Microbiology

Lecuture 1

Introduction to Microbiology

Lecturers of microbiology

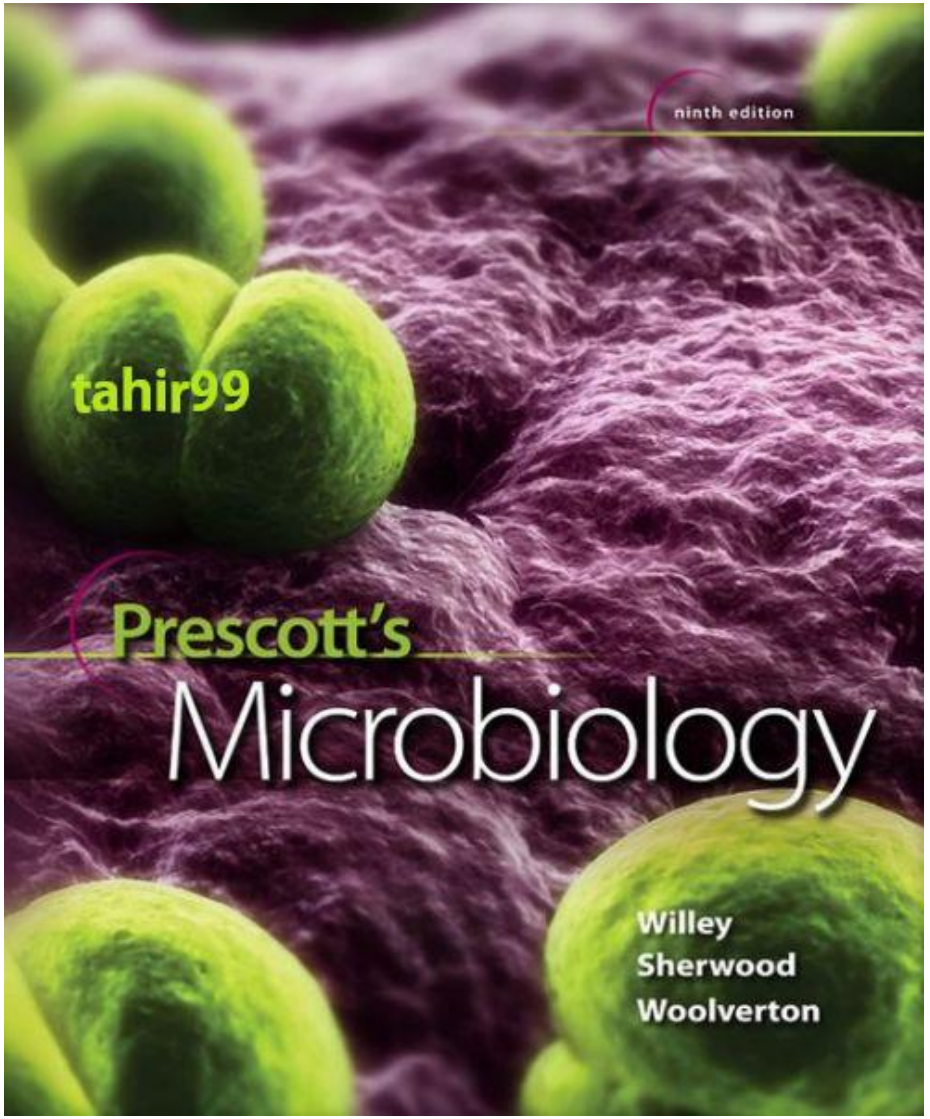
张连茹

田蕴

袁晶

郭峰

Textbook and reference books



Outline for this course

1. Brief introduction to microbiology (2, GF)
2. General structure of bacteria, archaea, fungi and acellular microbes (10, ZLR)
3. Microbial nutrition, growth and control (6, GF)

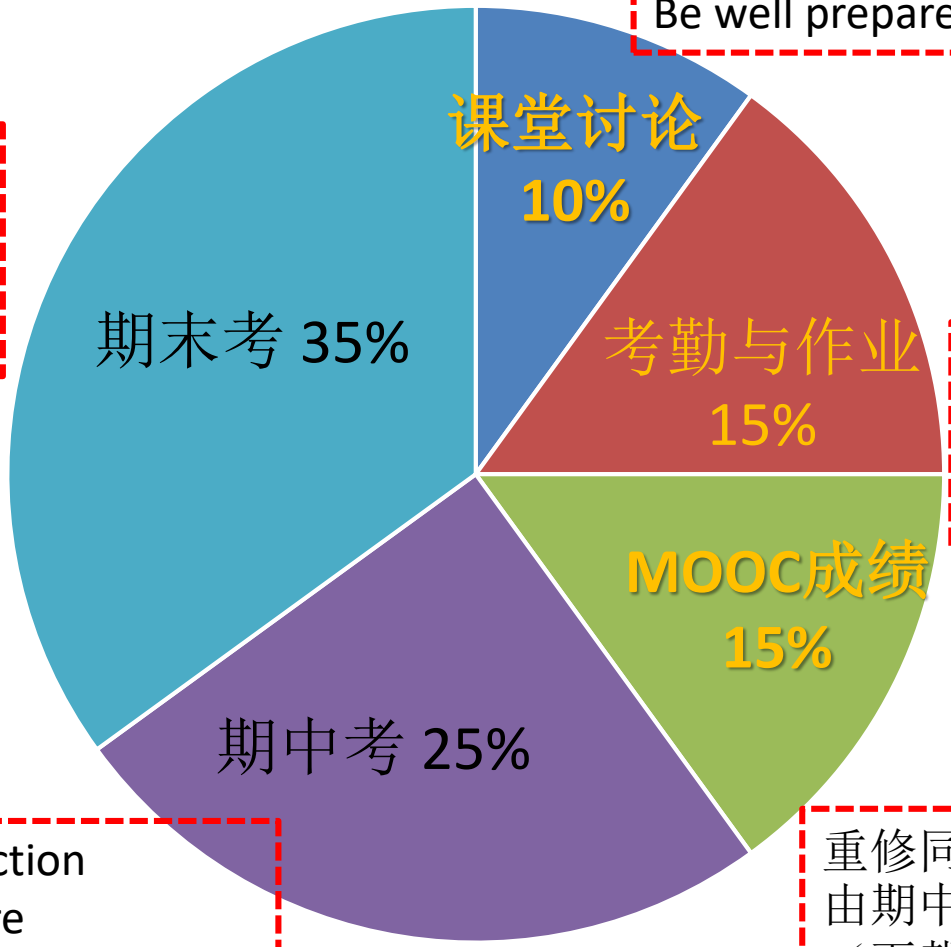
Mid-term examination

4. Microbial metabolism (10, TY)
5. Microbial molecular biology and genetics (12, YJ)
6. The diversity of the microbial world (3, GF)
7. Microbial ecology and applied microbiology (3, GF)

Final examination

Final score

4-6 topics each time
5-8 min per topic
Be well prepared!



Metabolism
Genetics
Diversity, ecology and applications

Keys to score>=60!!

