

Preview: history and introduction

Q1: Why do we study Microbiology?

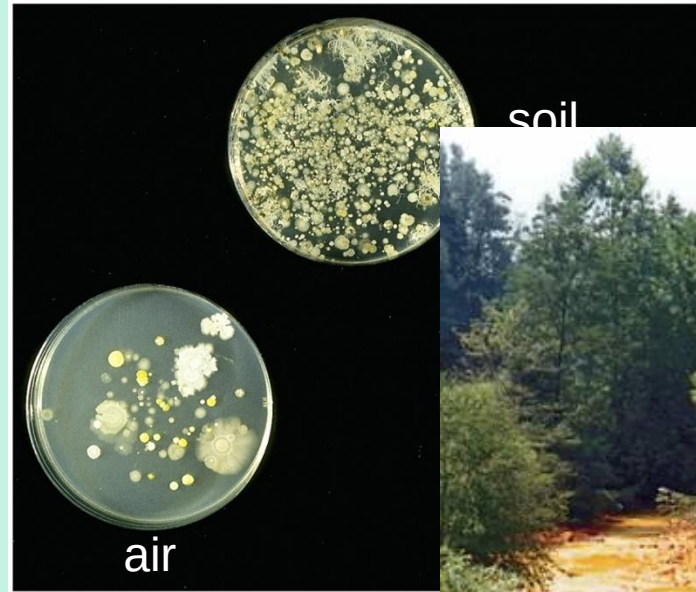
Q2: What did the famous
microbiologists do?

Q3: How many different kinds of
microbes?

Q4: What's the major applications for
microbiology?

Why Study Microbiology?

- Ubiquity
- Biological roles
- Animal digestion
- Food Microbiology
- Pharmaceuticals
- Bioremediation
- Pathogenicity
- Fundamental Biology



60% earth bi



Introduction: Humans and the Microbial World

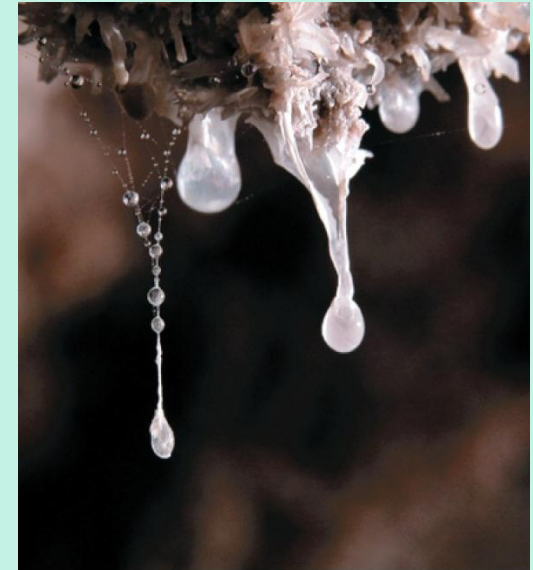
- Microbiology is the study of organisms too small to be seen with human eye
- Includes several sub-disciplines
 - Bacteriology
 - Virology
 - Mycology
 - Parasitology
 - Food microbiology
 - Environmental microbiology
 - Forensic microbiology

bacteria

virus

fungi

Helminthes. mainly in medical
fermentation



Role of Microorganisms

- Microbes have enormous impact on human existence
 - Microorganisms have killed more people than have ever been killed in wars
 - Without certain microorganisms life could not exist
 - Some microorganisms are responsible for the production of oxygen and nitrogen
 - Key elements for all living organisms
 - Some microorganisms are decomposers
 - Responsible for the breakdown of wide variety of material

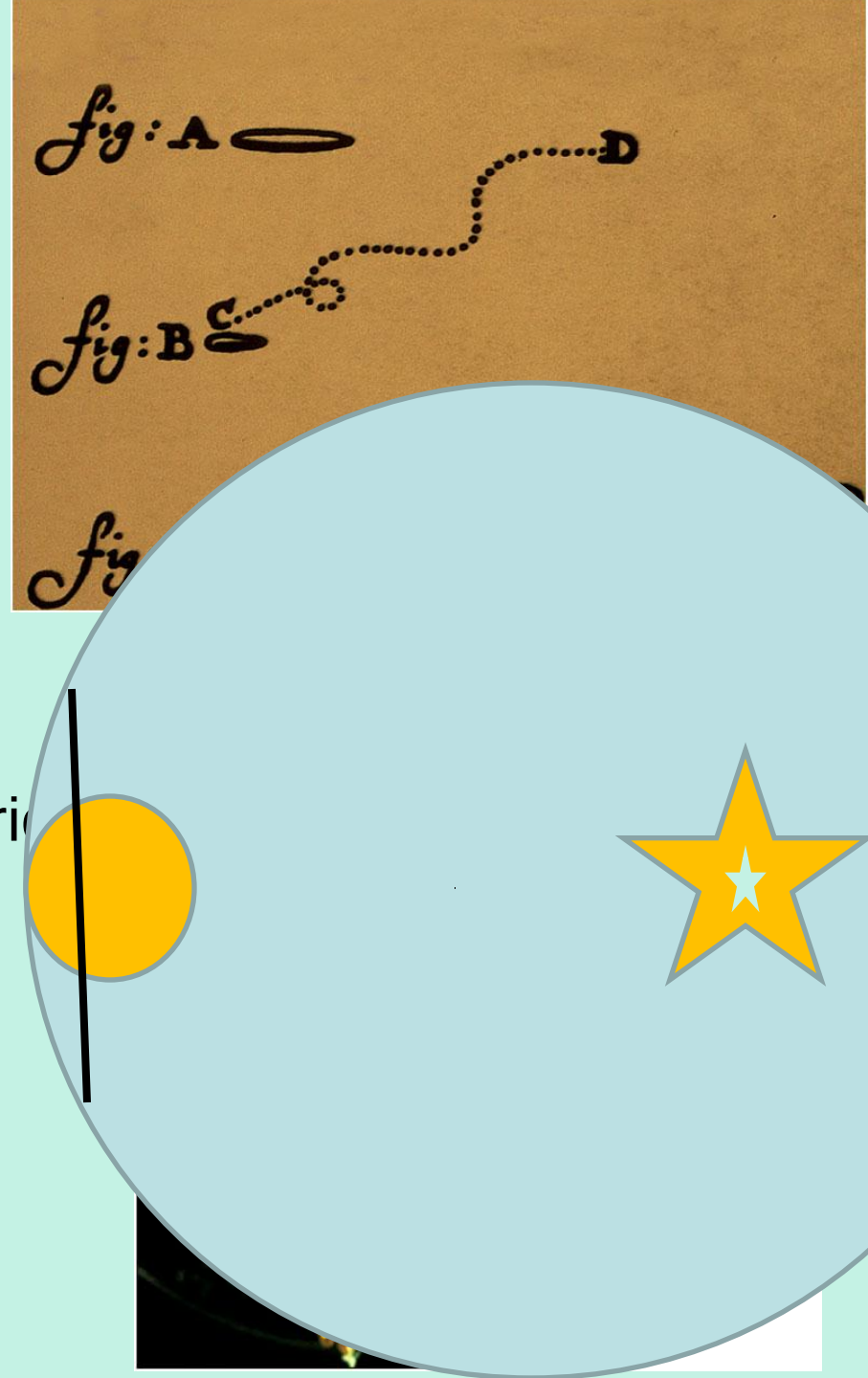


Which of the following distinguish the field of microbiology from other fields of biology?

- A. the size of the organism studied
- B. the techniques used to study organisms regardless of their size
- C. both the size of the organism studied and the techniques employed in the study of organisms
- D. the genome of the organisms

History

- Microbiology born as a science in 1674
 - Anthony van Leeuwenhoek (1632.10.24-1723.8.26)
 - Dutch drapery merchant
 - Ground lenses to view fabrics
 - Used lens to peer into a drop of lake water
 - First glimpses of microbial world
 - Called organisms “animalcules”



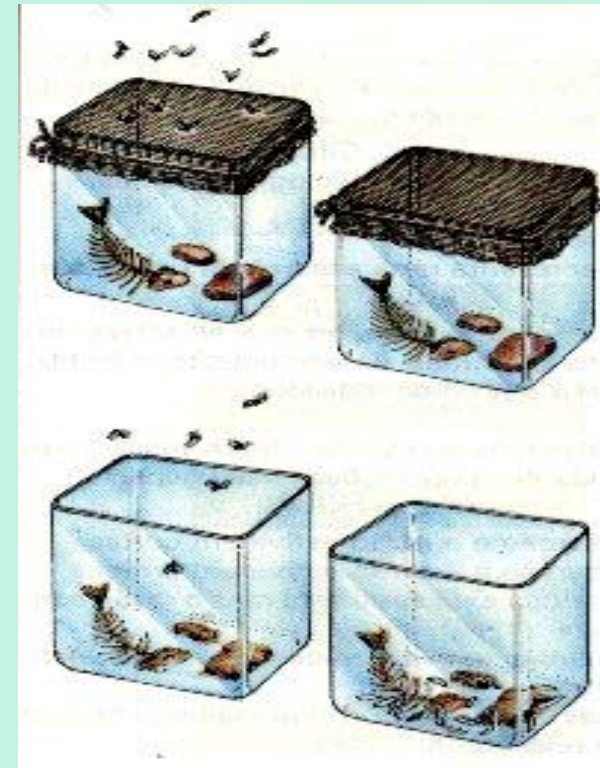
History: The Origin of Microorganisms

- Theory of Spontaneous Generation
 - Theory states
 - “organisms can arise from non-living matter”
 - Theory had its supporters and detractors
 - Detractors included
 - Francesco Redi
 - Louis Pasteur
 - John Tyndall
 - Each contributed to disproving the theory

