

Micro 280 Introduction

- Microorganisms
 - Bacteria
 - Archaea
 - Fungi (mycology)
 - Molds and yeasts
 - Protozoans (Parasitology)
 - Microscopic Algae
 - Viruses

Naming and Classifying Microorganisms

- 1735: Linnaeus established the binomial system of scientific nomenclature.
- Each organism has two names: the genus and specific epithet.

Classification

- Aristotle: all organisms into Plant or Animal Kingdoms
- 1866: new Kingdom, Protista, for bacteria, fungi, protozoans, algae
- Early 1940s: Electron microscope led to classification into prokaryotic and eukaryotic organisms

Scientific names

- *Staphylococcus aureus*
 - Describes the clustered arrangement of the cells (staphylo-) and the golden color of the colonies
- *Saccharomyces cerevisiae*
 - Saccharo (sugar) myces (fungi) cerevisiae (beer)
- *Escherichia coli*
 - Escherich (scientist that discovered it) coli (colon)

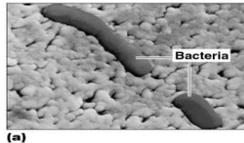
Classification of Microorganisms

- Three domains
 - Bacteria
 - Archaea
 - Eukarya
 - Protozoans
 - Fungi
 - Plants
 - Multicell Animals
 - Parasitic: flatworms and roundworms

- Prokaryotic cells:
 - Bacteria
 - Archaea
 - Cannot distinguish between microscopically, only chemically

BACTERIA

- Prokaryotes
- Peptidoglycan cell walls
- Binary fission
- Morphology
 - Cocci
 - Bacillus
 - Spiral



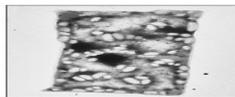
PROTOZOAN

- Eukaryotes
- Absorb or ingest organic chemicals
- May be motile via pseudopods, cilia, or flagella



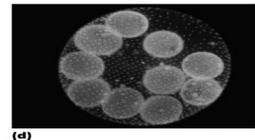
ARCHAEA

- Prokaryotic
- Lack peptidoglycan
- Live in extreme environments
- Include:
 - Methanogens
 - Extreme halophiles
 - Extreme thermophiles



ALGAE

- Eukaryotes
- Cellulose cell walls
- Use photosynthesis for energy
- Produce molecular oxygen and organic compounds



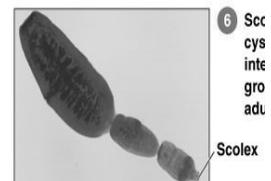
FUNGI

- Eukaryotes
- Chitin cell walls
- Use organic chemicals for energy
- Molds and mushrooms are multicellular consisting of masses of mycelia, which are composed of filaments called hyphae
- Yeasts are unicellular



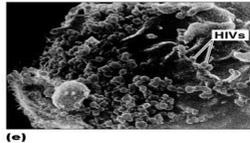
MULTICELLULAR ANIMAL PARASITES

- Eukaryote
- Multicellular animals
- Parasitic flatworms and round worms are called helminths.
- Microscopic stages in life cycles.



VIRUSES

- Acellular
- Consist of DNA or RNA core
- Core is surrounded by a protein coat
- Coat may be enclosed in a lipid envelope
- Viruses are replicated only when they are in a living host cell: Obligate intracellular parasite
- Inert outside of host



The Debate over Spontaneous Generation

- The hypothesis that living organisms arise from nonliving matter is called spontaneous generation. According to spontaneous generation, a “vital force’ Forms life.
- The Alternative hypothesis, that the living organisms arise from preexisting life, is called biogenesis.

Other Non-living infectious agents

- Viroid: cause of plant disease
 - Very small
 - RNA only; no protein coat
 - Obligate intracellular
- Prions: infectious proteins
 - causes serious fatal neurological disease:
 - Bovine spongiform encephalopathy
 - Creutzfeldt-Jakob (CJD)

1668: Francisco Redi filled six jars with decaying meat.

