

History and Scope of Microbiology

What is Microbiology?

- Micro - too small to be seen with the naked eye
- Bio - life
- ology - study of

Organisms included in the study of Microbiology

- | | |
|---------------------|--------------|
| 1. Bacteria | Bacteriology |
| 2. Protozoans | Protozoology |
| 3. Algae | Phycology |
| 4. Parasites | Parasitology |
| 5. Yeasts and Molds | Mycology |
| – Fungi | |
| 6. Viruses | Virology |

5 Kingdoms of Living Organisms

- 1. Animalia
- 2. Plantae
- 3. Fungi
- 4. Protista
- 5. Monera - Bacteria and Cyanobacteria
- Eukaryotic vs. Prokaryotic

Classification System

- 3 Domains 1978 Carl Woese
 - 1. Bacteria
 - Unicellular prokaryotes with cell wall containing peptidoglycan
 - 2. Archaea
 - Unicellular prokaryotes with no peptidoglycan in cell wall
 - 3. Eukarya
 - Protista
 - Fungi
 - Plantae
 - Animalia

Bacteria - what comes to mind?

- Diseases
- Infections
- Epidemics
- Food Spoilage
- Only 1% of all known bacteria cause human diseases
- About 4% of all known bacteria cause plant diseases
- 95% of known bacteria are non-pathogens

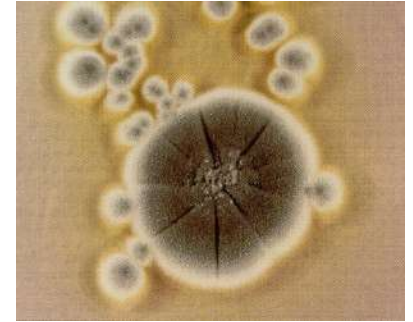
Uses of Microbes

Benefit Humans

- 1. Bacteria are primary decomposers - recycle nutrients back into the environment (sewage treatment plants)
- 2. Microbes produce various food products
 - cheese, pickles, sauerkraut, green olives
 - yogurt, soy sauce, vinegar, bread
 - Beer, Wine, Alcohol

3. Microbes are used to produce Antibiotics

- Mold
 - *Penicillium notatum* (Penicillin)
- 1928 Alexander Fleming



4. Bacteria synthesize chemicals that our body needs, but cannot synthesize

- Example: *E. coli*
 - B vitamins - for metabolism
 - Vitamin K - blood clotting
- *Escherichia coli*
 - Dr. Escherich
 - Colon (intestine)

5. Biochemistry and Metabolism

- Very simple structure
- rapid rate of reproduction
- provides “instant” data

6. Microbial antagonism

- Our normal microbial flora prevents potential pathogens from gaining access to our body

7. Insect Pest Control

- Using bacteria to control the growth of insects
- *Bacillus thuringiensis*
 - caterpillars
 - bollworms
 - corn borers

8. Bioremediation

- Using microbes to clean up pollutants and toxic wastes
- Exxon Valdez - 1989
- 2 Genera
 - *Pseudomonas sp.*
 - *Bacillus sp.*

9. Recombinant DNA Technology, Gene Therapy, Genetic Engineering

- Bacteria can be manipulated to produce enzymes and proteins they normally would not produce
 - Insulin
 - Human Growth Hormone
 - Interferon