Francesco Redi



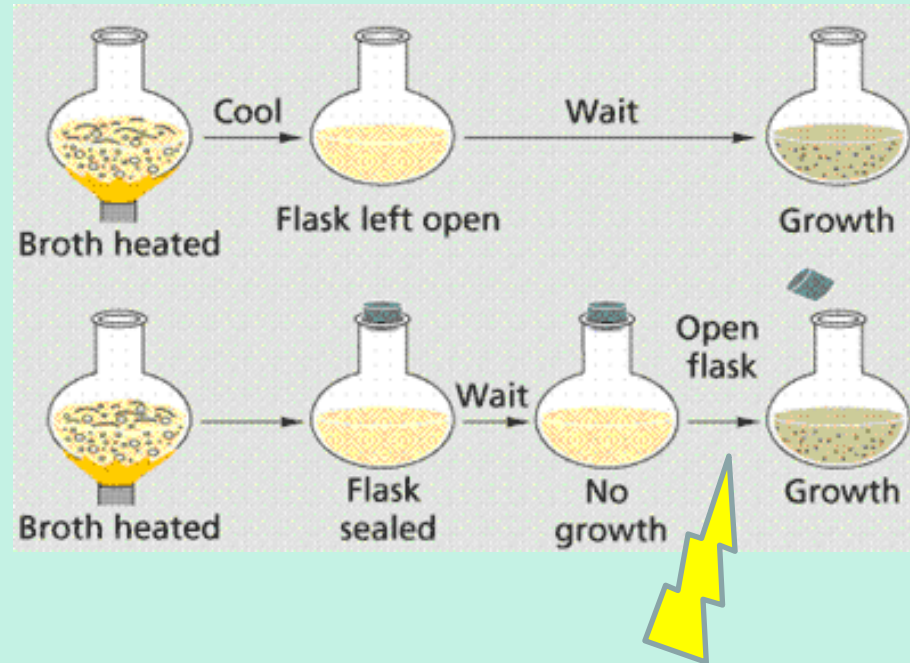
- Italian biologist and physician (1626.2.18-1697.3.1)
- Demonstrated worms found on rotting meat came from eggs of flies landing on meat
- Proved this by placing rotting meat in jars
 - Covered one jar with fine gauze
 - Gauze prevented flies from depositing eggs
 - No eggs – no worms



Louis Pasteur



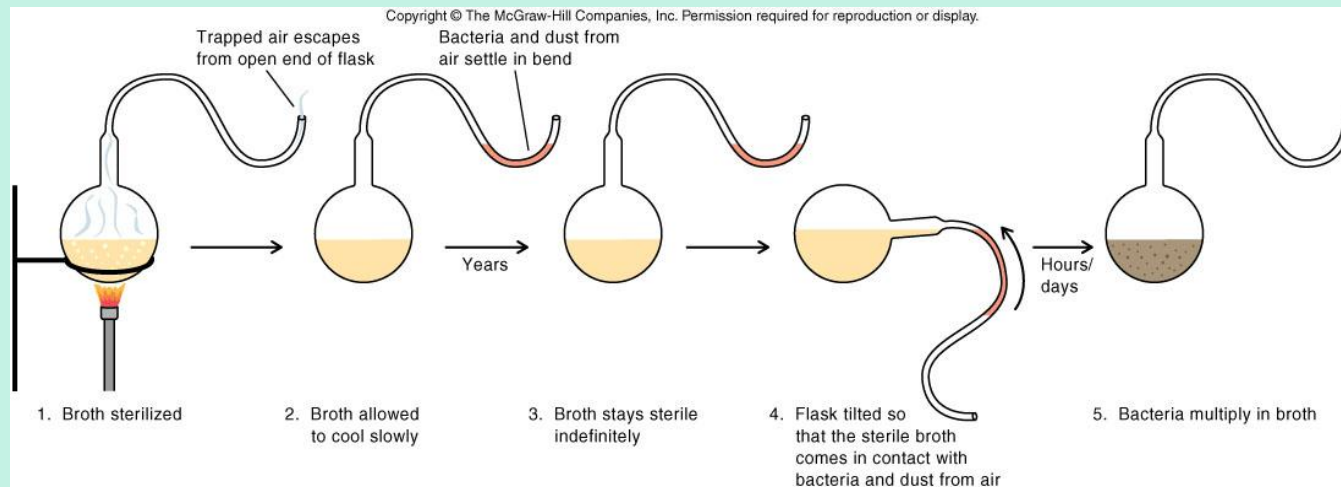
- Considered the father of modern microbiology (1822.12.27-1895.10.28)
- Demonstrated that air is filled with microorganisms
- Proved this by filtering air in cotton plug
 - Identified organisms in cotton as same organisms contaminating infusions



What's this means?

Louis Pasteur

- To further show air is filled with microbes Pasteur developed swan-necked flask (1857)
- Was able to demonstrate infusions remained sterile even if flask was left open



- Many scientists were skeptical of Pasteur's results
 - Some scientists could not reproduce same results
- John Tyndall was able to explain discrepancies

John Tyndall (1820.8.2-1893.12.4)

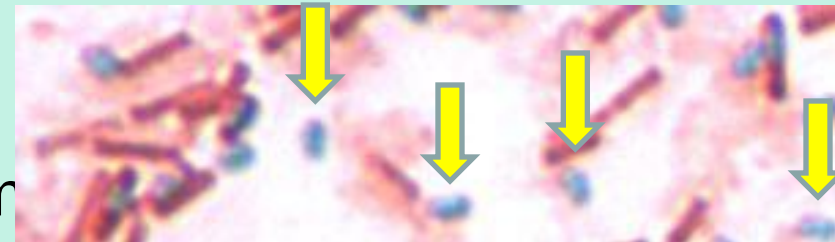
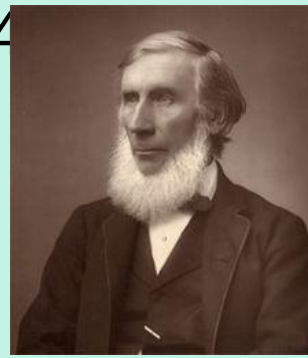
concluded different infusions required different boiling times

- Some infusions were sterile after boiling for 5 minutes, others did not achieve sterility after 5 hours of boiling (1870)

