BIO 205 – Microbiology for Health Professionals

- The study of microscopic agents as they relate to human health
  - The causes of infectious disease.
  - The control of infectious disease.
  - Host defenses against infectious disease.
  - Host pathology caused by infectious disease and avoidance of infection transmission.

Causes of Mortality Table

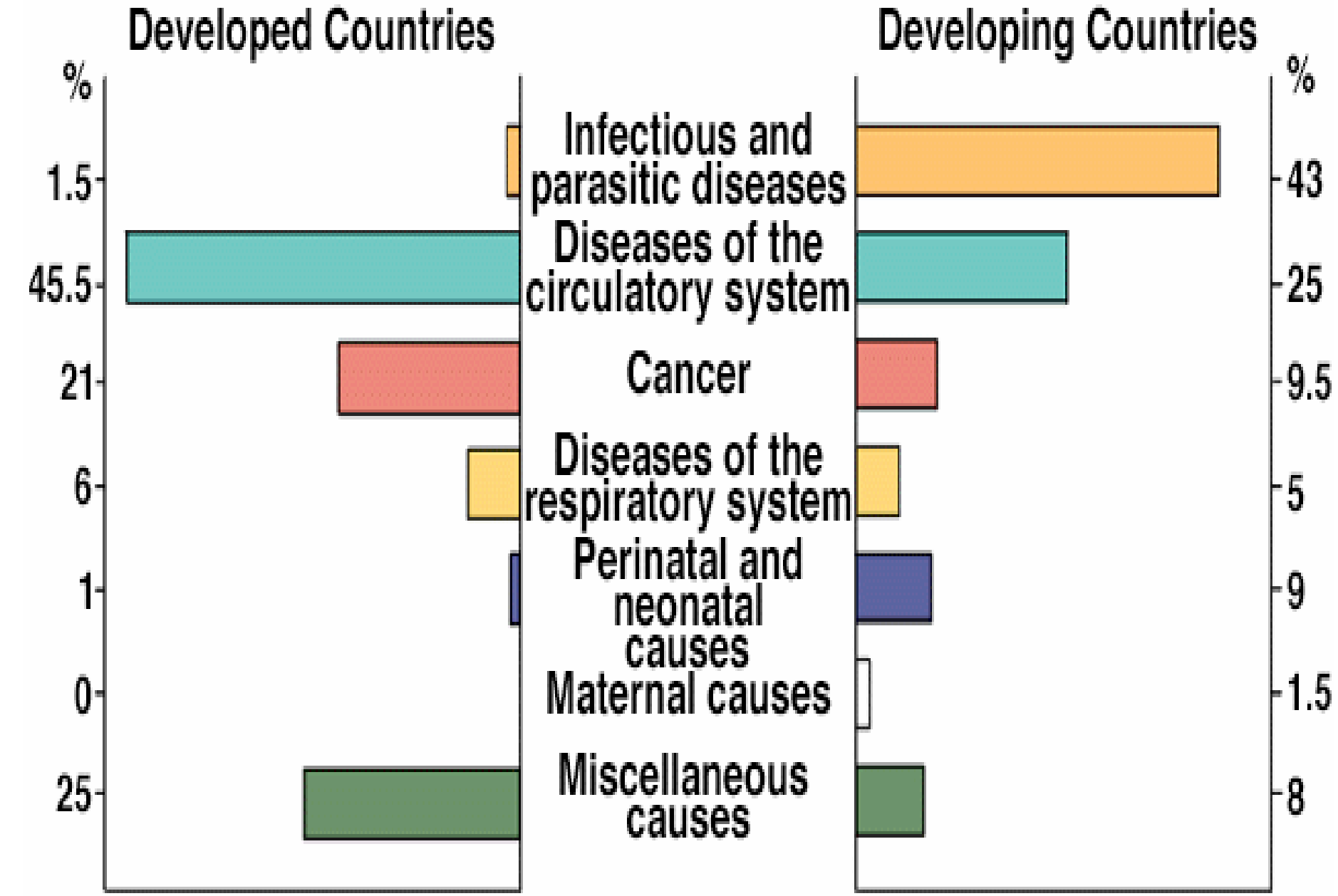
TABLE 1.1 Top Causes of Death—All Diseases

United States	No. of Deaths	Worldwide	No. of Deaths
1. Heart disease	725,000	1. Heart disease	11.1 million
2. Cancer	550,000	2. Cancer	7.1 million
3. Stroke	167,000	3. Stroke	5.5 million
4. Chronic lower-respiratory disease	124,000	4. Respiratory infections*	3.9 million
5. Unintentional injury (accidents)	97,000	5. Chronic lower-respiratory disease	3.6 million
6. Diabetes	68,000	6. Accidents	3.5 million
7. Influenza and pneumonia	63,000	7. HIV/AIDS	2.9 million
8. Alzheimer's disease	45,000	8. Perinatal conditions	2.5 million
9. Kidney problems	35,000	9. Diarrheal diseases	2.0 million
10. Septicemia (bloodstream infection)	30,000	10. Tuberculosis	1.6 million

*Diseases in red are those most clearly caused by microorganisms.

Data adapted from The World Health Report 2002 (World Health Organization).

Causes of Mortality Chart



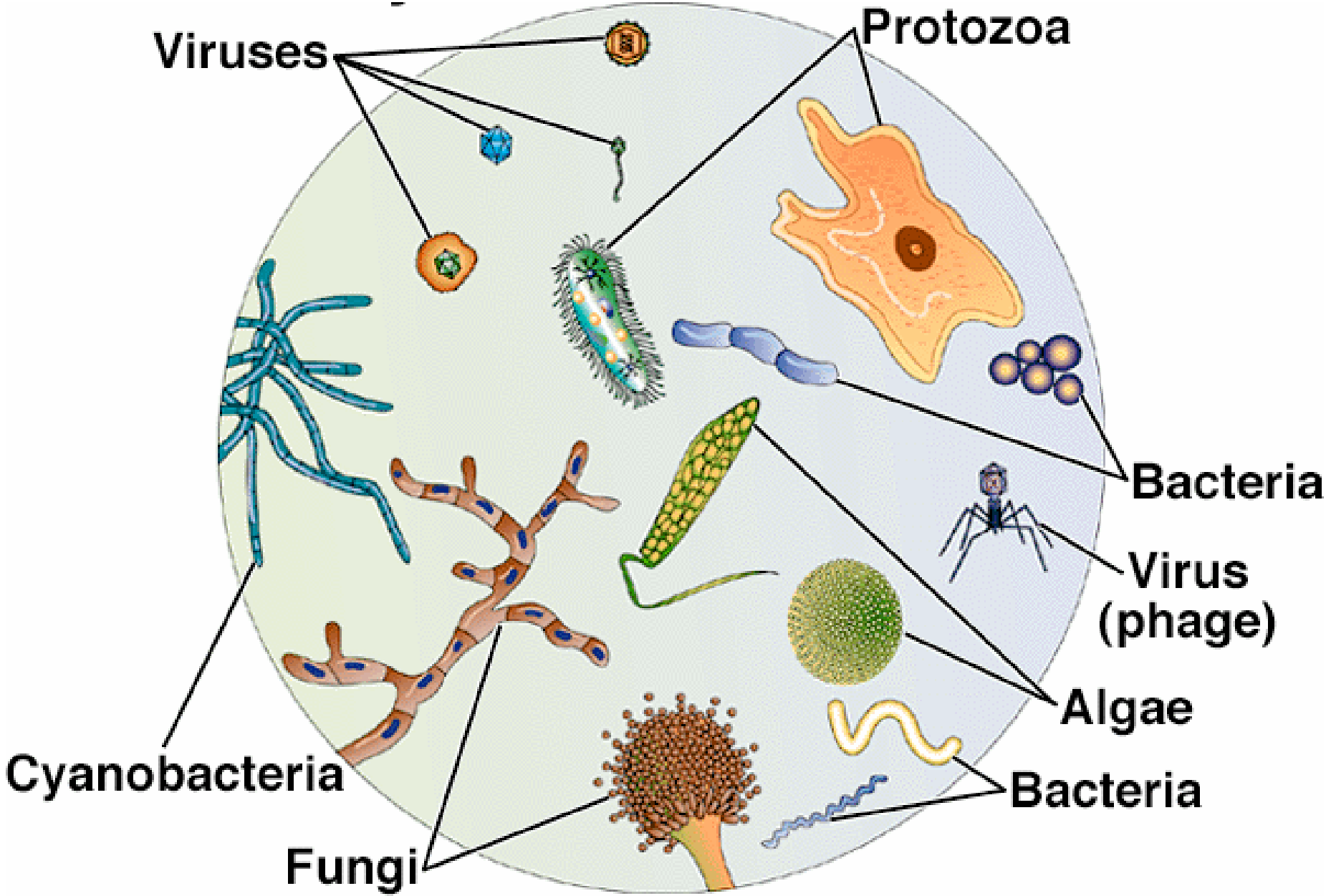
Microbiology-related Study

- Bacteriology
- Virology
- Mycology
- Parasitology
- Immunology
- Pathology
- Epidemiology

Types of Microbes

- Microbe alternate terms
  - Germs, microorganisms, pathogens, agents, bugs
- Groups of Microbes
  - Viruses
  - Bacteria
  - Fungi
  - Protists or Protozoa
  - Helminths

