

1. Introduction to Microbiology

Dr Mohammad Al-Tamimi, MD, PhD

Second Year Medical Students

Faculty of Medicine

Hashemite University

2023/2024

Course Details

- Course name and number: General microbiology (111501204)
- Second year (MD program)
- Credit hours: 3 (2.5 theory, 0.5 practical)
- Lectures Sunday Tuesday and Thursday for 1 hour
- Lab Sunday Tuesday and Thursday for 2 hours
- Course instructors:
 - Dr Mohammad Altamimi
 - Dr Hafeth Al Momani
 - Dr Ashraf Khasawneh
 - Dr Hala Altabel
- Course coordinator: Dr Hala Altabel
- Exams MID LAB and FINAL

Course resources

- Course outline and syllabus
- Lecture and lab notes
- Microbiology ms team
- Reference textbook:

Kenneth J. Ryan, C. George Ray: Sherris Medical Microbiology, Latest Edition.

Lecture Outline

- How diseases occur and what cause them?
- Importance of understanding microbiology
- Classification and difference between pathogens
- Naming of Bacteria
- Historical Background
- Modern Microbiology

Introduction

- How diseases occur and what causes them?
 - Old theories of human diseases
 - Recent theories of Human diseases
 - Germ theory



• جمجمة إنسان عاش في أريحا منذ 4,000 إلى 4,200 سنة مضت،
والفجوات أعلى الجمجمة نتيجة لعملية تربية أجريت لها. ويدل النمو
الجزئي للعظام على بقاء المريض على قيد الحياة بعد العملية، ويحتمل
أن إجراء عمليات ثقب الجمجمة كانت تهدف إلى طرد الشياطين المسببة
للأمراض العقلية.

Germ Theory of Disease

- Proposed by Robert Koch and Louis Pasteur.
- Every human disease is caused by a microbe or germ, which is specific for that disease and one must be able to isolate the microbe from the diseased human being.



ROBERT KOCH



LOUIS PASTEUR

Congenital
Cancer
Infarction
Infection
Autoimmunity
Psychological
Degenerative
Others

Microbiology for Medical Students

- Importance of understanding microbiology for medical students:
 - Difference between pathogens
 - Clinical picture for different infections
 - Investigations
 - Prevention and treatment





Definition

- Micro - too small to be seen with the naked eye
- bio - life
- ology - study of
- Microorganisms are organisms that are too small to be seen with the unaided eye.
- “Germ” refers to a rapidly growing cell.



Why does microbiology matter?

Importance of Microbiology

- Environment and agriculture
- Food
- Industry and biotechnology
- Research
- Medicine
 - About 2000 microbes cause diseases
 - 10 billion infections/year worldwide
 - 13 million deaths from infections/year worldwide

Classification

- Unicellular or multicellular
- Eukaryotes or prokaryotes
- Pathogenic or non-pathogenic
- Categories

