



Microbiology

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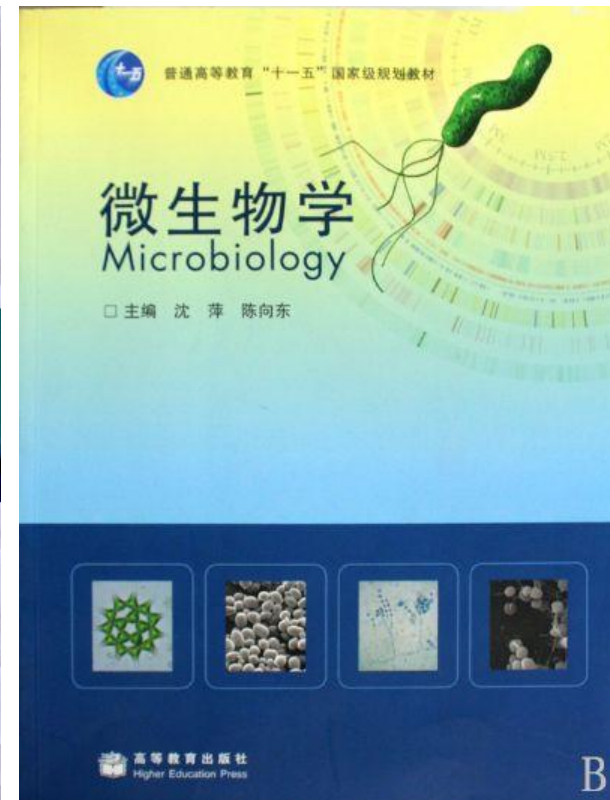
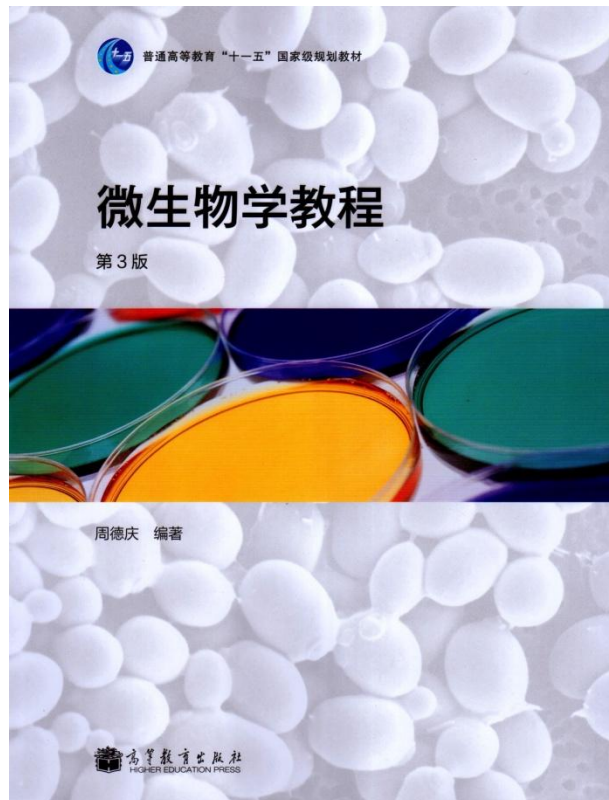
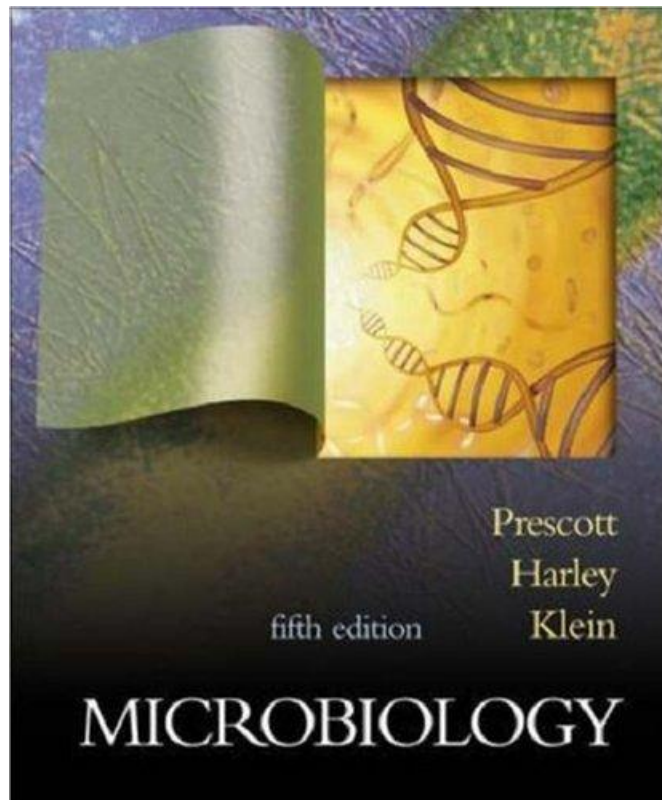
Arrangements

- **Lecture (50 hours)**
- **Laboratory practice (25 hours)**

Evaluation

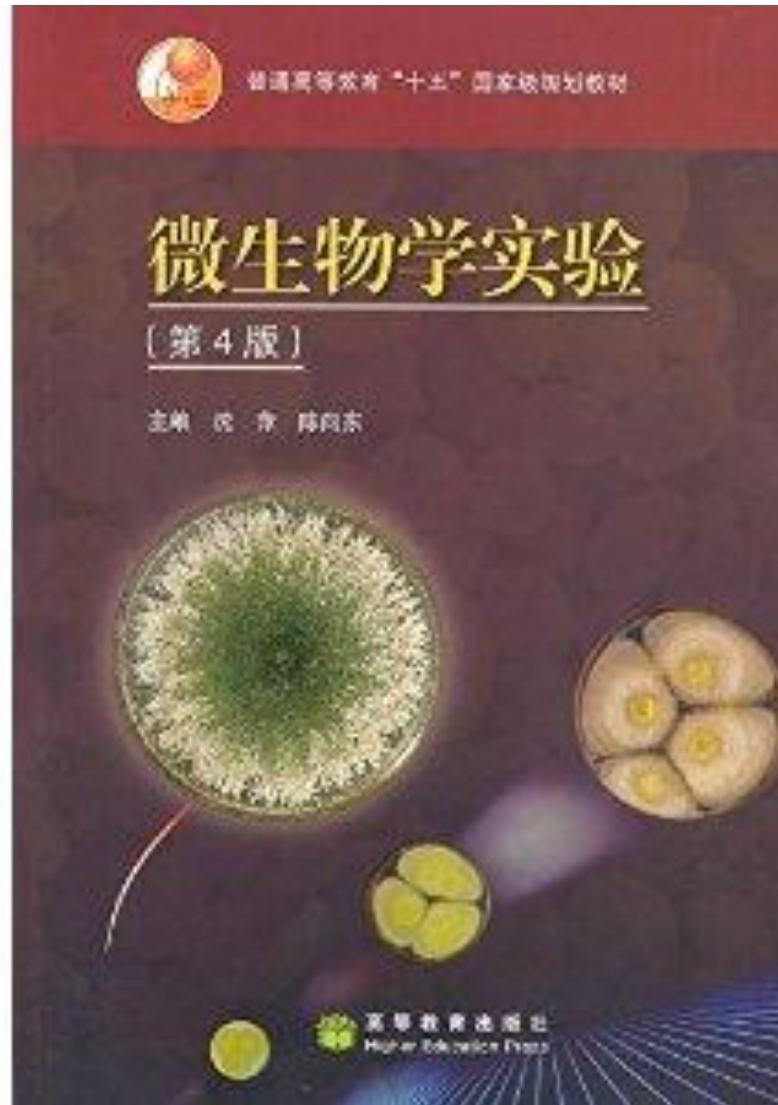
- **Participation**
- **Oral presentation**
- **Assignment**
- **Mid-term examination**
- **Laboratory work**
- **Final examination**