- Attributed contamination to heat resistant life form called endospore

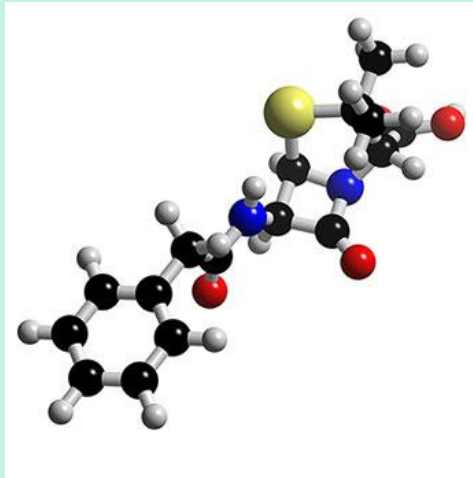
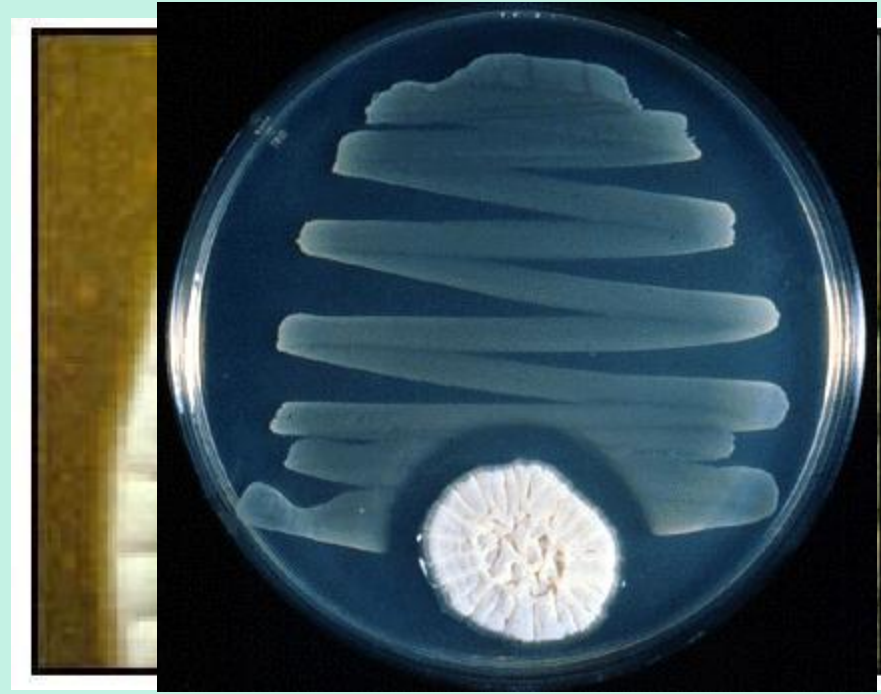
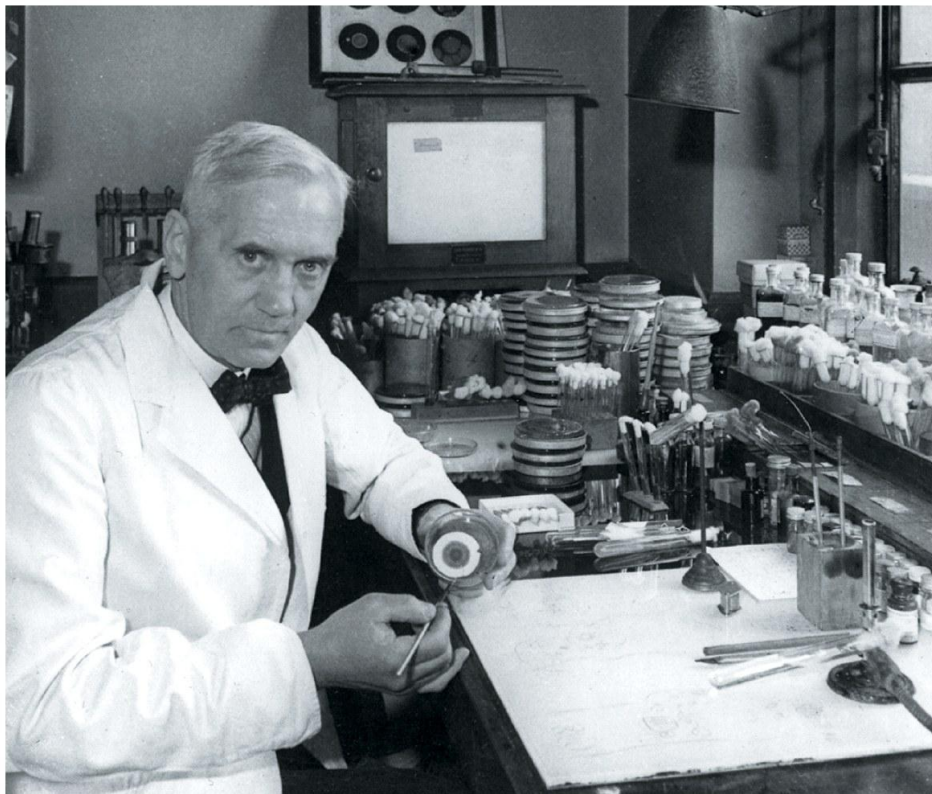
- German botanist **Ferdinand Cohn** discovered endospores in the same year (1828.1.24-1898.6.25)

- **Robert Koch** (1843.12.11-1910.5.27) was able to establish endospore role in disease transmission (1882, anthrax)



Alexander Fleming (1881.8.6-1955.3.11)

- Chemotherapy
 - Antibiotics
 - Synthetics



Golden Age of Microbiology

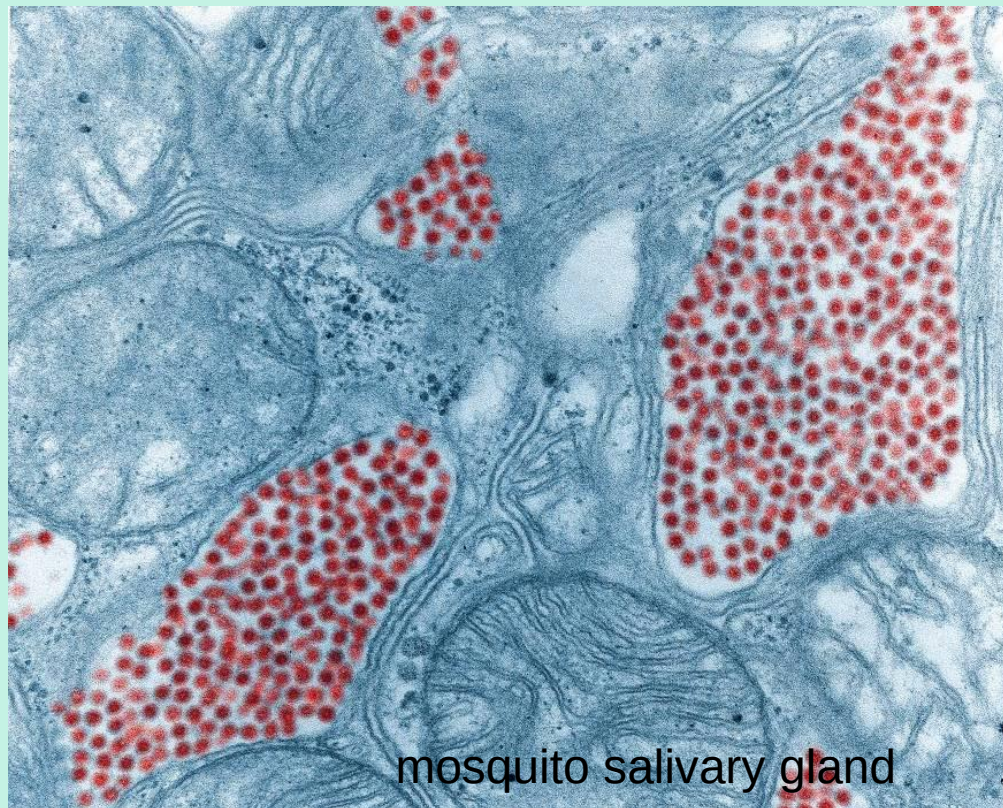
- After Theory of Spontaneous Generation was disproved, Golden Age of Microbiology was born
 - Golden Age 1854–1914
 - Time of great interest in the study of microorganisms
 - Between 1875 and 1918 most disease causing bacteria were discovered
 - Work on viruses began
 - Lead to the initiation of prevention and treatment of disease

Q: The contribution of Robert Koch:

- A. Isolate some bacteria
- B. Identify endospore
- C. Establish Koch's Postulates for pathogen identification
- D. All the above

Present and Future Challenges

- Infectious diseases remains a threat
 - 750 million cases each year in United States
 - Resulting in 200,000 deaths
 - Tens of billions of dollars spent on health care

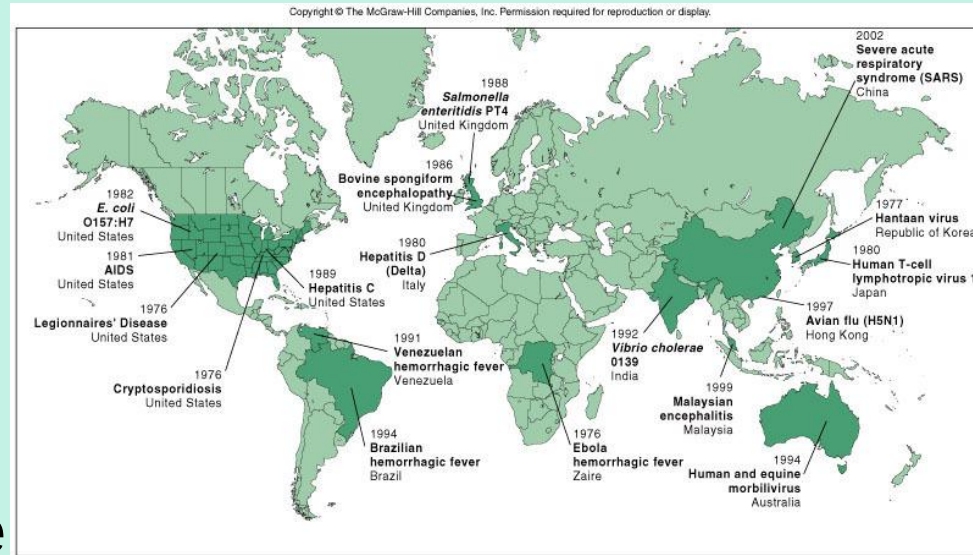


mosquito salivary gland

Present and Future Challenges

Emerging diseases

- Diseases show increased occurrence with wider distribution
- Seemingly new diseases
 - Actually not new
- Some diseases include
 - Legionnaire's disease
 - Lyme disease
 - West Nile virus disease
 - Severe Acute Respiratory Syndrome (SARS)
- Factors associated with emerging disease
 - Changing lifestyles
 - Genetic changes in organisms



Present and Future Challenges

- Resurgence of old diseases
 - Diseases thought to be “defeated” increasing in frequency
 - Often more serious
 - Causative agents usually resistant to treatment
 - Reasons for resurgence
 - Increase travel
 - » Visitors to foreign regions bring organisms from home region
 - Unvaccinated individuals susceptible to infection
 - » Causative agents of controlled diseases still around and infect vulnerable individuals

