

INTRODUCTION TO MICROORGANISMS

1:1 What is Microbiology?

MICROBIOLOGY: the study of living organisms that are individually too small to be seen with the unaided eye

e.g. bacteria, protozoan, viruses, yeasts, molds, and microscopic algae.

Microorganisms are commonly known as **germs** or **microbes**.

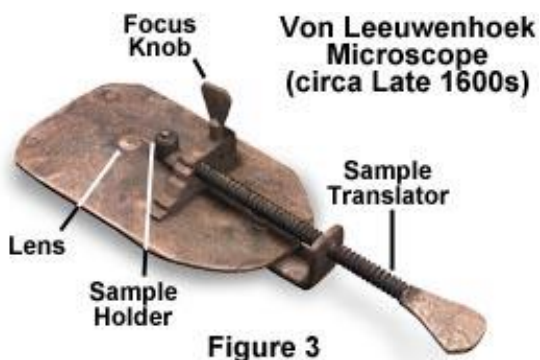
1:2 Microscopes and the Discovery of the Microscopic World

Anton van Leeuwenhoek: Dutch naturalist who first reported to observe microbes and gave accurate descriptions and drawings



Leeuwenhoek's accomplishments:

- Produced over 250 microscopes with magnification of up to 300X by grinding glass lenses
- Described and drew microbes from rainwater, seawater, saliva, vinegar, and tartar from his teeth. Called them "animalcules."



- Drew bacterial cells as COCCUS: spherical, BACILLUS: cylindrical or rod-shaped, or SPIRILLA: spiral.

Singular

Coccus

Bacillus

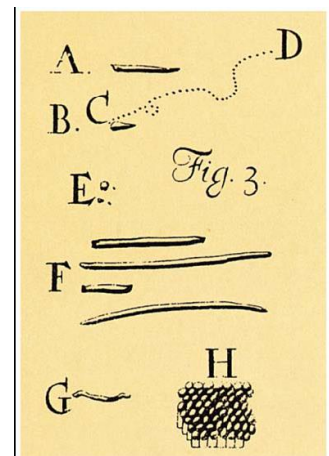
Sprillum

Plural

Cocci

Bacilli

Spirilla



1:3 Abiogenesis vs. Biogenesis

bio – life genesis – to create a – against

BIOGENESIS: living organisms come from other living organisms

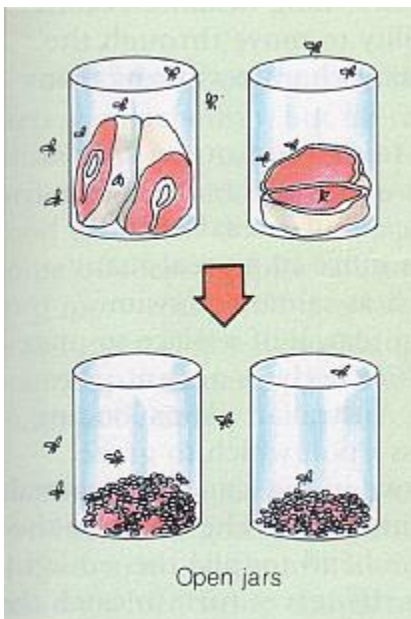
ABIOTENESIS (spontaneous generation): the theory that living organisms arose from nonliving materials upon decomposition

e.g. – decaying meat produced maggots and flies, mud turned into frogs

Francesco Redi and others did experiments to disprove spontaneous generation of multicellular organisms.

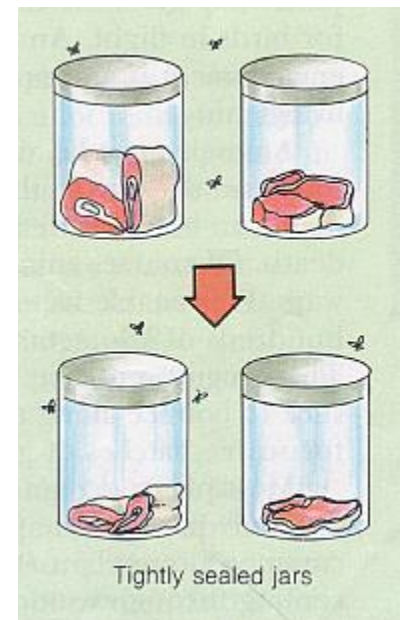
REDI'S FIRST EXPERIMENT

Hypothesis – Rotting meat will not turn into maggots or flies.