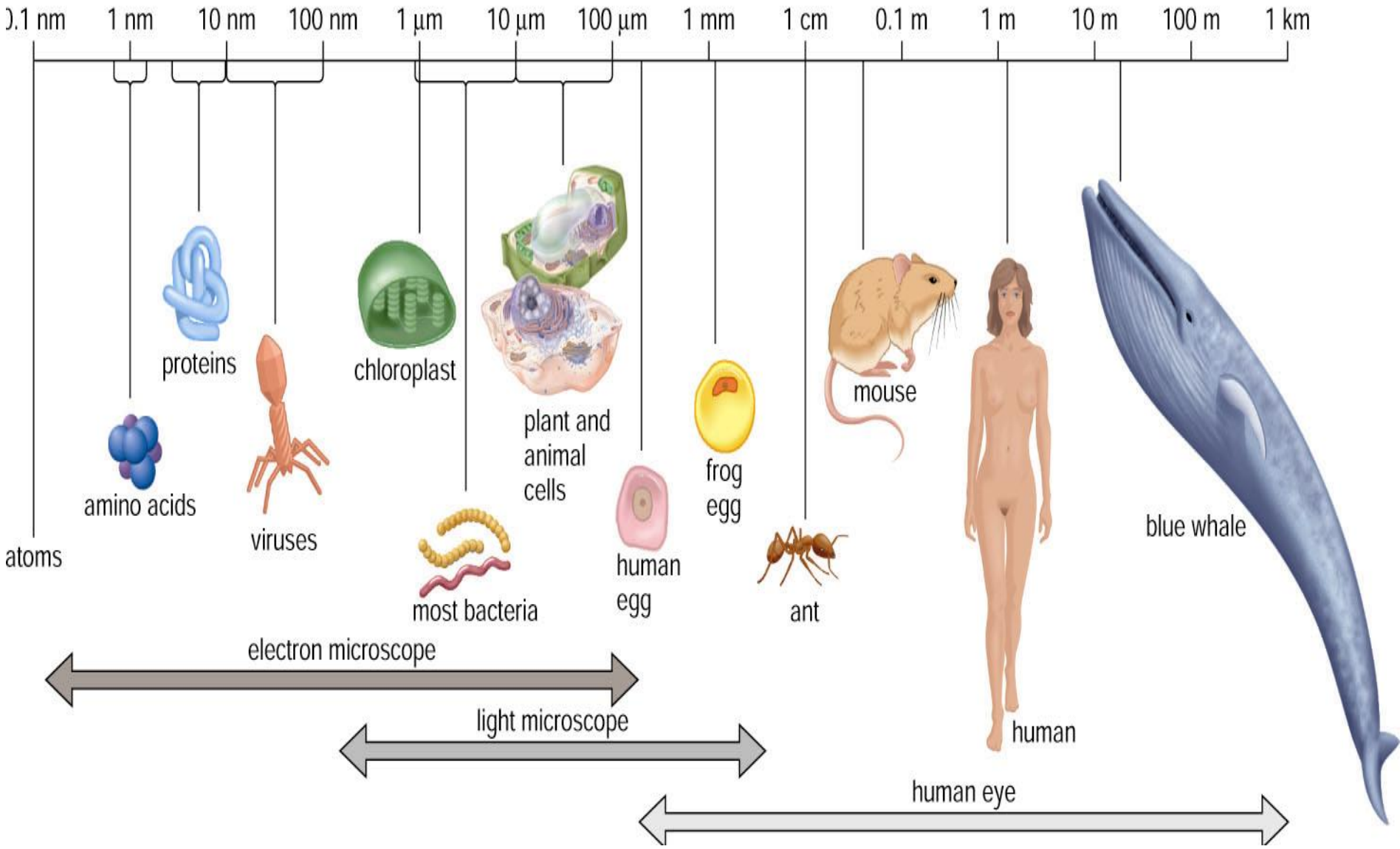
Microbial diversity image



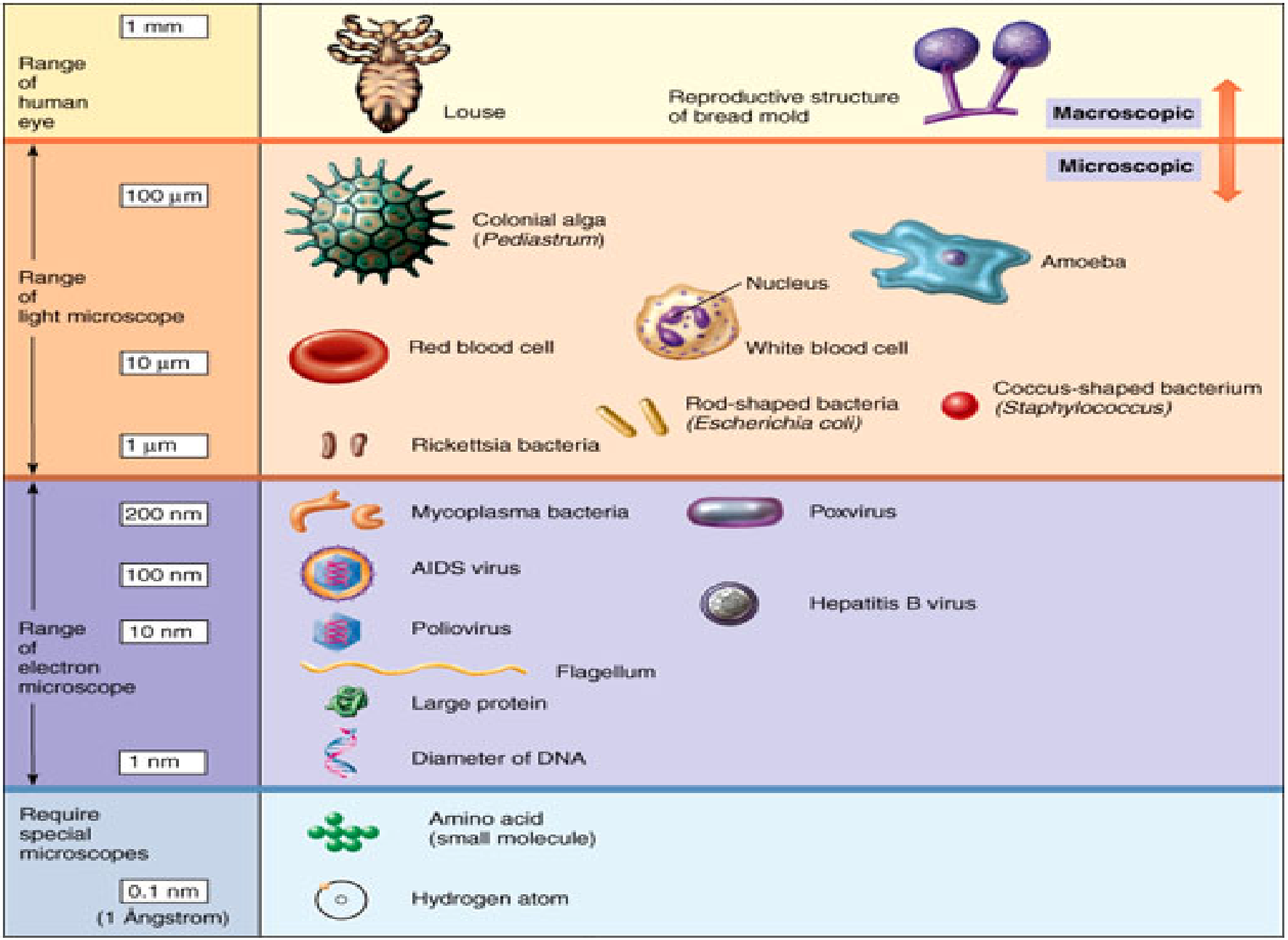
Organization of organisms

- Atomic
- Molecular
  - Macromolecular, Biochemical
- Organelle
  - Cell organs
  - Viruses
- Cellular
  - Single celled organisms
  - Bacteria
  - Fungi
- Tissues
- Organs
- Organ systems
- Multi-system organisms

Size scale


0.1 nm
1 nm
10 nm
100 nm
1 µm
10 µm
100 µm
1 mm
1 cm
0.1 m
1 m
10 m
100 m
1 km
atoms
amino acids
proteins
viruses
most bacteria
chloroplast
plant and animal cells
human egg
frog egg
ant
mouse
human
blue whale
electron microscope
light microscope
human eye

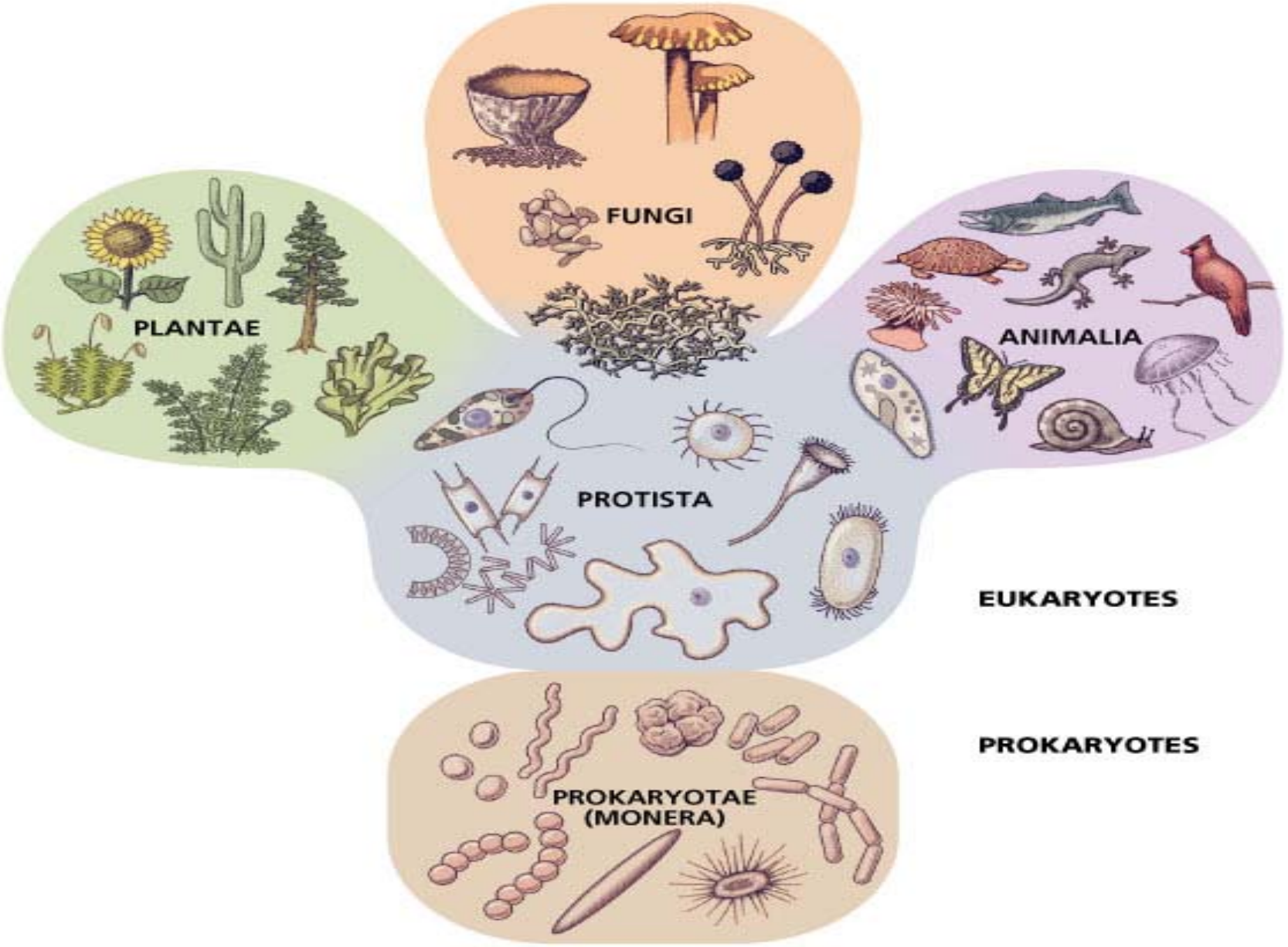
Size scale



Cell theory

- Cell theory definition
  - Cells are the smallest unit of life
  - Ability to reproduce and metabolize
  - All living things are made up of individual cells
- Types of cellular organisms
  - Animals, Plants, Fungi, Protists, Bacteria