Present and Future Challenges

- Chronic disease caused by bacteria
 - Many diseases once thought caused by environmental stressors actually caused by bacteria
 - Example: gastric ulcers
 - Causative agent – *Helicobacter pylori*

German scientists found spiral-shaped bacteria in the lining of the human stomach in 1875

Italian researcher Giulio Bizzozero
In the stomach of dogs in 1893

Australian pathologist Robin Warren, 1979
Australian physician Barry Marshall 1981
cultured in 1982, Nobel prize in 2005



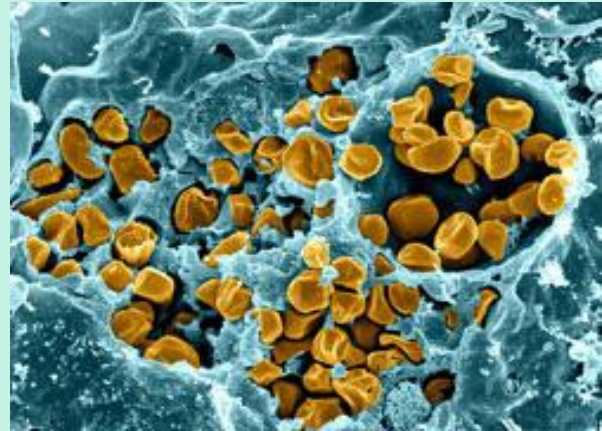
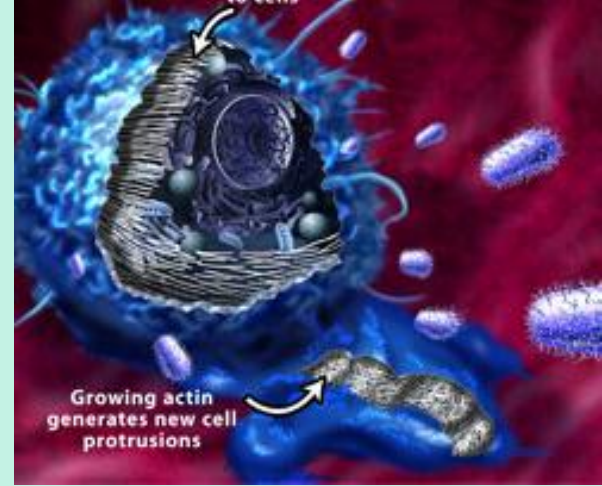
Regarding the size, human cell is

A. much bigger than a bacterium.

B. smaller than a bacterium.

C. similar as a bacterium.

D. not sure, depends on the cell type.



Host-Bacterial Interactions

- Estimated 500 – 1000 species of bacteria reside in and on the human body
- Bacteria outnumber cells in the body 10:1
 - For every one body cell, there are estimated 10 bacteria
- These bacteria compete with other organisms for food and space
 - Keep disease causing organisms from breaching host defenses
- Some bacteria and viruses use the human body as a habitat for multiplication, persistence and transmission

Give me a break.....



Quiz question:

List some examples you know that the microbes are important.

The concept that human and animal diseases are caused by microorganisms is called the

A. cell theory.

B. germ theory.

C. causative theory.

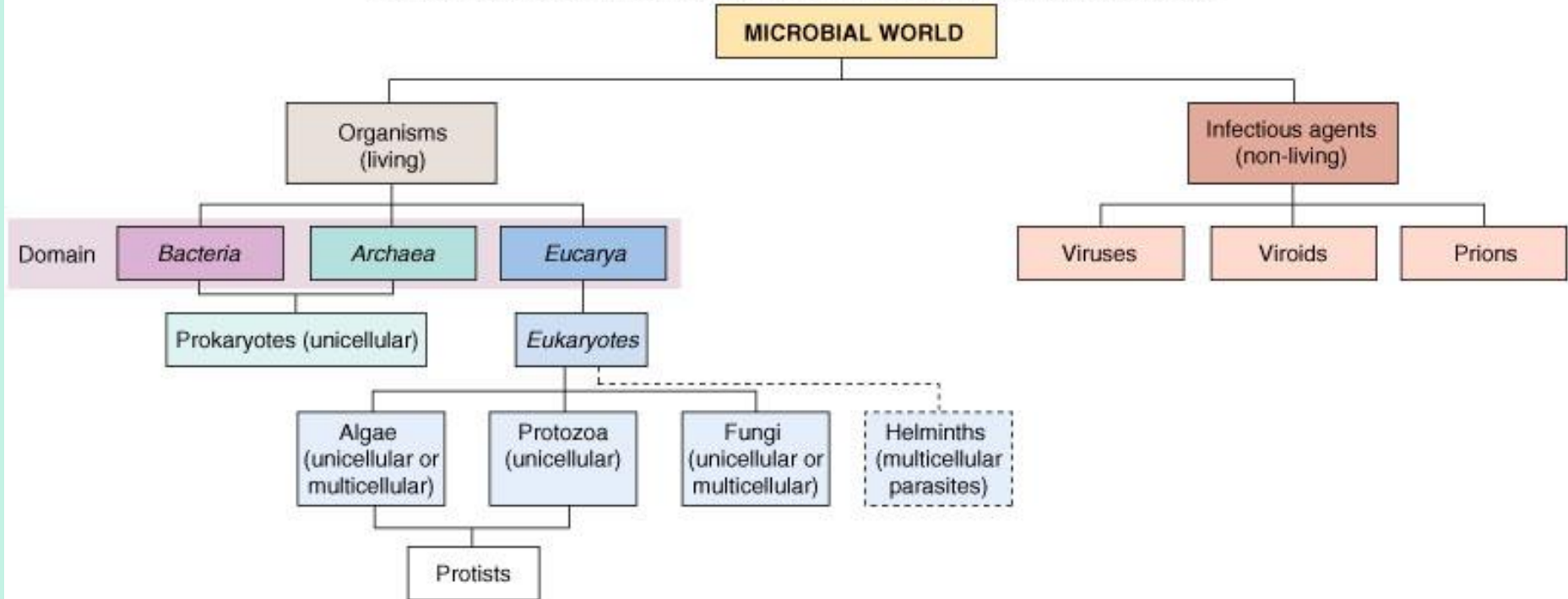
D. disease theory.

Microorganisms as Subjects for Study

- Wonderful model for study
 - Metabolism same as high forms of life
 - Genetic properties mimic other organisms
 - Building blocks of macromolecules same as other life forms
 - “what is true for an elephant is also true of a bacteria”

The Microbial World

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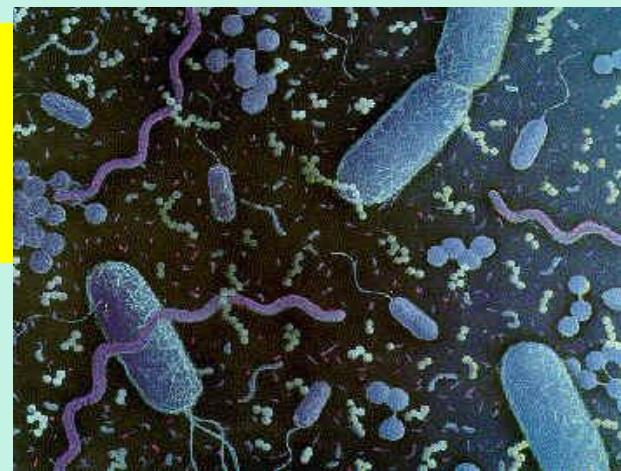


- All living things can be classified in one of three groups
 - Also known as domains
- Organisms in each domain share certain properties
 - These properties distinguish them from organisms in other domains
- Three domains are
 - *Bacteria*
 - *Archaea*
 - *Eucarya*

Nomenclature

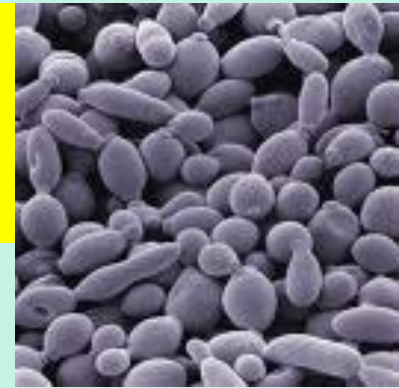
- Binomial naming system
 - Two word naming system
- First word is genus name
 - Always capitalized
 - *Escherichia*
- Second word is species name
 - Not capitalized
 - *coil*
- When writing full name, genus usually abbreviated
 - *E. coli*
- Full name always italicized
 - Or underlined