10. Food Chains

- Marine and fresh water microorganisms

Microbes do benefit us, but they are also capable of causing many **diseases**

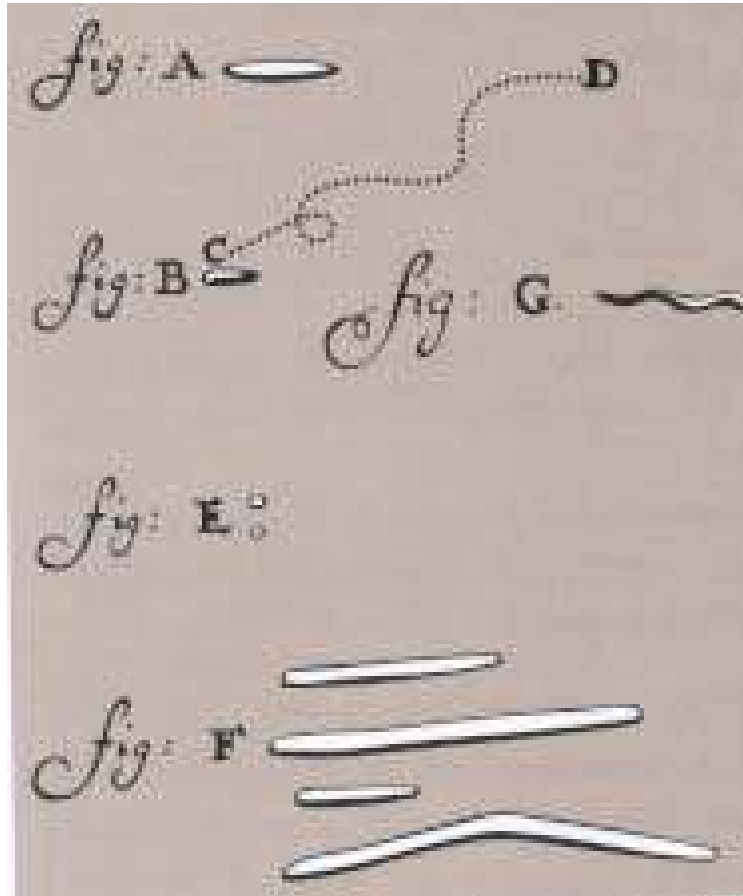
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|----------------|----------------|----------|
| • Pneumonia | Whooping Cough | |
| • Botulism | Typhoid Fever | Measles |
| • Cholera | Scarlet Fever | Mumps |
| • Syphilis | Gonorrhea | Herpes 1 |
| • Chlamydia | Tuberculosis | Herpes 2 |
| • Meningitis | Tetanus | RMSV |
| • Strep Throat | Lyme Disease | AIDS |
| • Black Plague | Diarrhea | Gangrene |

History of the Study of Microorganisms

- 1665 Robert Hooke
 - “little boxes” - “cells”
 - Cell Theory - all living things are made up of cells

Anton van Leeuwenhoek 1674

- 1st person to actually see living microorganisms



“wee animalcules”

Spontaneous Generation

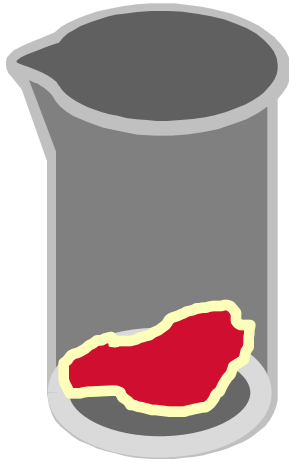
- Theory that life just “spontaneously” developed from non-living matter
- Example:
 - toads, snakes and mice - moist soil
 - flies and maggots - manure and decaying flesh

Experiments to disprove Spontaneous Generation

- Francesco Redi 1668
- Rudolph Virchow 1858
 - Theory of Biogenesis
 - Cells can only arise from preexisting cells
- Louis Pasteur 1861

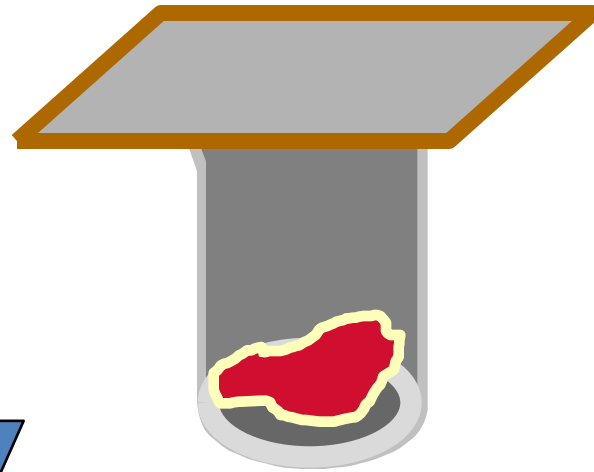
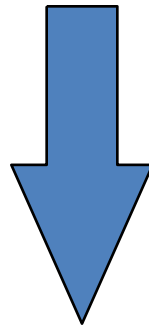
Francesco Redi's experiments with meat

