A Brief History of Microbiology

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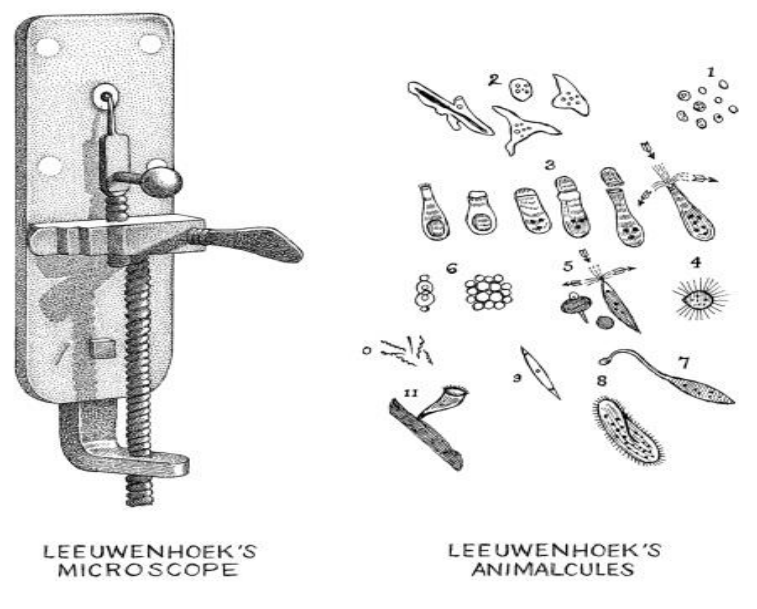
Lec. ٣

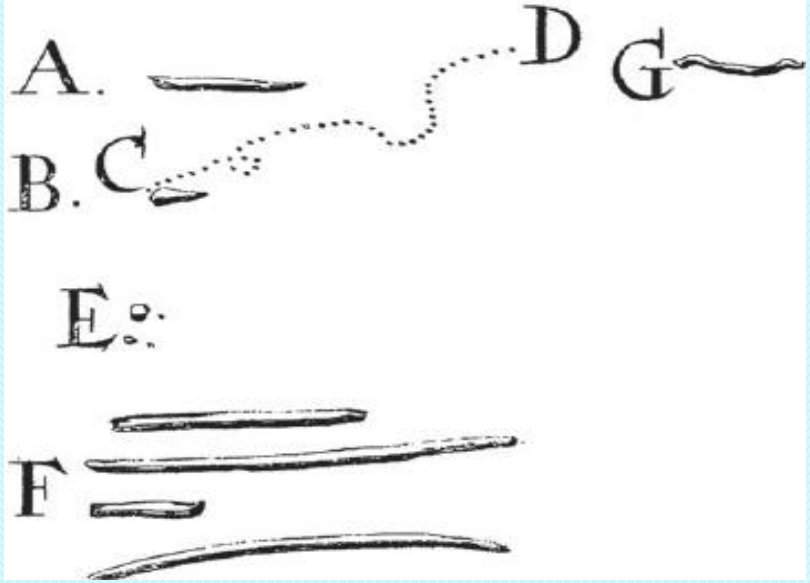
- ***Aristotle** and others believed that living organisms could develop from non-living materials.

- ***١٥٩٠: Hans and Zacharias Janssen** (Dutch lens grinders) mounted two lenses in a tube to produce the first compound microscope.

- ***Hooke:**
- **What discovery is he credited with? He first described "cellulae" (small rooms) in cork in ١٦٦٥.** His discovery led to the formulation of the cell theory, which states that cells are the basic organizational unit of all living things.

- ***Leeuwenhoeck (lived ١٦٣٢-١٧٢٣)**
- What discovery is he credited with? First person to use microscopes to observe microbes; as a hobby he made small handheld microscopes; he called microorganisms “animalcules.”





- ***١٨٨٣: Carl Zeiss and Ernst Abbe** pioneered developments in microscopy (such as immersion lenses and apochromatic lenses which reduce chromatic aberration) exist until the present day.
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- ***١٩٣١: Ernst Ruska** constructed the ١st electron microscope

- ***Redi and Spontaneous Generation**

- ١. What is this theory? Living organisms arise from nonliving things (ex. maggots come from rotting meat)
- ٢. Who disproved this theory and how? In the late ١٦٠٠'s **Francisco Redi** showed that maggots developed only in meat that flies could reach to lay eggs on.
- ٣. Many insisted that he only disproved spontaneous generation for macroorganisms; maybe microbes were an exception.