Introduction
Structure
Nutrition and control

重修同学的最终成绩只由期中考和期末考决定，（下载ppt自学，强烈建议学习MOOC）

讨论形式

- 负责讨论同学的顺序根据学号
- 课前准备（提前下载ppt，最后一页提供讨论题和负责同学学号）
- 讨论环节包括负责同学陈述观点和其他人提问，负责同学回答
- 教师打分记录

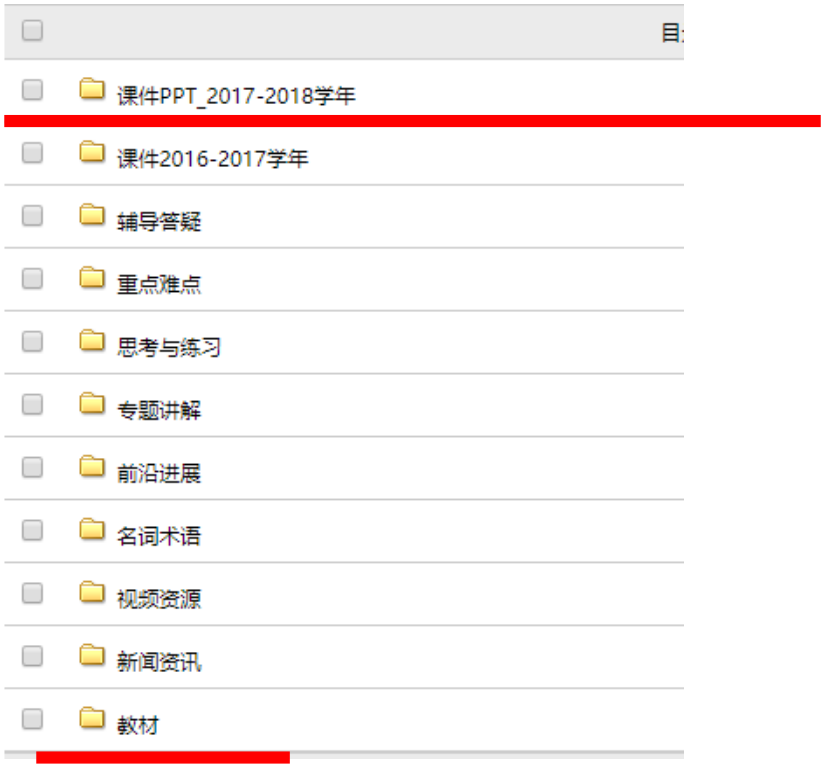
2016年期末成绩

课程名称	130110010033-微生物学A				学分/学时	3.0/48.0
教师	郭峰	上课人数	211		考试人数	211
最高分	94	最低分	0		平均分	69.4

分数段	95～100	90～94	85～89	81～84	78～80	75～77	72～74	68～71	64～67	60～63	0～59
人数	0	12	16	23	27	21	19	21	20	22	30
百分比	0%	6%	8%	11%	13%	10%	9%	10%	10%	10%	14%

Course平台

- 教材下载/每次课程PPT预习
- **明确下堂课负责讨论题的同学(预习与搜集资料)**
- 其他资源



http://course.xmu.edu.cn/

如何加入MOOC/SPOC

1.登录与身份认证

登录爱课程（www.icourses.cn），点击“学校云”，输入“厦门大学”并点击进入。

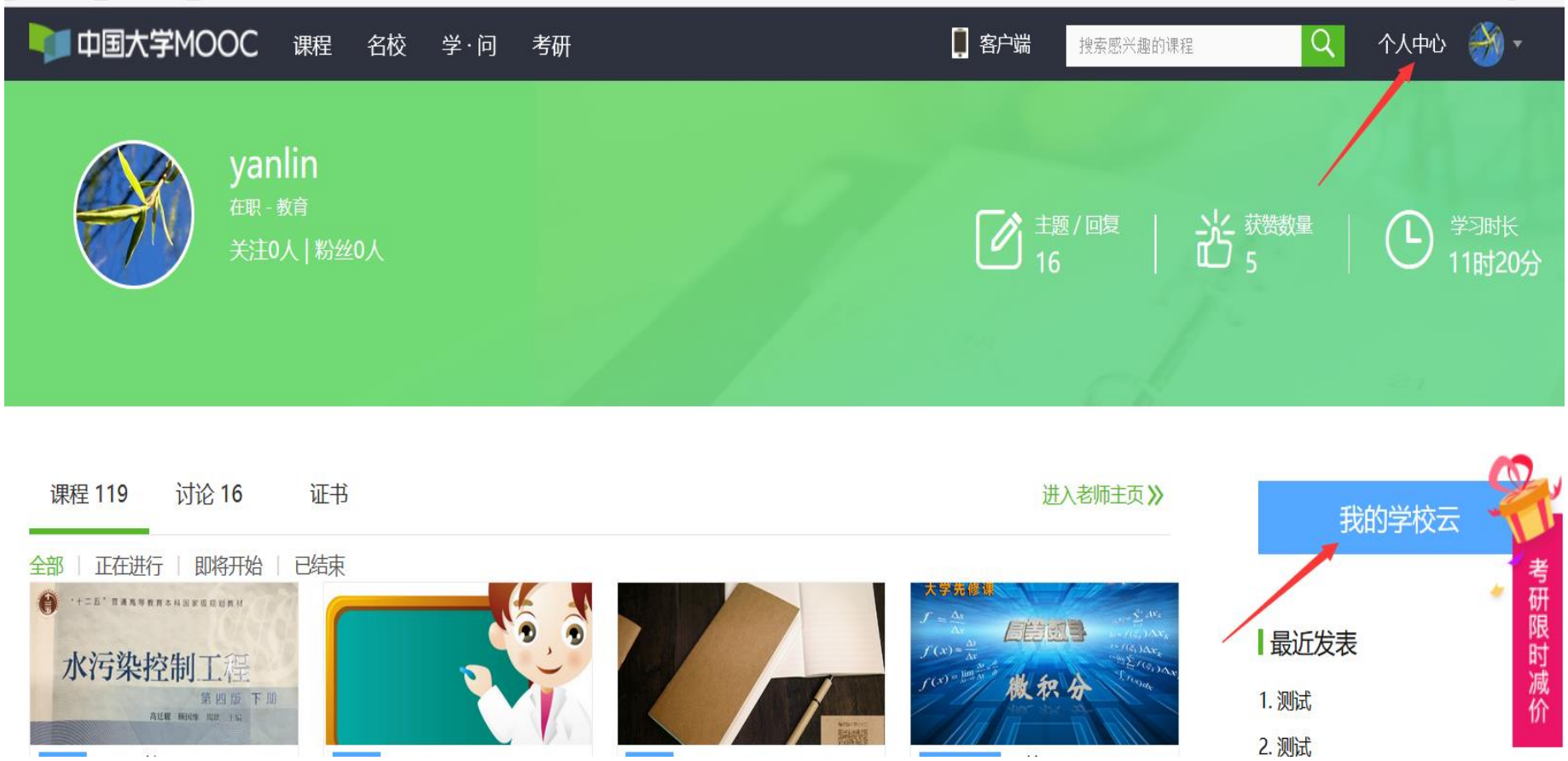
点击“学生入口”——点击“学生认证”

平台支持多种账号登录方式，可以选择注册账户登录或者直接使用第三方账号登录。
注意：
1.如果没有注册账号，建议使用第三方账号登录方式。
2.务必记住本次进入的方式，身份认证后，只能以该方式登录学习本校的专属课程。

登录后，进行身份认证(后台认证，需提前提供学号/姓名/身份证后六位信息)：

身份认证后，进入我的学校云，准备选课。

附：认证后，学生进入本校的“在线课程中心”还可在MOOC平台任意界面右上角，点击 “个人中心”，从页面上的“我的学校云”进入



2.“微生物学”课程选课与学习

认证以后，在我的学校云就能够看见本校专属课程，选定“微生物学”。

输入课程密码“life_xmu”，点击 “报名参加”该课程的学习

厦門大學
XIAMEN UNIVERSITY

微生物学

微生物学作为生命科学核心基础课程之一，具有重要的专业地位。建立与时俱进的微生物学开放课程，有助于大学资源在微生物这一重要生物学应用领域对社会的贡献，也有助于帮助需要了解相关知识进行科研工作的科技工作者以较短时间掌握相关信息。

课程概述

微生物学是生命科学的核心课程之一，其研究对象包括原核和真核的单细胞生物、这些单细胞生物的细胞群体以及非细胞形式的生命实体。本门课程将就微生物的形态、营养、繁殖、代谢、遗传、分类、生态、演化与应用等进行讲授。课程受众是可以生命科学学院的本科生和研究生或是任何对微生物感兴趣的人。

本课程将以英文教材Prescott's Microbiology第九版为纲，如果你无法获得该版本教材，也可使用更早一些版本的Prescott's Microbiology教材或者使用中文教材进行比对学习。课程课件也以英文为主辅以中文，因为我们认为对专业英文的学习和熟练掌握对微生物学乃至生命科学的基础研究和应用都至关重要。

课程团队均来自厦门大学生命科学学院，共有四位老师，分别负责不同章节的内容。关信息。

授课目标

通过本课程的学习，掌握微生物学的内涵与基本知识点，且能与研究和应用中的微生物学具体问题相联系。通过双语教学，使同学们熟悉相关领域内的关键词汇，提高英文文献的理解能力。

