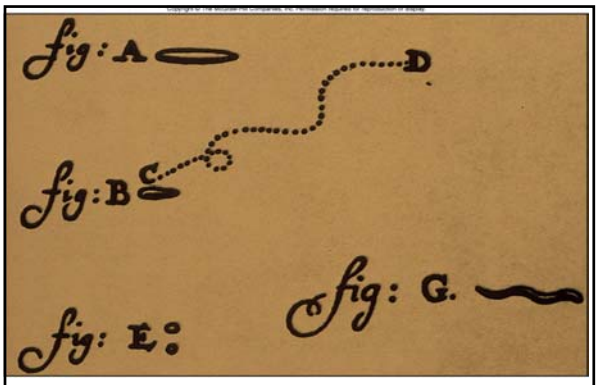
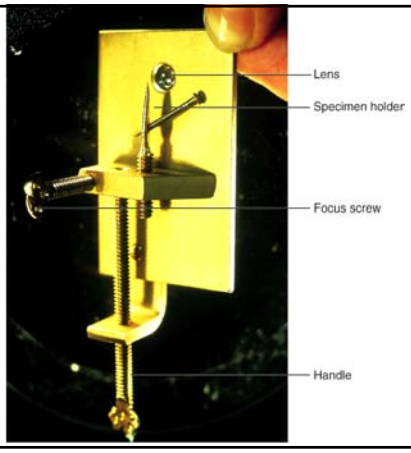


Leeuwenhoek's "Animacules"

Early History of Microbiology:

1668 – Francesco Redi disproves spontaneous generation
1676 – Antony van Leeuwenhoek first observes microbes
1861 – Louis Pasteur disproves spontaneous generation
1876 – John Tyndall and Ferdinand Cohn discover endospores
1877 – Robert Koch shows that anthrax is caused by *Bacillus anthracis* transmitted by heat resistant spores
1882 – Koch: Tuberculosis is caused by *Mycobacterium tuberculosis*
1884 – Koch's postulates

Fig. 1.4



Theory of Spontaneous Generation

- Organisms arise from non-living material

- Redi showed emergence of flies in rotting meat required previous contact with flies

- Pasteur refuted the theory of spontaneous generation using careful experiments

- Tyndall and Cohn confirmed Pasteur's finding by showing that endospores accounted for sterilization-resistant "spontaneous" bacterial growth

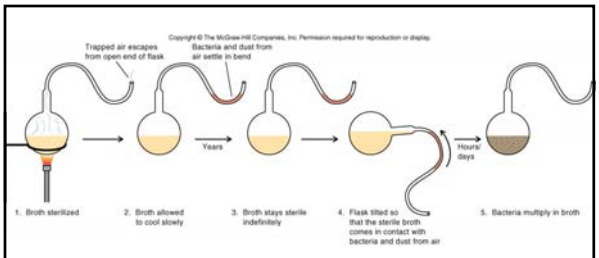


Fig 1.2 - Pasteur's experiment disproving spontaneous generation

Endospores:

Endospores account for sterilization-resistant life forms present in soil-derived infusions (from hay, for example)

Predicted by Tyndall (1876) from studies on different infusions

Discovered by Cohn (1876) in soil bacteria

Koch (1877) showed endospores transmit anthrax

Vital Activities and Roles of Microorganisms

- Support all living cells (Bacteria, Archaea, Eucarya)
- Involved in nitrogen fixation
- Replenish oxygen on Earth
- Degrade organic waste material
- Serve as models for eukaryotes in study of genetics, metabolism, and biochemical principles

Applications of Microbiology

- The fermentation process is used for making bread, wine, beer and cheeses.
- Bioremediation - degradation of toxic material
- Biosynthesis - production of antibiotics, amino acids, ethanol, insecticides, etc.