1. Bacteria

Bacteriology

2. Protozoans

Protozoology

3. Algae

Phycology

4. Parasites

Parasitology

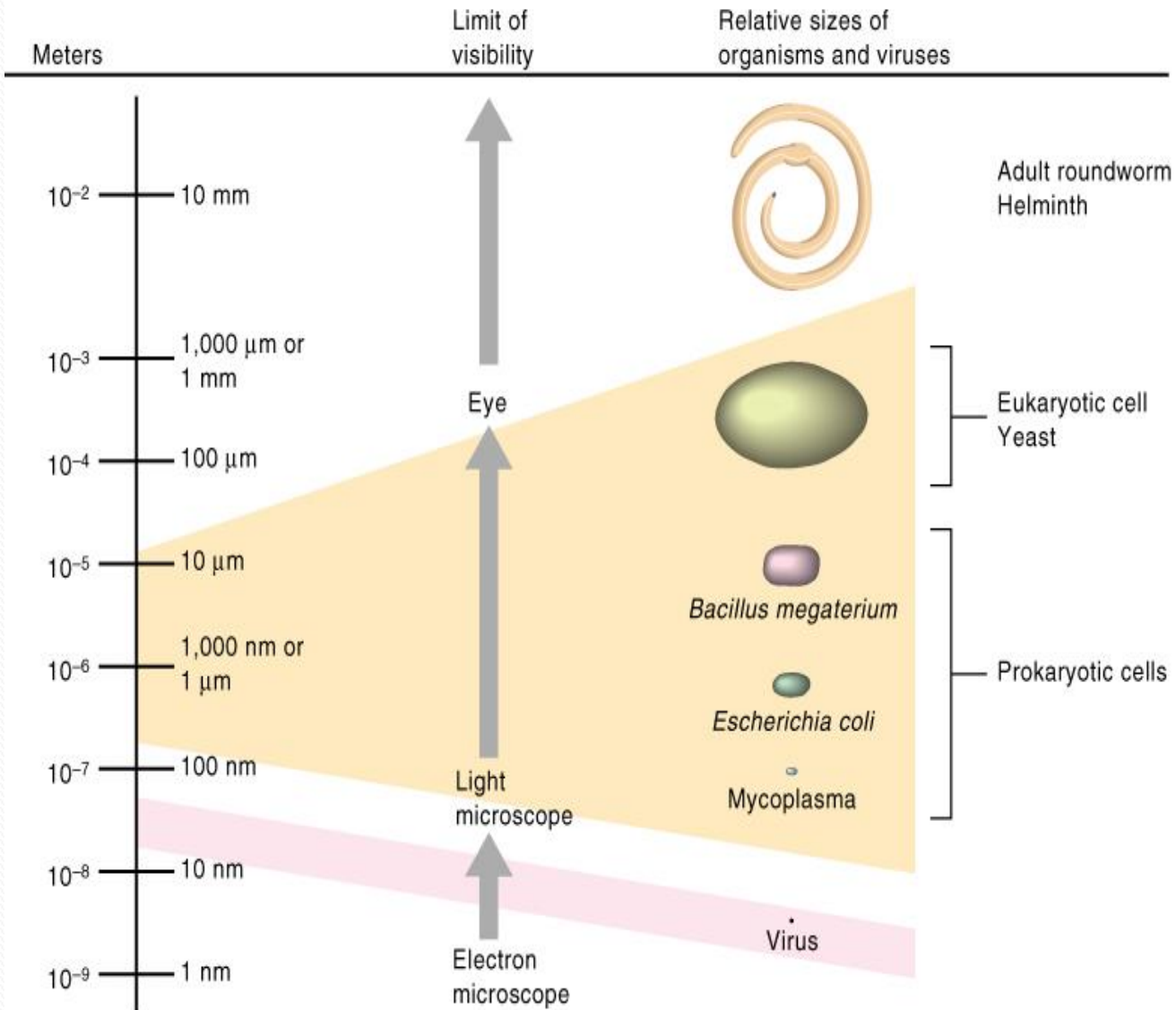
5. Fungi

Mycology

6. Viruses

Virology

Scale of Microns



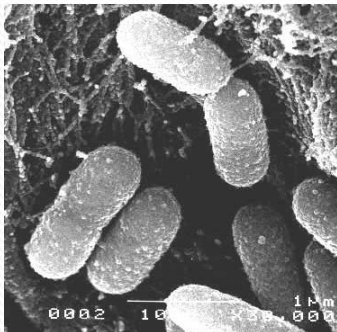
1. Bacteria



- Bacteria are microscopic, single-celled organisms that exist in their millions, in every environment, both inside and outside other organisms.
- Some bacteria are harmful, but most serve a useful purposes
- Bacteria are thought to have been the first organisms to appear on earth, about 4 billion years ago
- A gram of soil typically contains about 40 million bacterial cells
- Classification: prokaryotes, unicellular
- Types: Gram-negative, Gram-positive
- Diseases: strep throat, tetanus, tuberculosis, etc.,

Bacterial Shape and Organization

Bacilli



Cocci

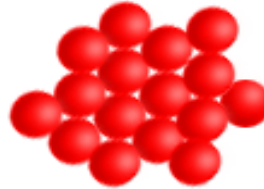
Diplocoques



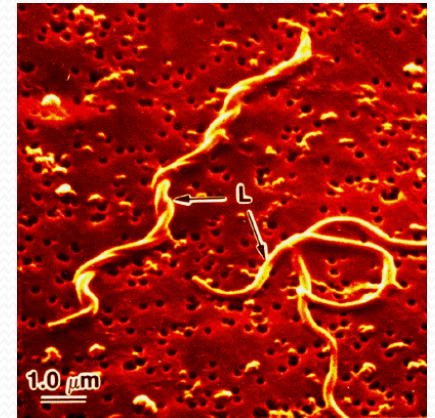
Streptococques



Staphylococques



Spiral



Naming of Bacteria

Scientific nomenclature: each microbe name composed of 2 parts

Genus: Noun and capital

Species: lower case

Both Italicized or underlined and can be briefed

Staphylococcus aureus (*S. aureus*)