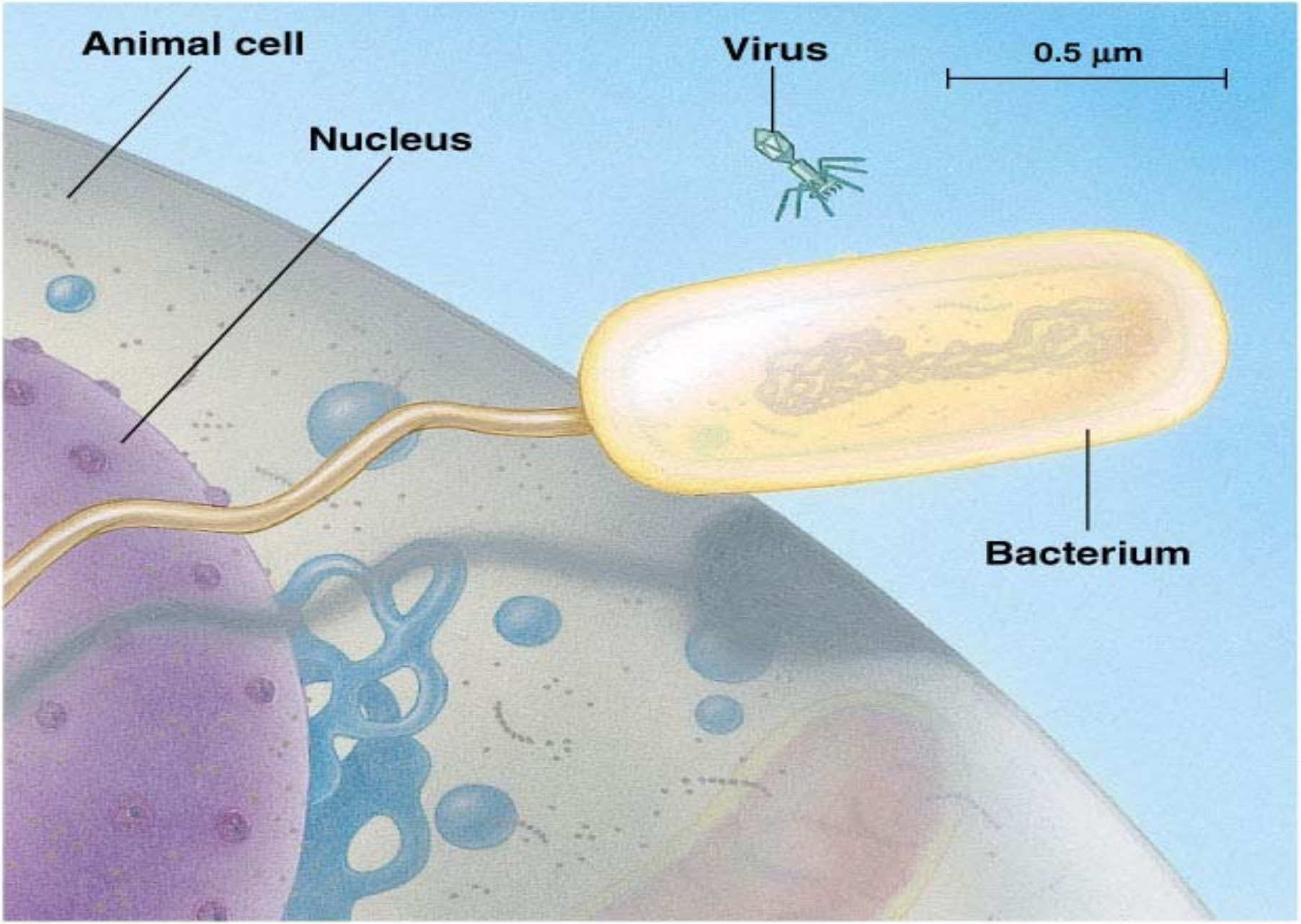
Living organisms image



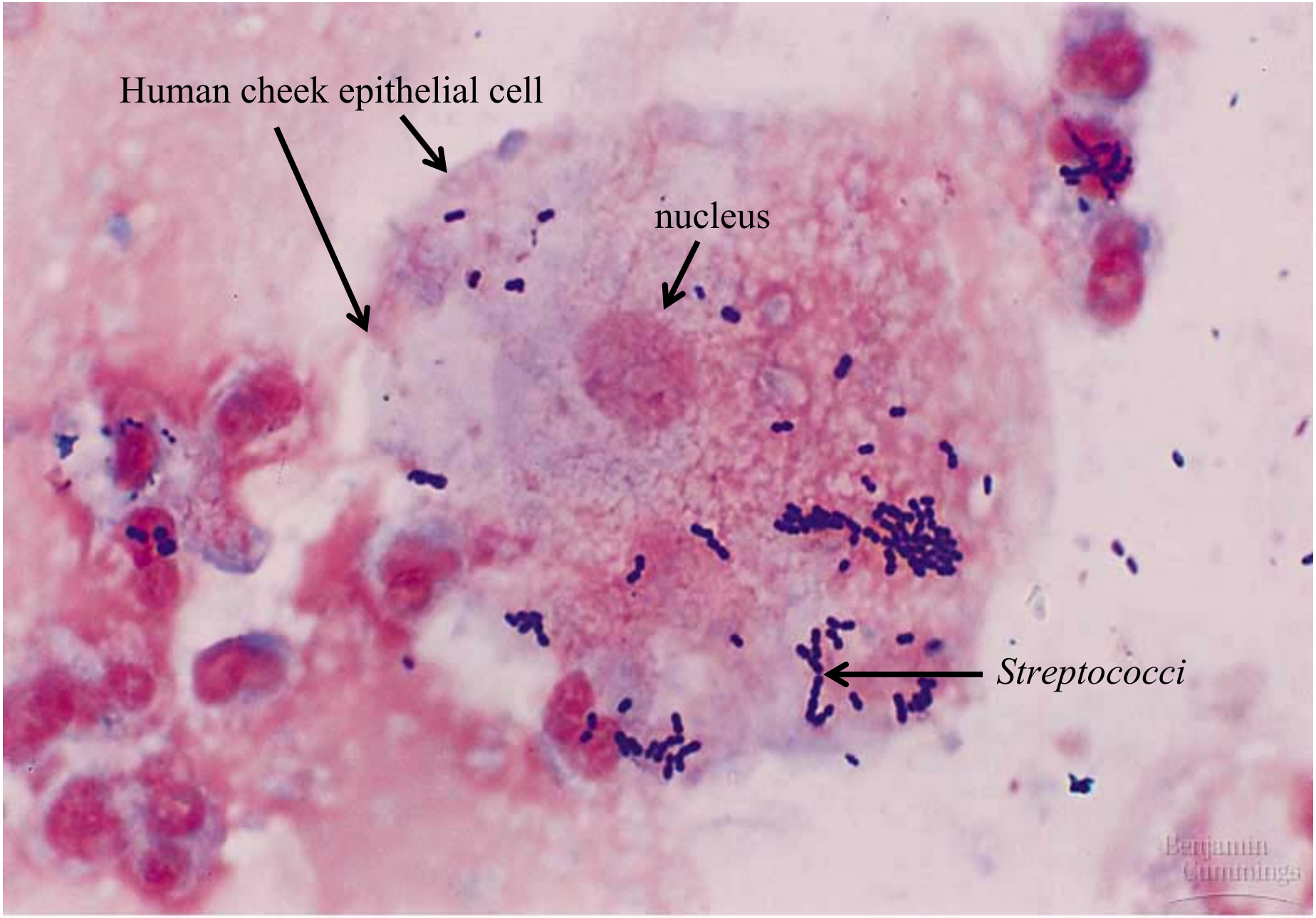
Acellular Agents

- Characteristics
  - Lack ability to reproduce and metabolize
    - Not organisms or living
  - Obligate intracellular parasites
  - Subcellular size
- Types of Acellular Microbes
  - Viruses
    - Organelle sized
  - Viroids
    - Nucleic acid
  - Prions
    - Protein molecule