Conditions	Results
3 jars covered with fine net	No maggots
3 open jars	Maggots appeared

From where did the maggots come?
What was the purpose of the sealed jars?
Spontaneous generation or biogenesis?

History of Microbiology

Microscope

- In 1665, Robert Hooke reported that living things were composed of little boxes or cells.
- 1673-1723, Antoni van Leeuwenhoek described live microorganisms that he observed in teeth scrapings, rain water, and peppercorn infusions.
- Zaccharias Janssen: spectacle maker

1745: John Needham put boiled nutrient broth into covered flasks.

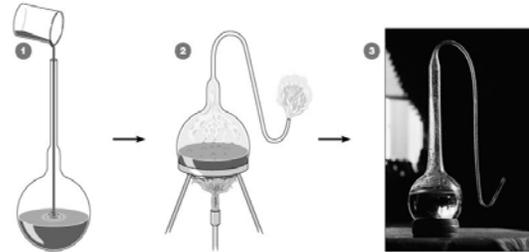
Conditions	Results
Nutrient broth heated, then placed in sealed flask	Microbial growth

From where did the microbes come?
Spontaneous generation or biogenesis?

1765: Lazzaro Spallanzani boiled nutrient solutions in flasks.

Conditions	Results
Nutrient broth placed in flask, heated, then sealed	No microbial growth
<i>Spontaneous generation or biogenesis?</i>	

Pasteur's S-shaped flask kept microbes out but let air in.



- 1858: Rudolf Virchow
 - Concept of biogenesis: living cells arise only from pre-existing cells

Golden Age of Microbiology

- 1857-1914
- Beginning with Pasteur's work, discoveries included the relationship between microbes and disease, immunity, and antimicrobial drugs
- Pasteur showed that microbes were responsible for fermentation (conversion of sugar to alcohol) and food spoilage.

1861: Louis Pasteur demonstrated that microbes are present in the air.

Conditions	Results
Nutrient broth placed in flask, heated, not sealed	Microbial growth
Nutrient broth placed in flask, heated, then sealed	No microbial growth
<i>Spontaneous generation or biogenesis?</i>	

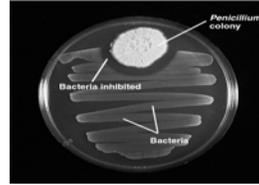
Fermentation and Pasteurization

- Pasteur demonstrated that these spoilage bacteria could be killed by heat that was not hot enough to evaporate the alcohol in wine. This application of a high heat for a short time is called pasteurization.

Germ Theory

- 1835: Agostino Bassi showed a silkworm disease was caused by a fungus.
- 1865: Pasteur believed that another silkworm disease was caused by a protozoan.
- 1840s: Ignaz Semmelweis advocated handwashing to prevent transmission of puerperal fever from one OB patient to another.
- 1860s: Joseph Lister used a chemical disinfectant to prevent surgical wound infections after looking at Pasteur's work showing microbes are in the air, can spoil food, and cause animal diseases.
- 1876: Robert Koch provided proof that a bacterium causes anthrax and provided the experimental steps, Koch's postulates, used to prove that a specific microbe causes a specific disease.

Antibiotics



- 1928: Alexander Fleming discovered the first antibiotic.
- He observed that *Penicillium* fungus made an antibiotic, penicillin, that killed *S. aureus*.
- 1940s: Penicillin was tested clinically and mass produced.

Vaccination

- 1796: Edward Jenner inoculated a person with cowpox virus. The person was then protected from smallpox.
- Called vaccination from *vacca* for cow
- The protection is called immunity
- 1880: Pasteur discovered that avirulent strains can induce immunity to virulent strains

Modern Developments in Microbiology

- Using microbes
 - George Beadle and Edward Tatum showed that genes encode a cell's enzymes (1942)
 - Oswald Avery, Colin MacLeod, and Maclyn McCarty showed that DNA was the hereditary material (1944).
 - James Watson, Francis Crick (Rosalind Franklin) developed the model of structure and replication of DNA; double helix (1953)
 - Francois Jacob and Jacques Monod discovered the role of mRNA in protein synthesis (1961).