Escherichia coli

Honors the discoverer, Theodor Eshcerich, and describes the bacterium's habitat, the large intestine or colon

2. Algae



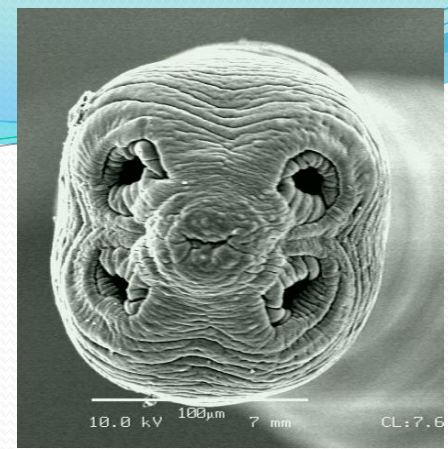
- Description: photosynthetic aquatic eukaryotes
- Can be both unicellular and multicellular
- Most algae live in fresh or sea water where they can either be free-floating or attached to the bottom
- Types: brown, red, green
- All algae contain a pigment called chlorophyll and they make their own food by photosynthesis
- Diseases: *Alexandrium* causes Paralytic Shellfish Poisoning (PSP) “is a serious illness caused by eating shellfish contaminated with algae that produce harmful toxins and can be fatal to humans”

3. Fungi



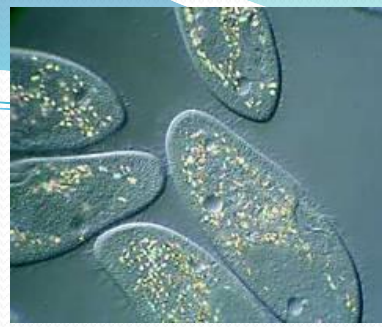
- Description: a group of eukaryotic organisms that includes microorganisms such as yeasts, molds, and mushrooms
- Nutrient absorbers, plant decomposers, does not contain chlorophyll
- ~100 human pathogens
- Types: yeasts (unicellular fungi), molds (filamentous fungi)
- Diseases: ringworm (pictured), athlete's foot, etc.

4. Helminthes



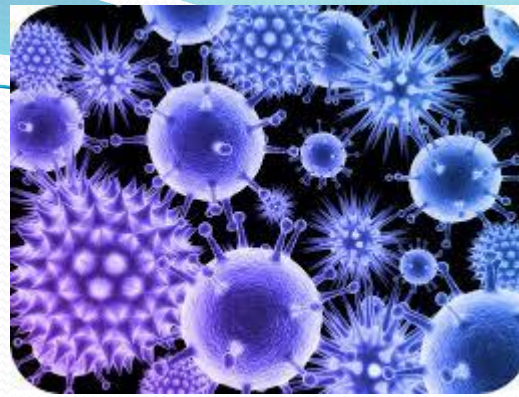
- Description: are worm-like parasites that survive by feeding on a living host to gain nourishment and protection, sometimes resulting in illness of the host
- Multicellular animal parasites, engulfers and absorbers
- Types: flatworms, roundworms, tapeworm, etc
- Diseases: hook worm, tape worm, etc.

5. Protozoa



- Description: is an informal term for single-celled eukaryotes, either free-living or parasitic, which feed on organic matter such as other microorganisms or organic tissues and debris.
- unicellular , flagellates, ciliate
- Types: eukaryotes, engulfers and absorbers
- wet conditions, no cell wall, ~30 human pathogens
- Diseases: malaria, giardiasis, amoebic dysentery, etc.