Further reading



<http://foodsfx.ujes.edu.cn/cuihenglin/>

Further reading



Acknowledgement

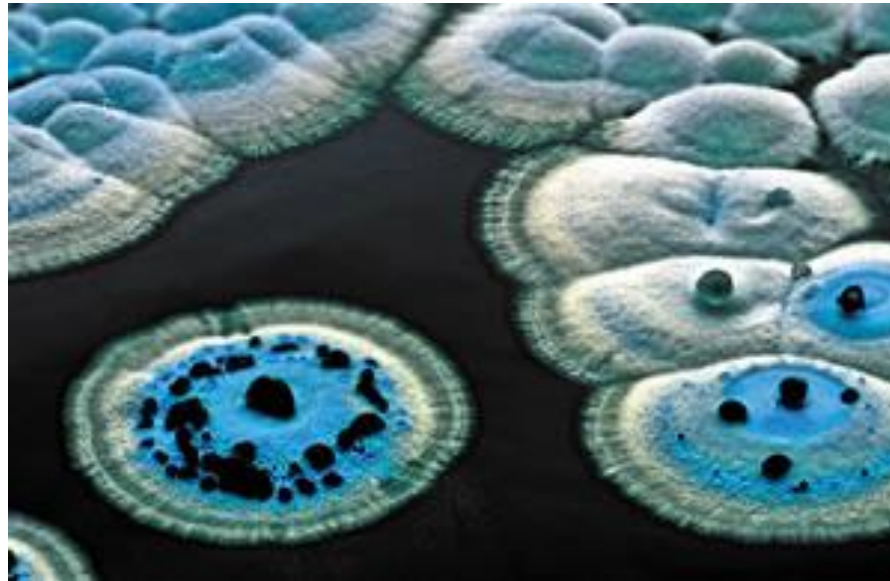
- Most of the pictures and animations are from:
 - BioL 230 Lecture Guide
 - Microbiology, Prescott, L.M., Harley, J.P., Klein, D.A. 2002, McGrawHill
 - Google searching.

Contacts

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Chapter 1

The History and Scope of Microbiology



1.1 Microbes around us



- Our world is populated by invisible creatures too small to be seen with the unaided eye. These life forms, the microbes or microorganisms, may be seen only by magnifying their image with a microscope.

Fungus



catterpillar fungus



catterpillar fungus



coral fungus

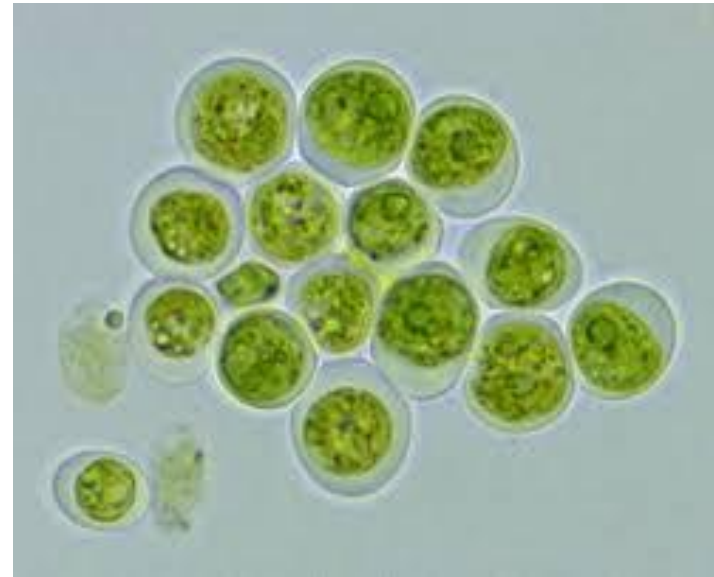


Jew's ear

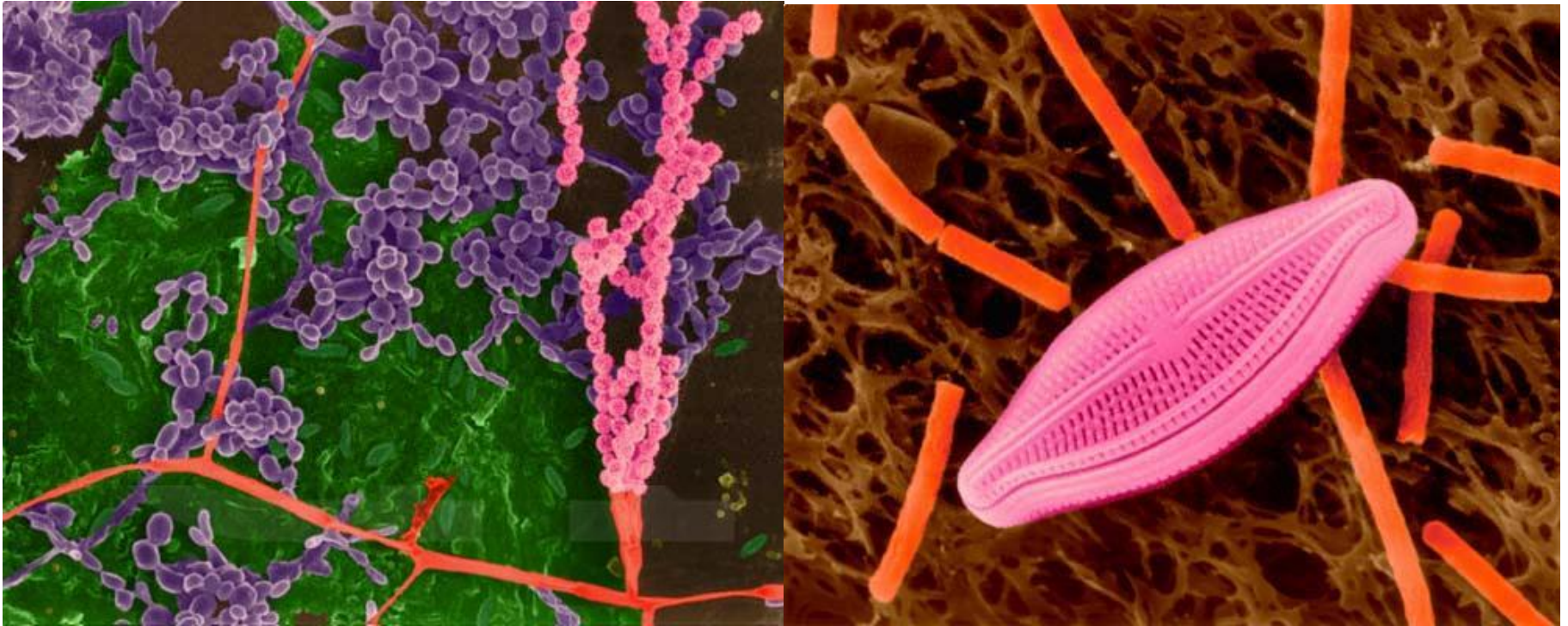
Slime mold



Unicellular algae



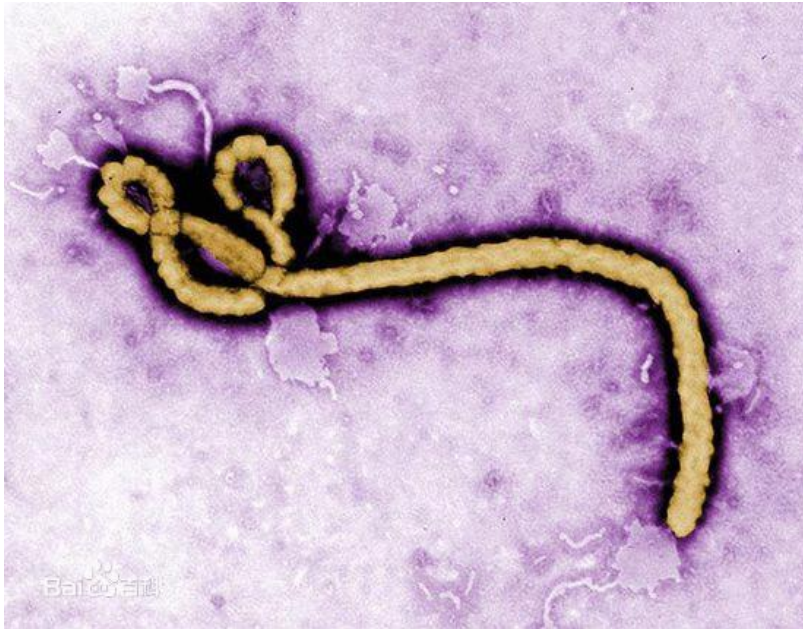
Bacteria



Plastic cutting board surface

**Fresh water pennate diatom frustule
(*Navicula* spp.)
and *Bacillus megaterium* ×1,450**

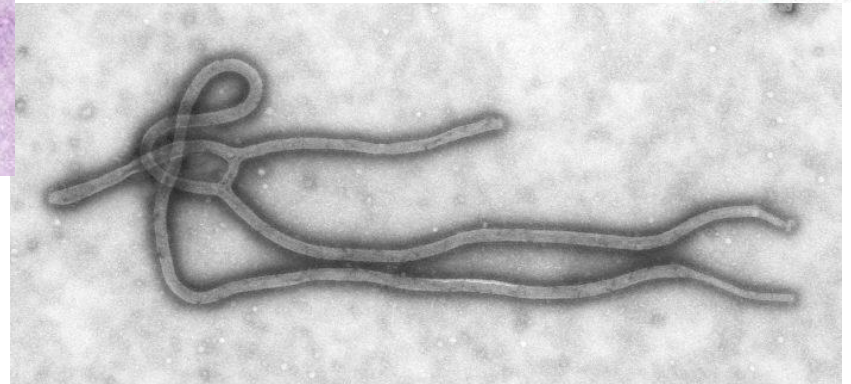
Virus



A hemorrhagic rash appears over entire body



ADAM.