成绩要求

课程的考核分为平时测验，期中考试和期末考试，比重分别为20%，35%和45%，总成绩60分

同步进行的源课程

厦门大学　微生物学

该SPOC课程部分内容来自以上源课程，在源基础上老师进一步增加了新的课程内容

第1次开课

课程已进行至1/18周

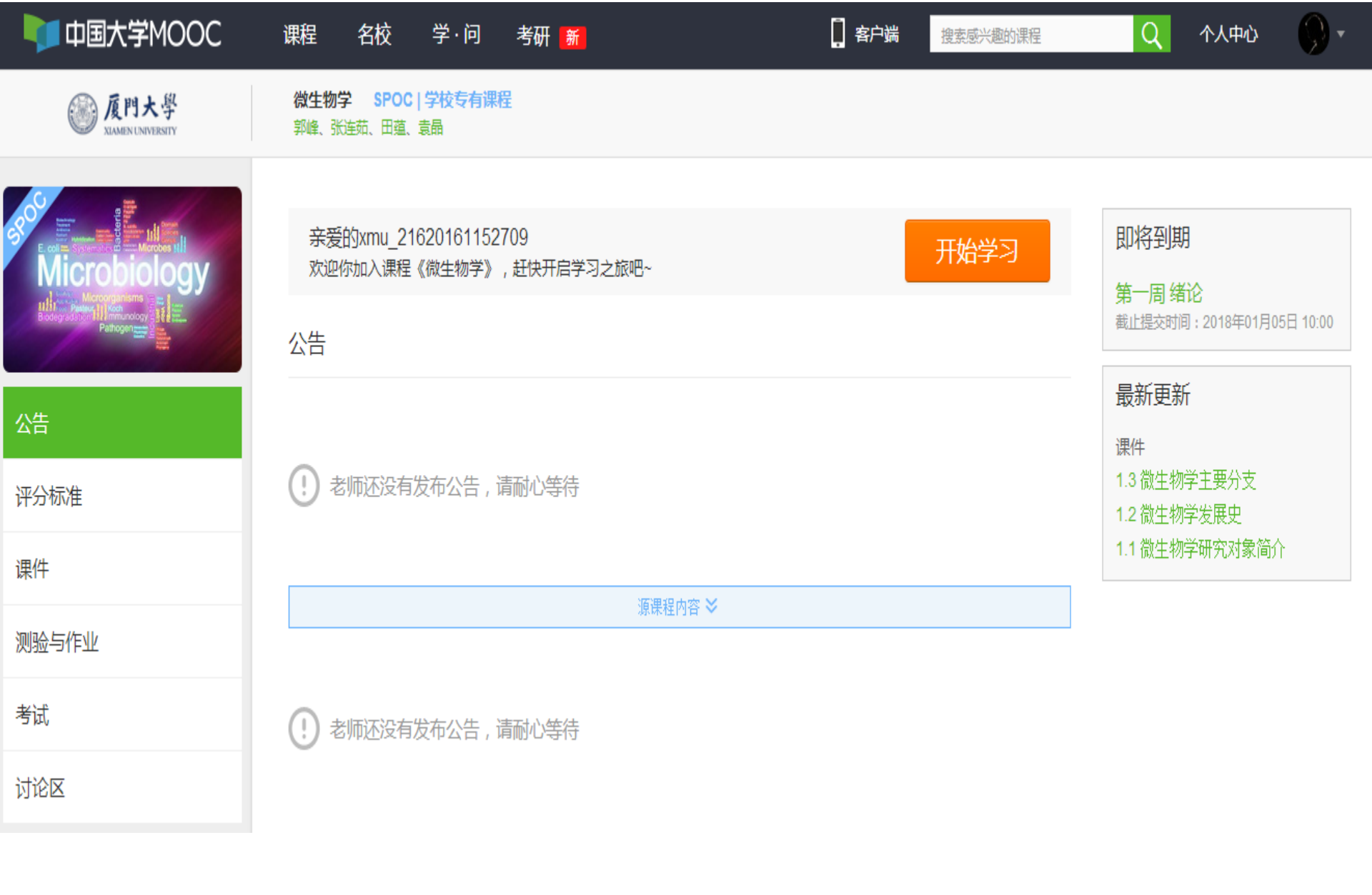
开课：9月8日 10:00
结束：2018年1月5日 23:30

课程密码

学校专有课程需输入正确的

立即参加

加入课程以后，课程界面如图所示，点击“开始学习”即可参与该门课程的在线学习。



3.昵称修改

指针放置于右上角头像上，会出现设置与退出按钮，选择“设置”，进入个人设置。

2.规范昵称，昵称统一为“xmu_学号”（如红框内所示），并填写真实姓名。填写完毕后，下拉到底端，单击“保存”按钮。

MOOC学习+平时考勤+讨论认真准备
≈ 60-70分

Chap. 1 The Evolution of Microorganisms and Microbiology

Outline

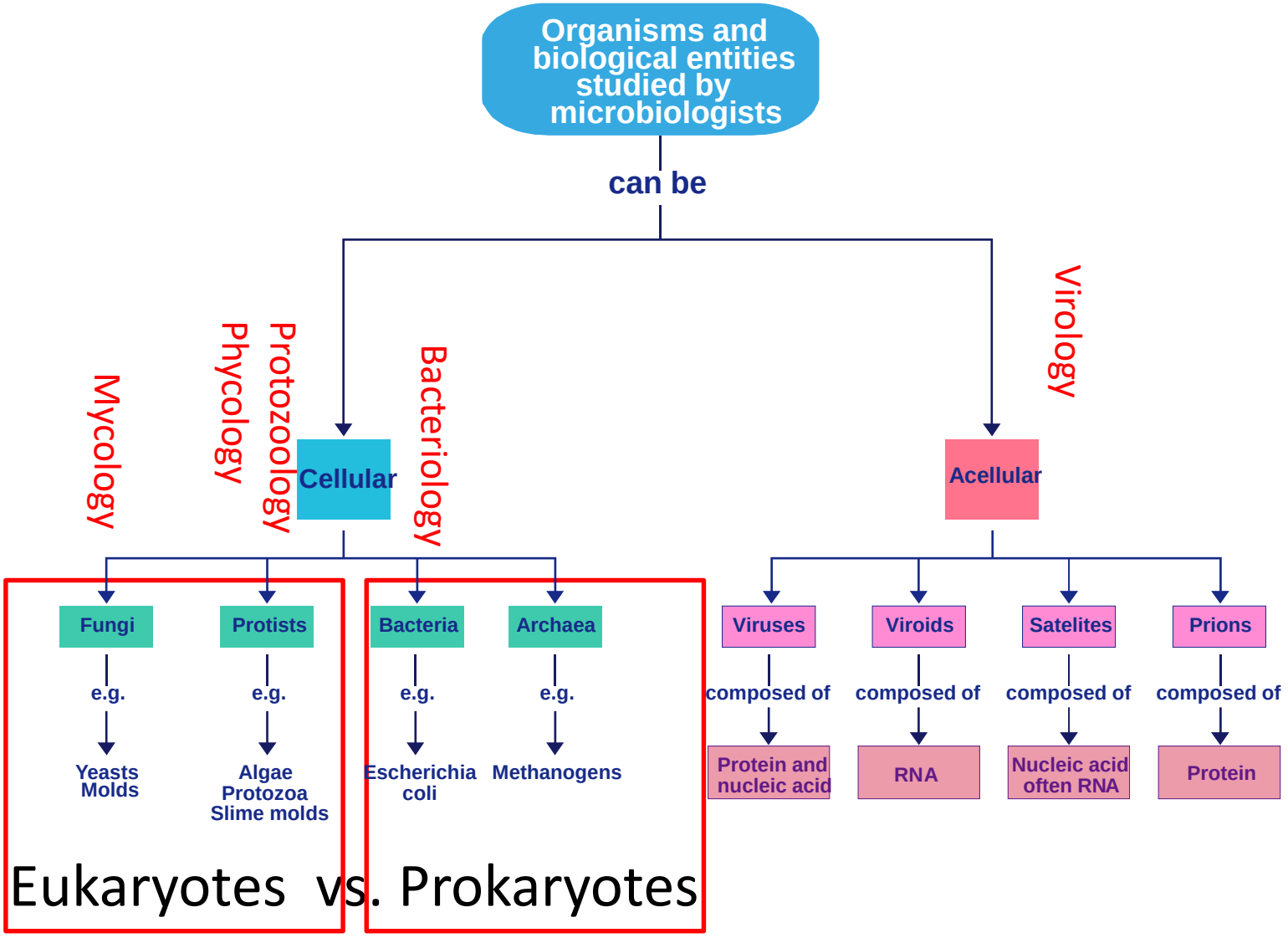
1. What is microbiology and what does it study?
2. Primary features of microbes
3. Microbes in the evolution of life
4. History of microbiology
5. Modern microbiology and its branches

What is microbiology?

