

Lecture- 3
Principles of Microbiology (Part-2)

Principles of Microbiology Content

1.1 Microbiology and Microorganisms

- The importance of microorganisms

1.2 Microbial Cells

- Cell chemistry and key structure
- Characteristics of living systems
- Cell functions: coding and metabolism.

1.3 Microorganisms and Their Environments

- Microbial interaction

1.4 The Impact of Microorganisms on Humans

- Microorganisms as disease agents
- Microorganisms and agriculture
- Microorganisms and food
- Microorganisms, energy and their environment
- Microorganisms and their genetic resources
- Microbiology as a career

1.3 Microorganisms and Their Environments

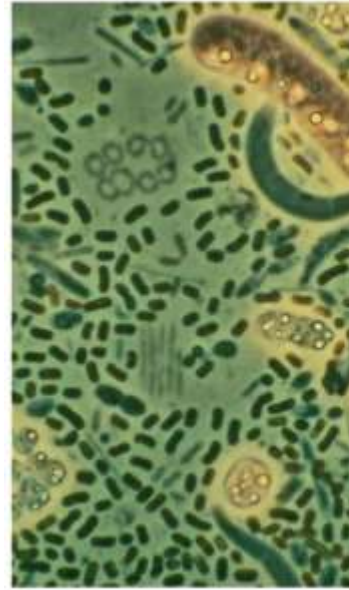
1. Microorganisms in nature live in populations of interacting assemblages called microbial communities.
2. A population is a group of cells derived from a single parental cell by successive cell divisions.
3. The environment in which a microbial population lives is its habitat
4. Ecosystem refers to all living organisms plus physical and chemical constituents of their environment (aquatic , terrestrial , other organisms such as plant)
5. Microbial ecology is the study of microbes in their natural environment

Different bacterial communities:

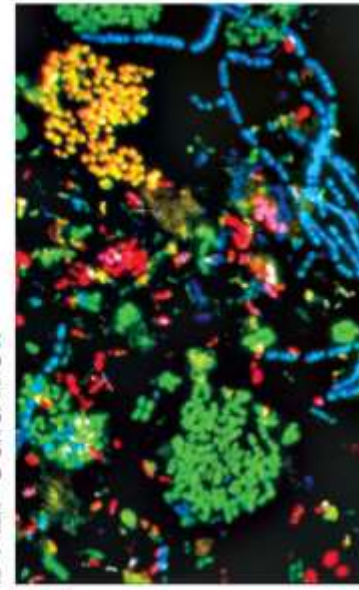
a)- from depth of small lake
showing cells of green and purple
phototrophic bacteria .

b)- sewage sludge sample .

c)- purple sulfur bacteria formed a
bloom .



D. E. Caldwell



Jiri Snaidr

(a)

(b)



Ricardo Guerrero

(c)

1.3 Microorganisms and Their Environments

1. **Diversity** and **abundances** of microbes are controlled by resources (nutrients , food) and environmental conditions (e.g., temperature , pH, O₂)
2. The activities of microbial communities can **affect** the chemical and physical properties of their habitats.

1.3 Microorganisms and Their Environments

Microbes also interact with their physical and chemical environment

- Ecosystems greatly influenced (if not controlled) by microbial activities
- Microorganisms change the chemical and physical properties of their habitats through their activities
 - For example, removal of nutrients from the environment and use them to build new cells
 - At the same time , they excrete waste products back into the environment.
- Microbial ecosystems expand and contract depending on the resources and conditions available.