Control sample – 4 clean jars containing 4 types of meat, NO COVER ON JARS.

Experimental sample – 4 clean jars containing 4 types of meat, JARS SEALED WITH LIDS.



Experimental factor(s) – no flies could enter experimental jars, also no air could enter.

Results – Maggots formed in control (open) jars, no maggots formed in experimental (sealed) jars.

Conclusion – Redi concluded maggots came from eggs laid by flies in the open jars.

Redi's first experiment was faulty due to 2 experimental factors. Redi's opponents (supporters of abiogenesis) said that air had to circulate in the jars to allow the meat to change to maggots.

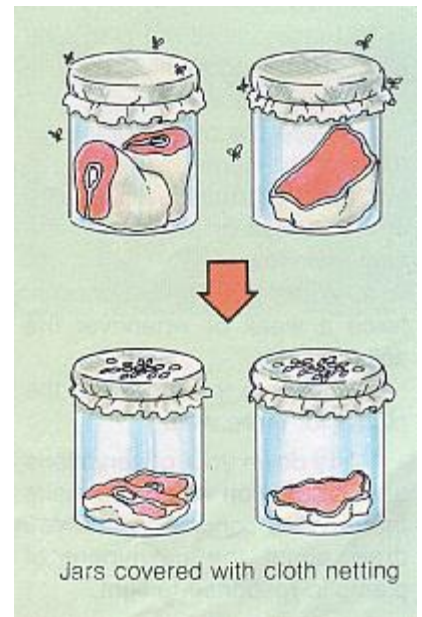
REDI'S SECOND EXPERIMENT

Hypothesis and Control sample – same as first

Experimental sample – 4 clean jars containing 4 types of meat, jars covered with gauze.

Results – maggots in open jars, no maggots in covered jars.

Conclusion – flies produce maggots (fly larvae)



Even after Redi disproved abiogenesis of multicellular organisms some scientists still tried to prove microorganisms were produced by abiogenesis because with microscopes they saw microbes in broth and sugar solutions.

JOHN NEEDHAM: English scientist whose experiments supported abiogenesis

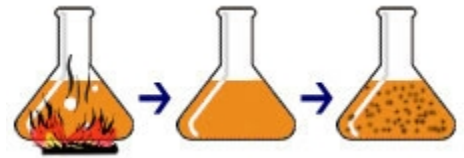


Needham's Experiment

1. Different meat and vegetable broths were boiled a FEW minutes, then the open flasks were cooled to room temperature.
2. Next the flasks were LOOSELY sealed.
3. After a few days Needham viewed the broths with a microscope and saw many microbes.
4. Needham concluded since boiling killed microbes those found after boiling formed spontaneously.

Needham's Flaws

1. Broth was not boiled long enough to kill all the microbes.
2. Because they were not tightly sealed, new microbes could enter flasks.



These flaws allowed Lazzaro Spallanzani to challenge Needham's conclusion.

LAZZARO SPALLANZANI: Italian scientist and biogenesis supporter who tried to disprove Needham's conclusions.

Spallanzani's first experiment

1. Tightly sealed flasks of broth were boiled for one hour.
2. After several days microscopic examination showed no microbes in the broth.
3. Spallanzani concluded he had disproved Needham.



Abiogenesis supporters said that boiling destroyed the “vital force” or “active principle”.

Spallanzani's second experiment

1. Four sets of flasks of broth were boiled
 - Set 1 – boiled ½ hour
 - Set 2 – boiled 1 hour
 - Set 3 – boiled 1 ½ hours
 - Set 4 – boiled 2 hours
2. Flasks were left loosely sealed so microbes could enter from air.
3. Spallanzani found more microbes in the flasks boiled longest because boiling removes water and enriches food.



LOUIS PASTEUR: French chemist whose experiments completely disproved spontaneous generation of organisms of all sizes

Pasteur hypothesized microbes were found in air on dust particles.

Pasteur's first experiment

1. Sealed flasks of broth were boiled long enough to kill all microbes.
2. Flasks were opened in different areas where the amount of dust in the air varied.
3. After microscopic examination a few days later the flasks opened in dusty areas showed more microbial growth than those opened in less dusty areas.