From Wikipedia:

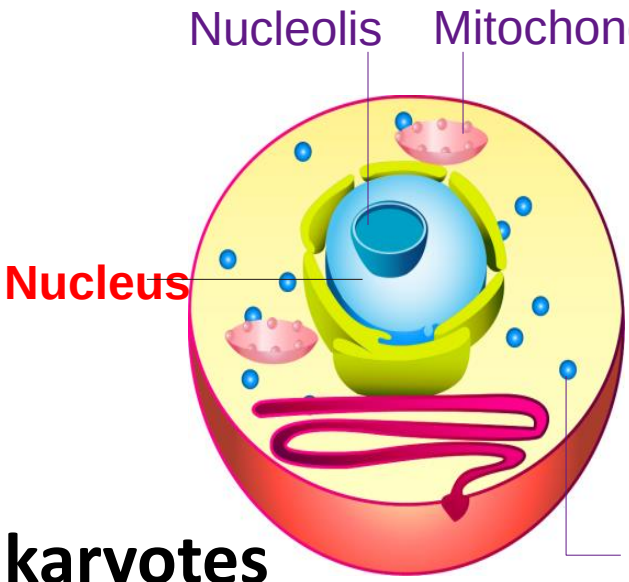
Microbiology is the study of microscopic organisms, those being unicellular (single cell), multicellular (cell colony), or acellular (lacking cells).

Objects of Microbiology

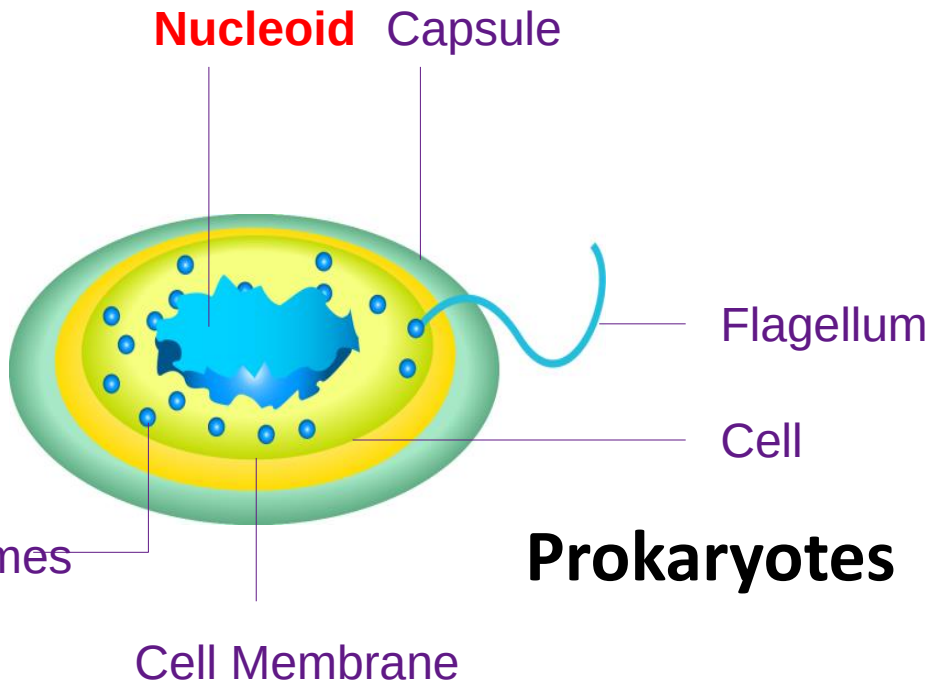


*A protist is any eukaryotic organism that is not an animal, plant or fungus.

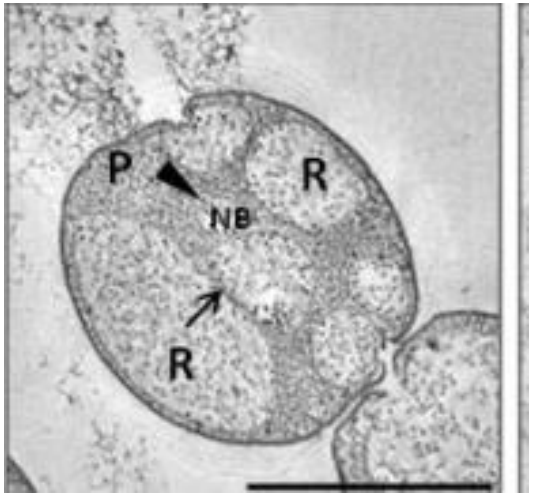
Prokaryote vs. Eukaryotes



Eukaryotes



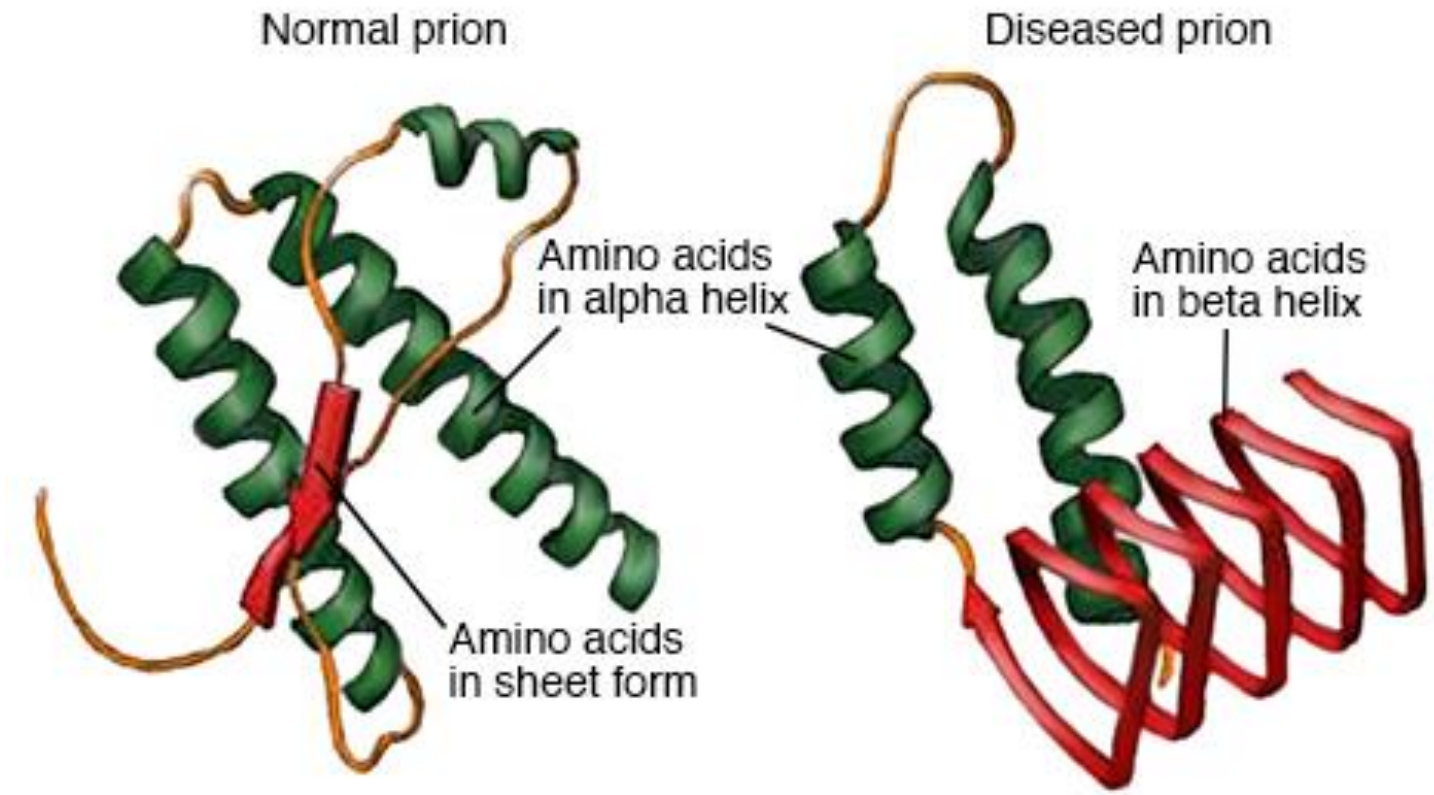
Prokaryotes



- **Nucleus enclosed with membrane**
- **Typical cell organelles with membrane**
- **Planctomycetes bacterium?**