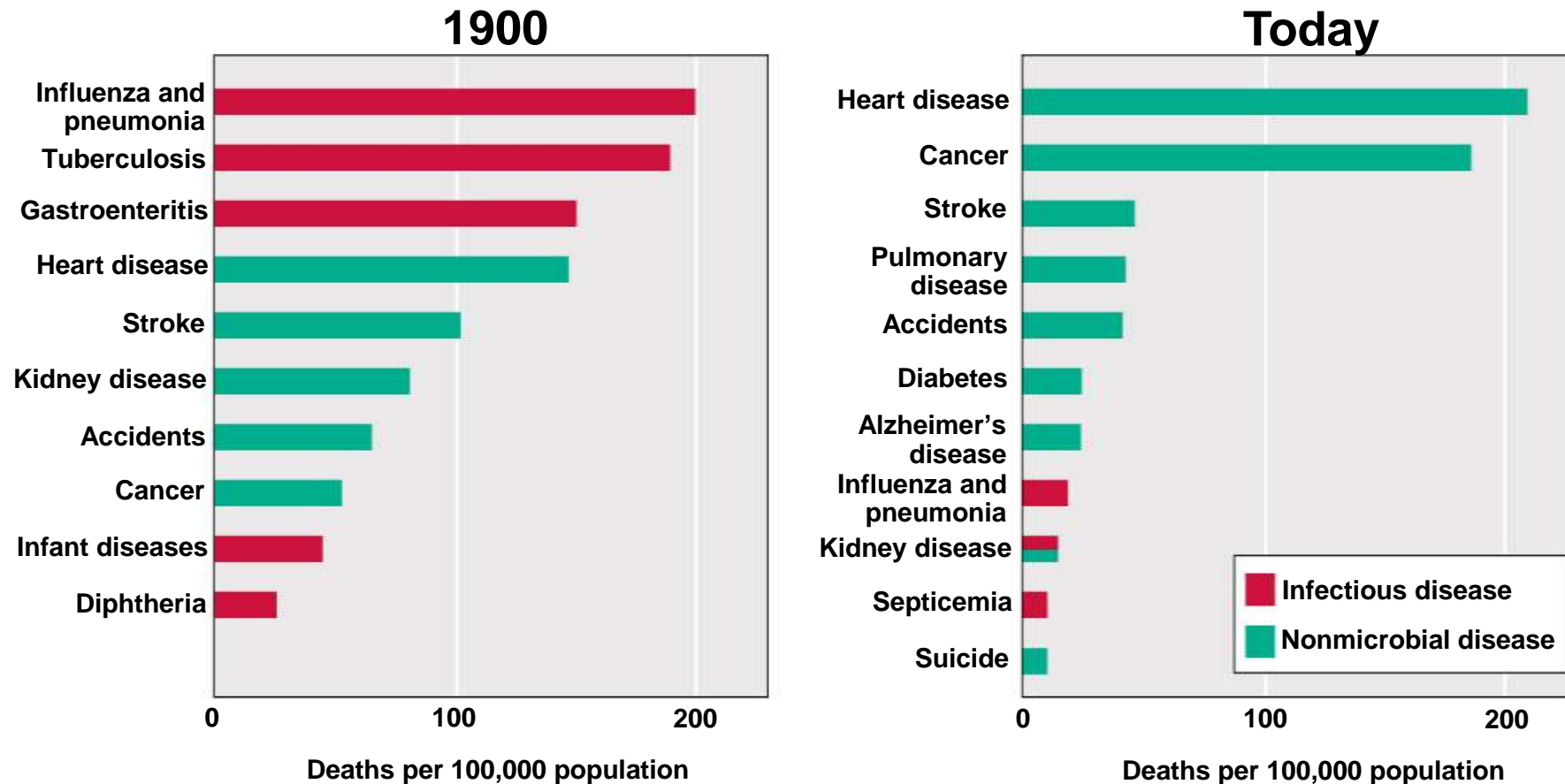
The Impact of Microorganisms on Humans

Microorganisms as disease agents

- Microorganisms can be both beneficial and harmful to humans
- Emphasis typically on harmful microorganisms (infectious disease agents which known as **pathogens**).
 - Pathogens pose a major threat to human's life in developing countries
 - **Some disease caused by microorganisms include:**
 - Malaria, tuberculosis, cholera, African sleeping sickness, measles, pneumonia and other respiratory diseases and diarrheal syndromes.
 - **Emerging infectious diseases** are of particular importance because they spread quickly
 - Such as Ebola, bird flu and **Middle East respiratory syndrome-related coronavirus (MERS-CoV)**
- Many more microorganisms are beneficial than are harmful
 - **Microbial flora:** In microbiology, collective bacteria and other microorganisms in a host are known as flora
 - **Normal microbiota:** The microorganisms that colonize a host without causing disease; also called normal flora.

The Impact of Microorganisms on Humans

Microorganisms as disease agents



The Impact of Microorganisms on Humans

Microorganisms and agriculture

Many aspects of agriculture depend on microbial activities. There are positive and negative impacts per as the following table:-

• Positive impacts

- 1) Microbes to fix chemical components in the soil (Nitrogen, Sulfate)
- 2) cellulose-degradation microbes in the rumen
- 3) regeneration of nutrients in soil and water



• Negative impacts

They can cause diseases in plants and animals plants and animals used for human food cause major economic losses in the agricultural industry .

Some details about the positive impacts of microbe in agriculture.

1. Microbes to fix chemical components in the soil (Nitrogen, Sulfate)

- Number of major crop plants are legumes which live in close association with bacteria that form a structure called nodules on their roots.
- In the root nodules , the bacteria convert atmospheric nitrogen N_2 into ammonia (NH_3) that the plants use as a nitrogen source for growth.
- These bacteria called a nitrogen -fixing bacteria such as Rhizobium.
- Other Bacteria cycle sulfur compounds , oxidizing toxic sulfur species such as hydrogen sulfide (H_2S) into sulfate SO_4^{2-} which is an essential plant nutrient.