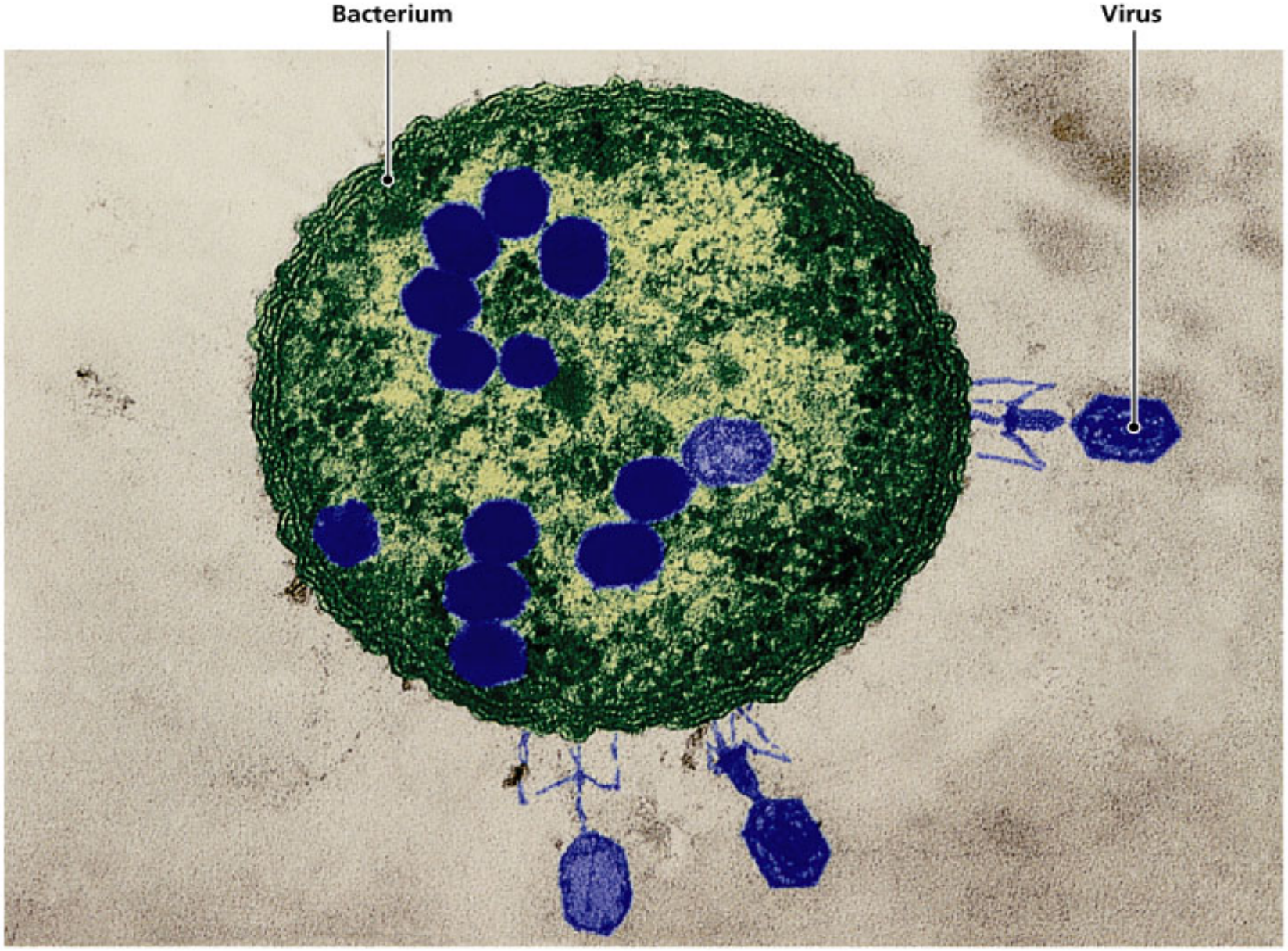
Size comparison of agents image 1



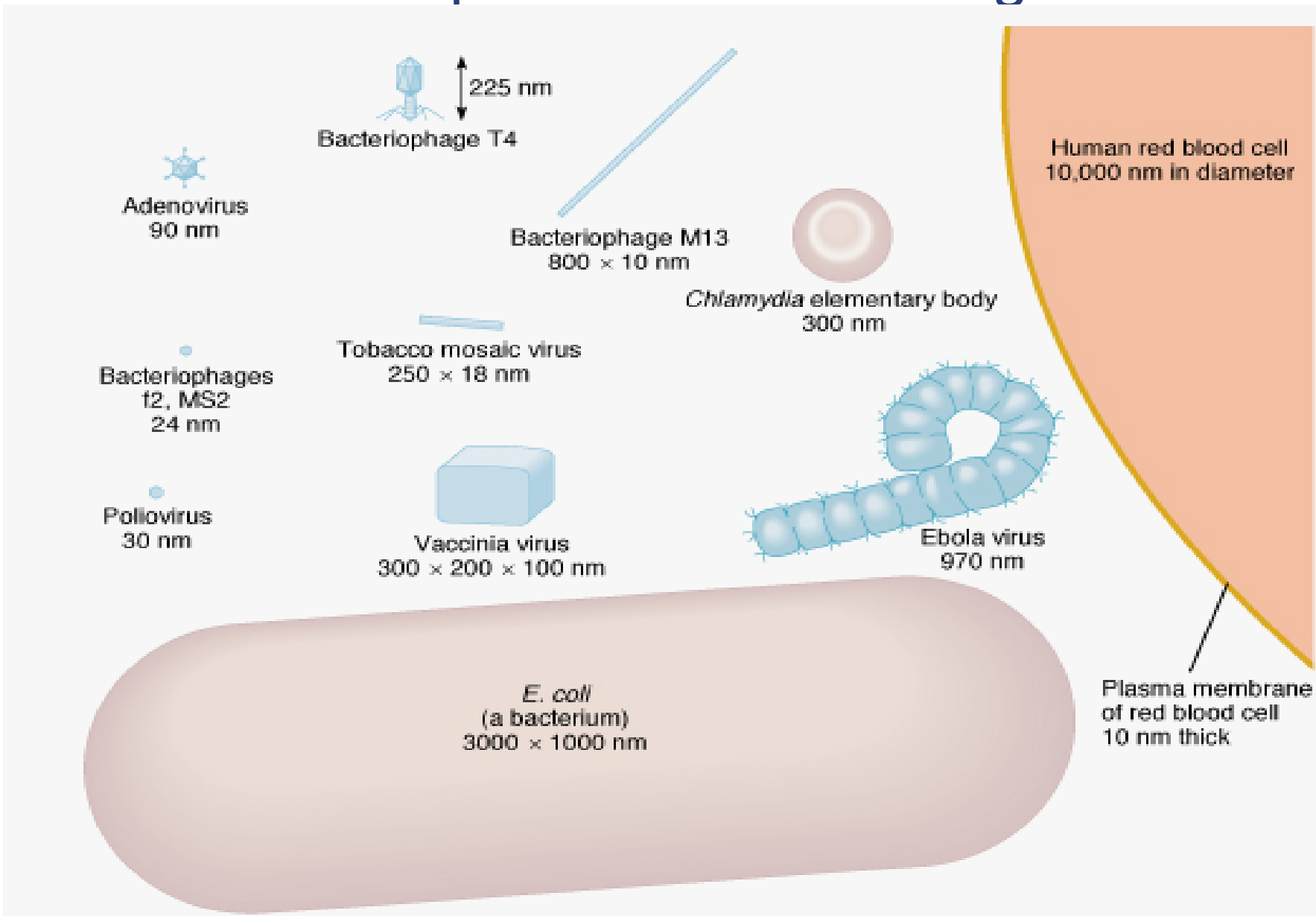
Bacteria on human cell photo



Viruses on a Streptococci photo



Size comparison of cells image 2



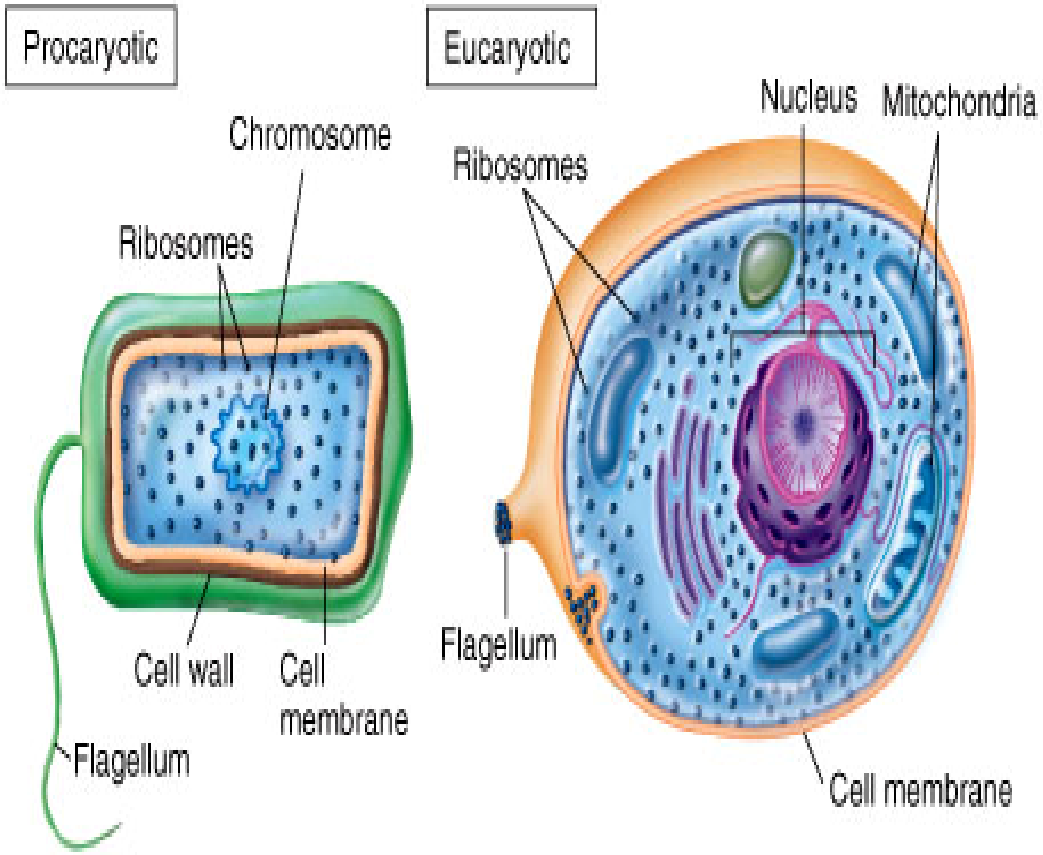
Prokaryotic cell characteristics

- Unicellular or single celled organisms
- Smallest living organisms
  - Bacteria
- Simple components and organelles
- No nuclear membrane
  - free chromosome

Eukaryotic cell characteristics

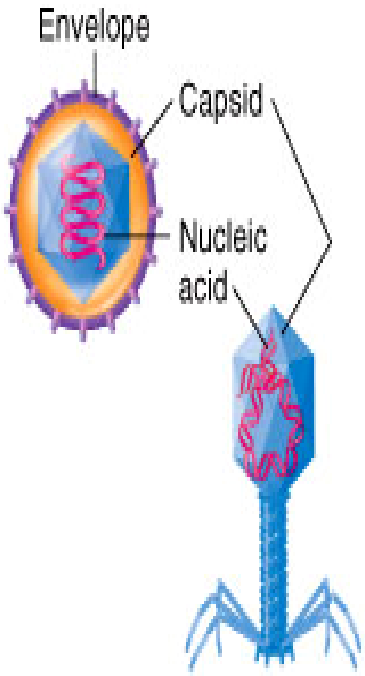
- Single celled and multicelled organisms
- Largest living organisms
- Complex organelles
- Nuclear membranes
  - Multiple chromosomes

Comparison of Cells and Viruses



(a) Cell Types

Microbial cells are of the small, relatively simple procaryotic variety (left) or the larger, more complex eucaryotic type (right). (Not to scale)



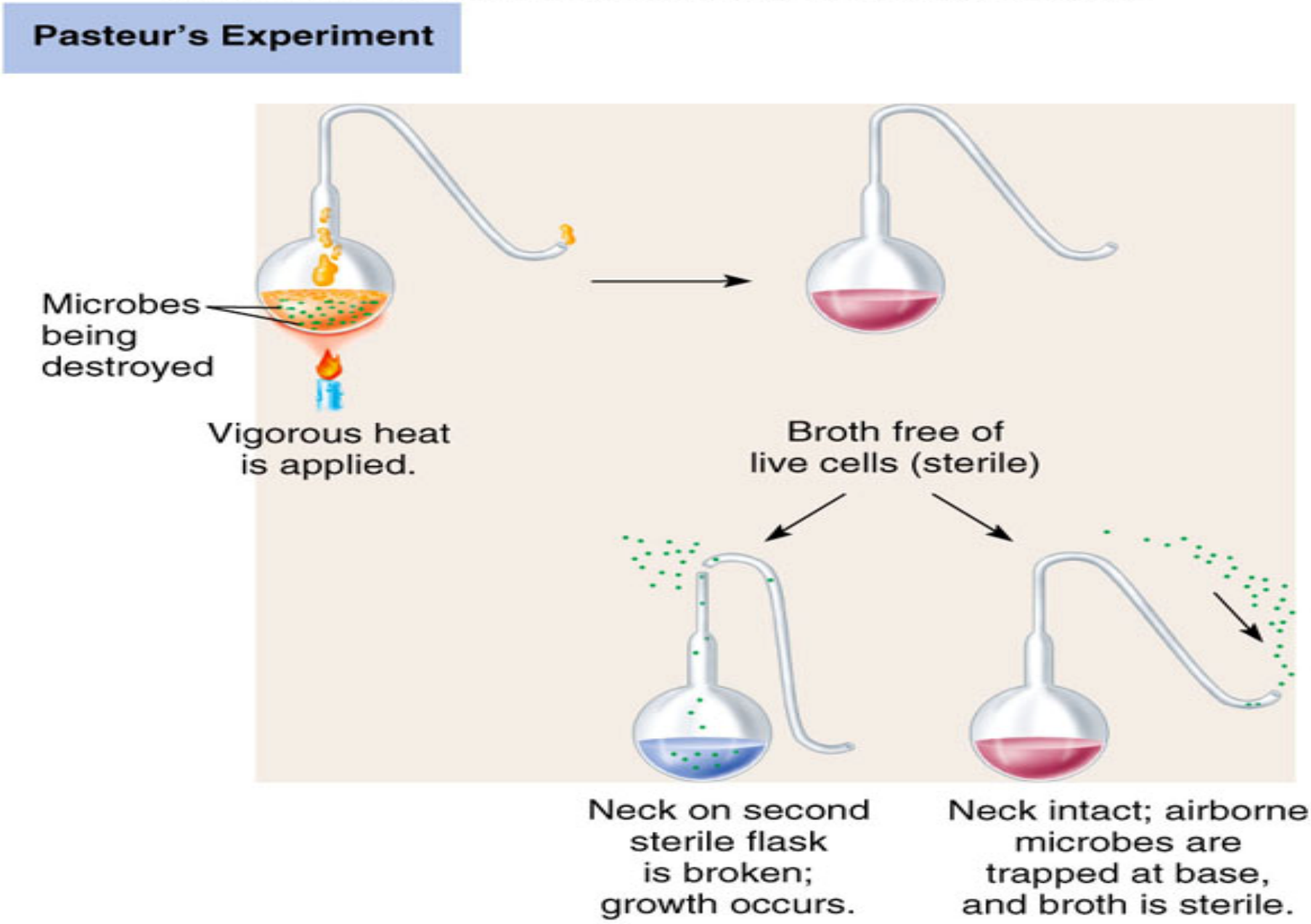
(b) Virus Types

Viruses are tiny particles, not cells, that consist of genetic material surrounded by a protective covering. Shown here are a human virus (top) and bacterial virus (bottom). (Not to scale)

Germ theory

- Infectious diseases are caused by specific microbes
- Infectious microbes cause specific pathology (damage) and symptoms
- Infectious disease microbes are also termed
  - Infectious agents
  - Causative agents
  - Pathogens

Pasteur's germ experiment



Determination of infection causative agent

- **Koch's Postulates**
  - 1.The microorganism must be detectable in the infected host at every stage of the disease.

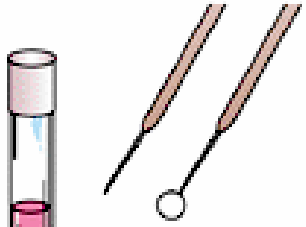
    2.The microorganism must be isolated from the diseased host and grown in pure culture.

    3.When susceptible, healthy animals are infected with pathogens from the pure culture, the specific symptoms of the disease must occur.

    4.The microorganism must be re-isolated from the diseased animal and correspond to the original microorganism in pure

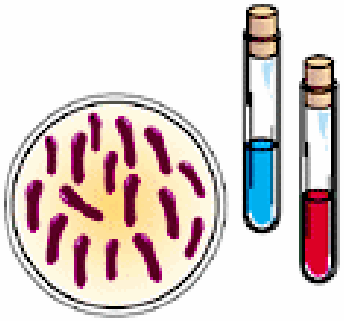
Koch's postulates

Specimen from patient ill with lung infection of unknown etiology



Pure culture

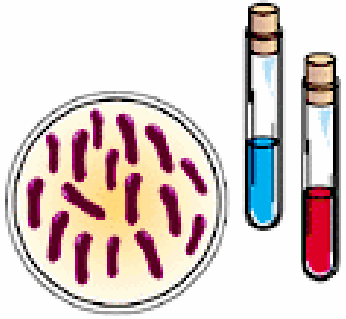
Full micro-scopic and biological characterization