The Microbial World

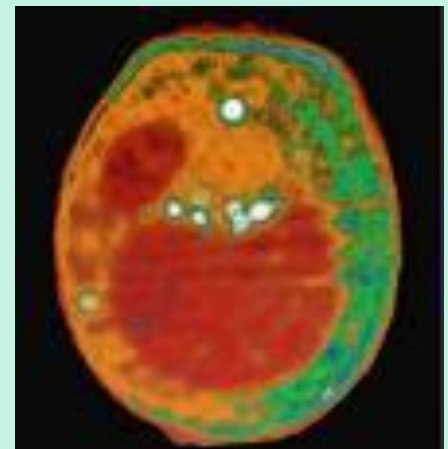
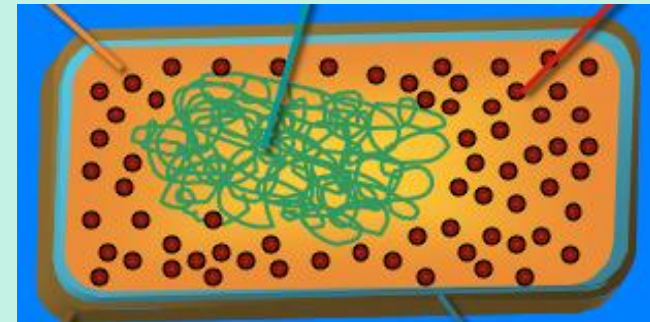


- *Bacteria and Archaea*
 - Both are single-celled organisms
 - Contain no membrane bound nucleus
 - Termed prokaryotes = *pre nucleus*
 - Pro = pre
 - karyote = nucleus
 - Do not contain any other organelles
 - Cytoplasm is surrounded by rigid cell wall

The Microbial World



- *Eucarya*
- Organisms contain membrane bound nucleus
 - Termed eukaryote = *true nucleus*
 - Eu = true
 - karyote = nucleus
- Contains internal organelles
 - Making organism more complex
 - Example = mitochondria
- May be single or multicellular

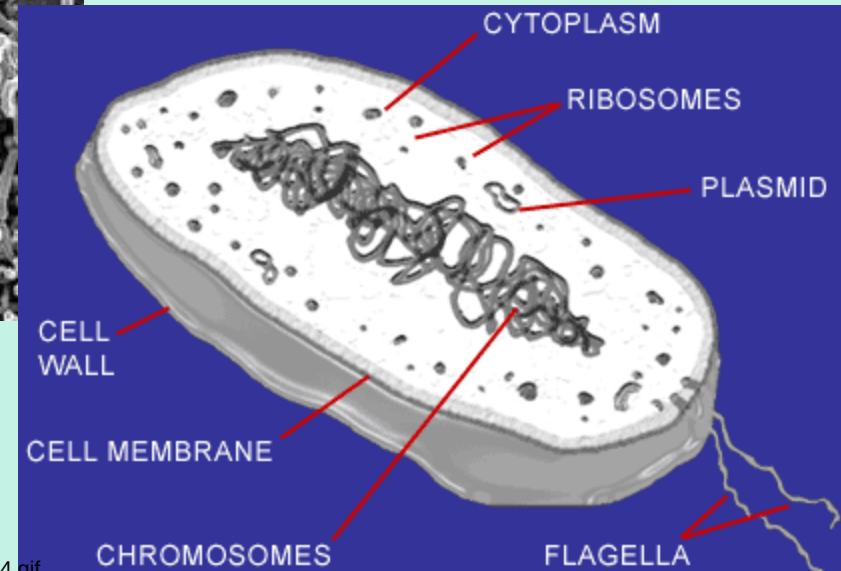
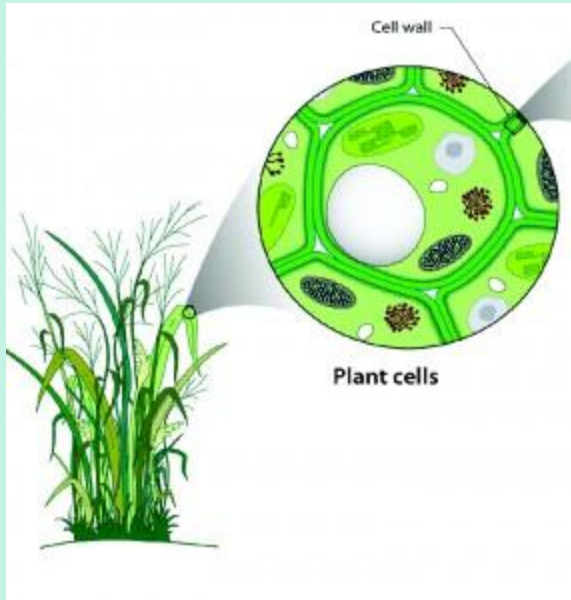
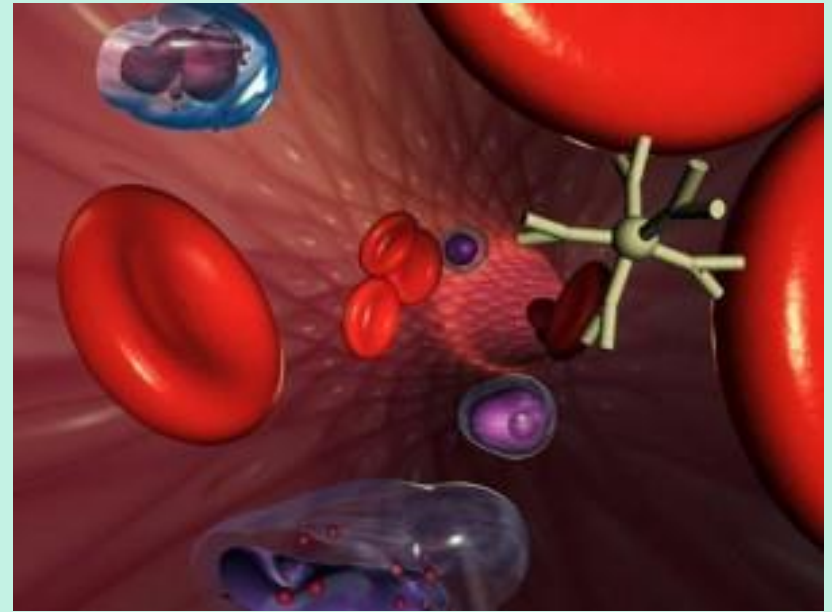


Human cells

A. Have cell wall.

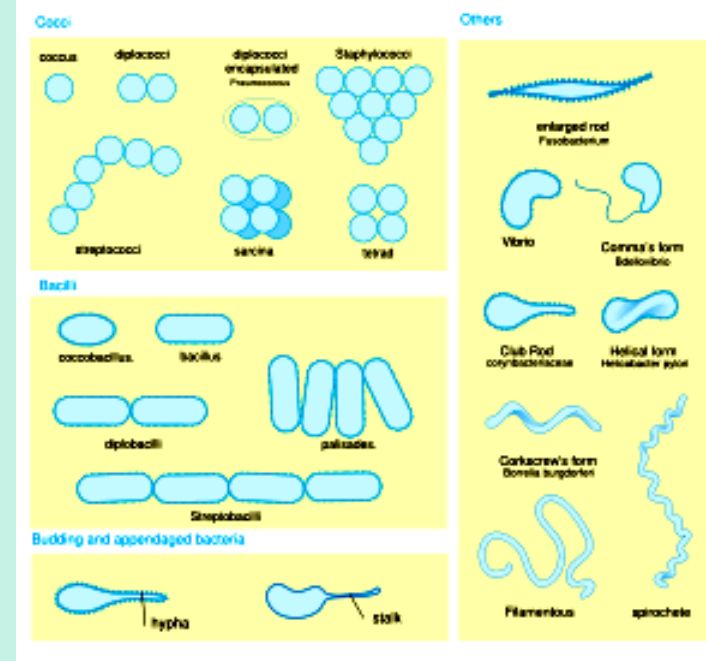
B. have no cell wall.

C. depending on cell type.



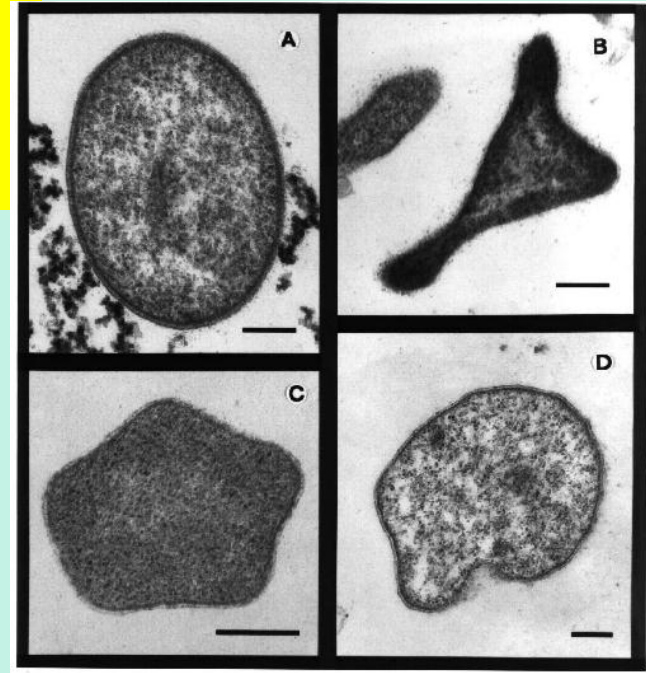
Domain *Bacteria*

- Most common type in human infection
- Members widely diverse
- Most prominent features include:
 - Specific shapes
 - Rod-shaped, spherical and spiral
 - Rigid cell walls
 - Responsible for cell shape
 - Multiply by binary fission
 - One cell divides into two
 - Each cell is genetically identical to the first
 - Some bacteria are motile
 - Move by means of flagella