6. Viruses

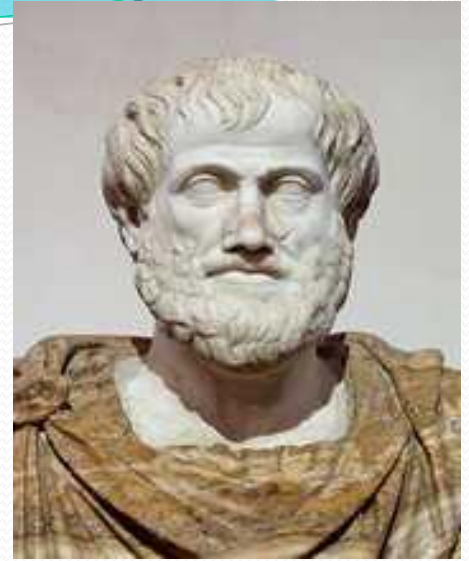


- Description: is a small infectious agent that replicates only inside the living cells of an organism.
- Viruses can infect all types of life forms, from animals and plants to microorganisms, including bacteria and archaea
- viruses are not cells but some viruses do have lipid envelopes (acellular),
- Diseases: common cold, flu, HIV, etc.

History

Aristotle believed that living things generate from non-living matters
“Spontaneous generation” 350 BC

This belief remained unchallenged for more than 2000 years.



Robert Hooke, 1665

Little boxes – cells

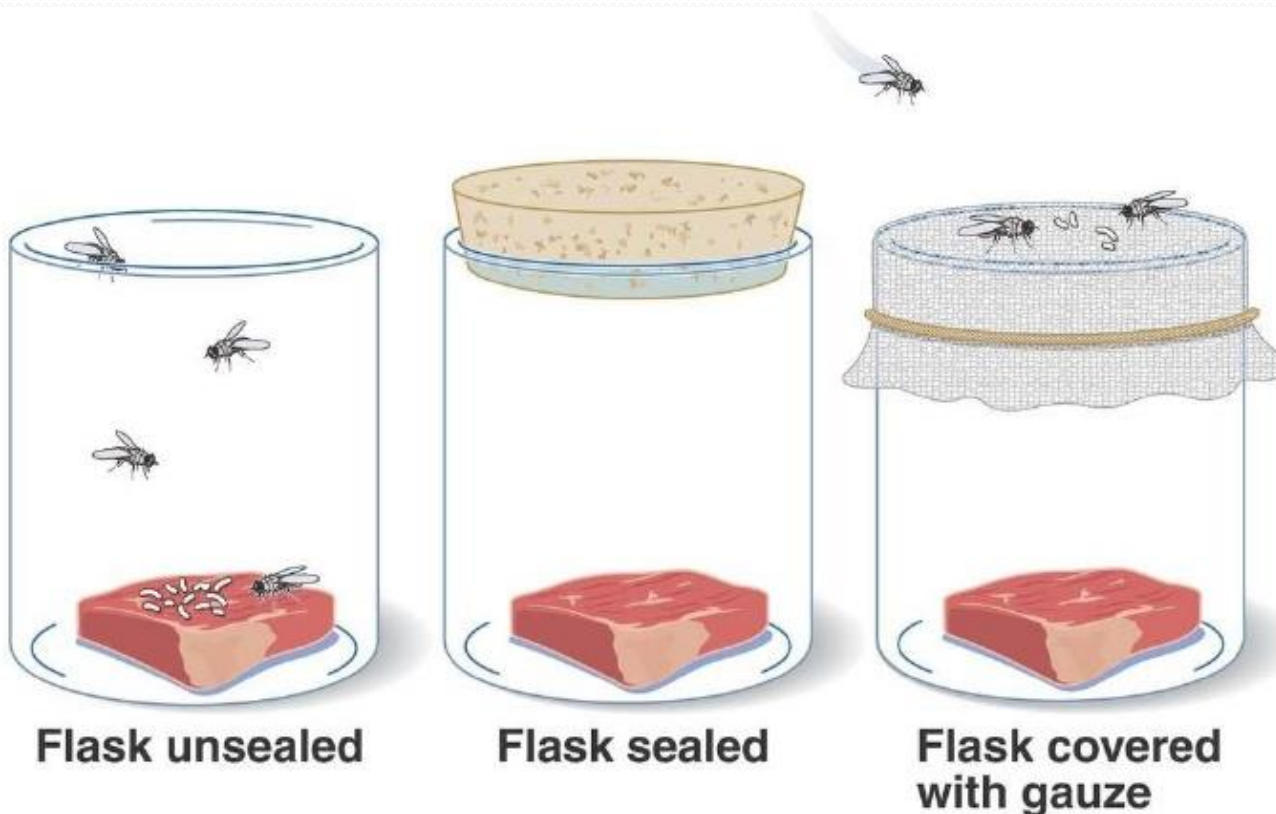
Cell theory – all living things are made up of cells