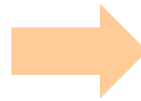
Ebola virus

1.2 What are microbes?

- Microbes or microorganisms are organisms that are usually too small to be seen by the unaided eye, generally less than 0.1 mm across.
- Most are single-celled organisms living independently, but some form groups of cells called colonies.



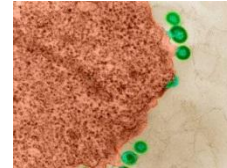
sweet ferment rice



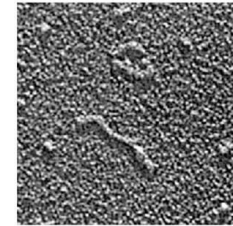
The composition of the microbial world

➤ Infectious agents

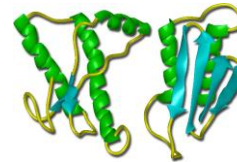
Viruses



Viroids



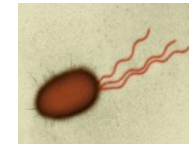
Prions



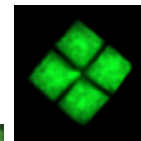
➤ Organisms

Prokaryotes

Bacteria



Archaea



Eukaryotes

Fungi



Algae



Protozoa



The size and cell type of microbes

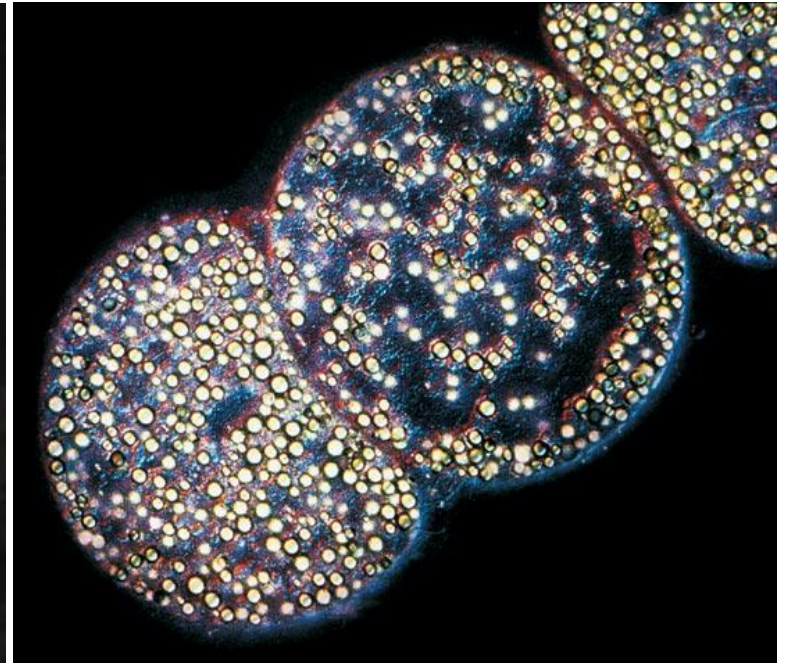
Microbe	Approximate range of sizes	Cell type
Viruses	0.01-0.25 μm	Acellular
Bacteria	0.1-10 μm	Prokaryote
Fungi	2 μm->1 m	Eukaryote
Protozoa	2-1000 μm	Eukaryote
Algae	1 μm-several meters	Eukaryote

The largest prokaryotes

- *Epulopiscium fishelsoni* lives in the intestines of surgeonfish in the tropical Pacific.
- It can grow up to 0.6 mm in length --- large enough to be seen without a microscope!

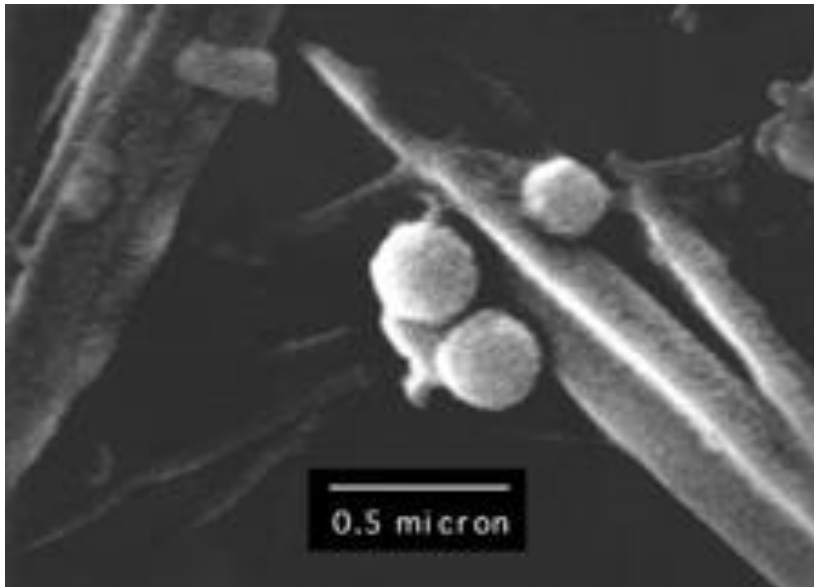


The largest prokaryotes

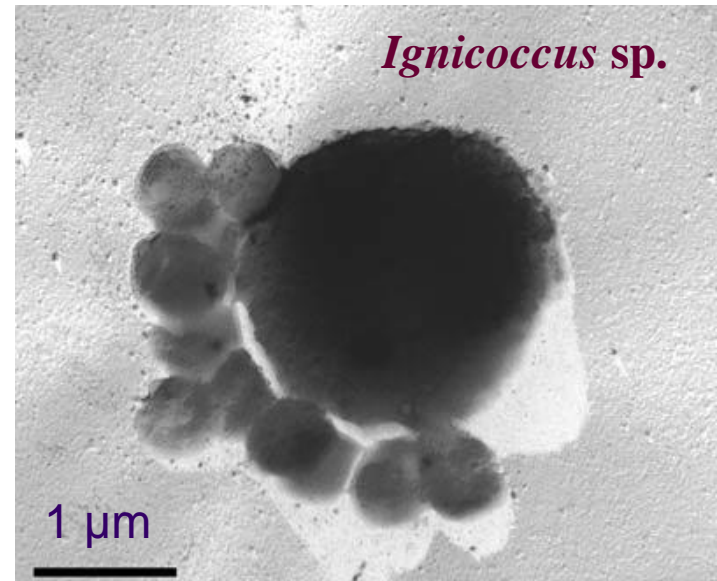


Thiomargarita namibiensis (0.1~0.3-0.75mm)

The smallest prokaryotes



**Three nanobacteria in hot springs
carbonates**



Nanoarchaeum equitans

1.3 The microbes in human welfare

- Microbes impinge on all aspects of our life.

