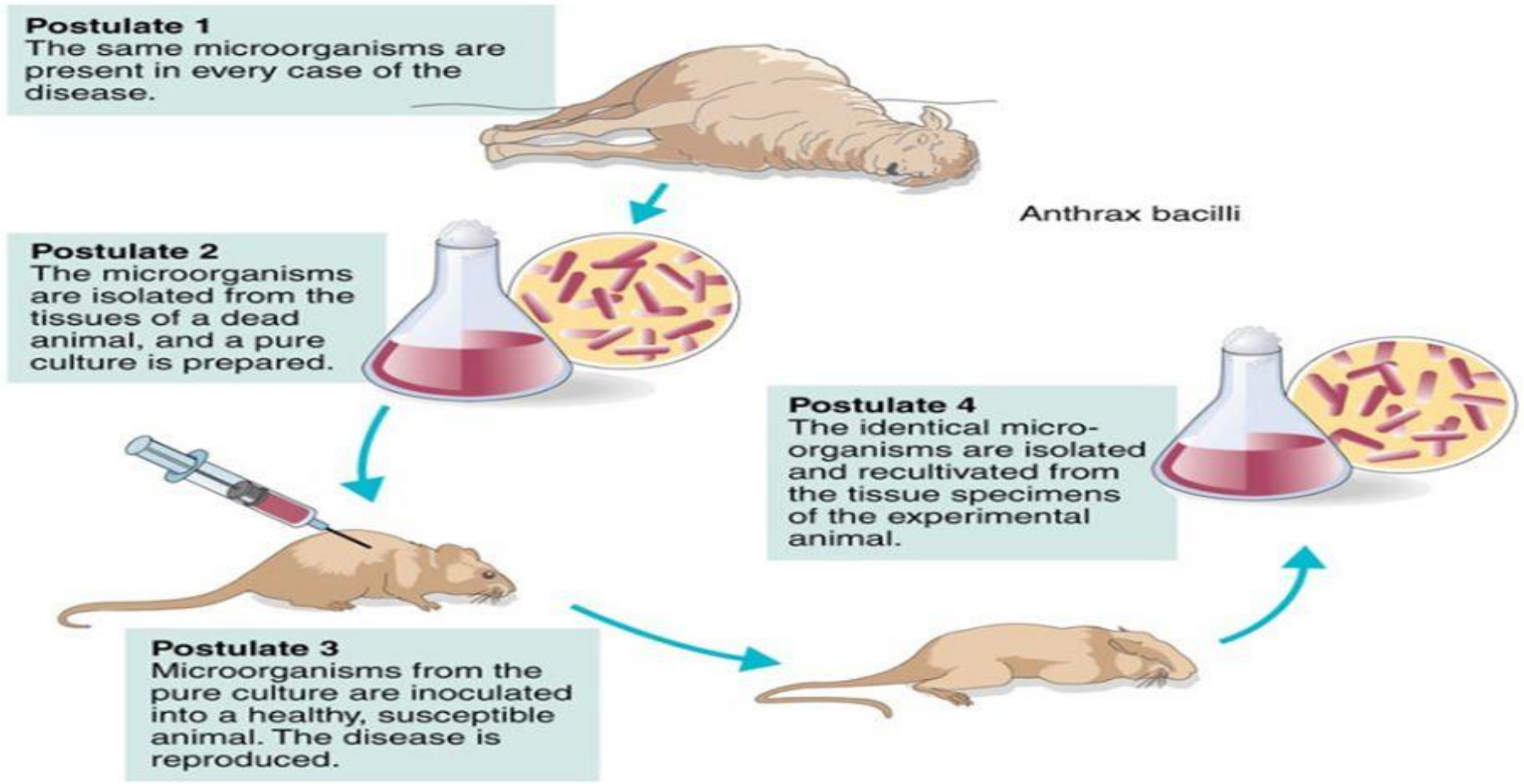


- Inoculation of such culture material in suitable laboratory animal should reproduce the disease

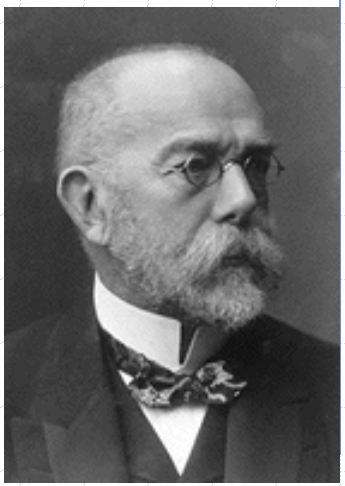
- Should be possible to reisolate same bacteria in pure culture from lesion in experimental animal



Koch Postulates



Robert Koch(1843-1910)



- FATHER OF BACTRIOLOGY
- German Physician
- Role in Microbiology
  - Staining Procedures
  - Methods of obtaining bacteria in pure culture
  - Developed agar
  - Discovered bacillus of Anthrax, tuberculosis and cholera
  - Established relationship between micro-organism and disease by providing Koch's postulates

Discoveries of Micro-organisms

YEAR	SCIENTIST	ORGANISM
1874	Hansel	Leprabacillus
1979	Neisser	Gonococcus
1881	Ogston	Staphylococcus
1884	Loeffler	Diptheria bacilusi
1884	Nicolaier	Tetanus bacillus
1886	Fraenkel	Pneumococcus
1887	Weiselbaum	Meningococcus
1905	Hoffman Scahaudinn	Spriochetes of syphillis