Domain *Archaea*

- Demonstrate a number of same attributes as *Bacteria*
 - Same shapes
 - Multiply through binary fission
 - Move by means of flagellum
- *Archaea* exhibit significant differences
 - Chemical composition of cell wall differs from organisms in other domains
 - Organisms of *Archaea* domain found in extreme environments
 - Extreme temperatures
 - Environments with high concentrations of salts



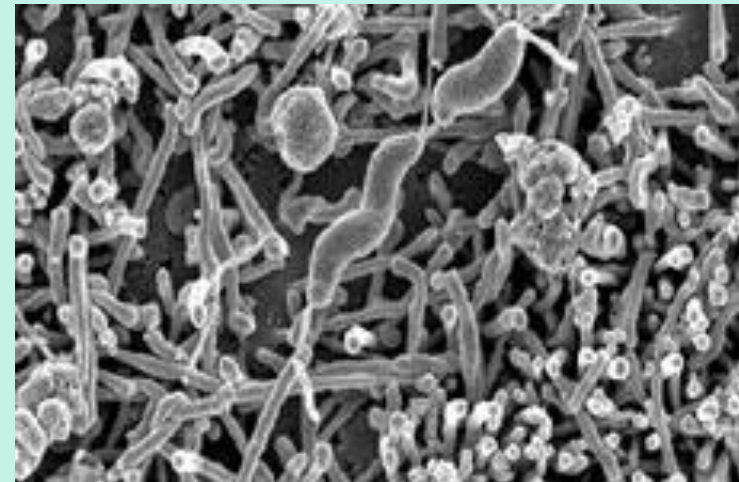
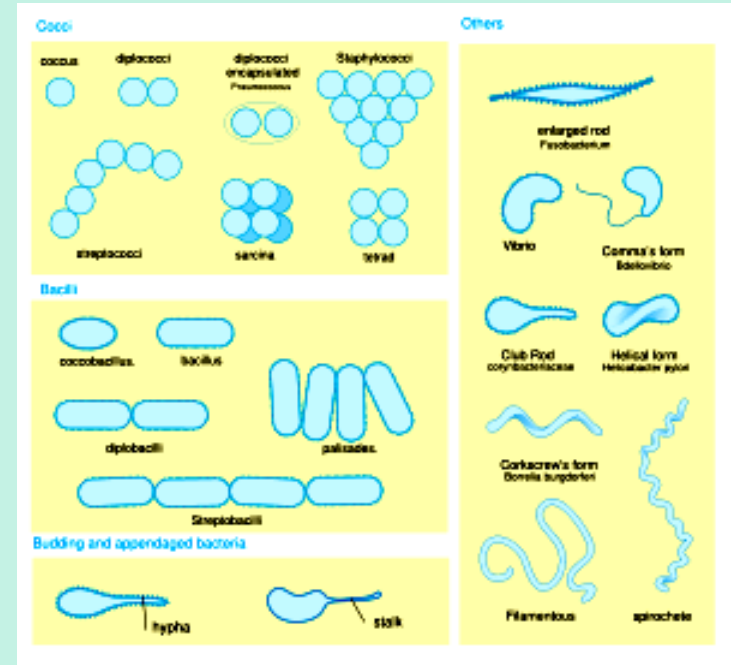
The shape of bacteria cell determined by

A. cell membrane.

B. RNA.

C. cell wall.

D. ribosome.

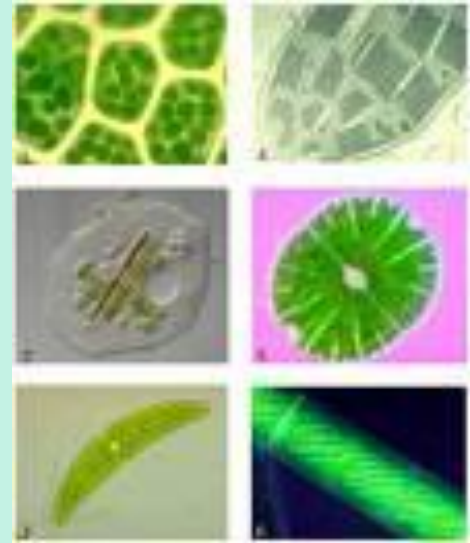


Domain *Eucarya*

- All members are eukaryotic
- Microbial world composed of single-celled Eucarya
 - Algae
 - Fungi
 - Protozoa

Domain *Eucarya*

- Algae
 - Diverse group
 - Includes single and multicellular organisms
 - All contain chlorophyll
 - Pigments used to absorb light to be used as energy source
 - Some contain other pigments
 - Usually found near surface waters
 - Have rigid cell wall
 - Distinct from bacterial cell walls



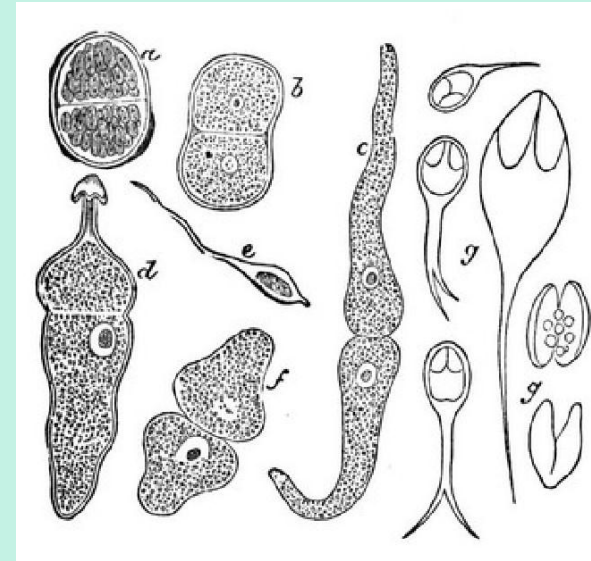
Domain *Eucarya*

- Fungi
 - Diverse single-celled and multicellular organisms
 - Single-celled = yeast
 - Multicellular = molds
 - Gain energy from organic materials
 - Found mostly on land



Domain *Eucarya*

- Protozoa
 - Microscopic, single-celled organism
 - Found in water and on land
 - Complex
 - Much larger than prokaryote
 - Do not have a rigid cell wall
 - Gain energy from organic matter
 - Most are motile
 - Means of motility diverse and a feature of their classification



<http://www.learningtreasures.com/suite101/protozoa.jpg>

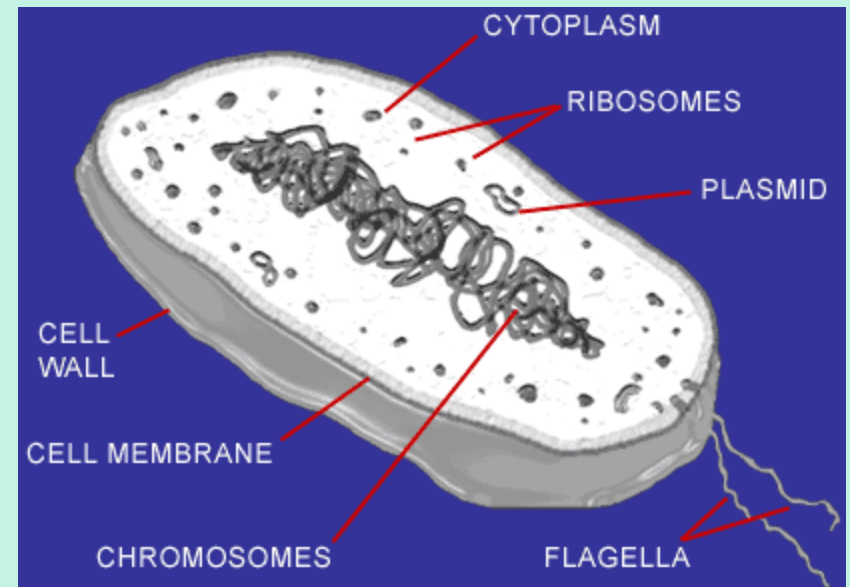
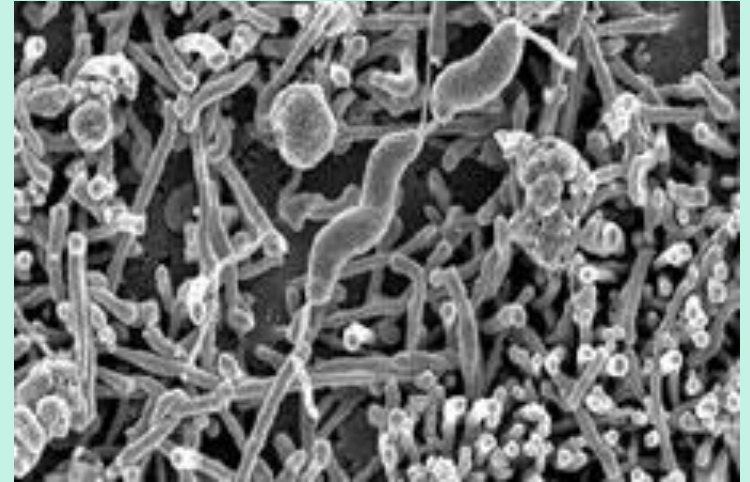
The shape of all cell determined by