Inocula-tion of test subject

Observe animal for disease characteristics

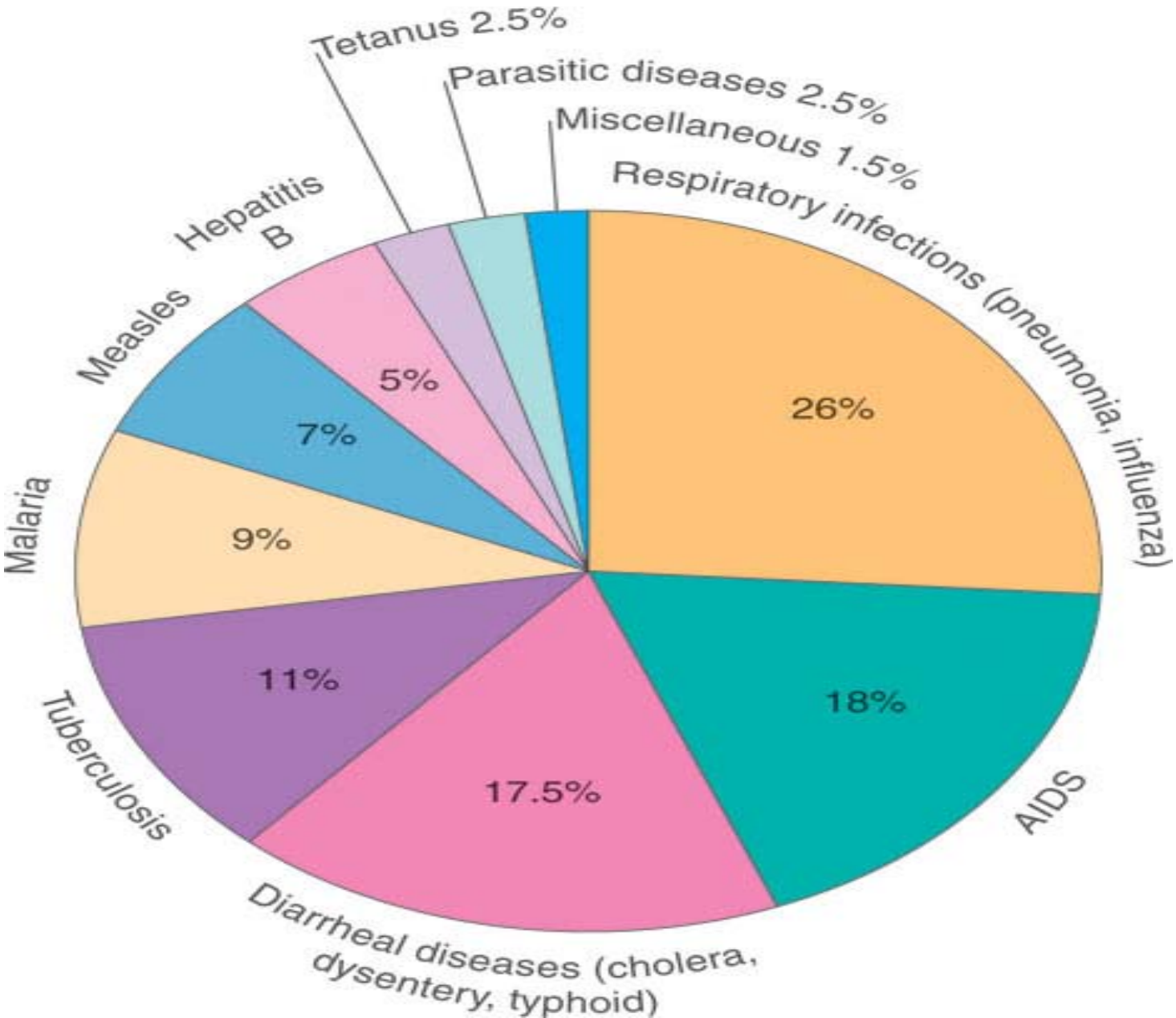
Pure culture and identification procedures



Diseases and Syndromes

- Infectious diseases and syndromes
  - A disease transmitted only by contact and caused by an infectious agent
- Noninfectious or Chronic diseases
  - Symptoms are not transmissible and usually not caused by a microbe
    - Osteoarthritis
  - Chronic disease caused by an infectious agent after the agent is absent
    - Lyme disease

World-wide Infection Rates

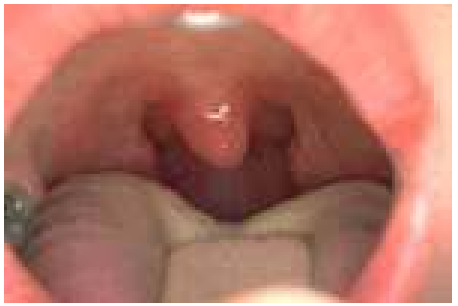


Disease Pathology

- Pathology is tissue damage and inflammation
  - Pathology causes symptoms
- Pathology terms relating to specific tissues or organs not relating to the cause
  - Pneumonia – lungs
  - Hepatitis – liver
  - Dermatitis - skin
  - Meningitis – menninges
  - Gingivitis - gums
  - Arthritis - joints