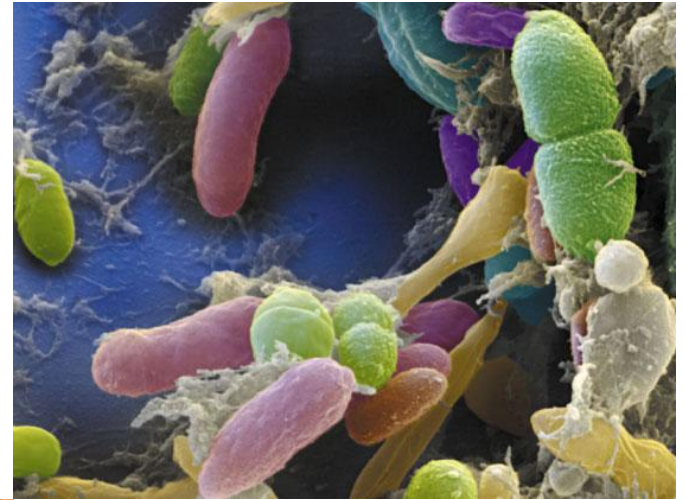


Fermented foods



Vitamin

- Vitamin C, B2, B12, D.

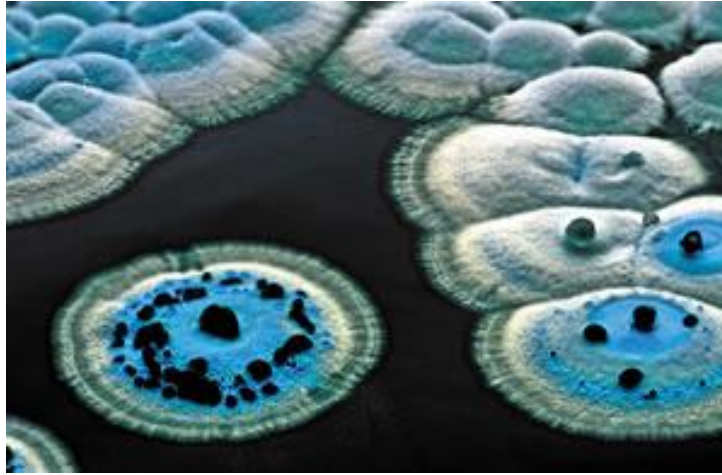


Vaccine



- A vaccine is a biological preparation that improves immunity to a particular disease.
- A vaccine typically contains an agent that resembles a disease-causing microorganism and is often made from weakened or killed forms of the microbe, its toxins or one of its surface proteins.

Antibiotic



Enzyme



Decomposer

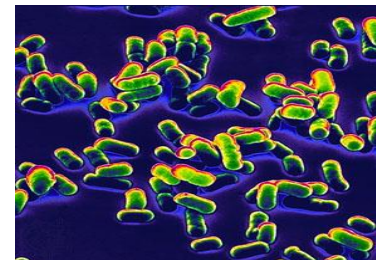


The recognition of the microbial role in disease

- **Black death** was one of the most devastating pandemics in human history, resulting in the deaths of an estimated 75 to 200 million people and peaking in Europe in the years 1346–1353.
- Although there were several competing theories as to the etiology of the Black Death, analysis of DNA from victims in northern and southern Europe published in 2010 and 2011 indicates that the pathogen responsible was the *Yersinia pestis* bacterium, probably causing several forms of plague.



Illustration of the Black Death from the Toggenburg Bible (1411)



鼠疫耶尔森菌



Oriental rat flea
Xenopsylla cheopis

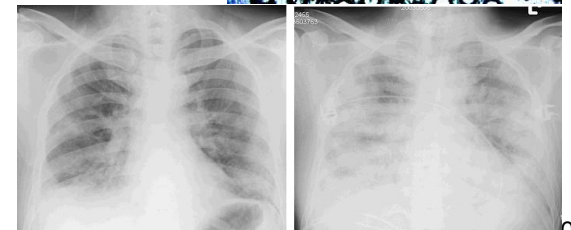
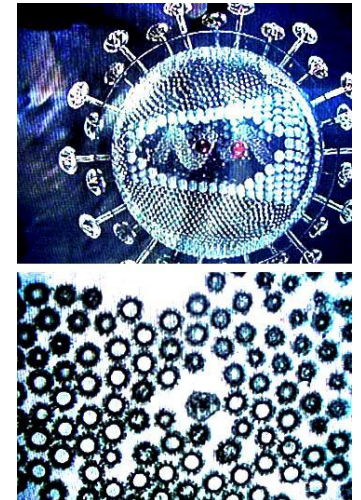
The recognition of the microbial role in disease

- **Mad cow disease** (bovine spongiform encephalopathy, BSE) is a progressive neurological disorder.
- Mad cow disease is caused by an infectious transmissible agent termed a **prion** (朊病毒).



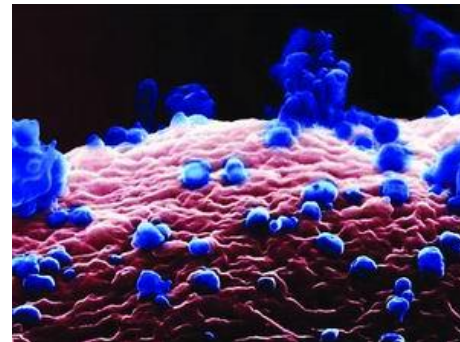
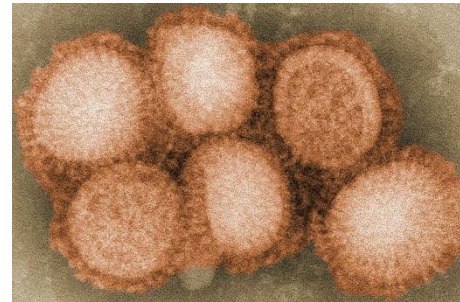
SARS

- SARS (Severe Acute Respiratory Syndromes): **coronavirus** (冠状病毒)



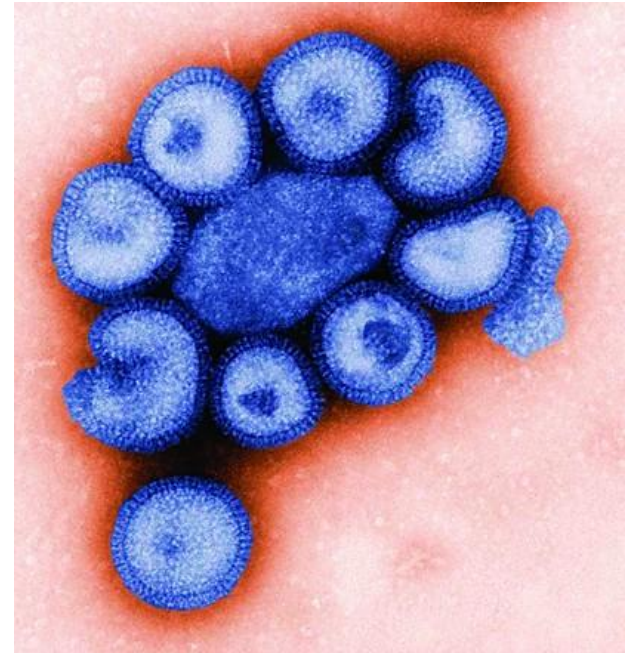
Avian influenza

- Avian influenza, known informally as avian flu or bird flu, refers to "influenza caused by viruses adapted to birds. The version with the greatest concern is highly pathogenic avian influenza (HPAI).



Swine influenza

- Swine influenza, a respiratory disease of pigs caused by type A influenza viruses that causes regular outbreaks in pigs.