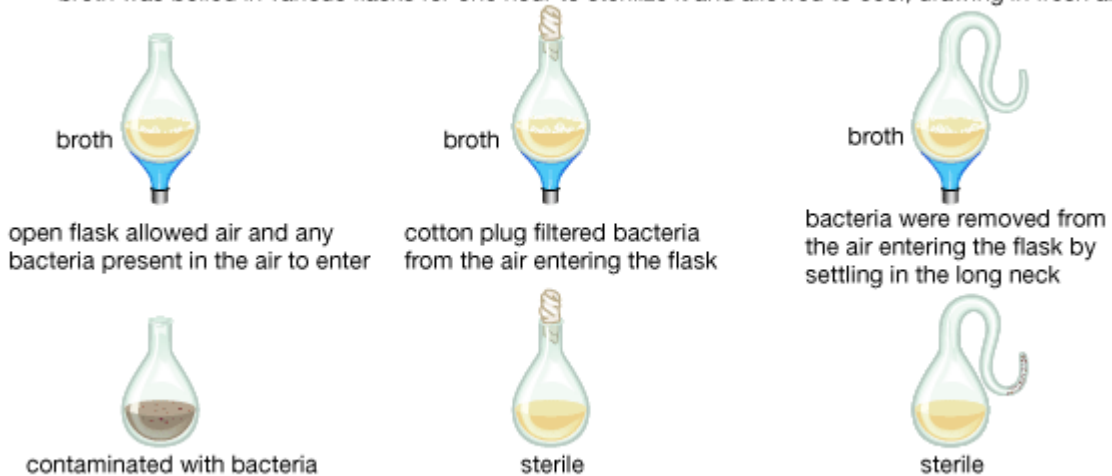
Pasteur's second experiment

1. Broth was placed in flasks and the necks of the flasks were bent into different shapes.
2. Flasks were boiled, killing microbes and forcing air out of the flasks, which were left open.
3. Air re-entered flasks as they cooled. If dust could fall into the broth microbes grew. If dust could not enter the curved neck of the flask no microbes grew.

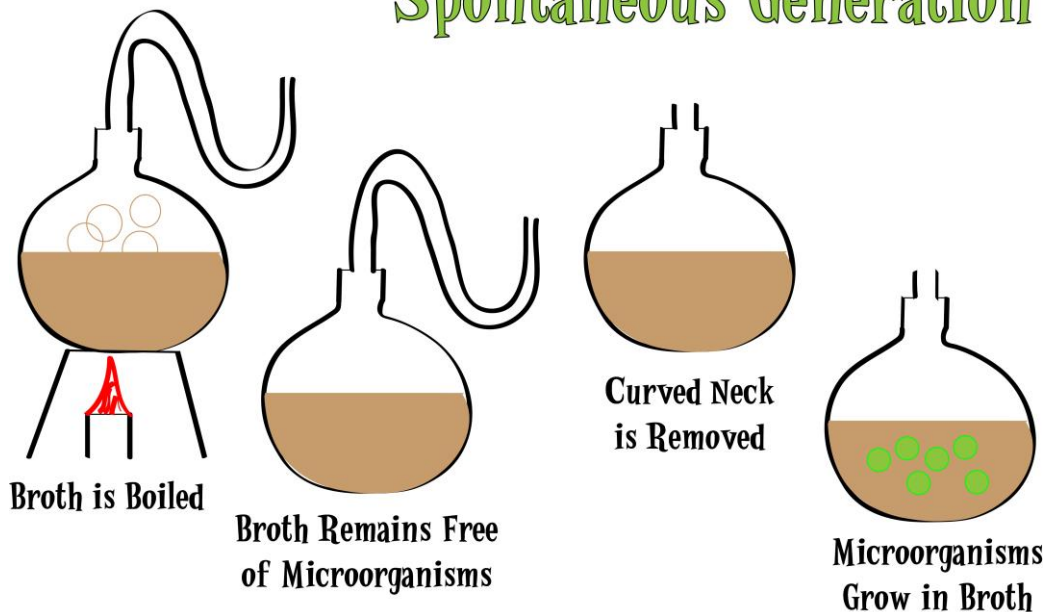


Louis Pasteur 1859 experiment

broth was boiled in various flasks for one hour to sterilize it and allowed to cool, drawing in fresh air.