A. cell membrane.

B. RNA.

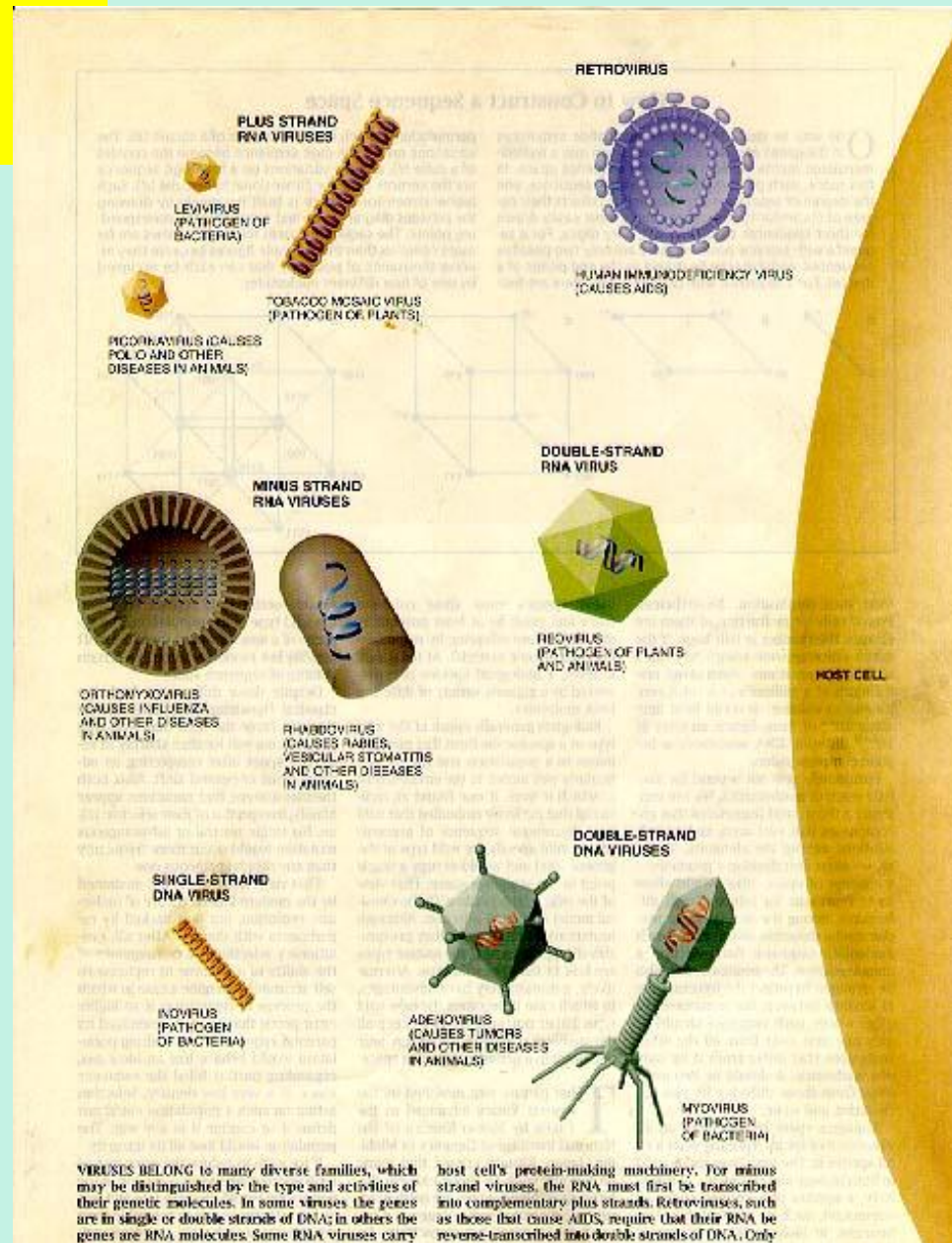
C. cell wall.

D. genomic DNA.



Viruses

- Non-living elements
- Called agents
 - Not organisms
- Usually consist of only a few molecules found in living cells



Viruses

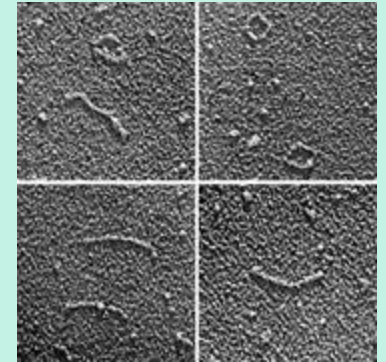
- Viruses contain protein coat surrounding nucleic acid
 - Essentially protein bag of nucleic acid
- Viruses termed obligate intracellular parasites
 - Must have host machinery to replicate
 - Inactive outside of host
- All forms of life can be infected by viruses
- Viruses frequently kill host cells
 - Some live harmoniously with host

Viroids

- Viroids are simpler than viruses
 - Still require host cell for replication
- Consist of a single short piece of RNA
 - Contain no protective protein coat
- Viroids smaller than viruses
- Generally cause plant diseases



<http://www.ars.usda.gov/sp2UserFiles/person/2273/viroids1a.jpg>

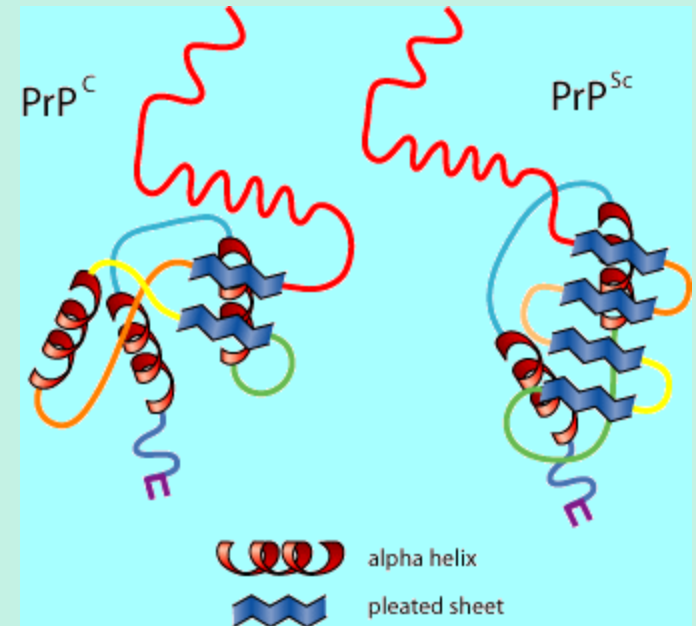


<http://emu.arsusda.gov/typesof/thumbnails/viroid.jpg>

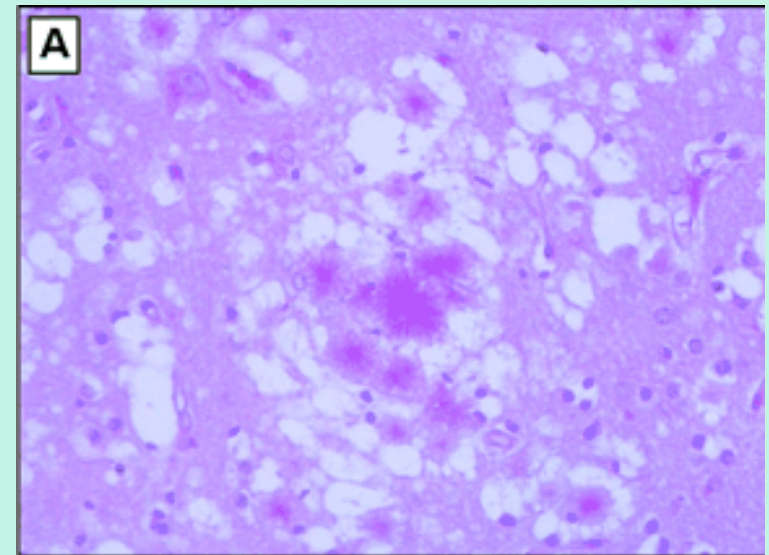


Prions

- Prions are infectious proteins
 - Contain no nucleic acid
- Responsible for six neurodegenerative diseases
 - Animal disease
 - Scrapie in sheep
 - Mad cow disease in cattle
 - Human disease
 - Kuru
 - Creutzfeldt-Jakob