Hooke's microscope was capable of showing large cells, it lacked the resolution so he didn't see the microbe

Francesco Redi, 1668

Meat exposed to flies became infested

- they claimed that fresh air was needed for spontaneous generation.



Flask unsealed

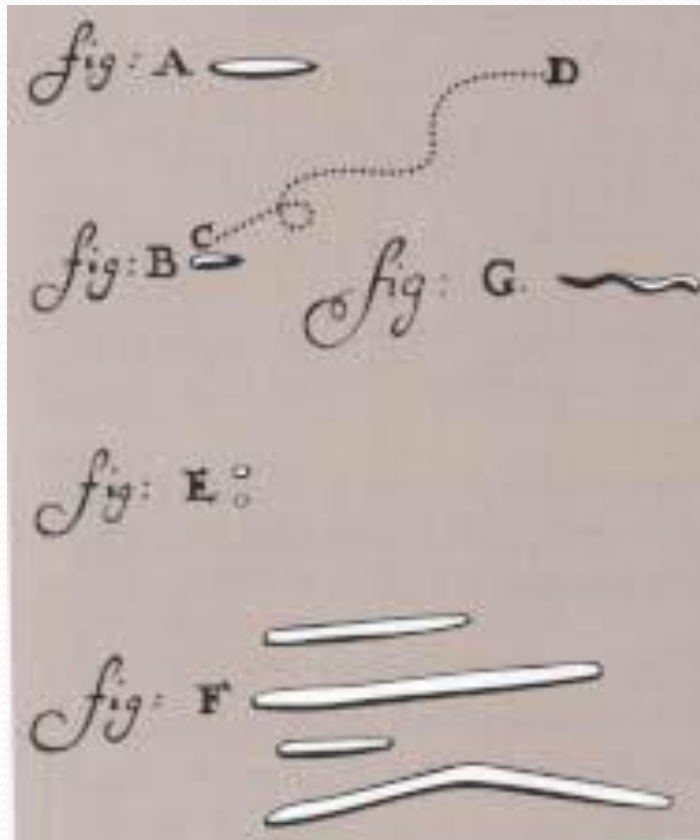
Flask sealed

Flask covered with gauze

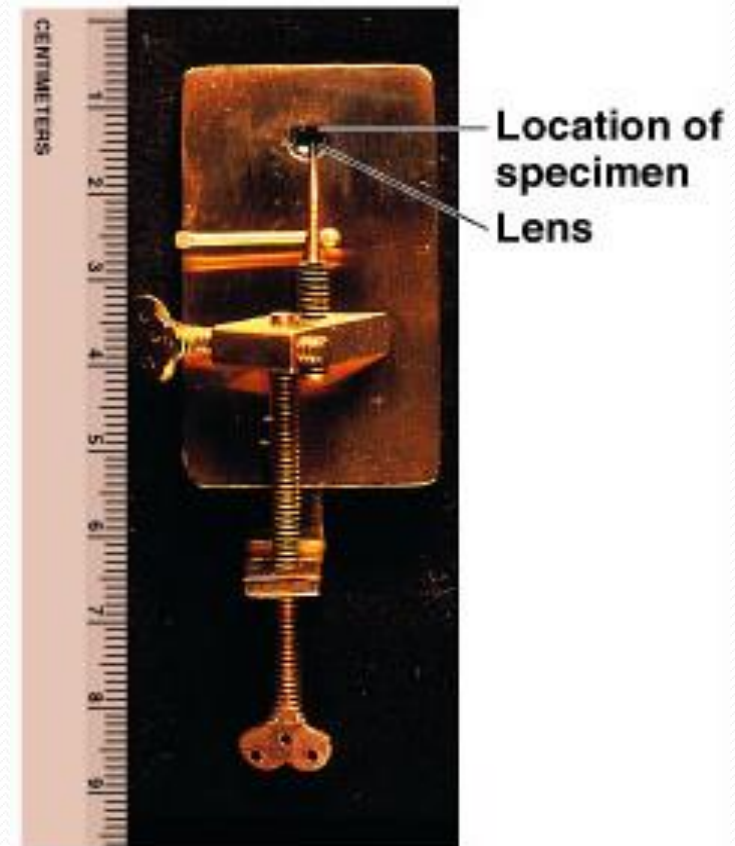
Anton van Leeuwenhoek, 1674



1st person to actually see living microorganisms