Pasteur's Test of Spontaneous Generation



1:4 Koch's Postulates and the Germ Theory of Disease



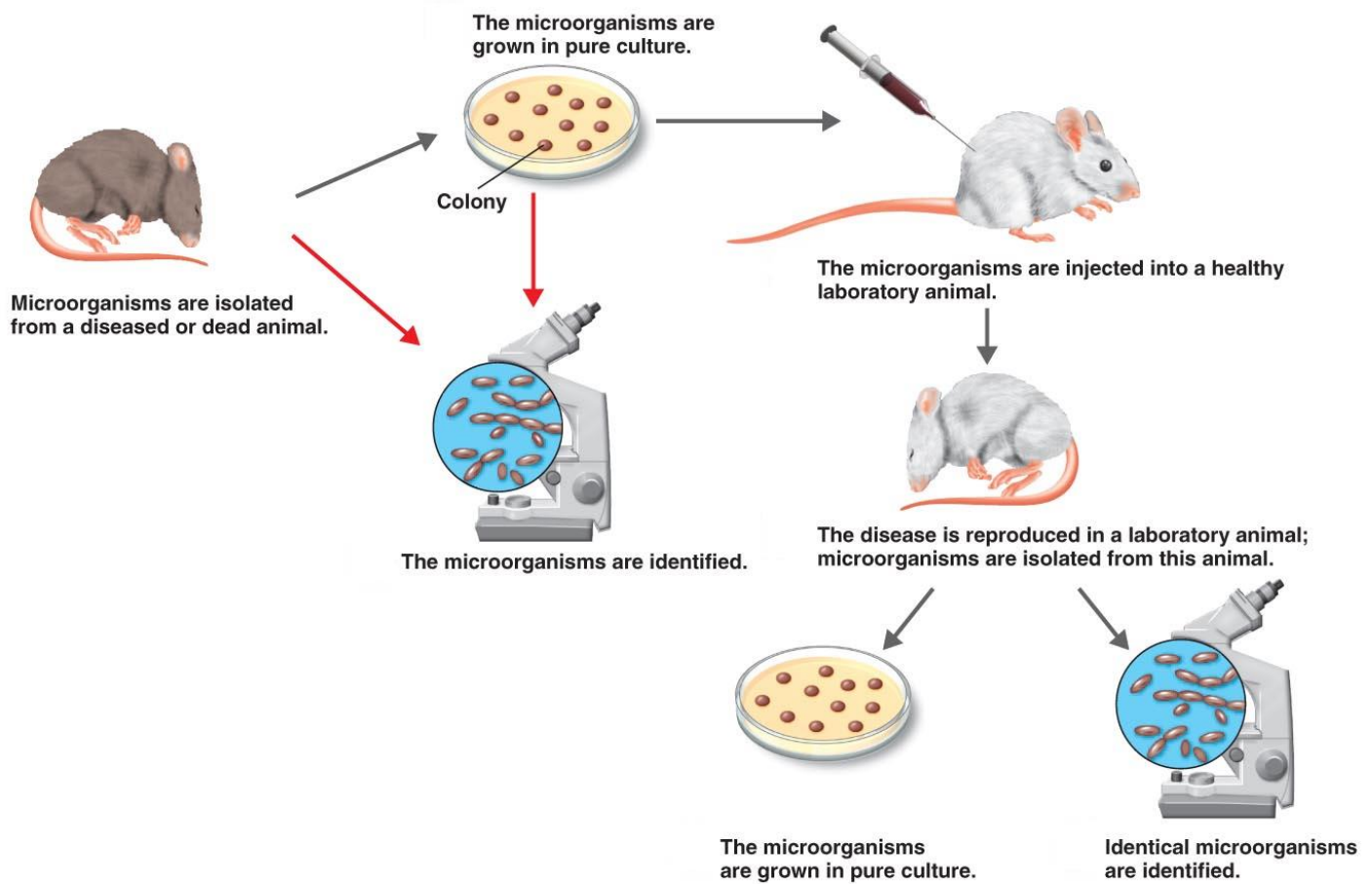
GERM THEORY OF DISEASE:

organisms too small to be seen cause diseases in other organisms

KOCH'S POSTULATES: Four conditions that can prove that a specific microbe causes a particular disease, discovered by Robert Koch.