2. cellulose-degradation microbes in the rumen

- Microorganisms that inhabit ruminant animals such as cattle ,sheep and goat play an important role also.
- These animals have a characteristic digestive vessel called **rumen** in which large populations of microorganisms digest and ferment cellulose , the major component of plant cell walls at **neutral** pH.
- Without these symbiotic microorganisms , cattle and sheep could not thrive on cellulose –rich food such as grass and hay

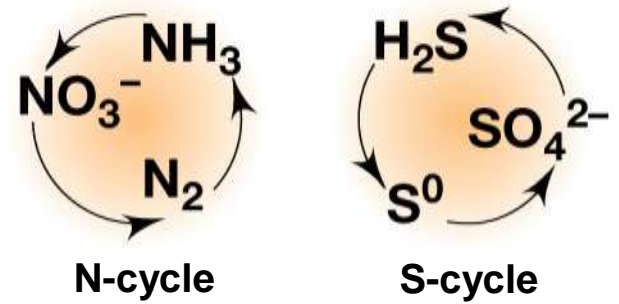
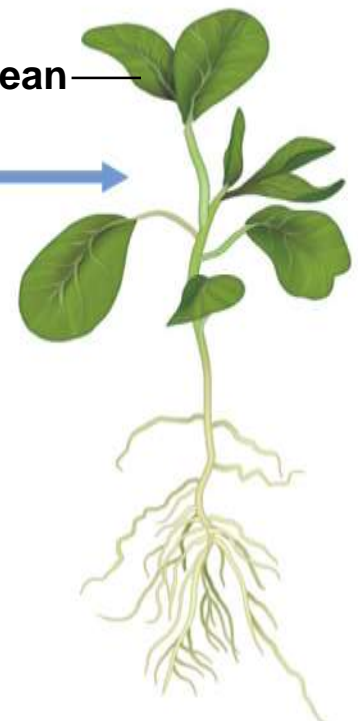
3. regeneration of nutrients in soil and water

As example:- Some microbes can make the decomposition of organic matter and mineralization of organic N, S, and P.



Joe Burton

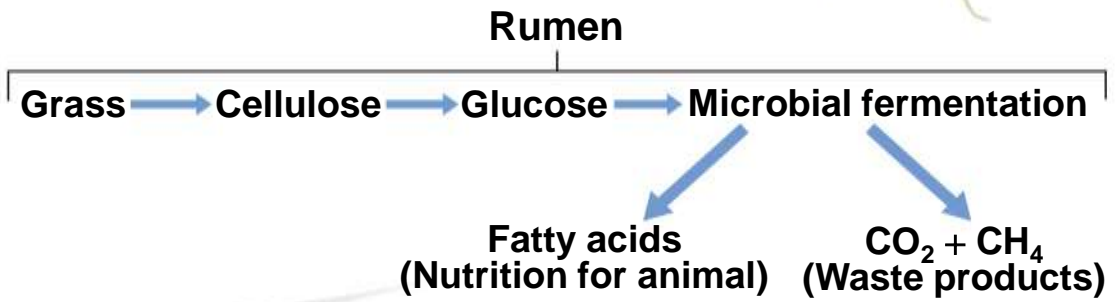
(a)



(c)



(d)



© 2012 Pearson Education, Inc.

The Impact of Microorganisms on Humans

Microorganisms and food

- Microorganisms and Food

- Negative impacts

- **Food spoilage** by microorganisms cause economical loss

- requires specialized preservation of many foods (canning , frozen and dried food)

- **Food poisoning** due to microbial contamination (*Salmonella* / *Escherichia coli* (*E.coli*))

- Requires constant monitoring to ensure food safety.

The Impact of Microorganisms on Humans

Microorganisms and food

- Microorganisms and Food

- **Positive impacts**

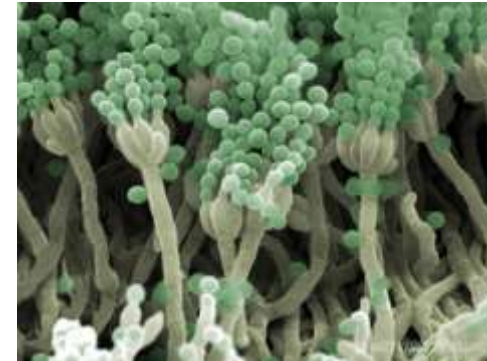
- Microbial transformations (typically fermentations) yield

- Many dairy products depend on the activities of microorganisms (e.g., cheeses, yogurt)

- Many baked goods rely on the fermentation activities of yeast which generate CO₂ to raise the dough .