- ***Needham vs. Spallanzani -** still trying to prove or disprove the theory of spontaneous generation.

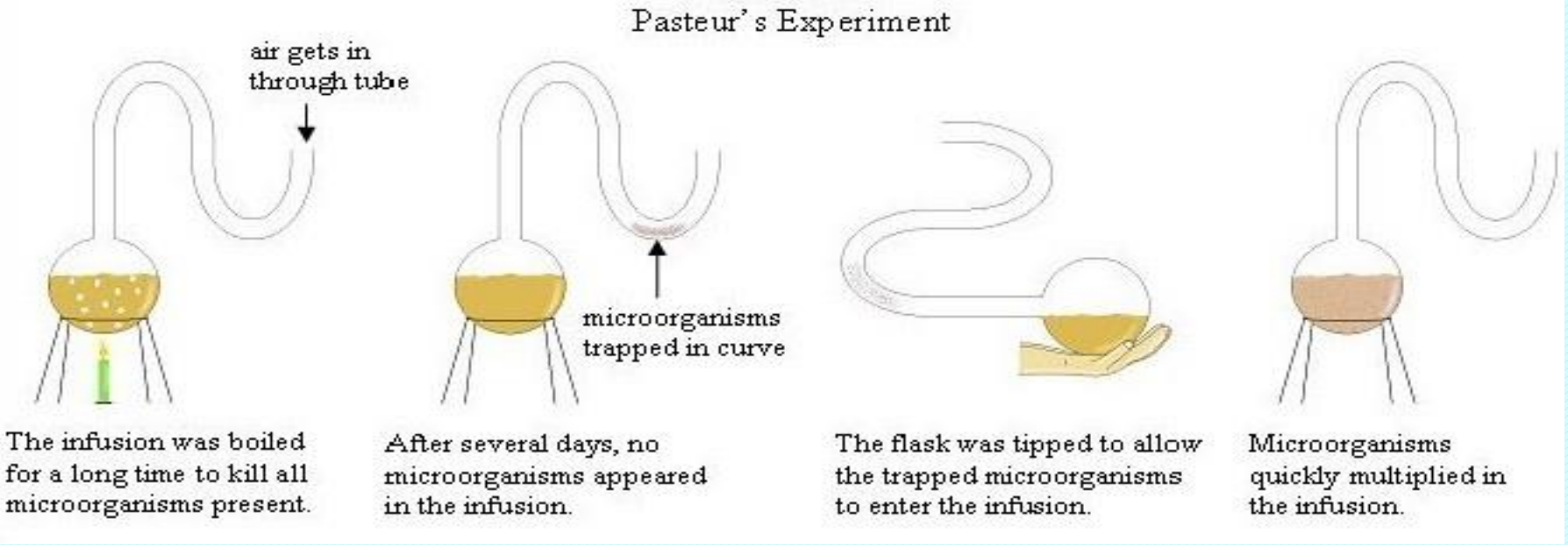
- ١. What was Needham's hypothesis, experiment, & conclusions? Everyone knew boiling killed microbes; so, he would boil chicken broth, put it in a flask, & seal it; if microbes grew, then it could only be because of spontaneous generation; they did grow. [We now know that microbes grew because the flask was not sterilized before he poured in the broth!]

- ٢.What was Spallanzani's hypothesis, experiment, & conclusions? He was not convinced by Needham's experiment. He put broth in a flask, sealed it (creating a vacuum), & then boiled it. There were no microbes in the cooled broth! Critics said he didn't disprove spontaneous generation - they said he just proved that spontaneous generation required air.

- ***Pasteur's Epic Experiments (١٨٥٩)**
- ١. What was his experimental method? To offset the argument that air was necessary for spontaneous generation, Pasteur allowed the free passage of air, but prevented the entry of microbes. He boiled meat broth in a flask & then drew out & curved the neck of the flask in a flame. No microbes developed in the flask. When he tilted the flask so some broth flowed into the curved neck & then tilted it back so the broth was returned to the base of the flask, microbes grew. Gravity had caused the microbes that had entered the flask in air & dust to settle at the low point of the neck, never reaching the broth in the base until the broth washed them in.