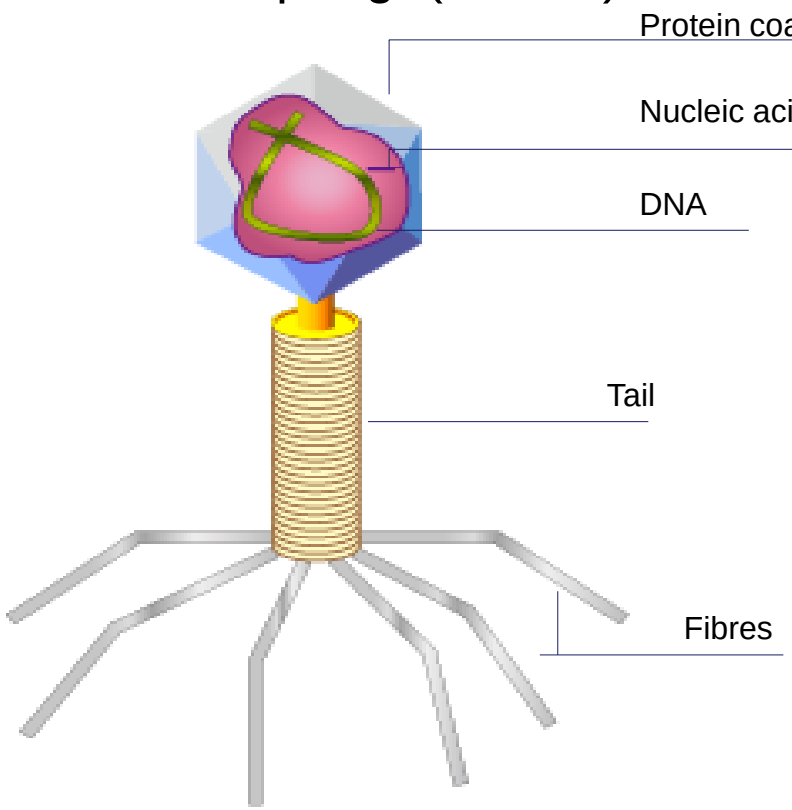
Diversity of microorganisms (from small size to large size)

Acellular entities (nanometer scale)

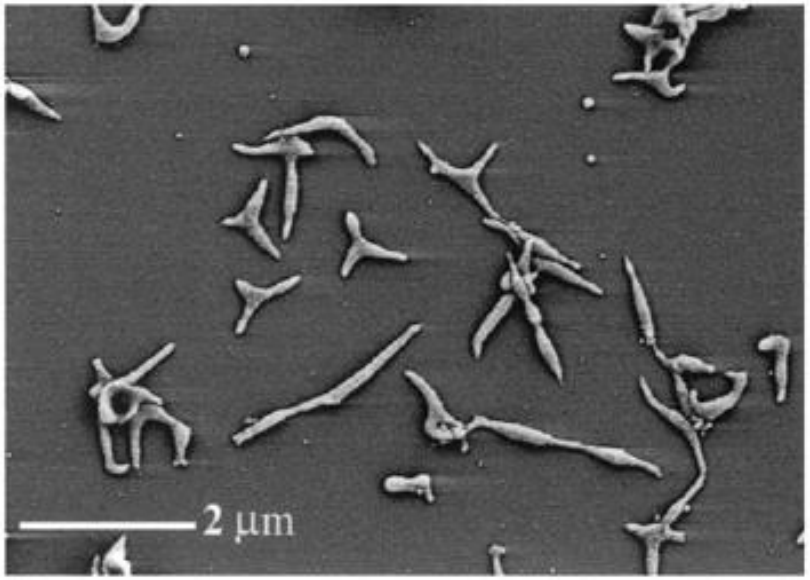


Prion

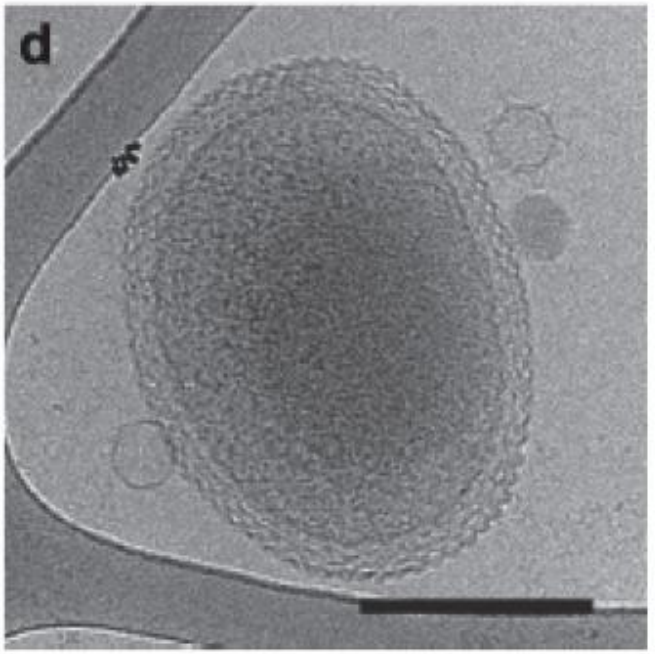
Bacteriophage(噬菌体)



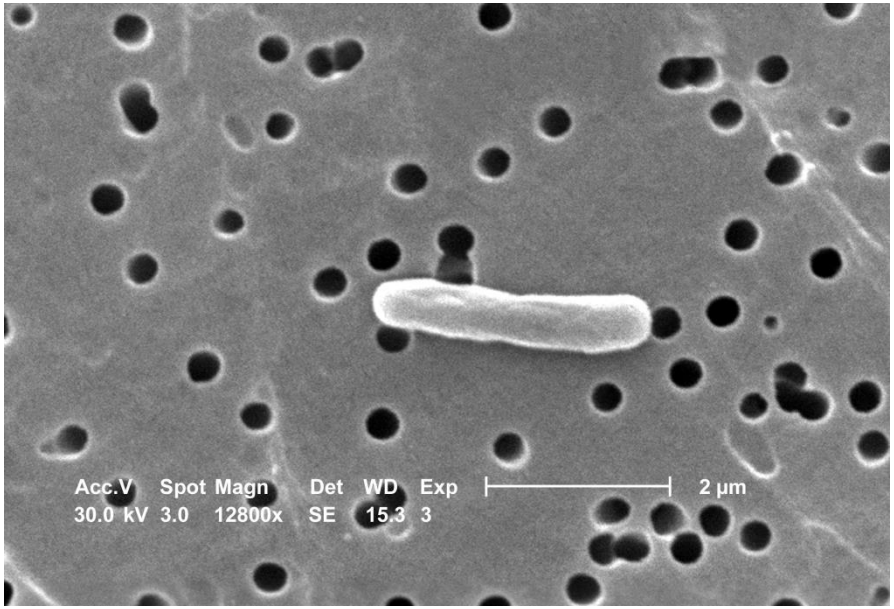
Bacteria and Archaea (0.1µm-?)