uncovered



Maggots

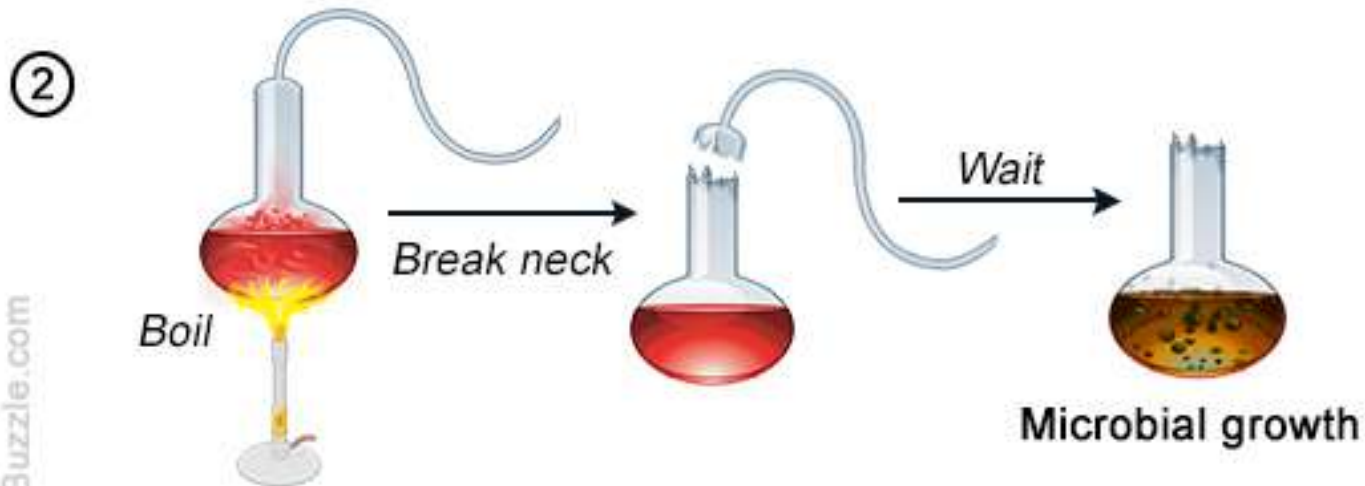
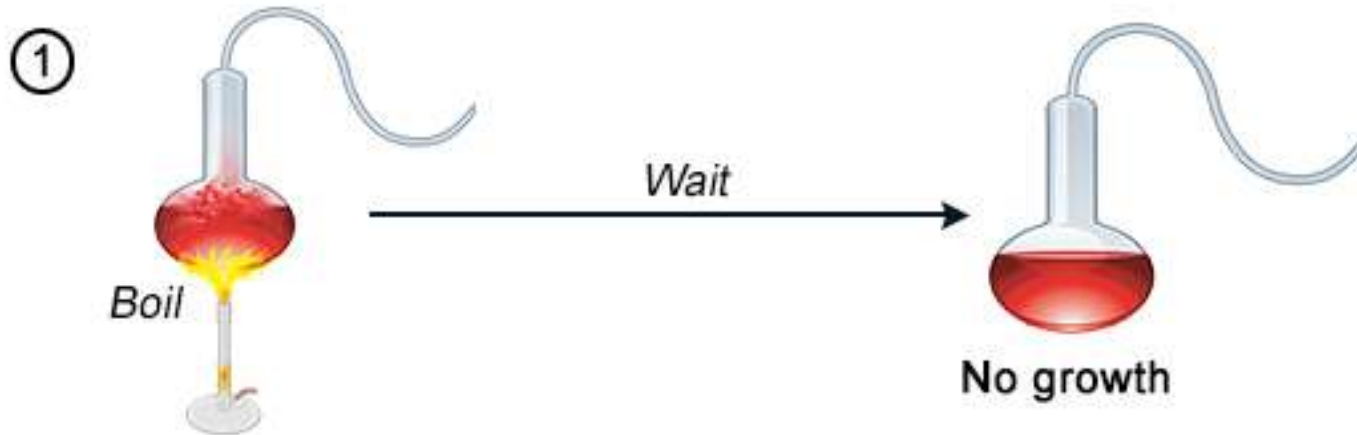
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No maggots

Disproved that maggots arise from decaying meat!!

Louis Pasteur (1861)



History (cont.)