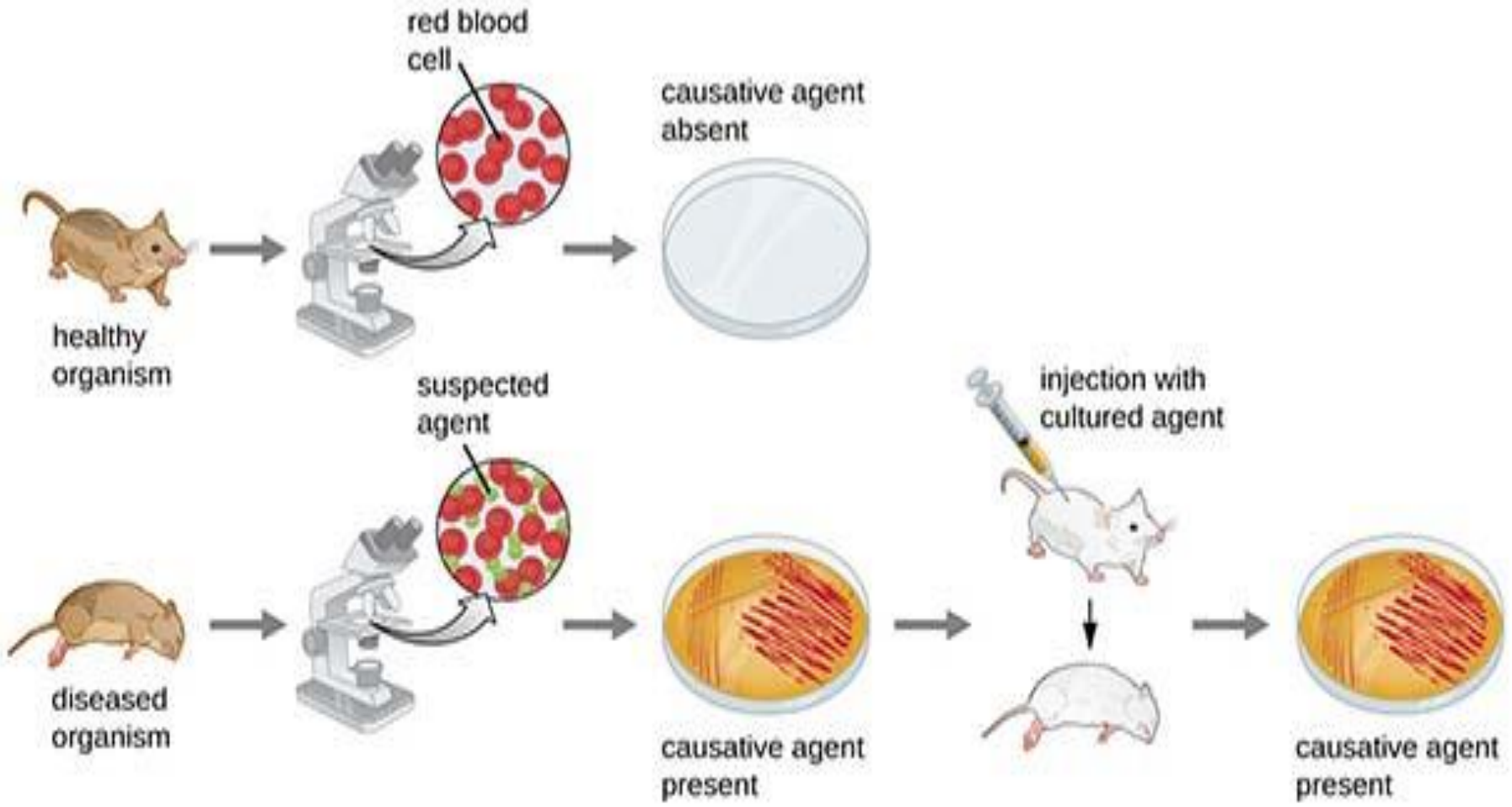
- ٢.Pasteur's success was partly due to good luck. He used meat, which contains few bacterial endospores (endospores are resistant to heat; many experiments done prior to Pasteur's used vegetable broths - plants contains many endospore-forming bacteria.)

- ٣. What ٣ things did Pasteur's experiments prove?
- a. No living things arise by spontaneous generation.
- b.Microbes are everywhere - even in the air and dust
- c. The growth of microbes causes dead plant & animal tissue to decompose & food to spoil (this led him to develop the technique of **pasteurization** - he developed it to keep wine from spoiling).
- ٤. Pasteur also contributed to the development of vaccines.