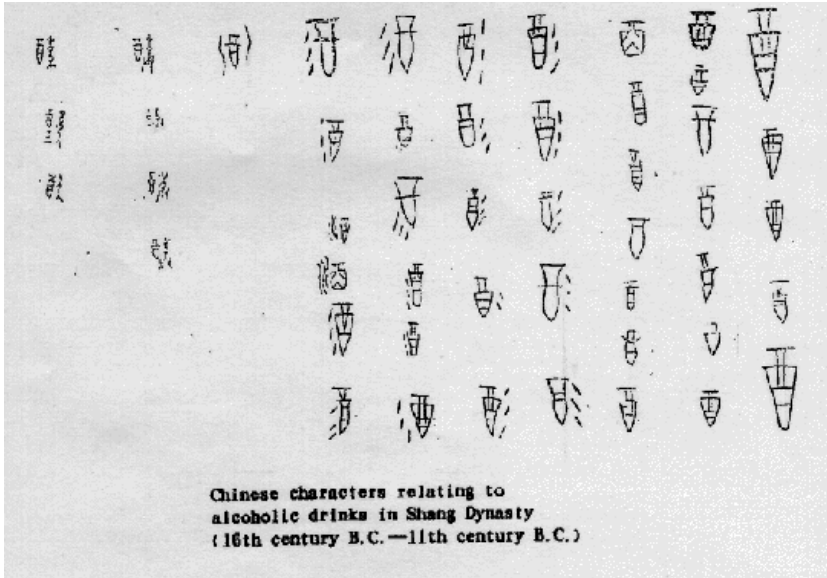
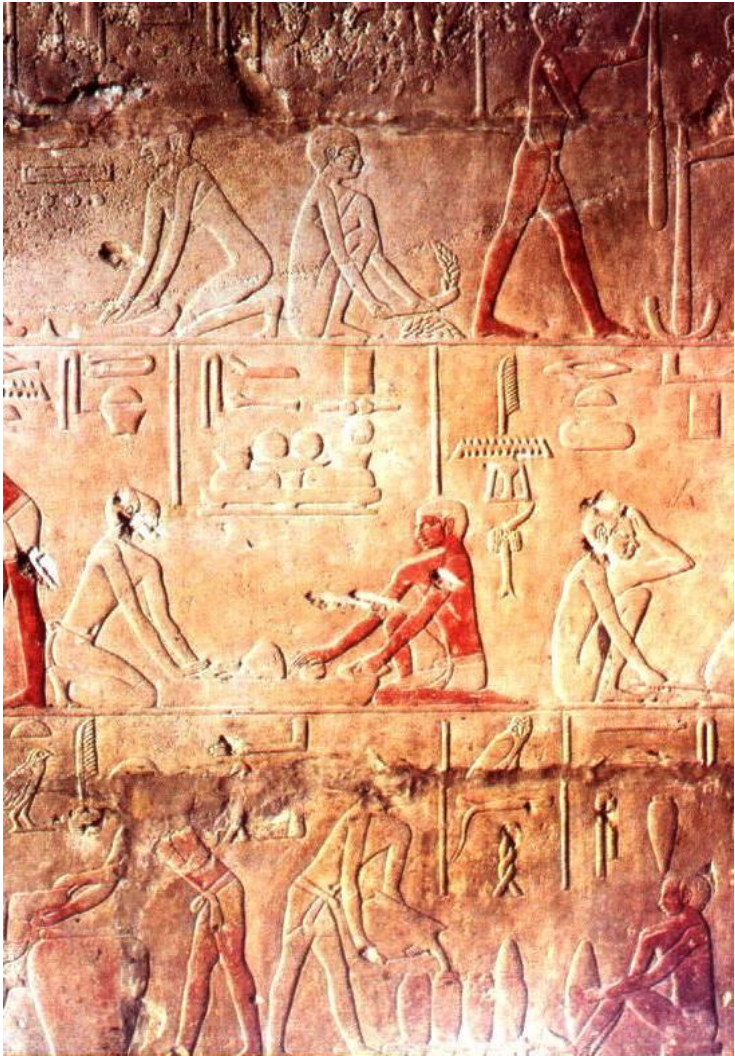


1.4 The history of microbiology

- Microbiology is the study of microorganisms.
- It employs techniques-such as sterilization and the use of culture media-that are required to isolate and grow these microorganisms.
- Microbiology is a large discipline, which has a great impact on other areas of biology and general human welfare.

Prehistory (8000-1676)

➤ Prehistoric people make wine.

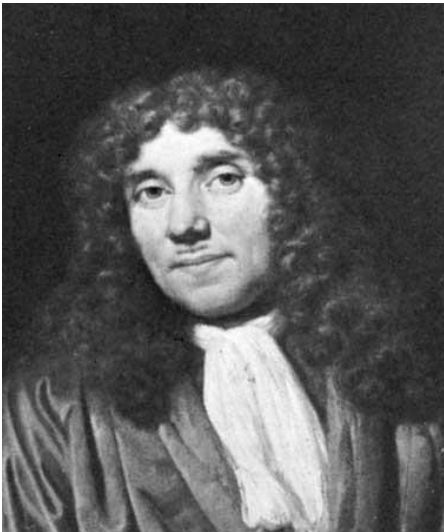
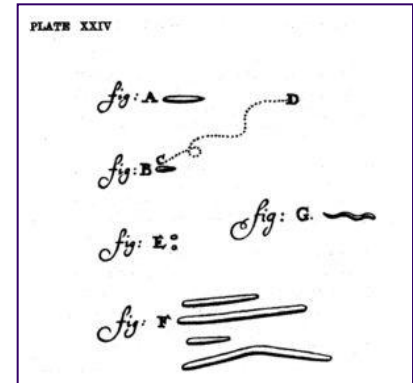


Chinese characters relating to alcoholic drinks in Shang Dynasty (16th century B.C.—11th century B.C.)

Early Stage

(1676-1861)

- **The discovery of microorganisms.**



Antony van Leeuwenhoek
(1632-1723)

- **The first person to observe and describe microorganisms was the amateur microscopist Antony van Leeuwenhoek of Delft, Holland.**
- **Leeuwenhoek made his simple, single-lens microscope which could amplify the object being viewed 50-300 times. Between 1673-1723, he wrote a series of letters to the Royal Society of London describing the microbes he observed from the samples of rainwater, and human mouth.**

Foundation Stage

(1861-1897)

Louis Pasteur

Pasteur's contributions:



Louis Pasteur
(1822-1895)

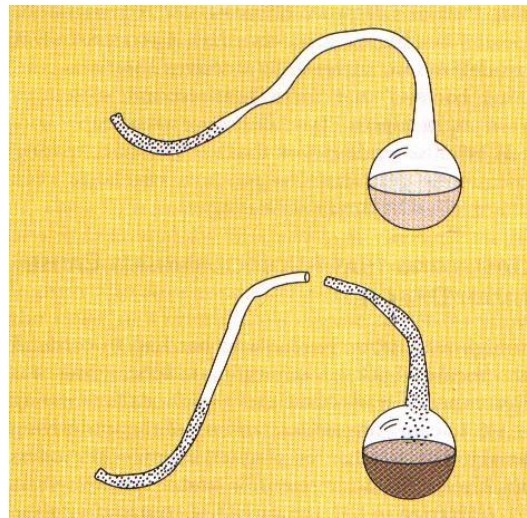
- Final refutation of spontaneous generation-birth of microbiology as a science
- Discovery of the existence of anaerobic life-fermentation
- Vaccines
- Pasteurization

Pasteur's contributions

- Pasteur (1857) demonstrated that lactic acid fermentation is due to the activity of microorganisms.
- Pasteur (1861) conflict over spontaneous generation-birth of microbiology as a science.
- Pasteur (1881) developed anthrax vaccine.
- Pasteurization

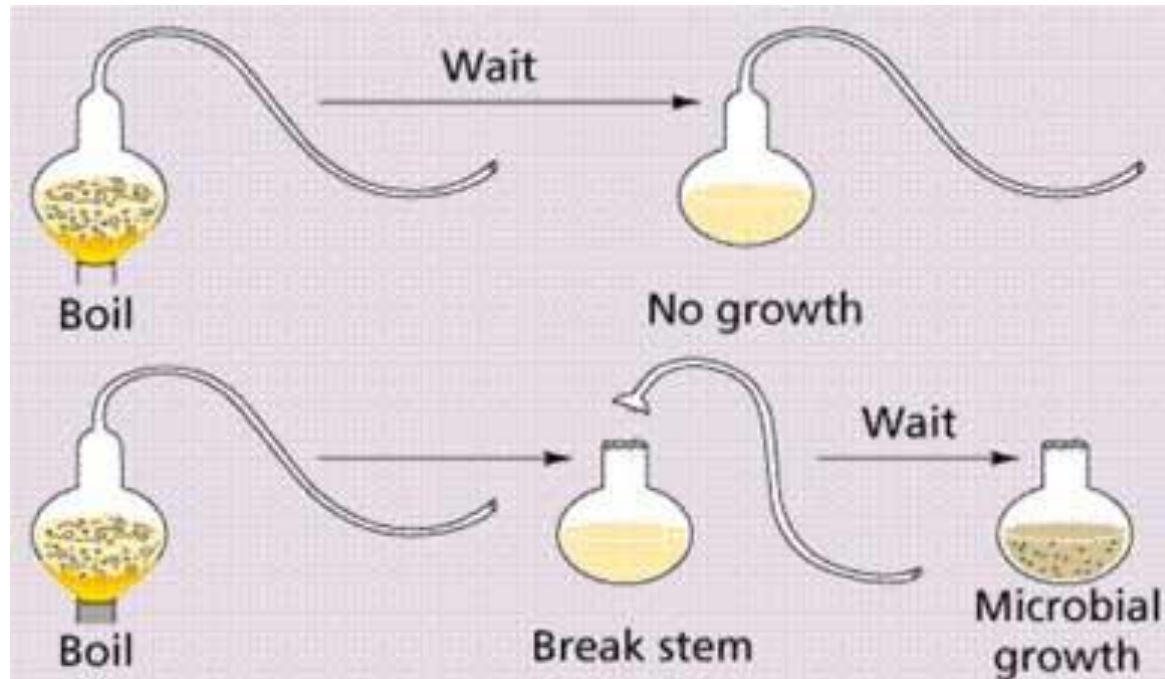
The spontaneous generation conflict

- **Spontaneous generation** - that living organisms could develop from nonliving or decomposing matter.