Koch's Postulates

1. The **disease microbe** must be **present in all sick** animals and **not in healthy** animals.
2. The **disease microbe** must be **found in** and **removed from a sick** animal and **grown in** pure **culture** in a lab.
3. If a **healthy animal is inoculated** with the **lab culture** of disease microbe the **animal** must **contract the disease**.
4. The **disease microbe** must be **found in** and **removed from** the experimentally infected animal and **compared to the microbe** from the first sick animal. They must be the **same**.



While developing the postulates Koch refined many important microbiological techniques.

STAINING: using dyes to color bacteria so they may be seen easier

CULTURING: growing bacteria or microbes in the laboratory

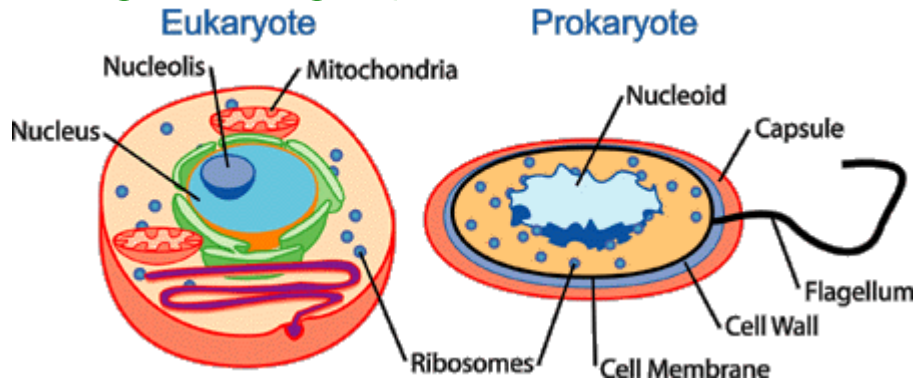
CULTURE: growth of microorganisms

MEDIUM (plural – media): solid or liquid nutrient substance in which microbes are cultured.

1:5 Prokaryotic vs. Eukaryotic Cells

PROKARYOTIC CELLS: simple cells with no true nucleus; DNA is not separated from cytoplasm by nuclear membrane

e.g. – bacteria and cyanobacteria (AKA blue green algae)



EUKARYOTIC CELLS: cells with a true, membrane bound nucleus and other membrane bound organelles

e.g. – plant and animal cells

Prokaryotic cells reproduce by BINARY FISSION: simple cell division accomplished by splitting into two cells of equal size.

Eukaryotic cells reproduce by MITOSIS: cell division accomplished by duplication of chromosomes and splitting of the nucleus.

1:6 The Microbial World

Of the 5 kingdoms of living organisms, 3 kingdoms contain microorganisms.

KINGDOM MONERA: prokaryotic organisms

KINGDOM PROTISTA: unicellular eukaryotic organisms

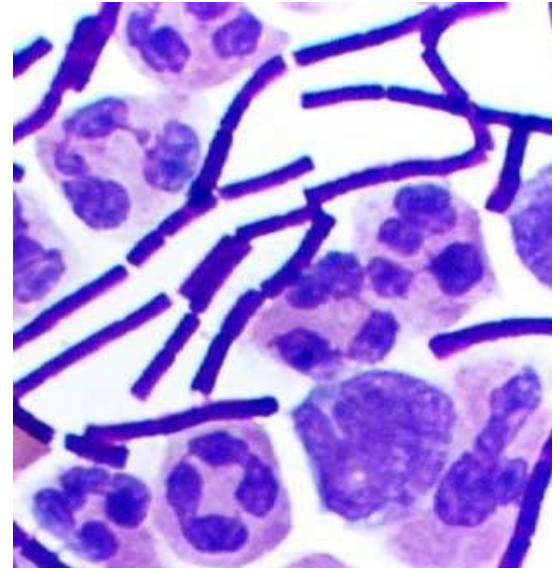
KINGDOM FUNGI: heterotrophic eukaryotic organisms that are plant-like in structure

Kingdom Plantae and Kingdom Animalia do not contain any microorganisms. Viruses are not considered living things and do not belong in any of the 5 kingdoms of life.