- ***The Germ Theory of Disease**
- ١ What is the **germ theory of disease**? Microbes (germs) cause disease and specific microbes cause specific diseases.
- ٢.Who proved this theory? Robert Koch in the late ١٨٧٠'s.
- ٣. What disease was he studying? anthrax - disease of cattle/sheep; also in humans
- ٤.What was his experimental method? He observed that the same microbes were present in all blood samples of infected animals. He isolated and cultivated these microbes (now known to be *Bacillus anthracis*). He then injected a healthy animal with the cultured bacteria & that animal became infected with anthrax & its blood sample showed the same microbes as the originally infected animals.
- ٥.What did his experiments prove? Particular microbes cause particular diseases.

- ٦.What are **Koch's ٤ Postulates**?
- ١.) The causative agent must be present in every individual with the disease.
- ٢.) The causative agent must be isolated & grown in pure culture (how did he invent pure cultures?; with Frau Hesse's help, he developed the **agar plate method** (see p. ١٣).
- ٣.) The pure culture must cause the disease when inoculated into an experimental animal.
- ٤.) The causative agent must be reisolated from the experimental animal & reidentified in pure culture.



1. The suspected causative agent must be absent from all healthy organisms but present in all diseased organisms.
2. The causative agent must be isolated from the diseased organism and grown in pure culture.
3. The cultured agent must cause the same disease when inoculated into a healthy, susceptible organism.
4. The same causative agent must then be reisolated from the inoculated, diseased organism.

What are Some Ways that We Can Control Infectious Diseases?

- ١. **Immunity -** stimulating the body's own ability to combat infection; from ancient times it was a recognized fact that people who suffered from certain diseases never got them again; infection could produce immunity.
- a.**Immunization** defined: produce immunity by providing exposure to altered organisms that do not cause disease.
- b. **Jenner & Smallpox -** observed that dairymaids that contracted a mild infection of cowpox seemed to be immune to smallpox. He inoculated a boy with fluid from a cow pox blister and he contracted cowpox; he then inoculated him with fluid from a smallpox blister; the boy did not contract smallpox; the term vaccination came from *vacca* for cow.

- **c. The first vaccines:**
- ١.) Pasteur's discovery? **attenuated** bacteria can produce immunity
- ٢.) **Attenuated** defined - weakened virus or bacteria that is unable to cause the disease (it was later discovered that killed microbes can also produce immunity)
- ٣.) What vaccines did Pasteur develop? anthrax, rabies
- **٢. Public Hygiene**
- a. Improving sewage disposal.
- b. Assuring a clean public water supply.
- c. Food preservation & inspection. ex. Pasteurization - kills most microbes by exposing to heat.
- d. Improving personal hygiene. **Semmelweiss** & childbed fever
- e. Developing antiseptic techniques. **Lister** & carbolic acid – he developed the first aseptic techniques.

- **٣. Chemotherapy**
- a. Who is the father of chemotherapy? **Paul Ehrlich -** he discovered a drug treatment for syphilis**;** he developed the guiding principle of chemotherapy, which is selective toxicity (the drug must be toxic to the infecting microbe, but relatively harmless to the host's cells).
- b.What was the first major class of drugs to come into widespread clinical use? sulfa drugs
- c.Who discovered the first antibiotic? **Flemming** discovered (penicillin); antibiotics are antibacterial compounds produced by fungi and bacteria.

Characteristics of Prokaryotic & Eukaryotic Cells

- **All cells have:**
- ١. Cell or plasma membrane (separates the cell from the outer environment)
- ٢. Genetic material (DNA)
- ٣. Cytoplasm.

TWO GENERAL TYPES OF CELLS:

- **A.Prokaryotic** ("before nucleus") - a cell lacking a membrane-bound nucleus & membrane-bound organelles (ex. bacteria); these cells do have some organelles, but they are not membrane-bound; all prokaryotic cells have a cell wall, its primary component being peptidoglycan; prokaryotic cells are much smaller than eukaryotic cells (about ١٠ times smaller); their small size allows them to grow faster & multiply more rapidly than eukaryotic cells (they have a higher surface area to volume ratio than larger cells; thus, because they are small, they can easily meet their modest nutritional needs and grow rapidly). This group includes all bacteria.

- **B. Eukaryotic** ("true nucleus") - a cell having a membrane-bound nucleus & membrane-bound organelles (“little organs” – specialized structures that perform specific functions within the cell); evolved about ٢ million years after the prokaryotes; cell walls are sometimes present, but they are composed of cellulose or chitin; organisms with eukaryotic cells include fungi, algae, protozoa, plants, & animals.
- It is important to know the differences between prokaryotic and eukaryotic cells; allows us to control disease-causing bacteria without harming our own cells.

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