Genetic Engineering

The process by which the genes from one organism are introduced into related or unrelated organisms

Examples:

Human growth hormone gene
Interferon
Insulin
Blood clotting and dissolving enzymes
Vaccine production
Genetically engineered plants
Gene therapy with viruses

Medical Microbiology

- Infectious diseases have existed for many years, and affect humans, animals, plants, and microbes
- Emerging infectious diseases
- Re-emerging infectious diseases

Historically important diseases

Small pox - 10 million deaths over last 4000 years
last case in 1977
current bioterrorist threat

Bubonic Plague – 25 million deaths (1346-1350)
currently less than 100 per year
rats, carriers of *Yersinia pestis*, transmitted by fleas
controlled by sanitation, antibiotics

Foot and Mouth Disease (2001)
Highly contagious
4 million stock animals destroyed to control disease

Infections in US currently at 750 million cases per year

200,000 deaths/year in the US

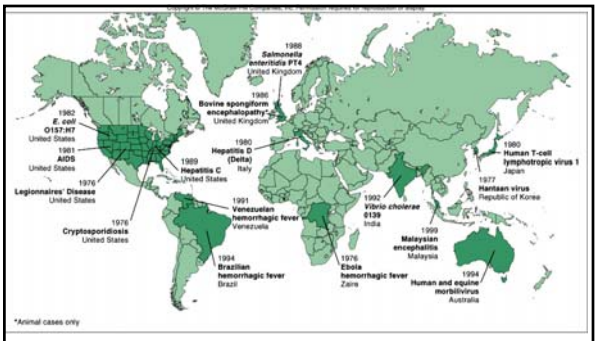


Figure1.3 "New" infectious Diseases in Humans since 1976

Emerging diseases

Legionaires' disease
Toxic shock syndrome
Lyme disease
AIDS
Hentavirus pulmonary syndrome
Hemolytic-uremic syndrome
Cryptosporidiosis
West Nile virus disease
SARS
Avian flu

Resurging old diseases

Antibiotic resistance
Spread by travelers
Unvaccinated children
Older people
AIDS

Three Domains based on ribosomal RNA sequencing:

Bacteria = prokaryotes

Archaea = prokaryotes

Eucarya = eukaryotes

	Bacteria	*Archaea*	*Eucarya*
Typical Size	0.3–2 μm	0.3–2 μm	5–50 μm
Nuclear Membrane	No	No	Yes
Cell Wall	Peptidoglycan present	No peptidoglycan	No peptidoglycan
Cytoplasmic Structures			
Mitochondria	No	No	Yes
Chloroplasts	No	No	In plant and algal cells
Cytoskeleton	No	No	Yes
Where Found	In all environments	Frequently in extreme environments	In environments that are not extreme

Table 1.2 – Comparison of Bacteria, Archaea and Eucarya

Bacteria:

Shaped as rods, spheres or spirals

Rigid cell walls containing peptidylglycan

Division by binary fission

Motility via flagella

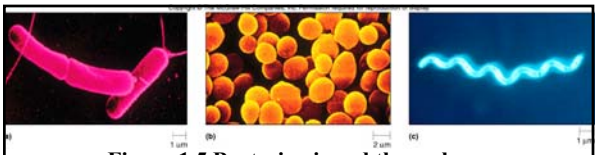
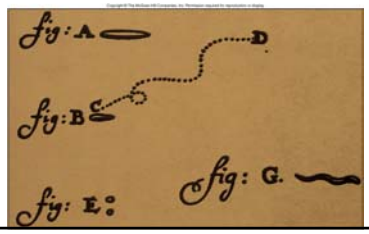


Figure 1.5 Bacteria viewed through a scanning electron microscope



Archaea:

- Life in extreme environments
- *Thermoplasma* – live in burning coal pile tailings
- *Sulfolobus* – live in acidic hot springs
- Methanogens – anaerobes, generate methane
- Halogens – live in saturated salt solutions

Eucarya:

- Algae
- Fungi
- Protozoa
- Multicellular parasites

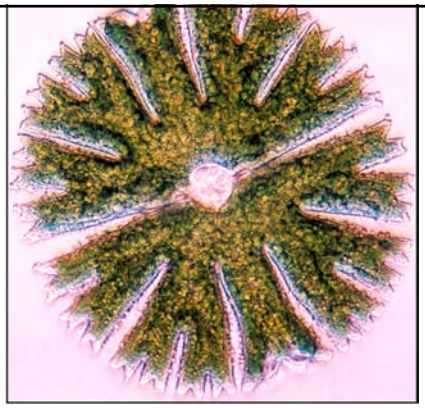


Figure 1.6 – Micrasterias, a green alga

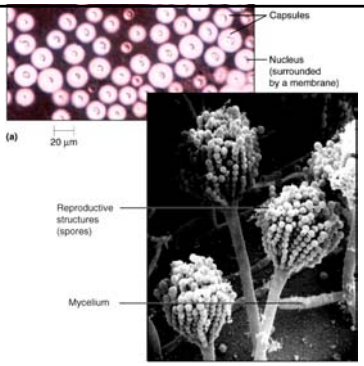


Figure 1.7 – Two forms of fungi:
***Cryptococcus* (unicellular yeast) stained with india ink**
***Aspergillus*, multicellular mold viewed with scanning EM**