The Birth of Modern Chemotherapy

- Treatment with chemicals is chemotherapy.
- Chemotherapeutic agents used to treat infectious disease can be synthetic drugs or antibiotics.
- Antibiotics are chemicals produced by bacteria and fungi that inhibit or kill other microbes.
- Quinine from tree bark was long used to treat malaria.
- 1910: Paul Ehrlich developed a synthetic arsenic drug, salvarsan, to treat syphilis.
- 1930s: Sulfonamides were synthesized.

Modern Developments in Microbiology

- Immunology is the study of immunity. Vaccines and interferons are being investigated to prevent and cure viral diseases.
- The use of immunology to identify some bacteria according to serotypes (variants within a species) was proposed by Rebecca Lancefield in 1933.
- Recombinant DNA is DNA made from two different sources. In the 1960s, Paul Berg inserted animal DNA into bacterial DNA and the bacteria produced an animal protein.
- Recombinant DNA technology or genetic engineering involves microbial genetics and molecular biology.

Importance of Microorganisms

- Biological: maintain balance of living organisms and chemicals in environment
 - Basis of food chain; Photosynthesis; Recycle vital elements; Nitrogen fixation; Normal flora
- Commercial
 - Production of chemicals and foods; Enzyme products; Bioremediation (degrade environmental pollutants); Sewage treatment; Pest control

- Infectious Diseases
- When a pathogen overcomes the host's resistance, disease results.
- Emerging Infectious Diseases (EID): New diseases and diseases increasing in incidence

Modern Biotechnology and Genetic Engineering

- Biotechnology, the use of microbes to produce foods and chemicals, is centuries old.
- Genetic engineering is a new technique for biotechnology. Through genetic engineering, bacteria and fungi can produce a variety of proteins including vaccines and enzymes.
- Missing or defective genes in human cells can be replaced in gene therapy.
- Genetically modified bacteria are used to protect crops from insects and freezing.

- West Nile encephalitis
 - West Nile Virus
 - First diagnosed in the West Nile region of Uganda in 1937.
 - Appeared in New York City in 1999.
- Bovine Spongiform Encephalopathy
 - Prion
 - Also causes Creutzfeldt-Jakob disease (CJD)
 - New-variant CJD in humans related to cattle fed sheep offal for protein.

Normal Microbiota(Normal Flora)

- Normal microbiota prevent growth of pathogens.
- Normal microbiota produce growth factors such as folic acid and vitamin K.
- Resistance is the ability of the body to ward off disease.
- Resistance factors include skin, stomach acid, and antimicrobial chemicals.

- *Escherichia coli* O157:H7
 - Toxin-producing strain of *E. coli*
 - First seen in 1982
 - Leading cause of diarrhea worldwide.
- Invasive group A *Streptococcus*
 - Rapidly growing bacteria cause extensive tissue damage.
 - Increased incidence since 1995

- Ebola hemorrhagic fever
 - Ebola virus
 - Causes fever, hemorrhaging, and blood clotting
 - First identified near Ebola River, Congo
 - Outbreak every few years
- *Hantavirus* pulmonary syndrome
 - *Hantavirus*
 - First identified in 1951 in Korea as cause of hemorrhagic fever and named for Hantaan River
 - A new disease involving respiratory symptoms was seen in the U.S. in 1995
 - The U.S. virus, called *Hantavirus* Sin Nombre virus, probably came to the U.S. with rats around 1900

- Acquired immunodeficiency syndrome (AIDS)
 - Human immunodeficiency virus (HIV)
 - First identified in 1981.
 - Worldwide epidemic infecting 40 million people; 14,000 new infections everyday.
 - Sexually transmitted disease affecting males and females.
 - In the U.S., HIV/AIDS in people 13-24 years of age: 44% are female and 63% are African American.

- Anthrax
 - *Bacillus anthracis*
 - In 1877, Koch proved *B. anthracis* causes anthrax.
 - Veterinarians and agricultural workers are at risk of cutaneous anthrax.
 - In 2001, dissemination of *B. anthracis* via mail infected 22 people.