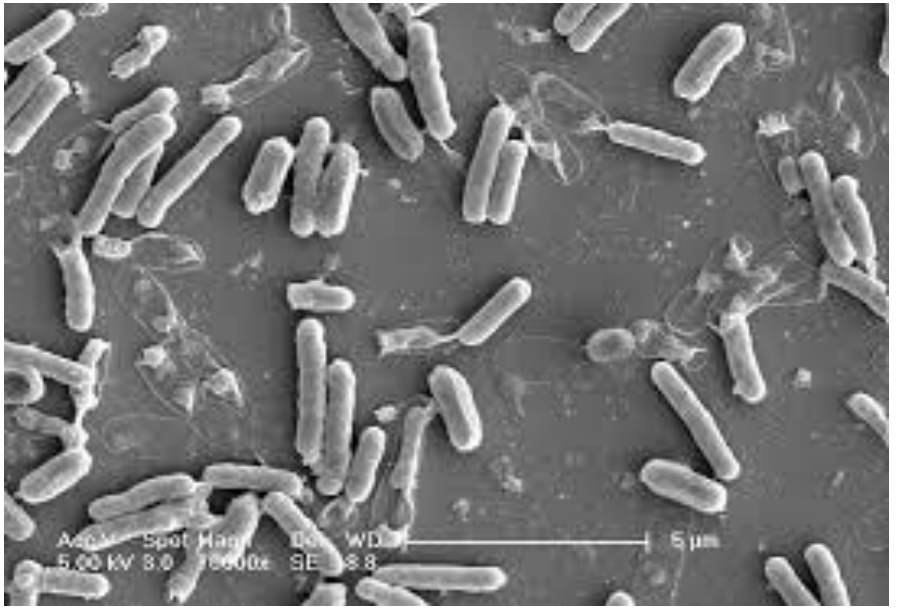
Mycoplasma 支原体



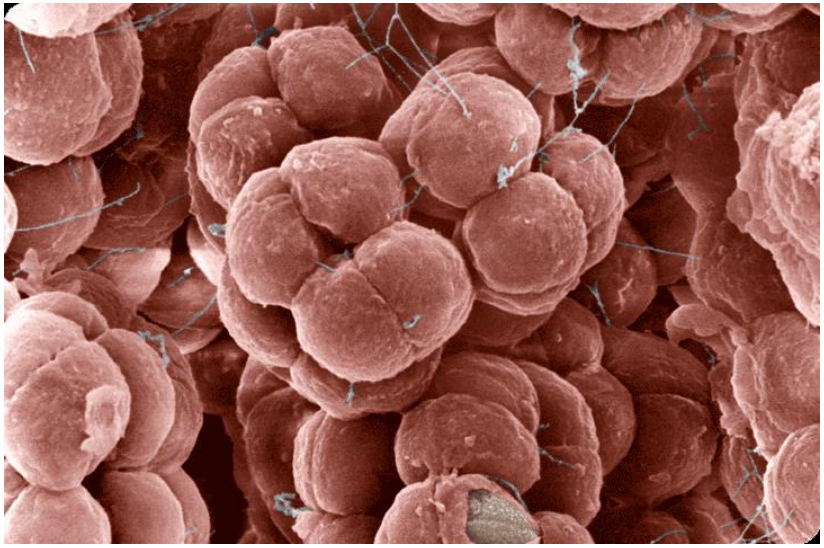
Unknown ultra-small microorganism



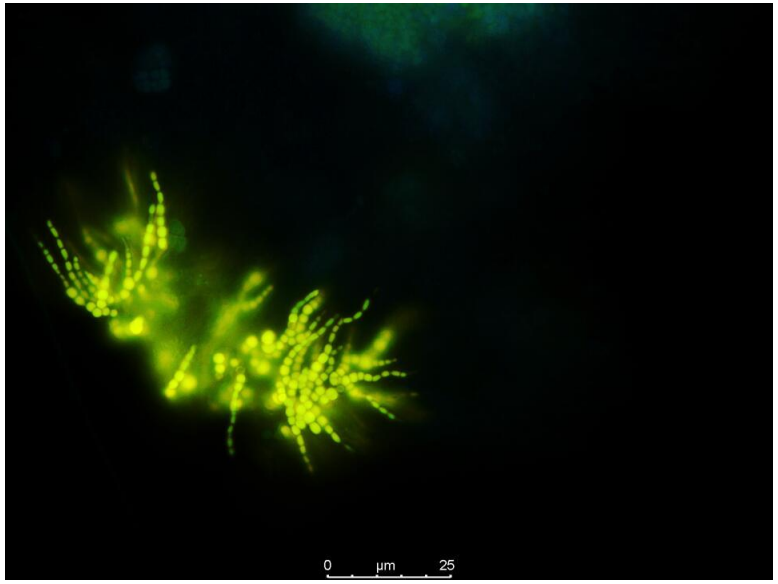
Escherichia coli (大肠杆菌)