Pasteur's swan neck flasks used in his experiments on the spontaneous generation of microorganisms

Pasteur's swan necked flask assay

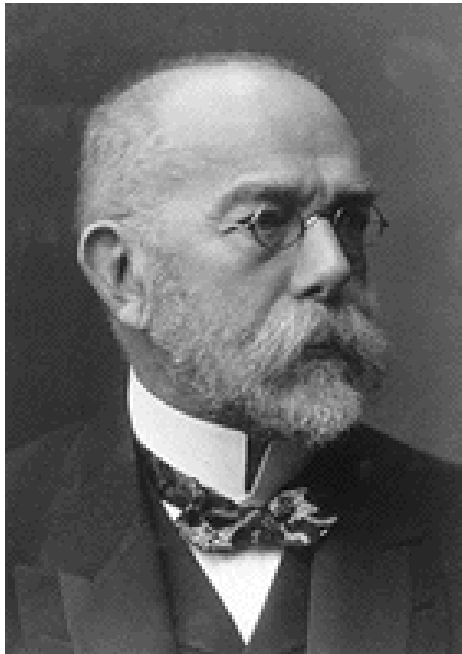


- **Conclusion:** Microorganisms are not spontaneously generated from inanimate matter, but are produced by other microorganisms.

Foundation Stage (1861-1897)

Robert Koch

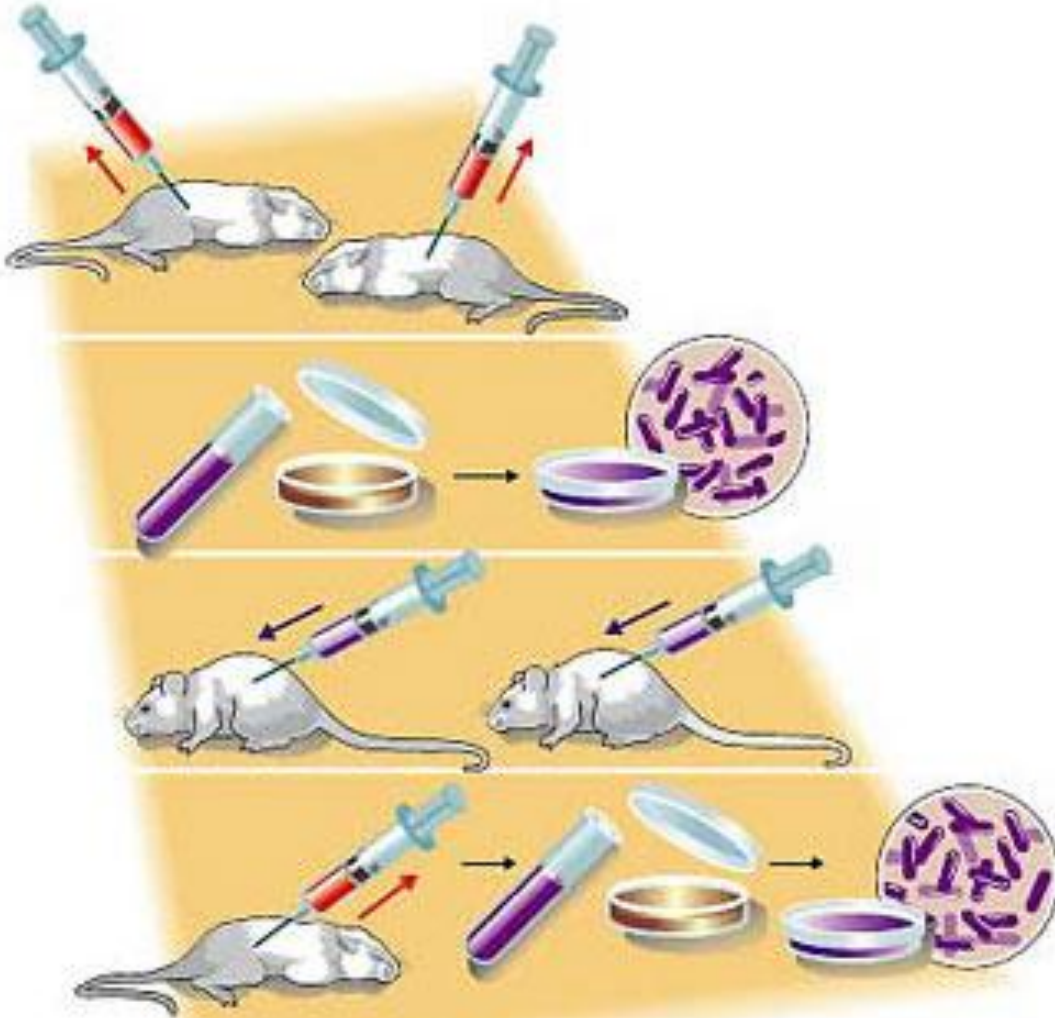
The recognition of microbial role in disease



Robert Koch
(1843-1910)

- Robert Koch's achievement
- He discovered the anthrax disease cycle (1876)
- the bacteria responsible for tuberculosis (1882) and cholera (1883).
- For his discoveries in regard to tuberculosis, he received the Nobel Prize for Physiology or Medicine in 1905.
- Koch's postulates

Koch's postulates (科赫法则)



- 1. The microorganisms must be present in every case of the disease but absent from healthy organisms.
- 2. The suspected microorganisms must be isolated and grown in a pure culture.
- 3. The disease must result when the isolated microorganisms is inoculated into a healthy host.
- 4. The same microorganisms must be isolated again from the diseased host.

The Golden age of microbiology

- Koch and pure cultures
- Fermentation and Pasteurization
- Germ theory of disease
- Vaccination

The discovery of microbial effects on organic and inorganic matter



Sergei N. Winogradsky
(1856-1953)



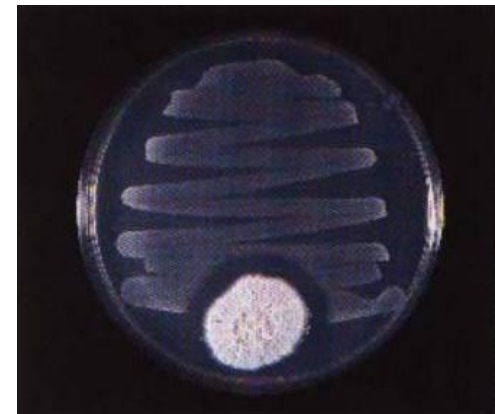
Martinus W. Beijerinck
(1851-1931)

- The Russian microbiologist Winogradsky discovered that soil bacteria could oxidize iron, sulfur and ammonia to obtain energy, and also isolated nitrogen - fixing bacteria.
- Beijerinck made fundamental contributions to microbial ecology. He isolated *Azotobacter* (固氮菌) and *Rhizobium* (根瘤菌).

Alexander Fleming (1881-1955)



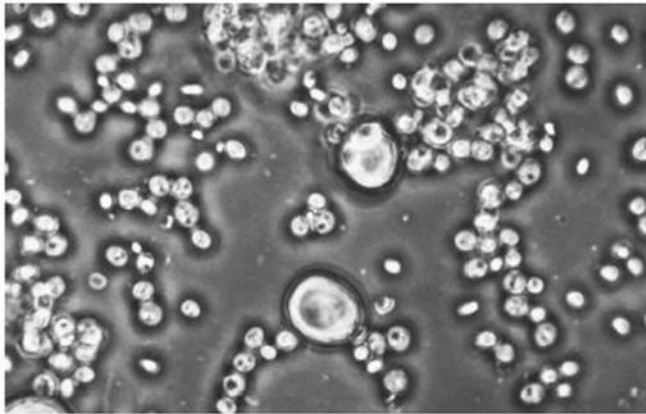
- Sir Alexander Fleming discovered the antibiotic penicillin.
- He had the insight to recognize the significance of the inhibition of bacterial growth in the vicinity of a fungal contaminant when most other scientists probably would have simply discarded the contaminated plates.