- 1861 Pasteur
 - Proved Microorganisms are present in nonliving matter
 - Microbes can be destroyed by heat
- Fermentation mediated by yeast, not air
 - Pasteurization to prevent wine and beer spoilage (by bacteria)

1857-Louis Pasteur saves France's wine

1) Good wine contained yeast

2) Sour wine contained bacteria

1) (Bacteria that use alcohol and produce acetic acid spoil wine by turning it to vinegar (acetic acid)).

3) He reasoned that if wine is heated to destroy the harmful bacteria it wouldn't spoil (process known as Pasteurization)

Ignaz Semmelweis

(1818-1865)

- Taught medicine in Vienna
- No one connected germs w/ disease yet
- Puerperal fever “childbirth fever” caused 25-30% mortality
- Nearby obstetric hospital had only a 2% death rate

Ignaz Semmelweis (*cont.*)

- He made some observations
- Medical Students working on cadavers moved from the dissecting room to the maternity ward
- Midwives
 - Stayed only in maternity ward

Ignaz Semmelweis (*cont.*)

- Ordered students to wash hands and medical instruments in chlorinated lime
- Mortality dropped to 1.3%
- By 1848, 0% mortality

Germ Theory of Disease

- Pasteur proposed that wine spoiling in an analogy for disease (bacterial growth made the wine “sick”)
- germ theory
 - some diseases are caused by microorganisms

Germ Theory of Disease

- Hard for people to believe that diseases were caused by tiny invisible “wee animalcules”
- Diseases, they thought, were caused by:
 - demons
 - witchcraft
 - bad luck
 - the wrath of God
 - curses
 - evil spirits

Edward Jenner (country doctor)

- Milkmaid didn't get smallpox b/c they contracted the milder form of cowpox
- Immune system cannot distinguish btw cowpox/smallpox
- Scratched a farmboy w/ a needle bearing fluid from cowpox
- Small pox Vaccine
 - *Vacca*-cow
 - Vaccination w/ cowpox provided immunity for smallpox

Robert Koch

- -1st to prove that bacteria actually caused diseases
- 1876
- Microbial Etiology of Infectious Disease
 - etiology - the cause of a disease
- Established “scientific rules” to show a cause and effect relationship between a microbe and a disease
 - Koch’s Postulates

Pure Culture

Key to Studying Microbes

Definition: Pure culture is a population of organism, all of which are the progeny of a single organism