MONERA

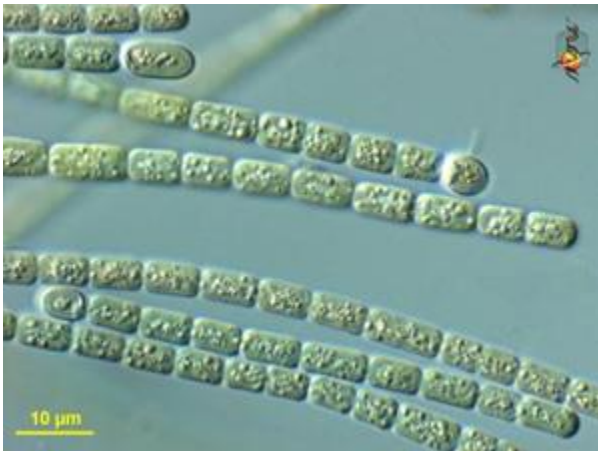
Bacteria

- unicellular, ubiquitous
- major cause of human disease
- used for research because their life processes are similar to all other living organisms and the ease of culturing



Cyanobacteria

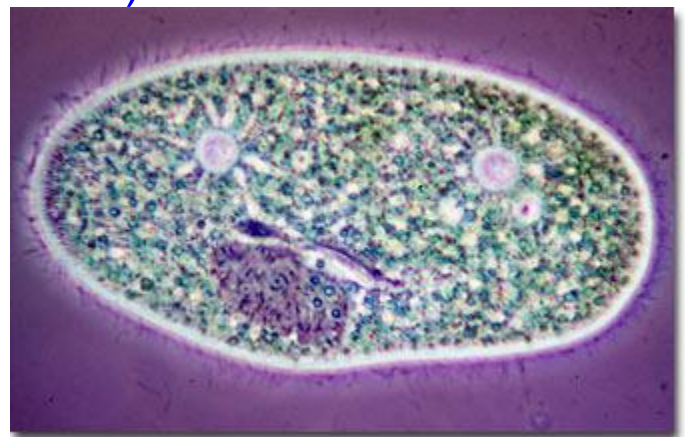
- unicellular, aquatic
- perform photosynthesis
- may form HETEROCYSTS: cells which are capable of converting atmospheric nitrogen to ammonia (nitrogen fixation)



PROTISTA

Protozoans

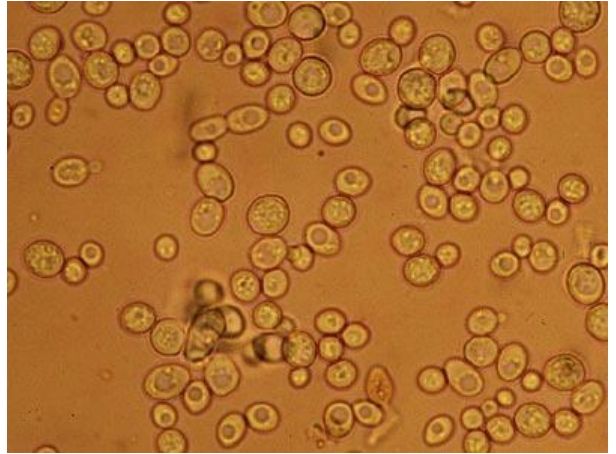
- wide variety of shapes and sizes
- 5 µm to 2 mm in size
- reproduce both sexually and asexually



FUNGI

Yeasts

- reproduce by budding or sporulation
- ferment carbohydrates into ethyl alcohol
- produce CO₂ during fermentation making bread dough “rise”
- few cause diseases in humans



Molds



- multicellular fungi, more complex than yeast
- branching, hair-like growths
- form both sexual and asexual spores

1:7 Divisions of Microbiology

MEDICAL MICROBIOLOGY: study of microbes that cause disease in humans and other animals

AGRICULTURAL MICROBIOLOGY: study of microbes that either harm or benefit agricultural production

INDUSTRIAL MICROBIOLOGY: study of commercial products of microbial activities

IMMUNOLOGY: study of mechanisms of resistance to microbial disease