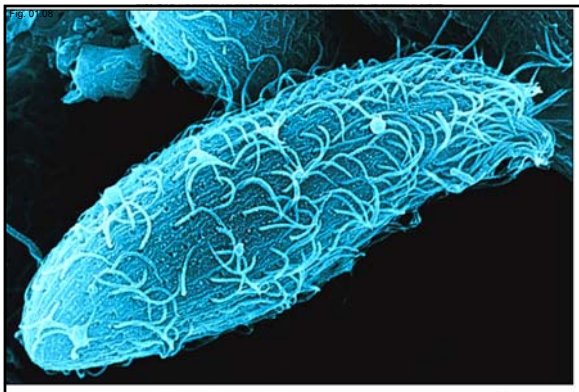
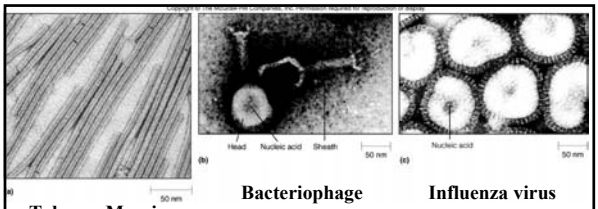


Figure 1.8 – Paramecium, a ciliated protozoan

Viruses:

- Nucleic acid + protein coat = virus
- Multiply only in cells
- "Obligate" intracellular parasites



Tobacco Mosaic Virus (TMV)

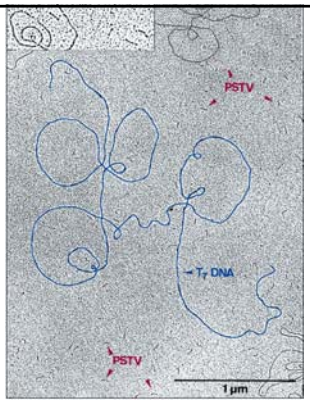
Bacteriophage

Influenza virus

Figure 1.9 – Three kinds of viruses

Viroids:

Short pieces of nucleic acid (RNA)
Intracellular parasites (plant diseases)



PSTV = Potato spindle tuber viroids

Figure 1.10 – Viroids compared to bacteriophage T7

Prions:

Apparently no nucleic acid; only protein
Cause neurodegenerative diseases such as mad cow disease

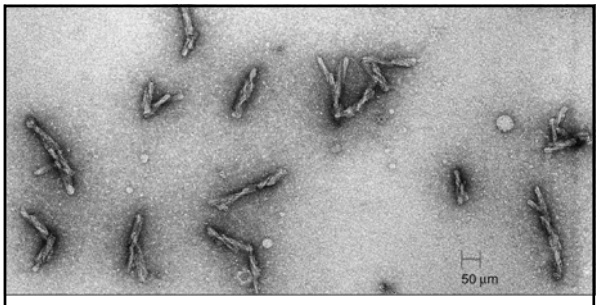


Figure1.11 – Prions from a scrapie-infected hampster

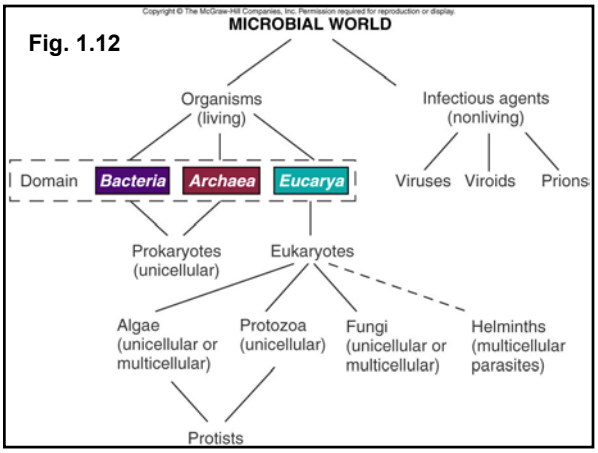


Fig. 1.13 – Sizes of Organisms and Viruses