-In nature, microbes almost never occur as pure cultures

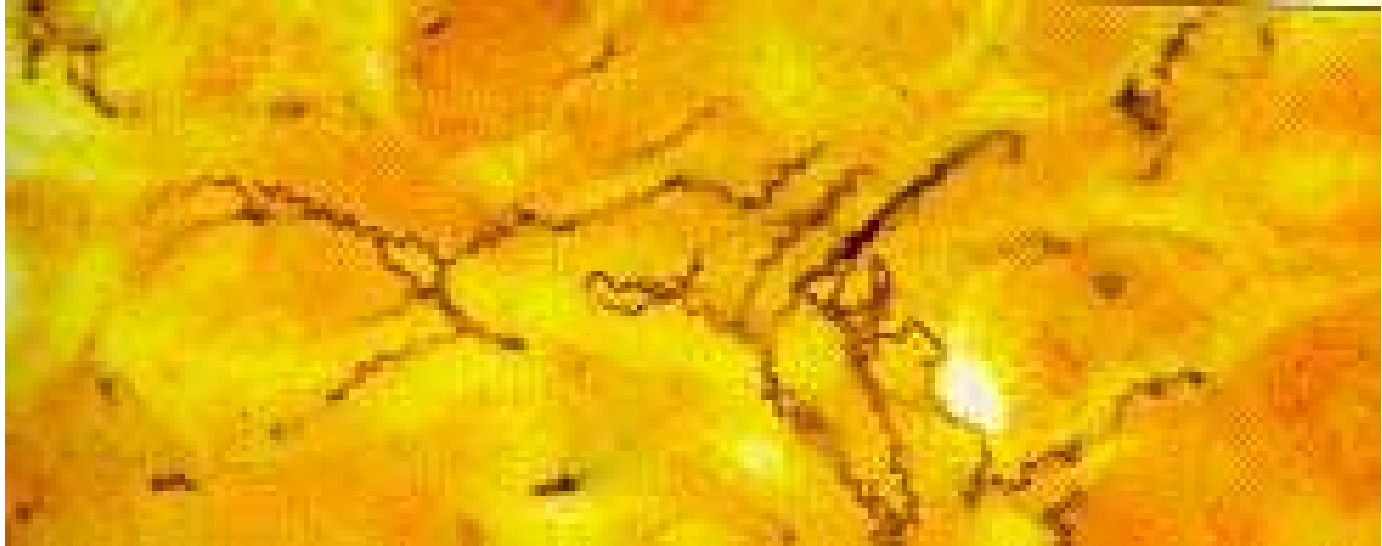
Koch's Postulates

- 1. The same organisms must be found in all cases of a given disease.
- 2. Organism can be isolated and grown in pure culture.
- 3. The isolated organism must reproduce the same disease when inoculated into another animal
- 4. The original organism must again be isolated from the experimentally infected animal.

Exceptions to Koch's Postulates

1. Some organisms have never been grown in pure culture on artificial media

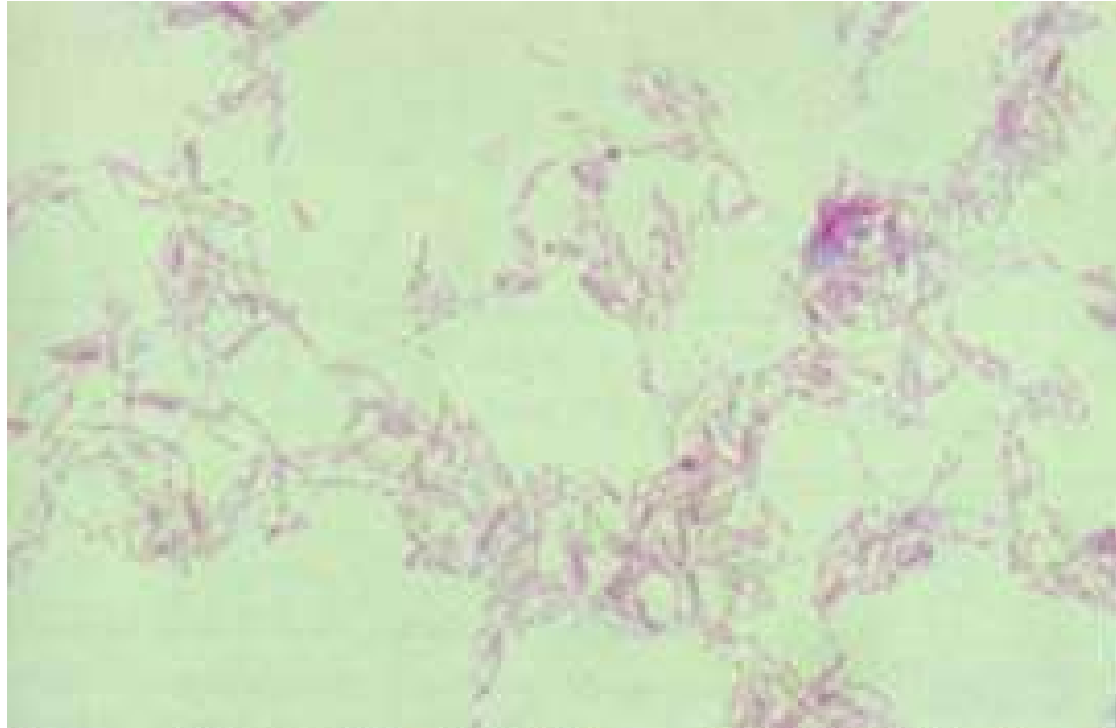
Treponema pallidum - Syphilis



Exceptions to Koch's Postulates

Mycobacterium leprae

Leprosy



Never been grown in pure culture on artificial media

Abdominal cavity of the Seven Banded Armadillo

Exceptions to Koch's Postulates

- In exclusively human diseases, it is not morally acceptable to inoculate a deadly pathogen into a “human guinea pig”
- HIV