Bacterial Diseases & Agents

- Pharyngitis - Strep throat
  - *Streptococcus pyogenes*
  - Flesh-eating forms



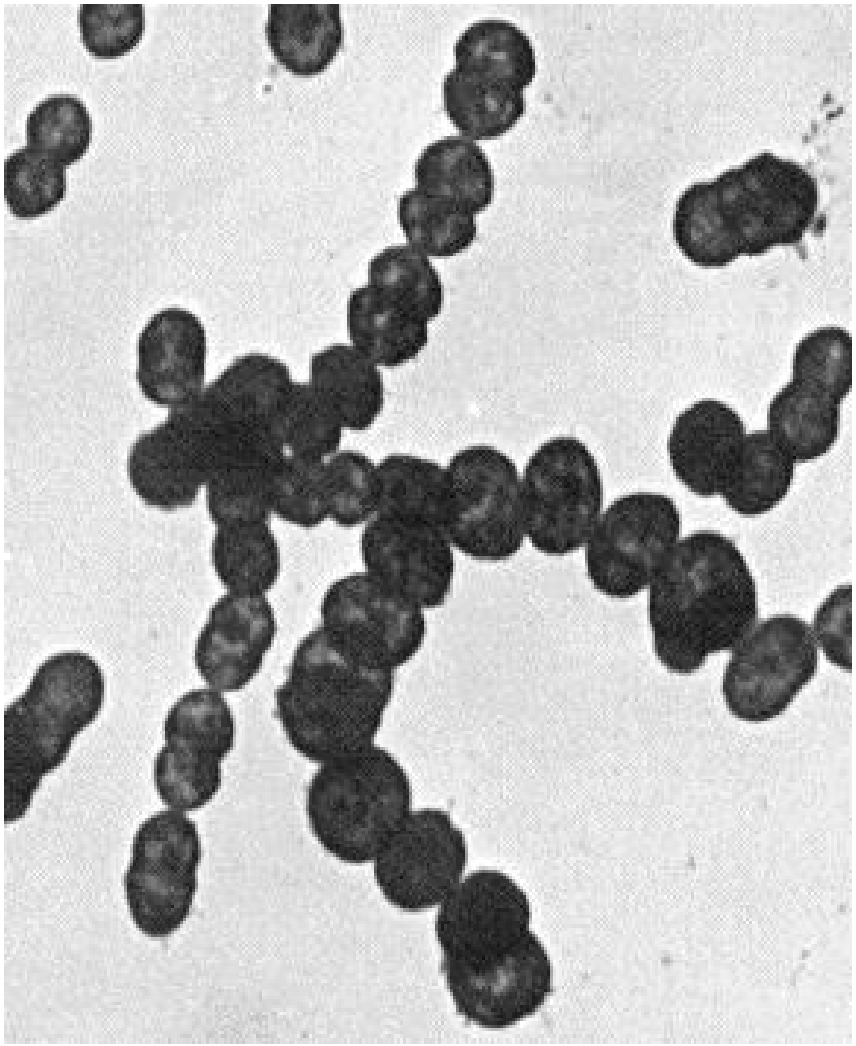
- Gangrene
  - *Clostridium difficule*

- Bubonic or Black plague
  - *Yersinia pestis*

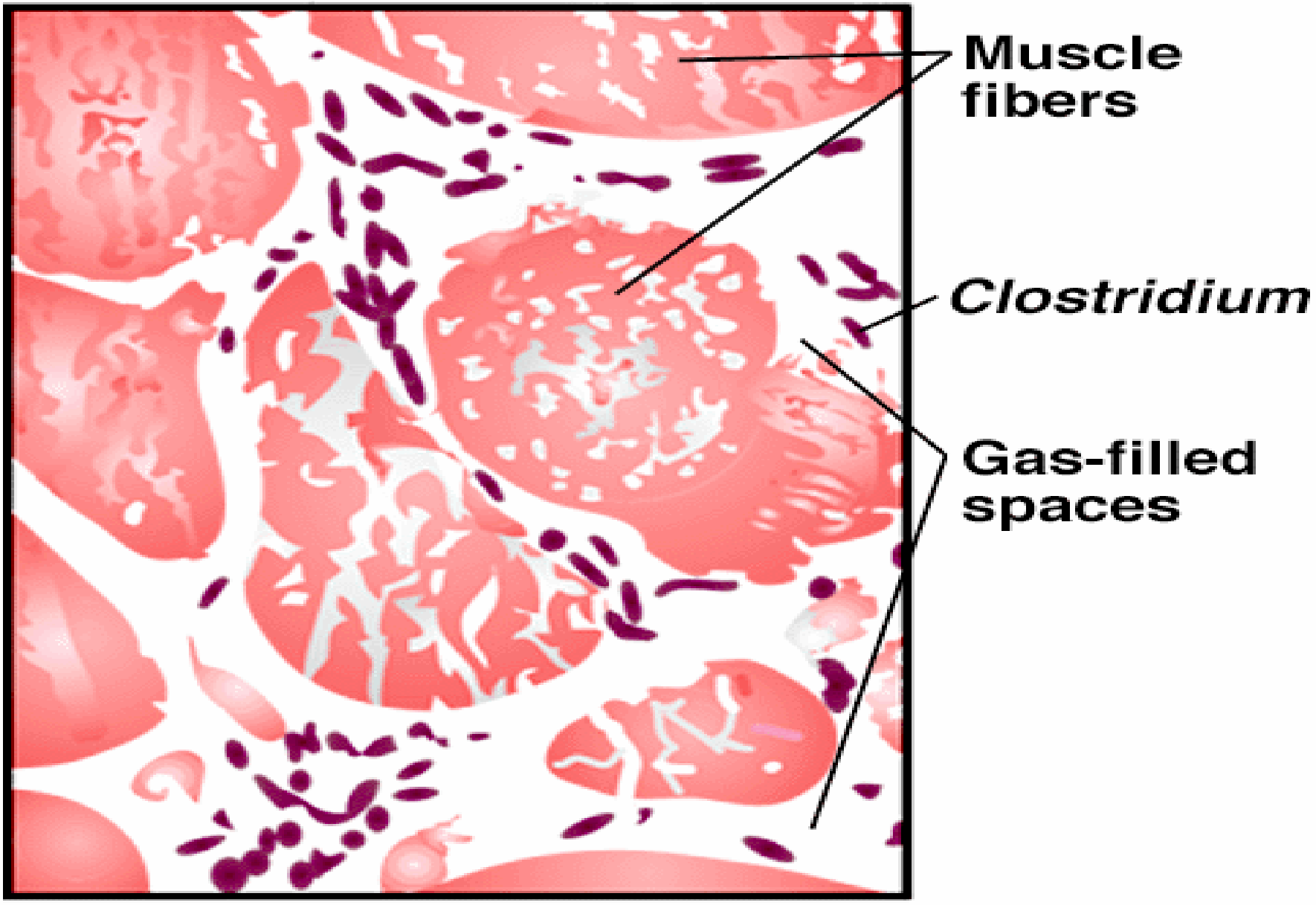
Streptococcus pyogenes photos

Strept chains on human cell

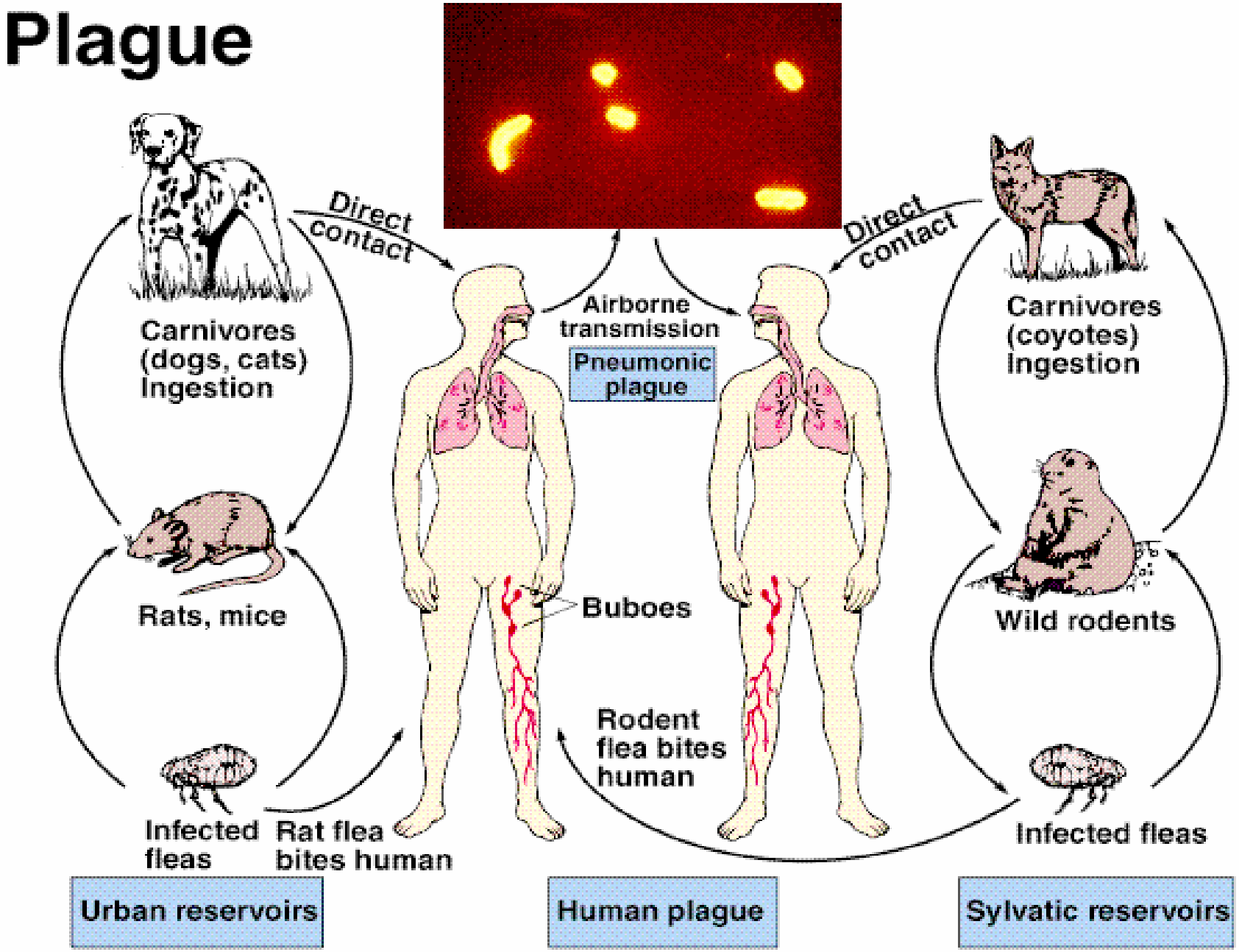
Strept chains close up



Clostridial myonecrosis pathology image



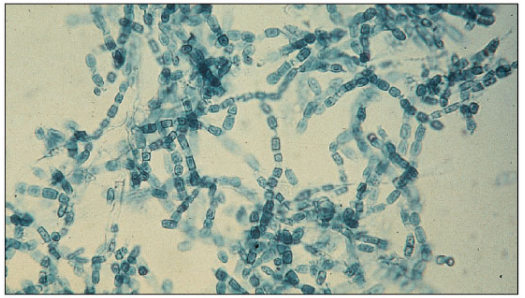
Bubonic plague image



Fungal Diseases & Agents

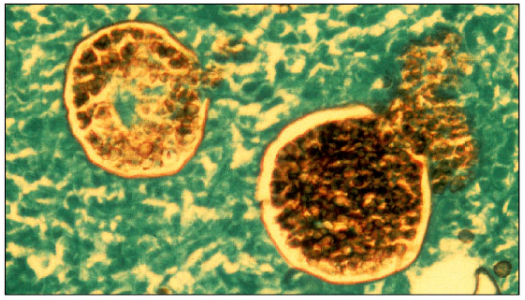
- Valley fever
  - Caused by *Coccidiodies immitis*
  - Flu-like symptoms
  - Spread by inhalation of soil & dust

- Athletes foot, Jock itch
  - Caused by dermatophytes (mold)
    - *Dermophyton or Tricophyton*
  - Symptoms include rash &itching



(a)

20 µm



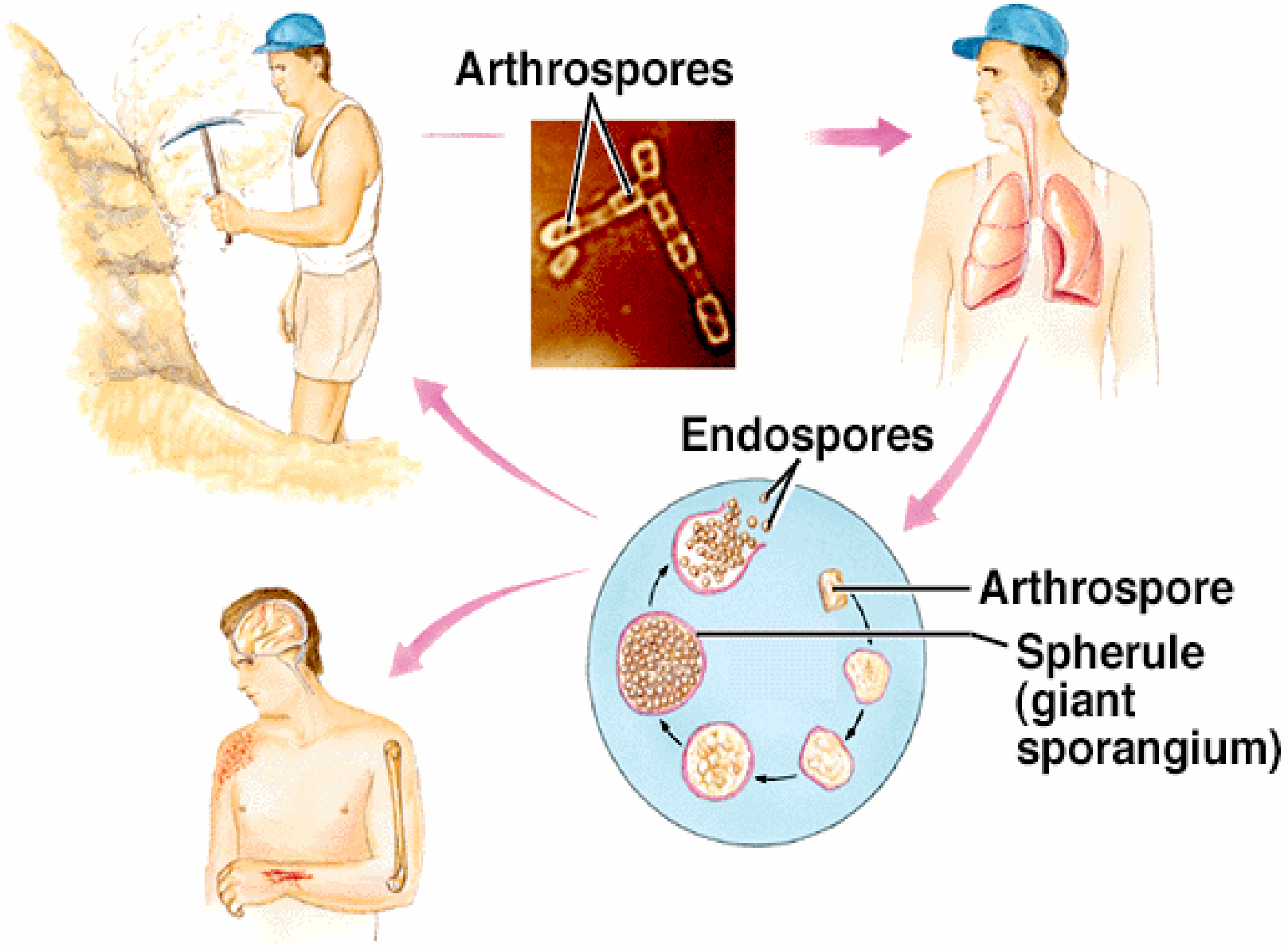
(b)

(a)

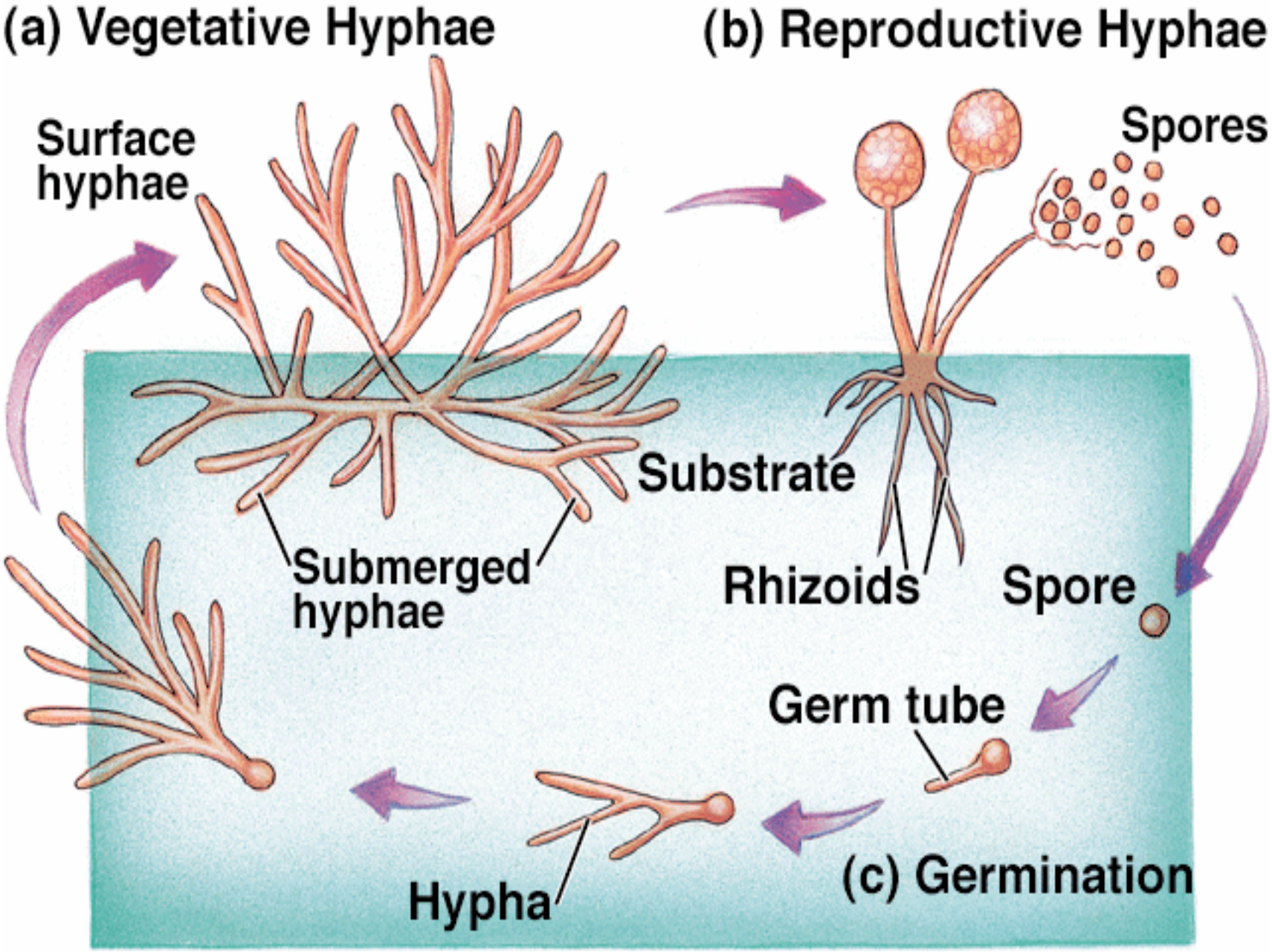
(b)