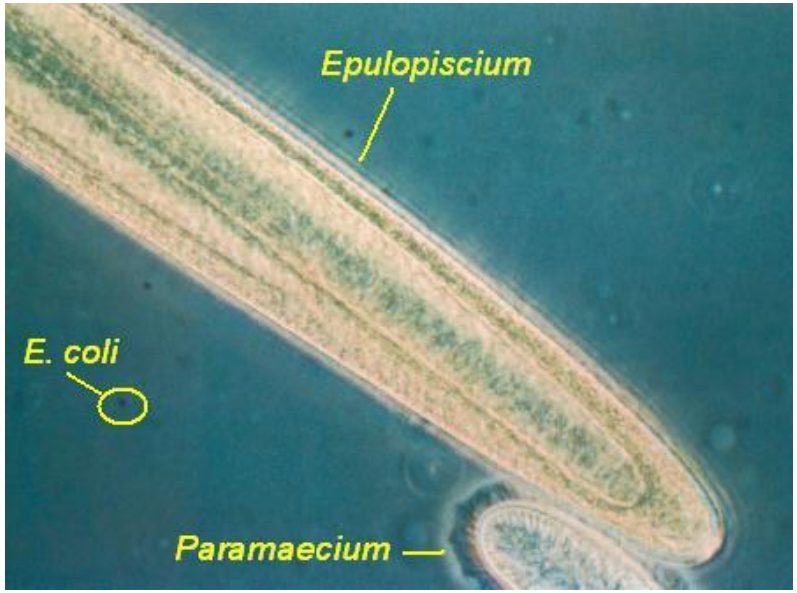
Bacillus subtilis（枯草芽孢杆菌）

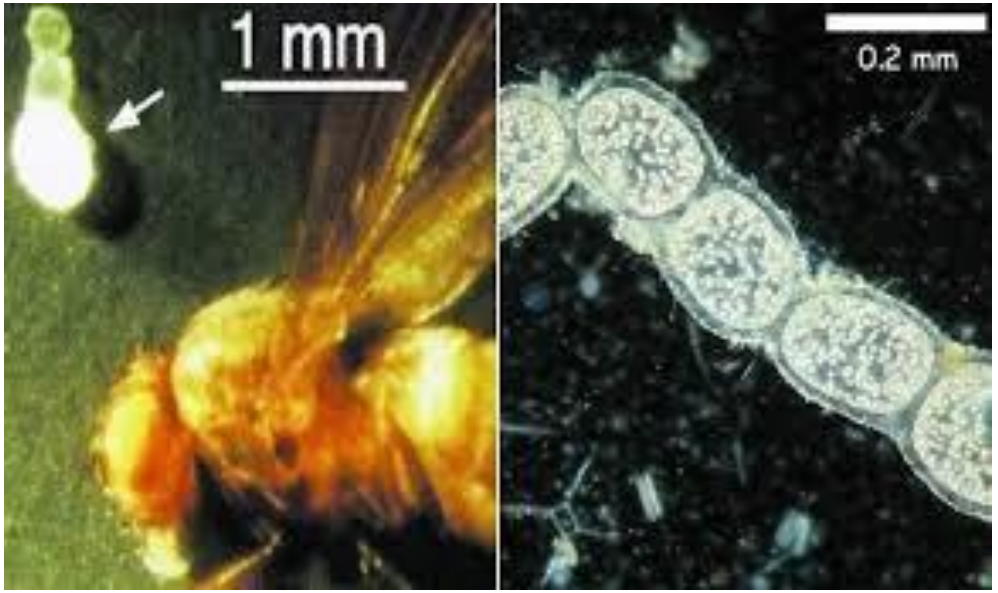


八叠产甲烷球古菌



Unknown bacteria in a bio-reator



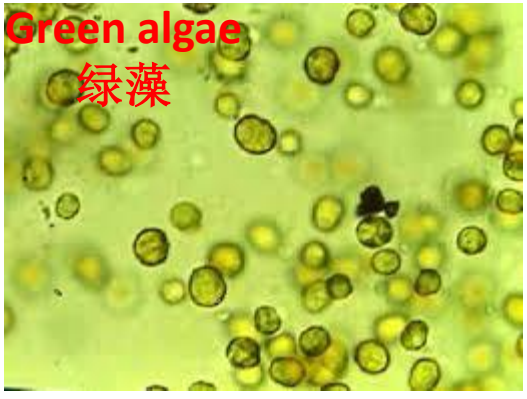


Epulopiscium fishelsoni

Thiomargarita namibiensis

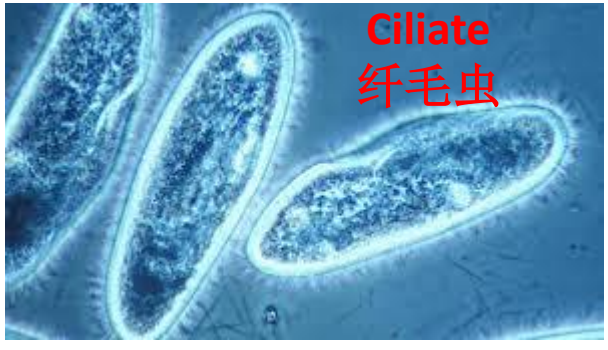
Eukaryotic microorganisms

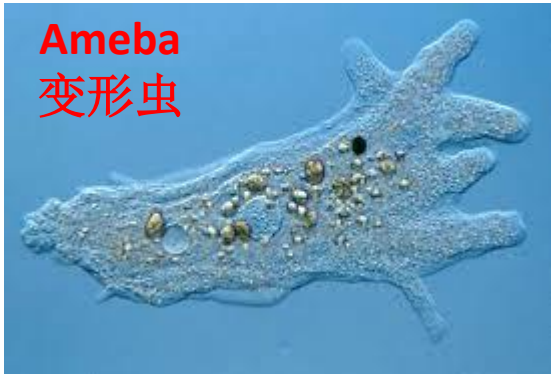
Several μm to ?



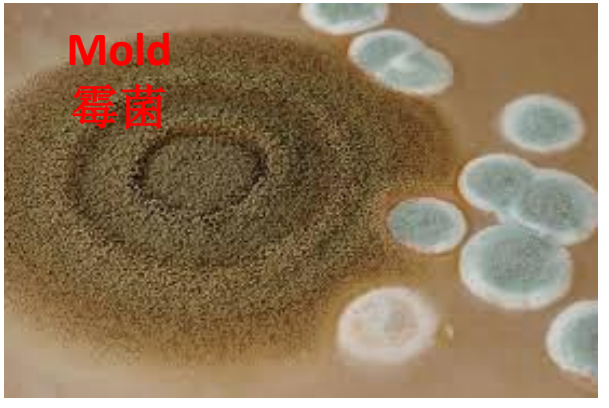
Microalgae
单细胞藻类

Protozoa 原生动物



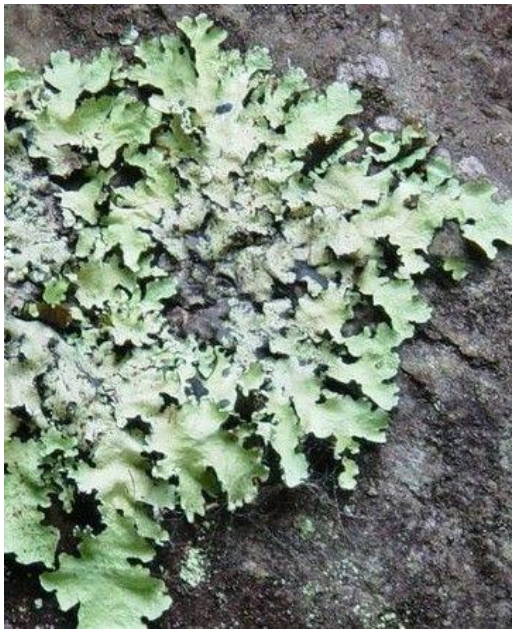


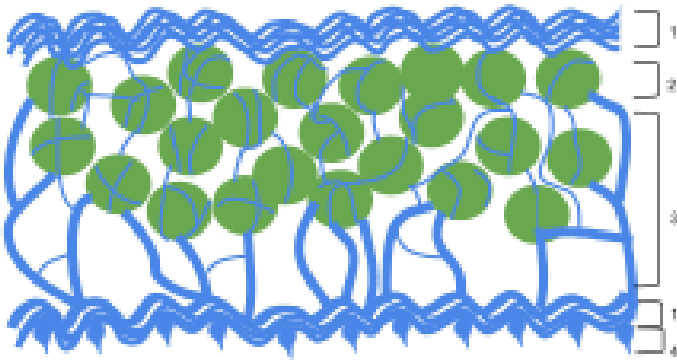
Fungus (Fungi)
真菌



Xenophyophore (a protozoa over 10 cm)

What is a **lichen(地衣)**?





A lichen is a **composite organism** that arises from algae or cyanobacteria living among filaments of multiple fungi in a symbiotic relationship.

Microbes have so diverse types and so many shapes!

Huge number of microorganisms on our planet

Sample	No. of prokaryotic cells
Soil (per gram)	10^9
Seawater (per mL)	10^4-10^6
Freshwater (per mL)	10^4-10^6
Tap water (per mL)	10^3
Clean air (per m^3)	10^5
Human feces (per gram)	10^{11}
Skin (per person)	10^{12}