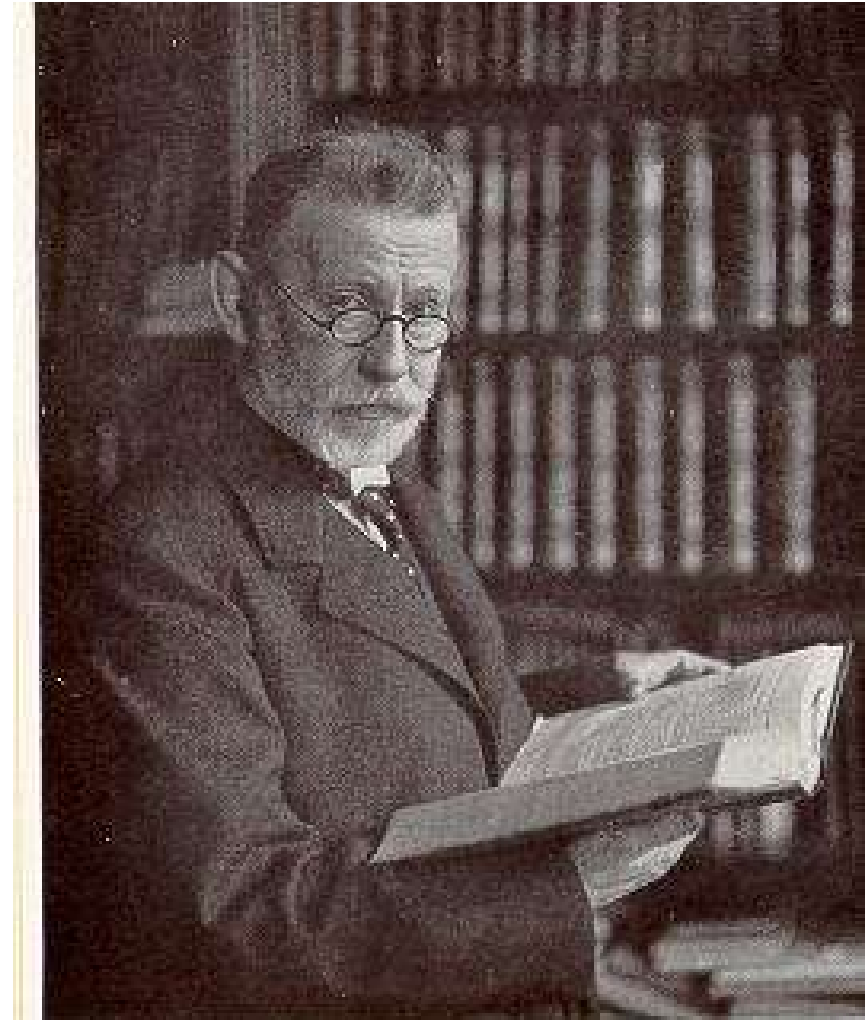
Koch established the Microbial Etiology of 3 important diseases of his day

- 1. Cholera (fecal-oral disease)
 - *Vibrio cholerae*
- 2. Tuberculosis (pulmonary infection)
 - *Mycobacterium tuberculosis*
- 3. Anthrax (sheep and cattle)
 - *Bacillus anthracis*

Koch - 1st to use Agar to solidify
culture media

Paul Ehrlich-hospital dermatologist

- Chemotherapy-
Treatment using
chemical substances
- 1910 Paul Ehrlich -
"Magic bullet"
 - Salvarsan (arsenic
derivative)
 - Preparation 606
 - Syphilis



Golden Age of Microbiology 1857 - 1914

- Pasteur
 - Pasteurization
 - Fermentation
- Joseph Lister
 - Phenol to treat surgical wounds – 1st attempt to control infections caused by microorganisms
- Robert Koch
 - Koch's Postulates
- Edward Jenner
 - vaccination
- Paul Erlich
 - 1st synthetic drug used to treat infections
 - Salvarsan - arsenic based chemical to treat Syphilis
 - “salvation” from Syphilis

- Alexander Fleming 1928
 - scottish researcher
- Discovered Penicillin (fungus) by accident
- Was convinced that nasal mucus had antibacterial effects
- Left his *Staphylococcus* culture on an agar plate for 2 weeks-went on vacation-came back & found mold on his plate which prevented bacterial growth
 - (a mycology lab underneath him had this rare spore drift)