Wee animalcules



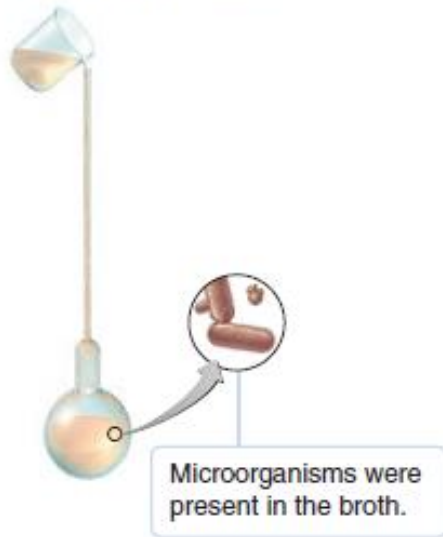
(b) Microscope replica



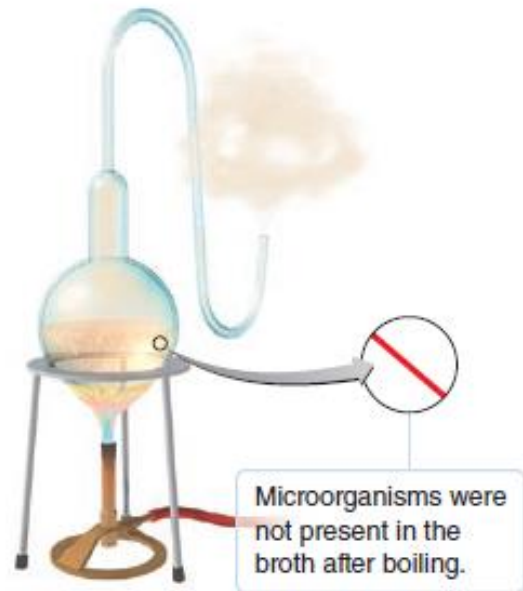
Louis Pasteur , 1861

Disproving the Theory of Spontaneous Generation

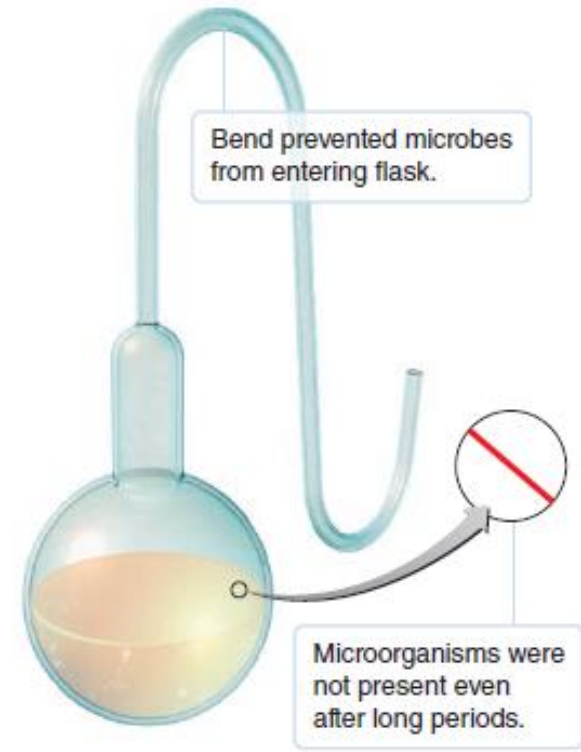
- 1 Pasteur first poured beef broth into a long-necked flask.



- 2 Next he heated the neck of the flask and bent it into an S-shape; then he boiled the broth for several minutes.