20 µm

Coccidiomycosis image



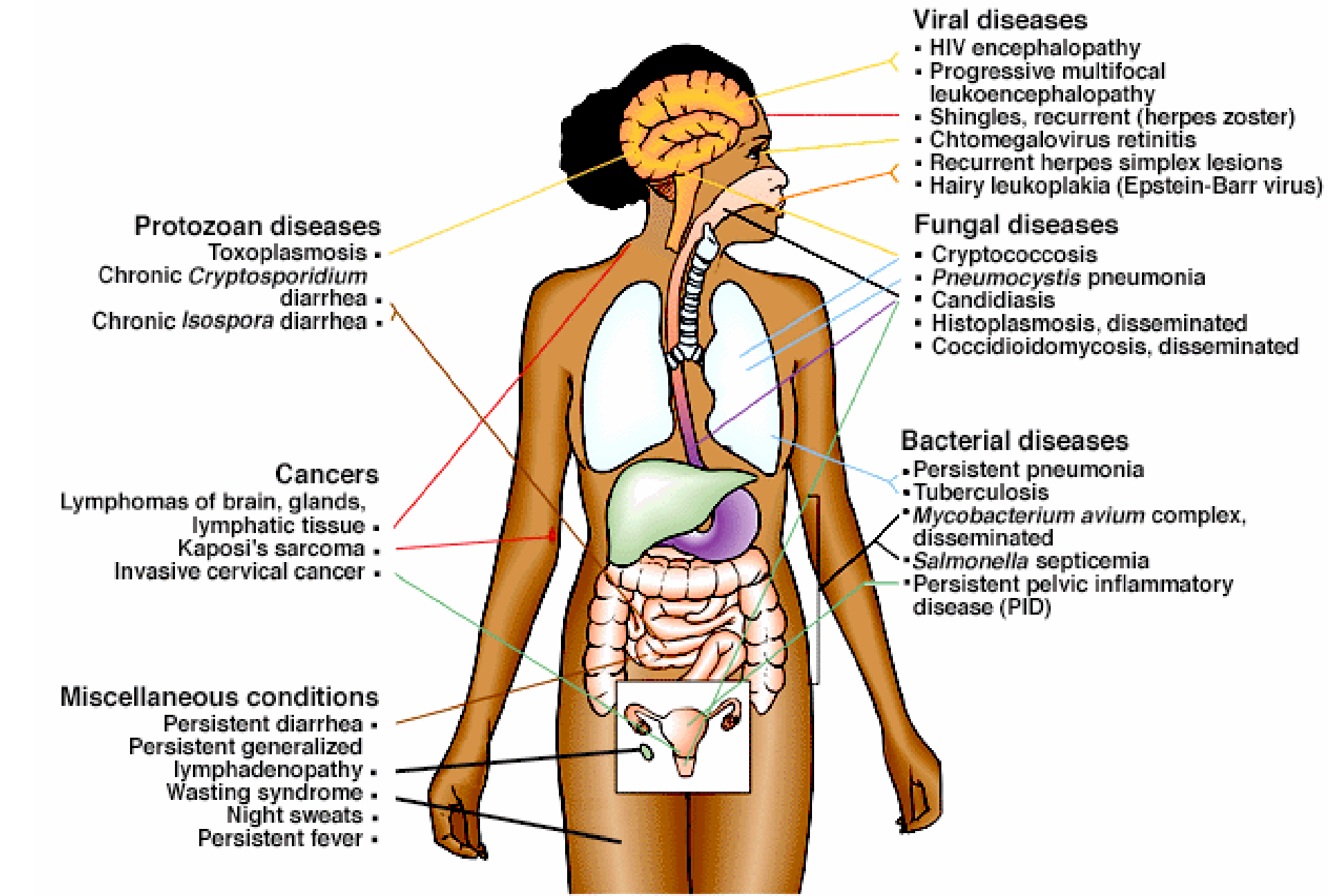
Mold growth on host image



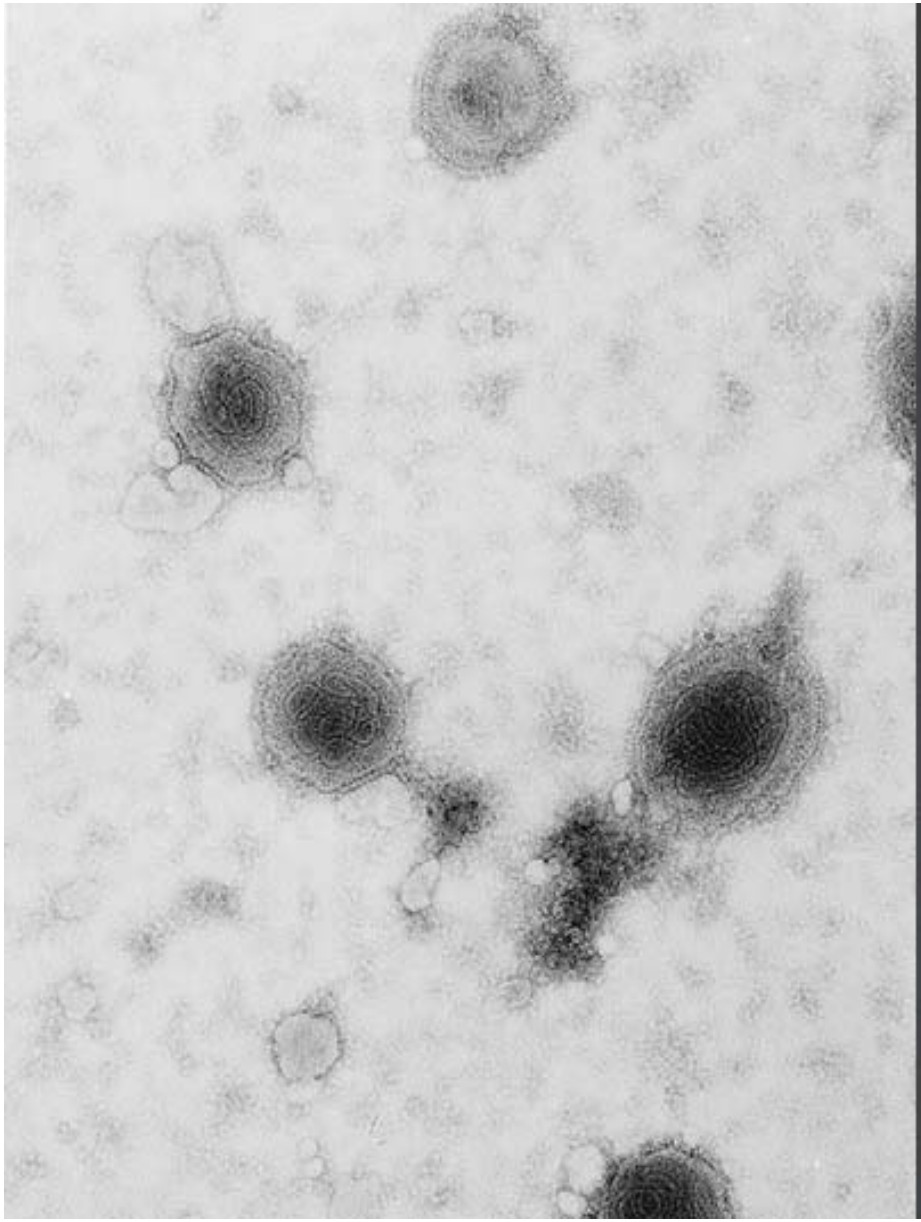
Viral Diseases & Agents

- Colds
  - *Rhinovirus*
- Severe Acute Respiratory Syndrome
  - *Coronavirus*
- AIDS
  - Human Immunodeficiency Virus (HIV)
  - Retrovirus (RNA→DNA)
- Childhood Measles (red rash)
  - *Rubeola* virus

AIDS image


Viral diseases
HIV encephalopathy
Progressive multifocal leukoencephalopathy
Shingles, recurrent (herpes zoster)
Chtomegalovirus retinitis
Recurrent herpes simplex lesions
Hairy leukoplakia (Epstein-Barr virus)
Protozoan diseases
Toxoplasmosis
Chronic Cryptosporidium diarrhea
Chronic Isospora diarrhea
Fungal diseases
Cryptococcosis
Pneumocystis pneumonia
Candidiasis
Histoplasmosis, disseminated
Coccidioidomycosis, disseminated
Cancers
Lymphomas of brain, glands, lymphatic tissue
Kaposi's sarcoma
Invasive cervical cancer
Bacterial diseases
Persistent pneumonia
Tuberculosis
Mycobacterium avium complex, disseminated
Salmonella septicemia
Persistent pelvic inflammatory disease (PID)
Miscellaneous conditions
Persistent diarrhea
Persistent generalized lymphadenopathy
Wasting syndrome
Night sweats
Persistent fever

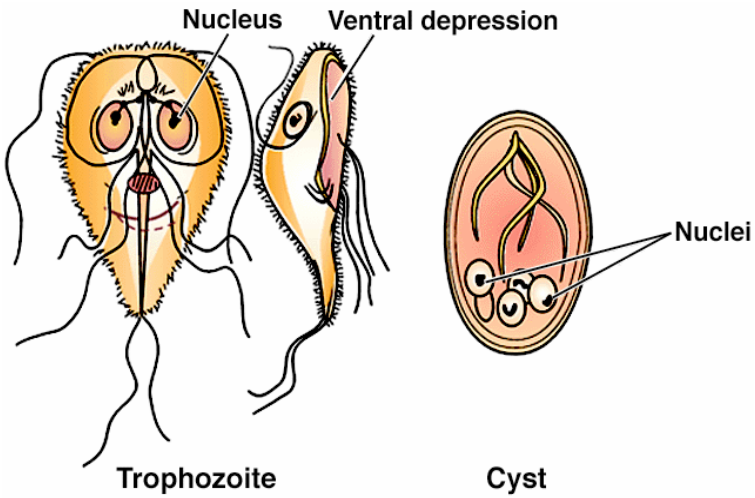
Rubeola photo



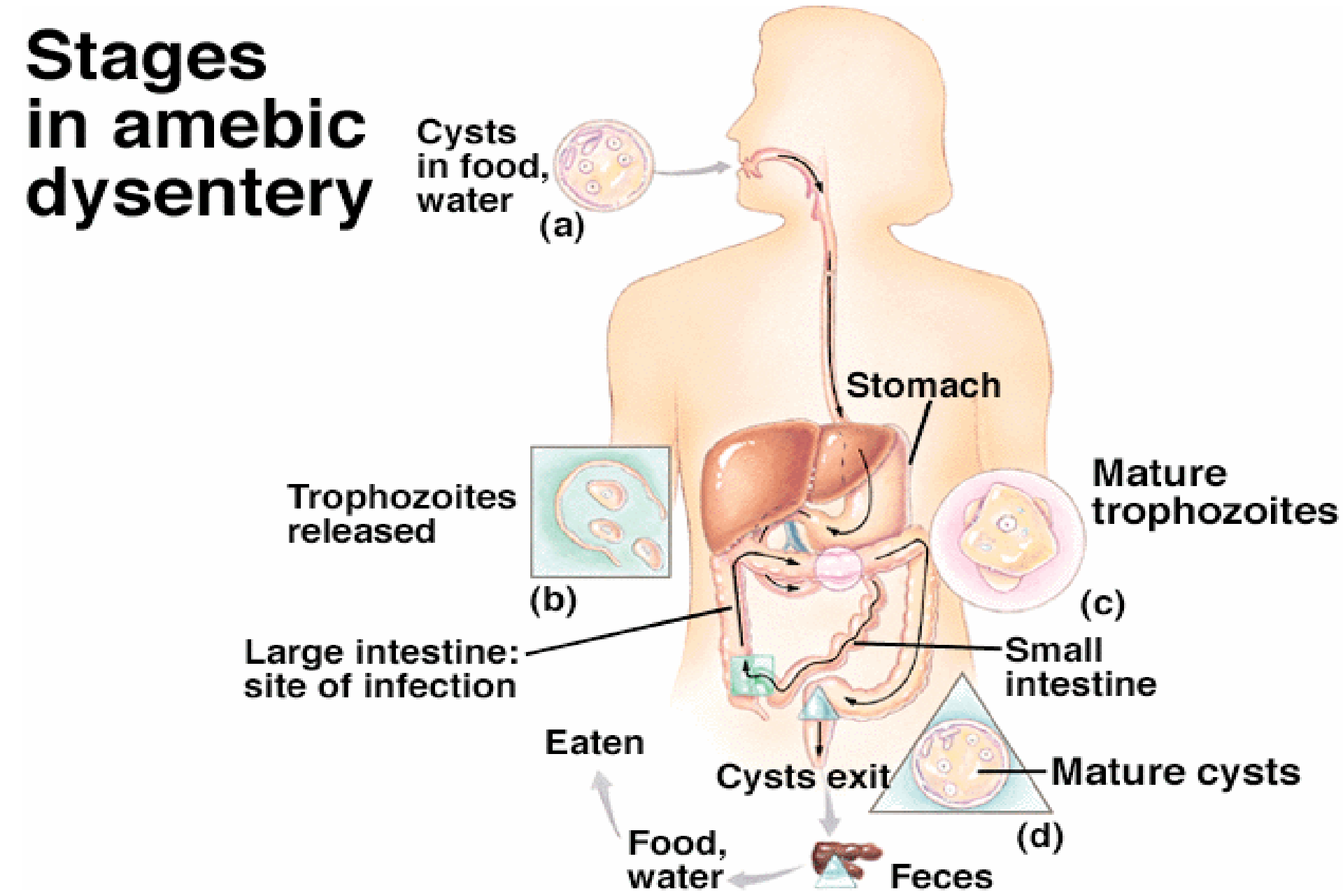
Protozoal Diseases & Agents

- Dysentery
  - *Entamoeba histolytica*
  - Ingested cysts produce trophozoites
  - Diarrhea and abdominal pain
  - Fecal contaminated food or water