Development stage

(1897-1953)

- In 1897, E. Büchner discovered zymase and began the microbial physiological research.



Maturity stage (1953~)

- James Dewey Watson and Francis Harry Compton Crick described the DNA structure as a double helix in 1953.



Francis Harry Compton Crick
(1916-2004)



James Dewey Watson
(1928-)

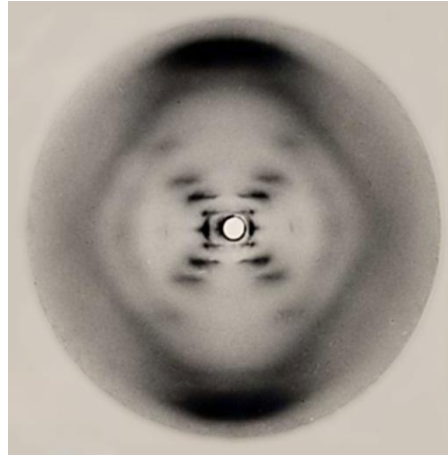


Maurice Hugh Frederick Wilkins
(1916-2004)

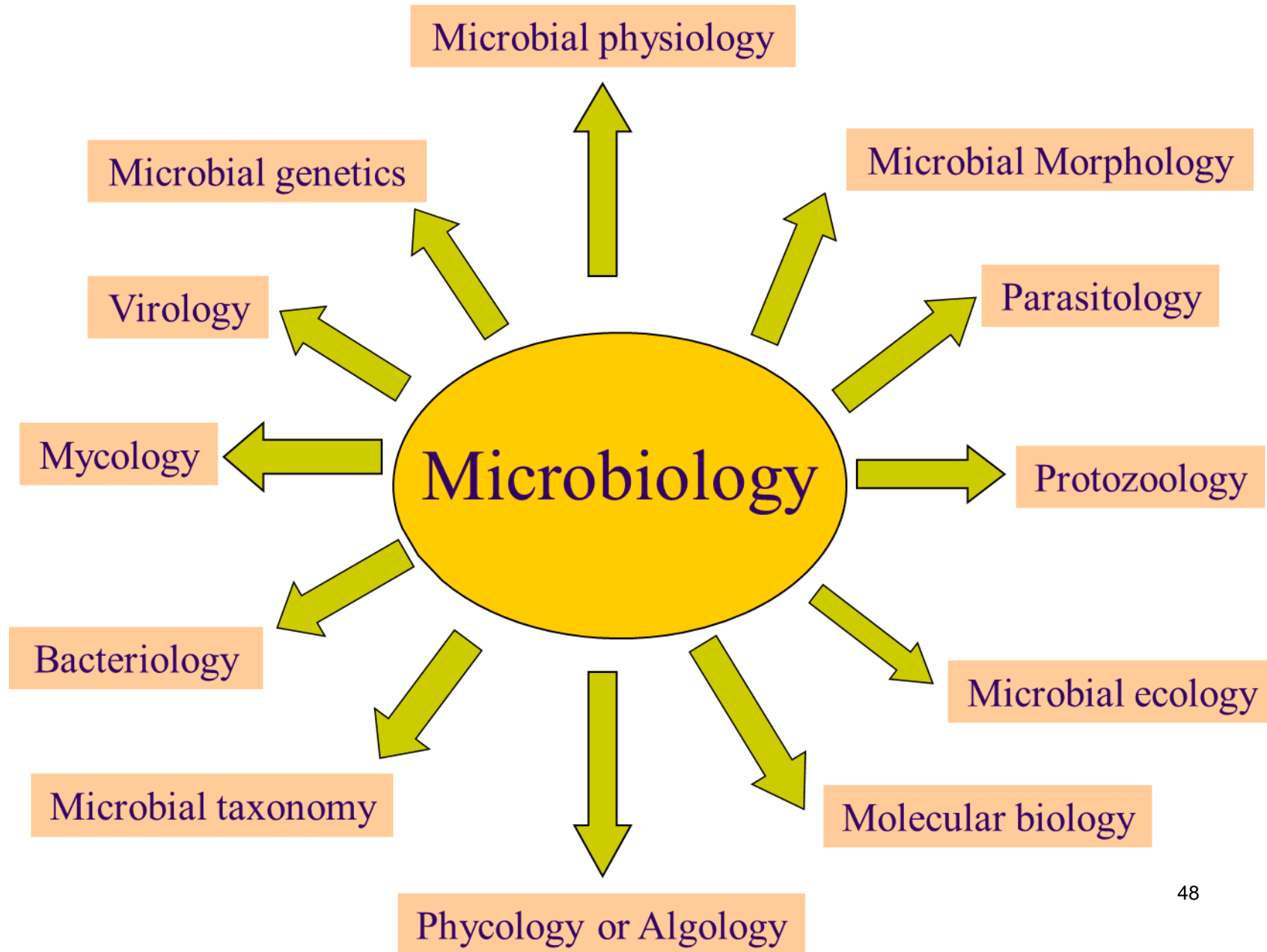
Rosalind Franklin and the Discovery of DNA Structure



Rosalind Elise Franklin
(1920-1958)



The branches of Microbiology



1.5 Modern Microbiology

- Important events in the development of microbiology:
 - 1892, Ivanowsky provides evidence for virus causation of tobacco mosaic disease.
 - 1897, Buchner prepares extract of yeast that ferments.
 - 1899, Beijerinck proves that a virus particle causes the tobacco mosaic disease.
 - 1909, Ricketts shows that Rocky Mountain spotted fever is transmitted by ticks and caused by a microbe (*Rickettsia rickettsii*).
 - 1911, Rous discovers a virus that causes cancer in chickens.
 - 1915-1917, D'Herelle and Twort discover bacterial viruses.
 - 1921, Fleming discovers lysozyme.
 - 1923, First edition of *Bergey's Manual*.

Modern Microbiology

- Important events in the development of microbiology:
 - 1928, Griffith discovers bacterial transformation.
 - 1929, Fleming discovers penicillin.
 - 1933, Ruska develops first transmission electron microscope.
 - 1935, Stanley crystallizes the tobacco mosaic virus; Domagk discovers sulfa drugs.
 - 1937, Chatton divides living organisms into prokaryotes and eucaryotes.
 - 1930s, The experiment of Luria and Delbruck.

Modern Microbiology

- Important events in the development of microbiology:
 - 1941, Beadle and Tatum, one-gene-one-enzyme hypothesis.
 - 1944, Avery shows that DNA carries information during transformation; Waksman discovers streptomycin.
 - 1946, Lederberg and Tatum describe bacterial conjugation.
 - 1950, Lwoff induces lysogenic bacteriophages.
 - 1952, Hershey and Chase show that bacteriophages inject DNA into host cells; Zinder and Lederberg discover generalized transduction.

Modern Microbiology

- Important events in the development of microbiology:
 - 1953, Watson and Crick propose the double helix structure for DNA.
 - 1955, Jacob and Wollman discover the F factor is a plasmid.
 - 1961, Jacob and Monod propose the operon model of gene regulation.
 - 1961-1966, Nirenberg, Khorana, and others elucidate the genetic code.
 - 1970, Discovery of restriction endonucleases by Arber and Smith. Discovery of reverse transcriptase in retroviruses by Temin and Baltimore.

Modern Microbiology

- Important events in the development of microbiology:
 - 1973, Ames develops a bacterial assay for the detection of mutagens. Cohen, Boyer, Chang, and Helling use plasmid vectors to clone genes in bacteria
 - 1975, Kohler and Milstein develop technique for the production of monoclonal antibodies.
 - 1977, Recognition of archaea as a distinct microbial group by Woese and Fox. Carl Woese uses ribosomal RNA analysis to identify a third form of life, the Archea, whose genetic makeup is distinct from but related to both Bacteria and Eucaryea.