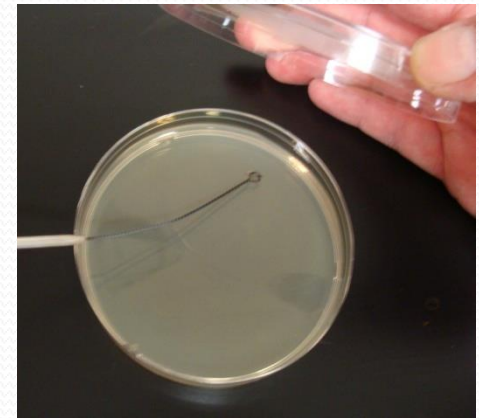
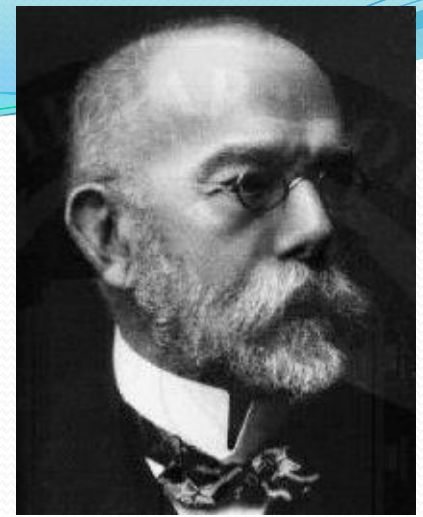
- 3 Microorganisms did not appear in the cooled solution, even after long periods.



- Pasteur demonstrated that microorganisms are present in the air and can contaminate sterile solutions, but that air itself doesn't create microbes.

Robert Koch, 1876

- Experimented with **medium** to grow bacteria
- Using **agar** (a gelatin-like product derived from seaweed)
- Add various **nutrients** necessary to grow certain organisms.
- He provided proof that a bacterium causes anthrax (**Koch's postulates**) used to prove that a specific microbe causes a specific disease



Koch's postulates : Understanding Disease

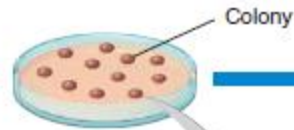
- Pathogen must be present in all cases of disease
- Pathogen must be isolated and grown in lab in pure culture
- Pathogen from pure cultures must cause disease when inoculated into healthy, susceptible lab animal
- Same pathogen must be isolated from the diseased lab animal

Robert Kock experiment

1 Microorganisms are isolated from a diseased or dead animal.



2a The microorganisms are grown in pure culture.



2b The microorganisms are identified.



3 The microorganisms are injected into a healthy laboratory animal.



4 Disease is reproduced in a laboratory animal.



5a The microorganisms are isolated from this animal and grown in pure culture.



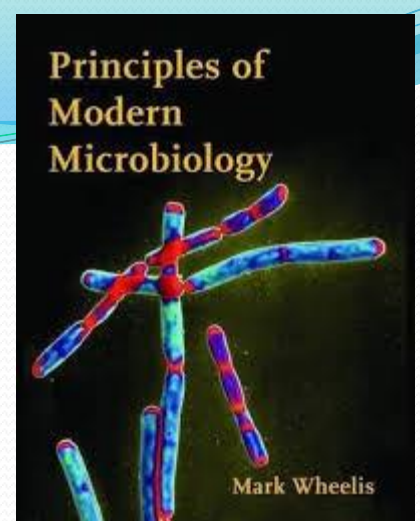
5b Microorganisms are identified.



The microorganism from the diseased host caused the same disease in a laboratory host.

Modern Microbiology

- Molecular biology
- Immunology
- Recombinant DNA and genetic engineering
- Laboratory Medicine and pathology
- Prevention and treatment
- Emerging infections: AIDS, SARS, CORONA, etc



Microbes Benefit to Humans



- Bacteria are primary decomposers
- Microbes produce various food products
- Microbes produce Antibiotics
- Bacteria synthesize chemicals that our body needs, but cannot synthesize (Vitamin b and K)
- Normal microbial flora prevents potential pathogens from gaining access to our body
- Using bacteria to control the growth of insects
- Using microbes to clean up pollutants and toxic wastes
- Bacteria can be manipulated to produce enzymes and proteins they normally would not produce (insulin)
- Microbes form the basis of the food chain



Thank you...