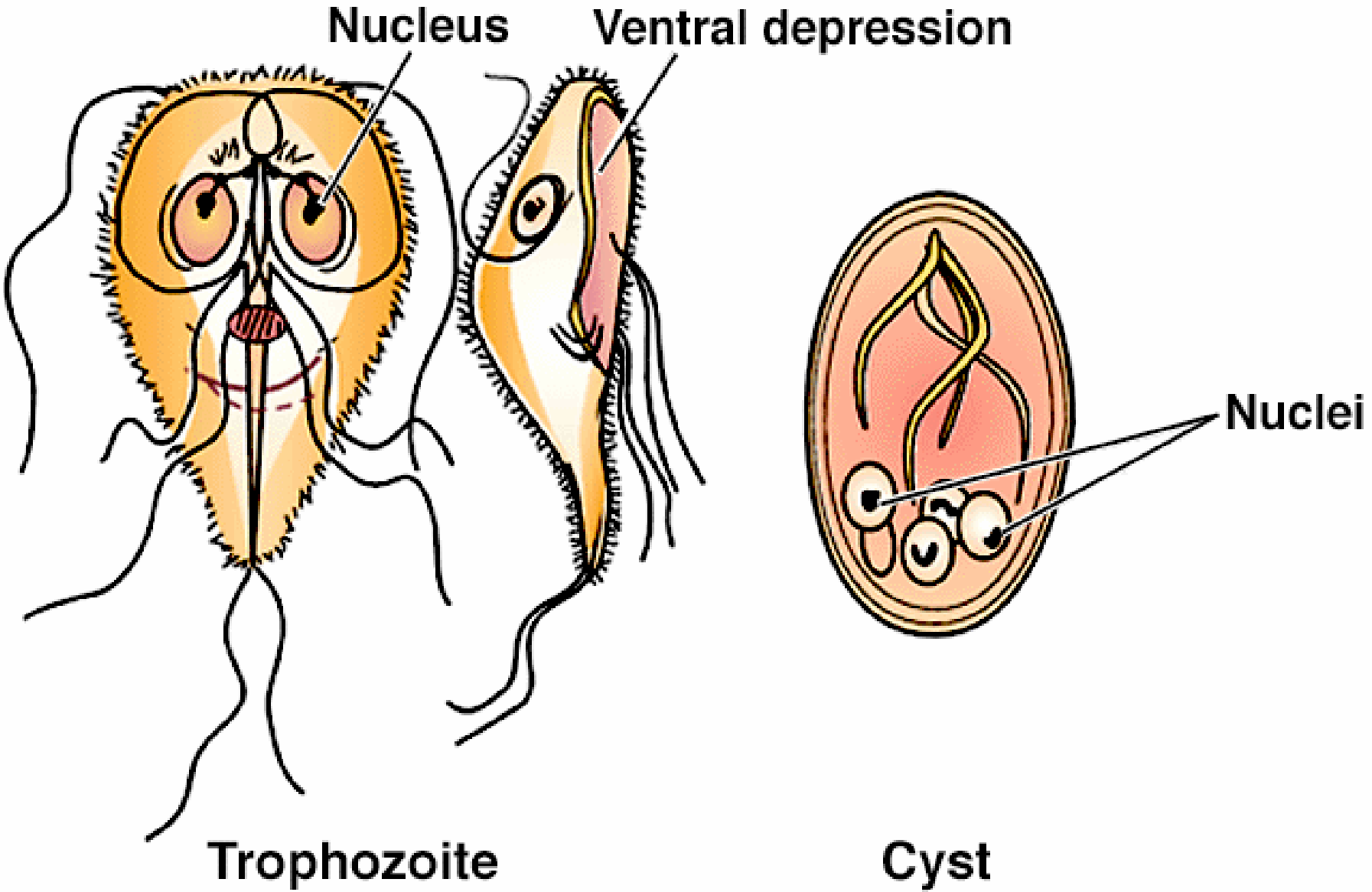
- Giardiasis
  - *Giardia lamblia*
  - Ingested cysts produce trophozoites
  - Vomiting & diarrhea
  - Fecal contaminated water



Amebic dysentery image

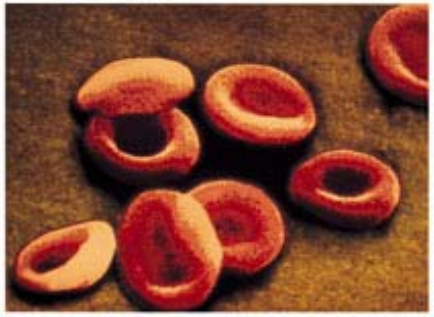


Giardia lamblia image



Helminths or Worm Diseases & Agents

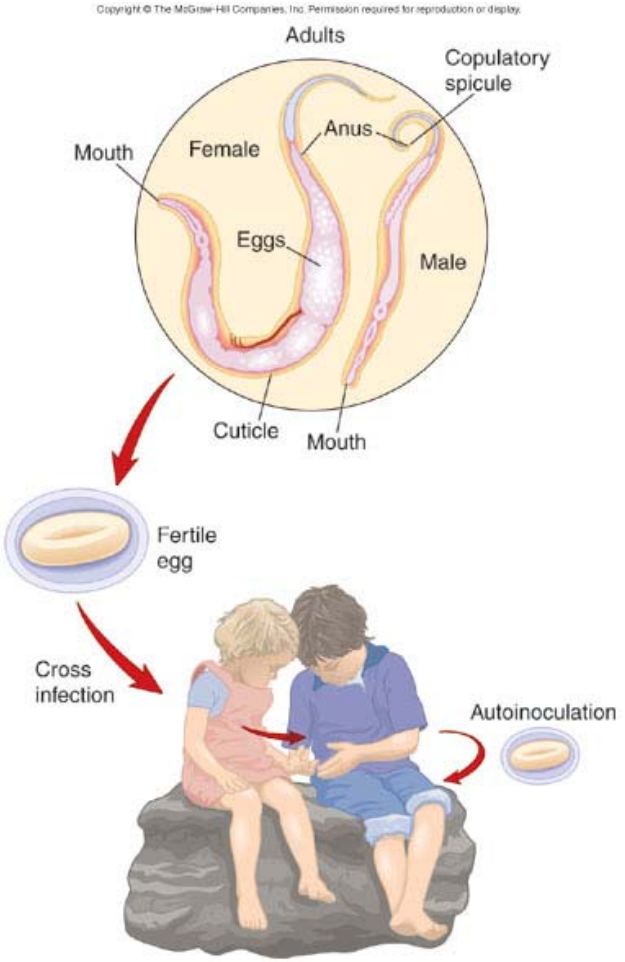
- **Malaria**
  - *Plasmodium*
  - Violent chills & fever
  - Red blood cells rupture
  - Carried by mosquito vector



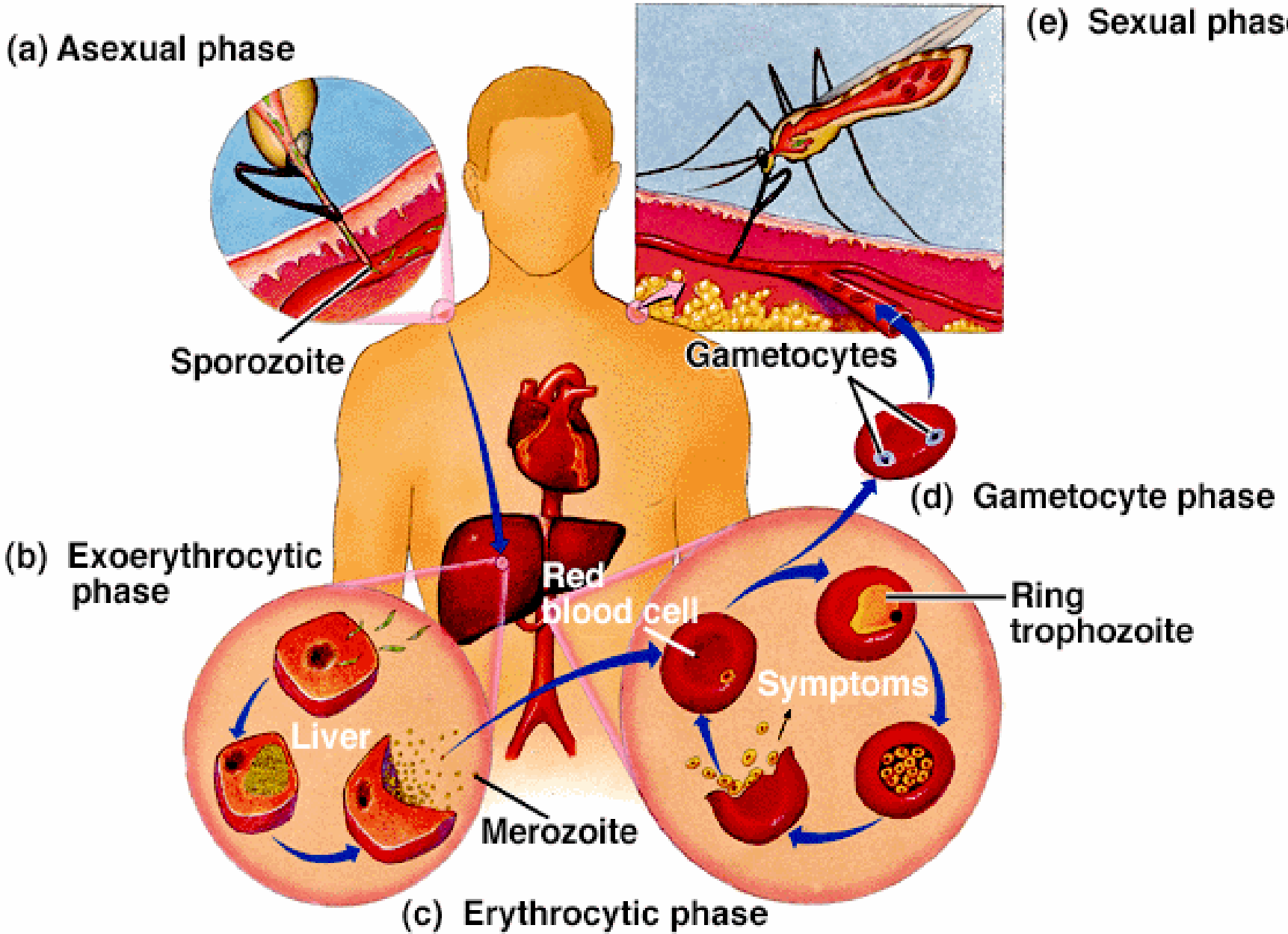
10 µm
normal red blood cells

2 µm
sickled red blood cells

- **Pinworm**
  - *Enterobius*



Plasmodium life cycle image



Enterobius infection cycle image