Modern Microbiology

- Important events in the development of microbiology:
 - 1977, Holger Jannasch shows that microbial sulfur oxidation is a source of energy for dense animal colonies in the absence of light at deep sea hydrothermal vents. Jannasch and Wirsen use a device for sampling of microbial populations at depths of 6000 meters and then study the population without decompression.
 - 1979, Smallpox (*variola*) is declared officially eliminated; last natural case seen in Somalia in 1977. Small quantities remain held under tightly controlled conditions in the U.S. and former U.S.S.R. **THE ONLY MICROBIAL DISEASE EVER COMPLETELY DEFEATED.**

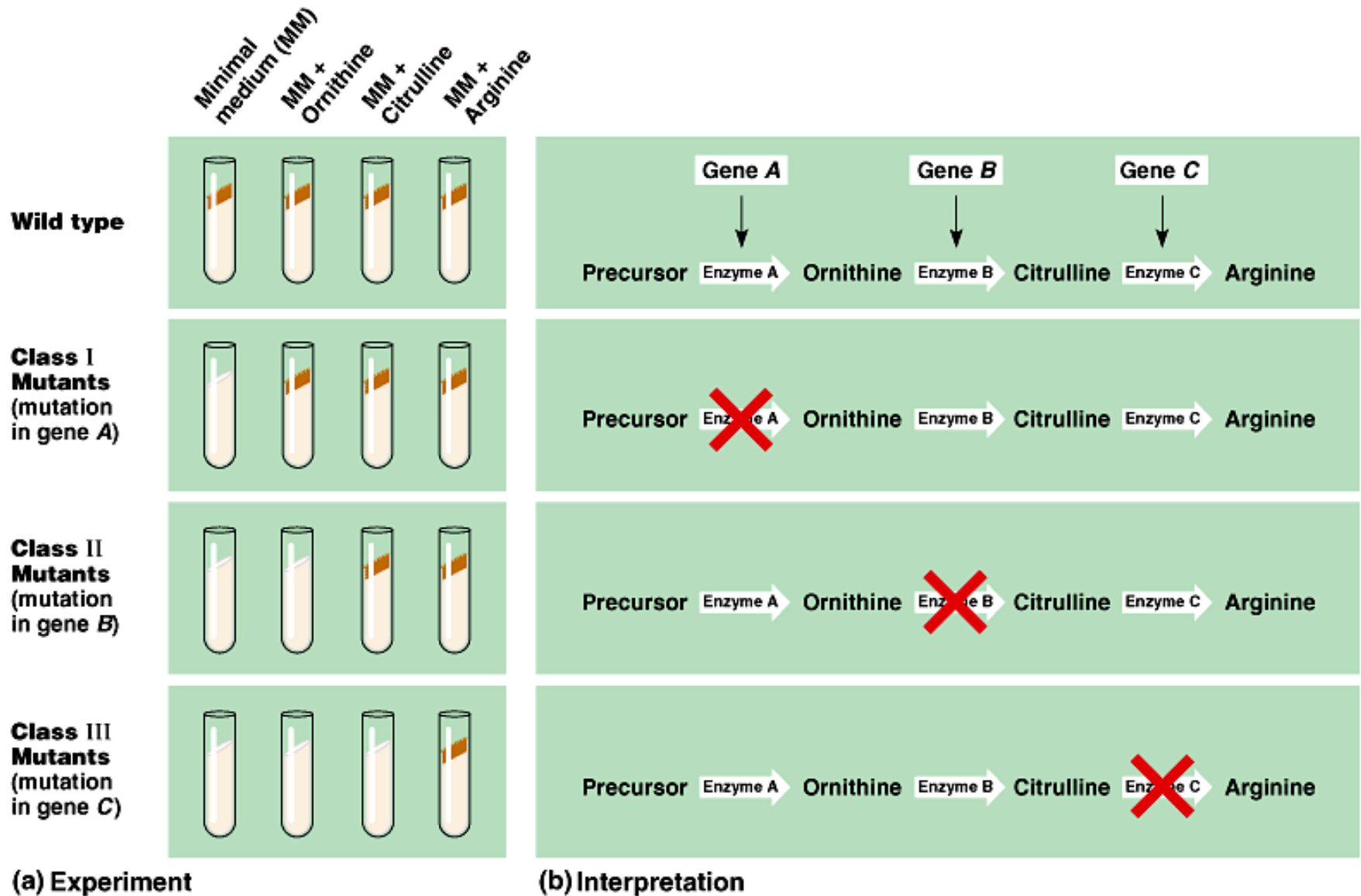
Modern Microbiology

- Important events in the development of microbiology:
 - 1980, The U. S. Supreme Court rules that microorganisms altered in the laboratory can be patented.
 - 1981, Ananda Chakrabarty receives a patent for metabolizing. *Pseudomonads* developed by conjugation that can degrade camphor, octene, salicylate and naphthalene.
 - 1981, Helen Whiteley and Ernest Schnepf at the University of Washington clone a Bt toxin gene.
 - 1982, Recombinant hepatitis B vaccine developed.
 - 1982-1983, Discovery of catalytic RNA by Cech and Altman.
 - 1983-1984, The human immunodeficiency virus isolated and identified by Gallo and Montagnier.

Modern Microbiology

- Important events in the development of microbiology:
 - 1986, The polymerase chain reaction developed by Mullis
 - 1986, First vaccine (hepatitis B vaccine) produced by genetic engineering approved for human use.
 - 1990, First human gene-therapy testing begun.
 - 1997, Discovery of *Thiomargarita namibiensis*, the largest known bacterium *Escherichia coli* genome sequenced.
 - 2000, Discovery that *Vibrio cholerae* has two separate chromosomes.

One Gene – One Enzyme



(a) Experiment

(b) Interpretation

Barbara McClintock & jumping gene

In 1983, McClintock received the Nobel Prize for Physiology or Medicine for her studies of transposable elements.



**Barbara McClintock
1902-1992**

1.6 Microbiology development in China

➤ Dr. **Wu Lien-Teh** (伍连德) was a Malayan-born Chinese doctor and the first medical student of Chinese descent to study at University of Cambridge. He was also the first Malaysian Chinese nominated to receive a Nobel Prize in Medicine in 1935. In the winter of 1910, was given instructions from the Foreign Office, Peking, to travel to Harbin to investigate an unknown disease which killed 99.9% of its victims.



Lien-Teh Wu
(1879-1960)



Microbiology development in China

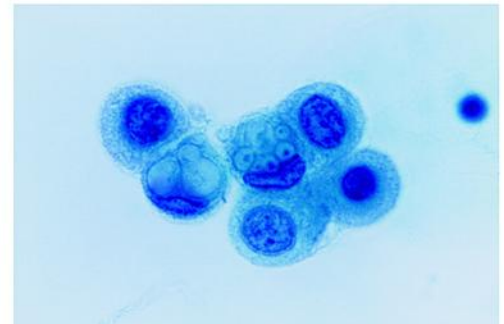
- The *Chlamydia trachomatis* agent was first cultured in the yolk sacs of eggs by Professor **Feifan Tang** (汤飞凡) et al in 1957.



Feifan Tang
(1897-1958)



Trachoma



Microbiology development in China

- **December 3, 1958**

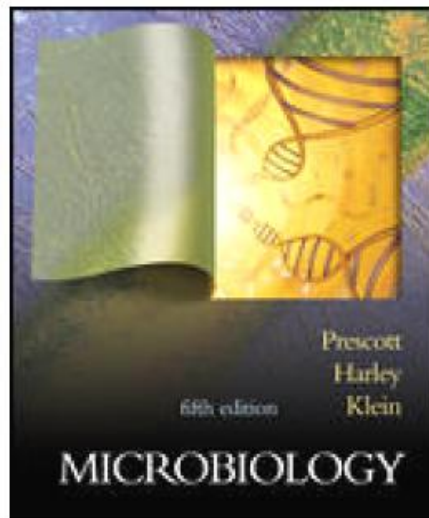


Summery

- 1.1 Microbes around us
- 1.2 What are microbes?
- 1.3 The microbes in human welfare
- 1.4 The history of microbiology
- 1.5 Modern microbiology
- 1.6 Microbiology development in China

Further reading

- **Microbiology (5th Edition):**
- Chapter 1 The History and Scope of Microbiology



Microbiology

5th Edition

Lansing M. Prescott