http://www.ens-newswire.com/ens/jul2006/20060710_prions.gif



<http://www.sciencemag.org/feature/data/prusiner/medium/se3875740004.gif>

In summary,

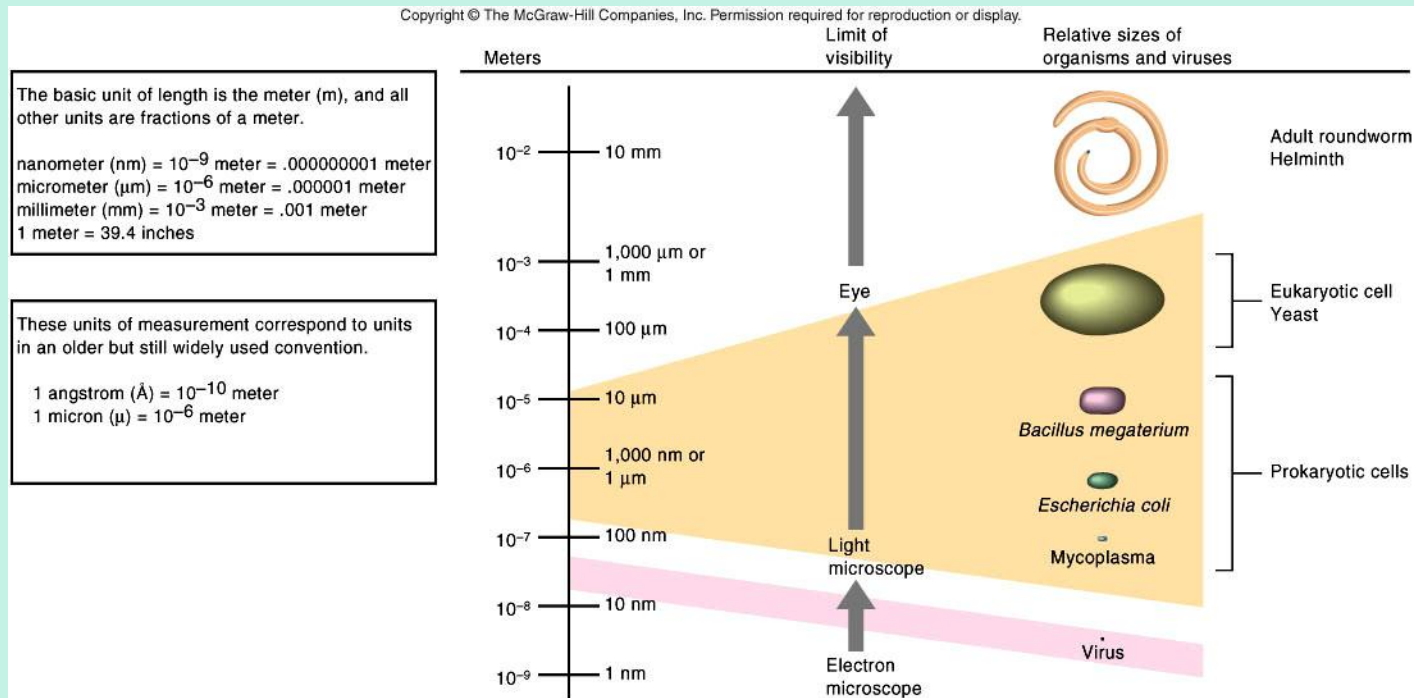
	bacteria	virus	viroids	prion
protein	✓	✓		✓
Nucleic acids (DNA/RNA)	✓	✓	✓	

Before the cattle gets “mad cow” disease, the wrong statement is

- A. it has prion protein already.
- B. it has no prion protein at all.
- C. it has prion protein no matter it gets sick or not.
- D. it may have misfolded prion.

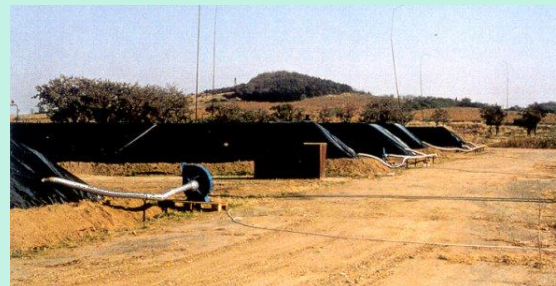
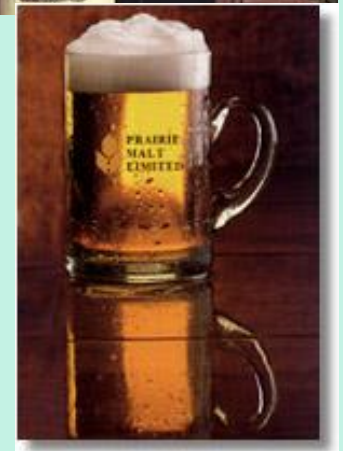
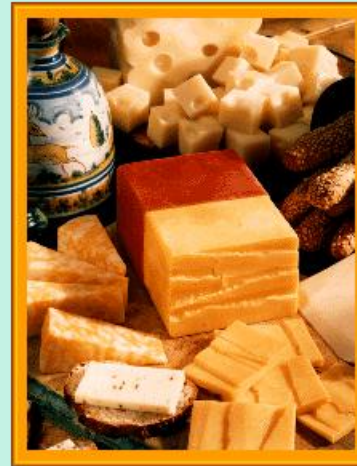
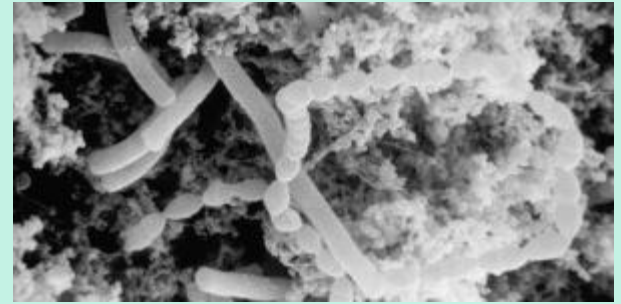
Size in the Microbial World

- Tremendous range in size
 - Smallest virus approximately 1/1,000,000th size of largest eukaryotic cell



Applications of Microbiology

- Food production
 - Fermentation of milk to produce numerous products
 - Yogurt, cheese, buttermilk
- Bioremediation
 - Use organisms to degrade environmental waste
 - Degrade PCB's, DDT
 - Clean up oil spills
 - Treat radioactive waste



Applications of Microbiology

- Bacteria can synthesize numerous products
 - Ethanol
 - Pesticides
 - Antibiotics
 - Dietary amino acids



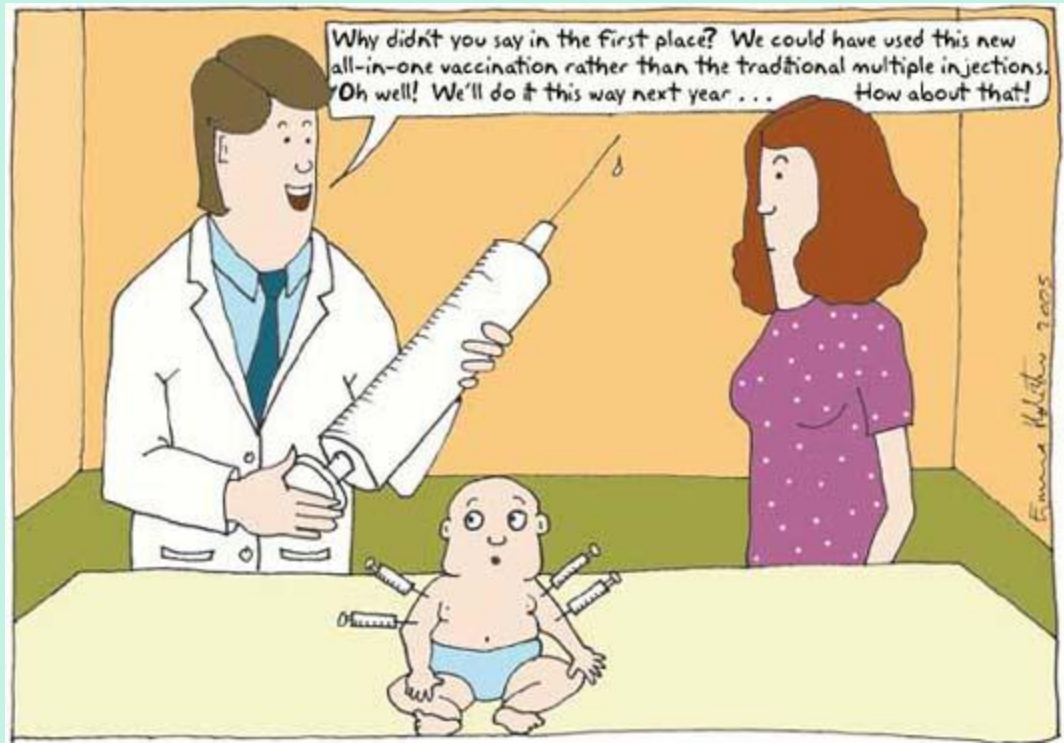
Applications of Microbiology

- Genetic engineering
 - Definition: introduce genes of one organism into an unrelated organism to confer new properties on the organism
 - Applications include engineering organisms to produce medically important products and vaccines
 - Engineered plants resist disease
 - Potentially therapeutic
 - Gene therapy



Medical Microbiology

- Bacteria do cause disease
 - More people died worldwide of influenza in the 1918 epidemic than died in WWI, WWII, Korean War and Vietnam combined
 - Modern sanitation, vaccination and effective antimicrobial treatments have reduced incidences of the worst diseases



Summary: history and introduction

1: Why do we study Microbiology?

We need to!

2: What did the famous microbiologists do?

Very good stories...

3: How many different kind of microbes?

prokaryotes and eukaryotes

4: What's the major applications for microbiology?

medical, agricultural, industrial,
environmental...