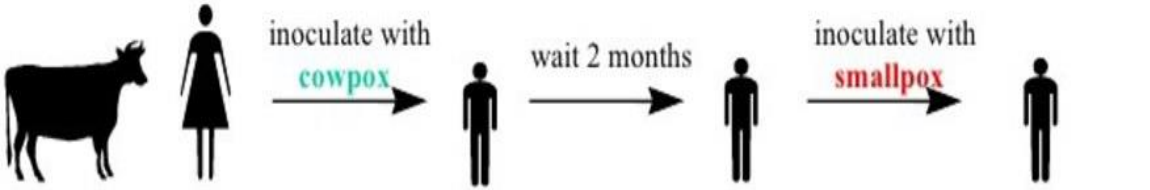
THE BEGINNING OF VIROLOGY

- Ivanoski(1864-1920)- first man to describe a filtered extract capable of causing disease in plants
  - He reproduced mosaic disease of tobacco plants by rubbing juice over healthy leafs
- 1898-Beijrinck confirmed the findings and coined the term "VIRUS" for such agents
- 1898-Walter Reed in Cuba established that Yellow fever was caused by bite of infected mosquitoes-first disease proved to have a viral etiology
- 1934-Ruska developed Electron Microscope
- 1930-Goodpasteur developed techniques of growing viruses in chick embryo

THE BEGINNING OF IMMUNOLOGY

- The practice of variolation-Lady Mary Wortley Montague-1718 in England
- Jenner's observation-immunity in milkmaids to smallpox-1796
- Louis Pasteur-1881-bacteria lost their virulence(ability to cause disease) after extensive subculturing in laboratory but still capable of providing immunity
- Kitasato and von Behring-described antibody in 1890
- Bordet-1895-defined two components participating in reaction- heat labile complement and heat stable antibody

Edward Jenner's experiment (1796)



material from cowpox lesion of milkmaid

village boy susceptible to smallpox

child recovers from cowpox

child does not develop smallpox

Images: Dr. Edward Jenner by James Northcote; Child with Smallpox, James Hicks, CDC

History of Microbiology

Chemotherapy – treatment with chemicals

- **Chemotherapeutic agents used to treat infectious disease can be synthetic drugs or antibiotics.**
- **Antibiotics are chemicals produced by bacteria and fungi that inhibit or kill other microbes.**
- **Quinine from tree bark was long used to treat malaria.**

History of Microbiology

Chemotherapy – treatment with chemicals

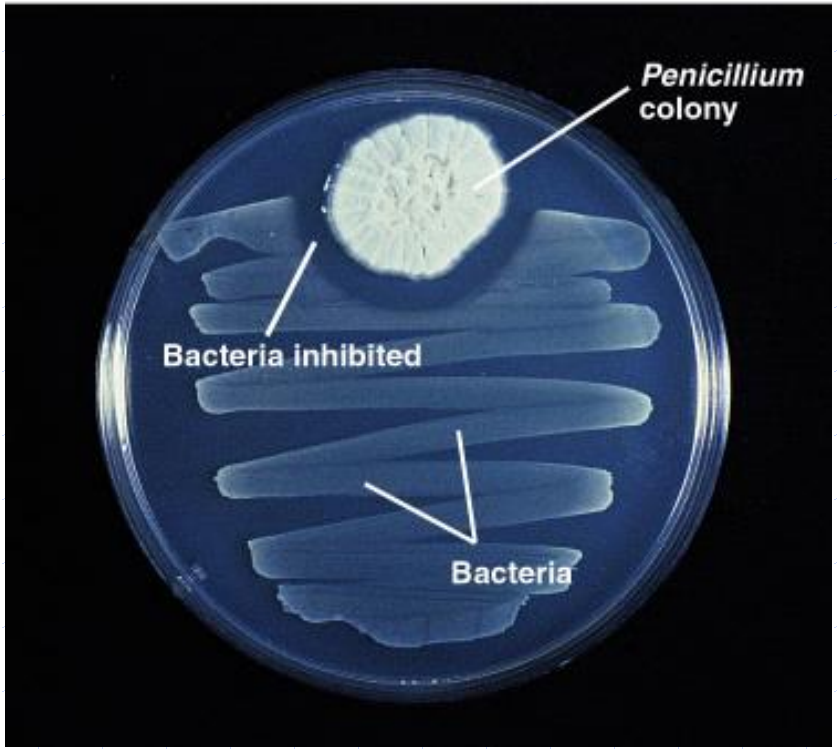
- 1910: Paul Ehrlich developed a synthetic arsenic drug, salvarsan, to treat syphilis.
- 1930s: Sulfonamides were synthesized.

History of Microbiology

1928: Alexander Fleming discovered the first antibiotic.

He observed that *Penicillium* fungus made an antibiotic, penicillin, that killed *S. aureus*.

1940s: Penicillin was tested clinically and mass produced.




Thanks to PENICILLIN
...He Will Come Home!

Classification of Microbes

Taxonomy

- The science of classifying organisms
- Provides universal names for organisms
- Provides a reference for identifying organisms

Classification of Microbes

Taxonomy

- **Systematics or phylogeny**
  - **The study of the evolutionary history of organisms**
- **All Species Inventory (2001-2025)**
  - **To identify all species of life on Earth**

Classification of Microbes

Taxonomic Hierarchy

Domain

Kingdom

Phylum

Class

Order

Family

Genus

Species

Binomal Nomenclature uses the Genus and Species name to identify each creature.

Classification of Microbes

Taxonomic Hierarchy

Each name is Latinized

There is a specific way to write each name.

Vibrio cholerae

The first word is capitalized

Name is in italics

Vibrio cholerae

V.cholerae


Thank you

Questions from this chapter:

- Contribution of Louis Pasteur
- Contribution of Robert Koch
- Koch's postulates
- Antony Van Leuwenhoek
- Joseph Lister
- What is Lister's antiseptic surgery ?