- other food products (e.g., sauerkraut, pickles, leavened breads, vinegar)

The Impact of Microorganisms on Humans
Microorganisms and food (**NEGATIVE IMPACT**)

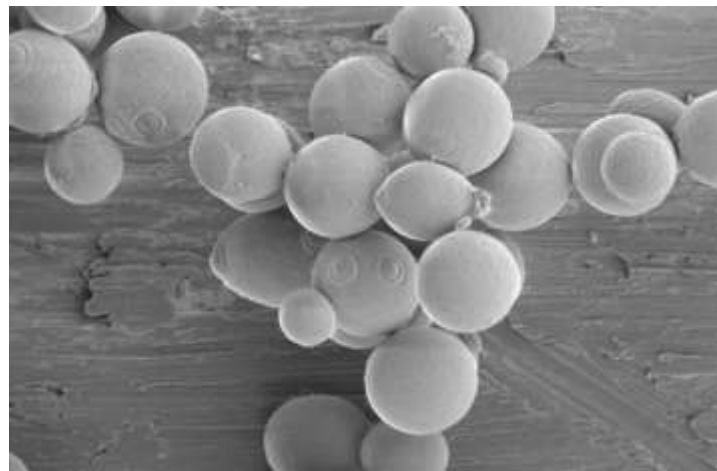


Penicillium sp.



Rhizopus sp.

The Impact of Microorganisms on Humans Microorganisms and food (**POSITIVE IMPACT**)

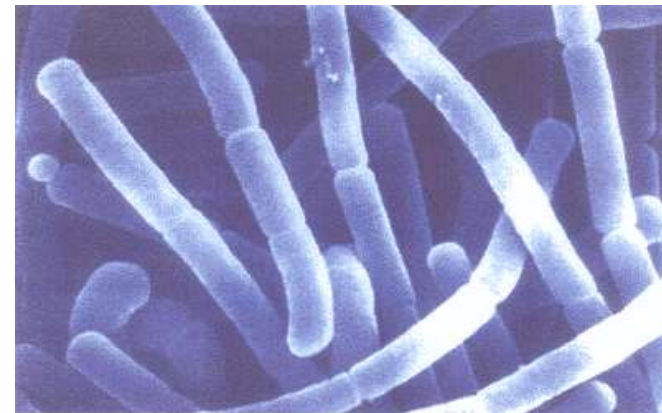
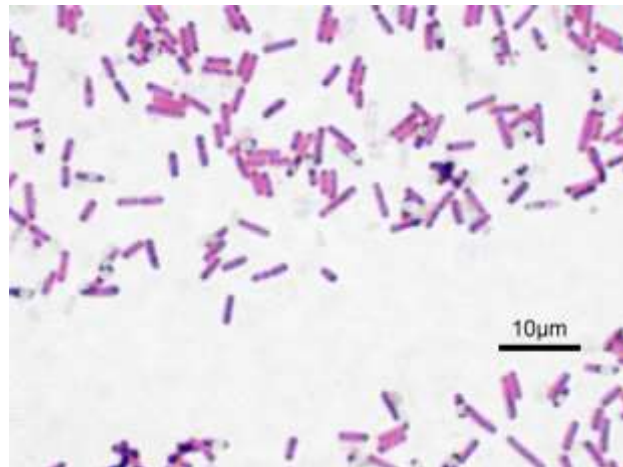


Saccharomyces cerevisiae

The Impact of Microorganisms on Humans
Microorganisms and food (**POSITIVE IMPACT**)



Lactobacillus delbrueckii subsp. *bulgaricus*



The Impact of Microorganisms on Humans

Microorganisms, Energy, and the Environment

❑ **The role of microbes in *biofuels* production . For example:**

- **methane** a natural gas , which is a product of anaerobic degradation of organic matter by methanogenic bacteria.
- **ethanol** , which is produced by microbial fermentation of glucose .

- ❑ **Industrial microbiology:** Growing microorganisms in large scales to make products of low commercial value. e.g. antibiotics and various chemicals (such as citric acid).

The Impact of Microorganisms on Humans

Microorganisms, Energy, and the Environment

□ The role of microbes in cleaning up pollutants (*bioremediation*).

- There are 2 ways:

- By introducing specific microorganisms to a polluted environment
- By adding nutrients that stimulate preexisting microorganisms to degrade the pollutants.

The Impact of Microorganisms on Humans Microorganisms, Energy, and the Environment

Oil spill –bioremediation
treatment



Sewerage spill –
bioremediation treatment



The Impact of Microorganisms on Humans

Microorganisms and Their Genetic Resources

Biotechnology employs **genetically engineered** microorganisms to generate products of high value to humans, such as insulin and human proteins.

Microbiology as a Career:

- Clinical medicine
- Research and development – pharmaceutical, chemical/biochemical, biotechnology
- Microbial monitoring in food and beverage industries, public health, government.

ANY
QUESTIONS
~

REMEMBER

You can always ask questions through our discussion board on
www.lms.ksu.edu.sa