Microbes in the evolution of life

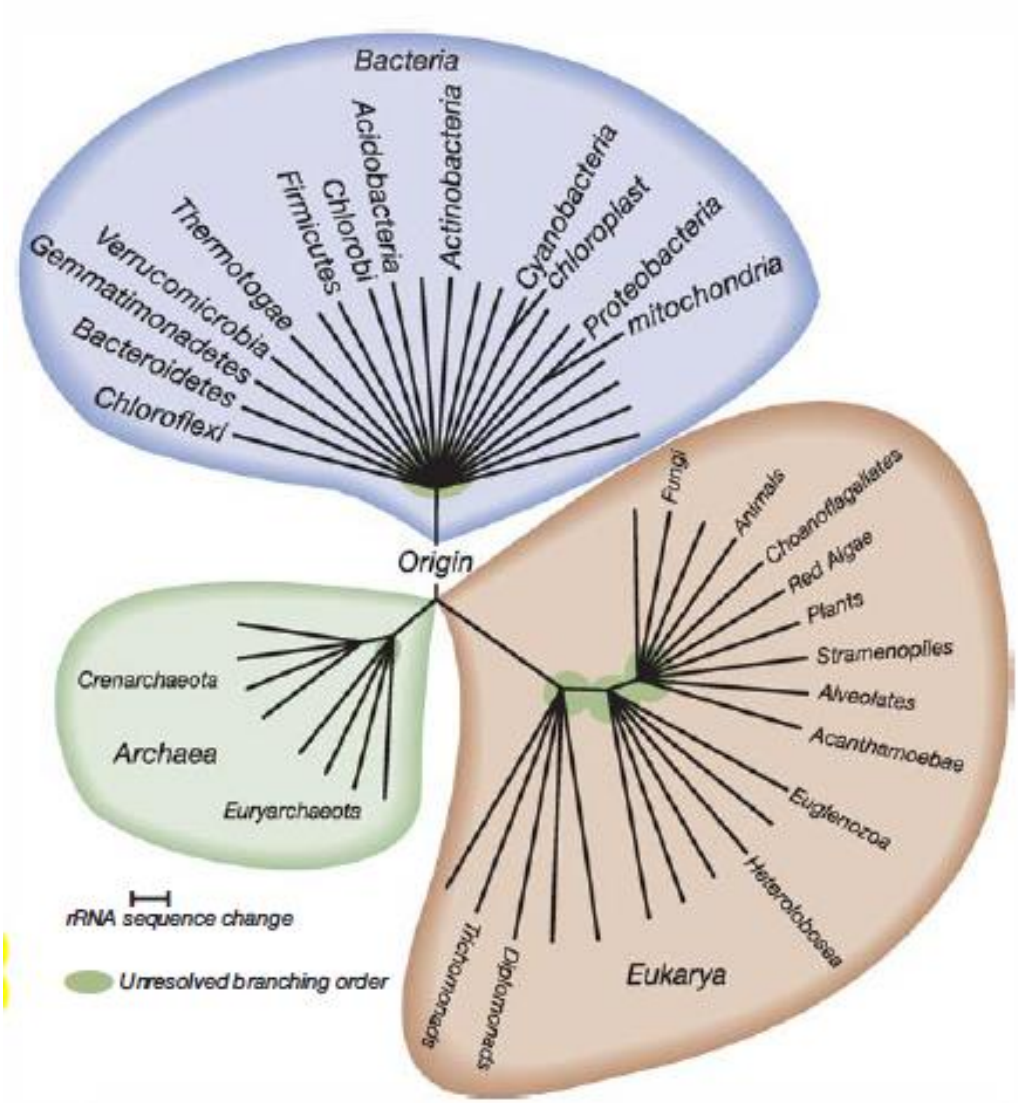


Figure 1.2 Universal Phylogenetic Tree. These evolutionary relationships are based on rRNA sequence comparisons. To save space, many lineages have not been identified.

Three Domains of Life

The six kingdoms:
Animalia, Plantae, Fungi, Protista, Archaea/Archaeabacteria, and Bacteria/Eubacteria

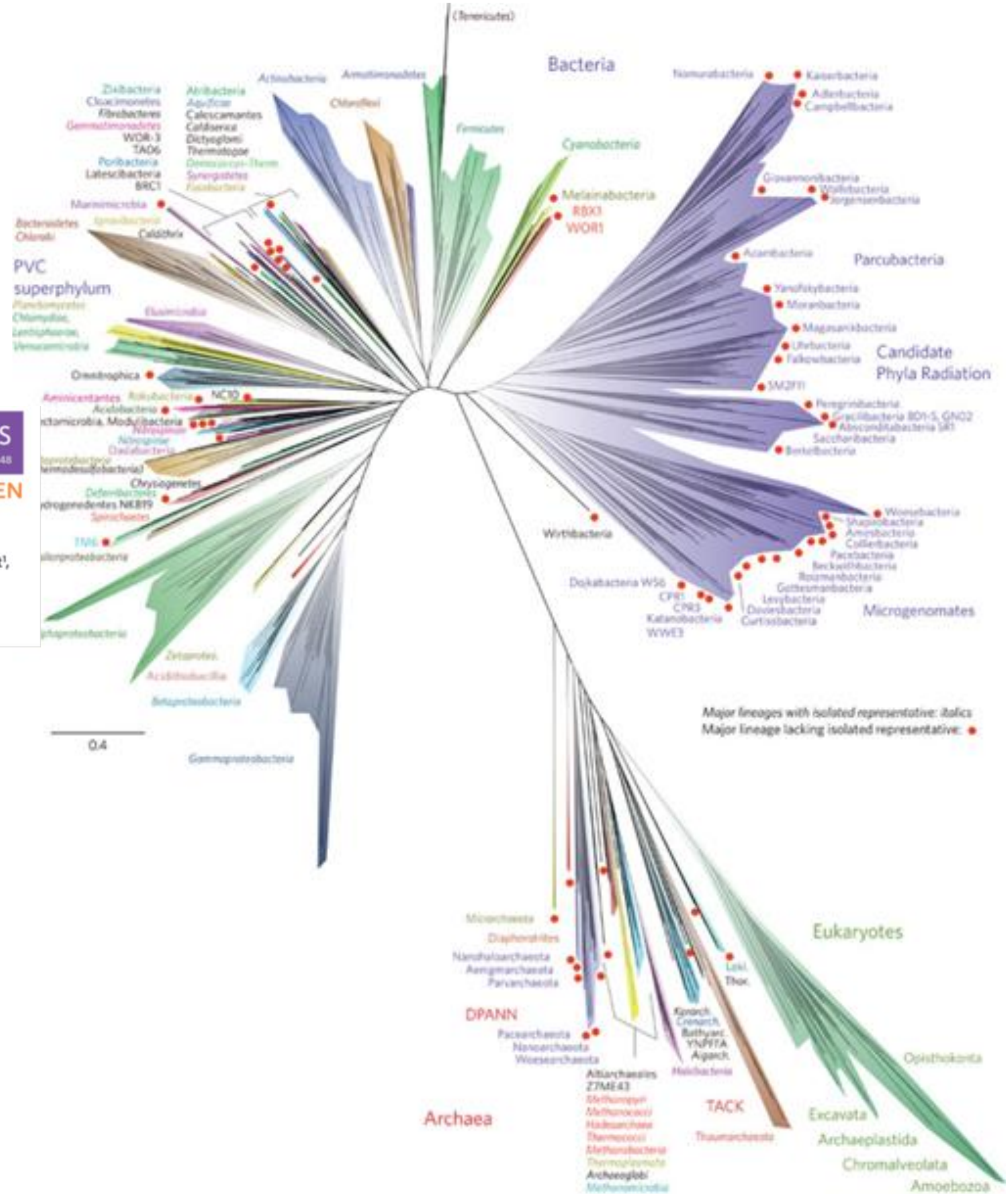
<D>Domain (域)

<K>Kingdom (界)
<P>Phylum (门)
<C>Class (纲)
<O>Order (目)
<F>Family (科)
<G>Genus (属)
<S>Species (种)

nature microbiology | LETTERS
PUBLISHED: 11 APRIL 2016 | ARTICLE NUMBER: 16048 | DOI: 10.1038/NMICROBIOL.2016.48
OPEN

A new view of the tree of life

Laura A. Hug[1†], Brett J. Baker[2], Karthik Anantharaman[1], Christopher T. Brown[3], Alexander J. Probst[1], Cindy J. Castelle[1], Cristina N. Butterfield[1], Alex W. Hernsdorf[3], Yuki Amano[4], Kotaro Ise[4], Yohey Suzuki[5], Natasha Dudek[6], David A. Relman[7,8], Kari M. Finstad[9], Ronald Amundson[9], Brian C. Thomas[1] and Jillian F. Banfield[1,9]*



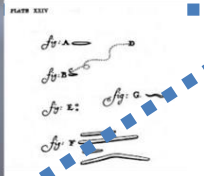
Timeline of Microbiology

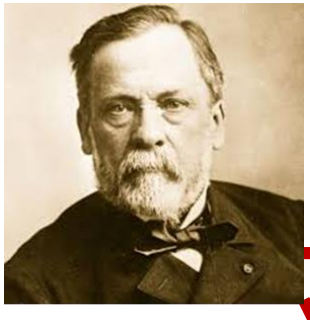
1665, Hook published Micrographia

Robert Hook
(1635-1703)

1674-1676, Leeuwenhoek discovered microorgansims

Antony van Leeuwenhoek
(1632-1723)

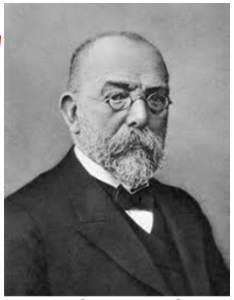




Louis Pasteur
(1822-1895)

Mid-late 19th century

Pasteur's three main contributions to microbiology



Robert Koch
(1843—1910)

Koch's two main contributions to microbiology

1995 the first prokaryotic genome was sequences

1928, Griffith discovers bacterial transformation

1929, Fleming discovered penicillin

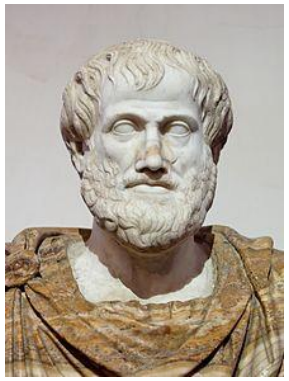
1944, Avery verified was the carrier of genes in cells

1977, Woese separated *Archaea* from *Bacteria*

Louis Pasteur
1822-1895

Pasteur ‘s contributions:

I. Settle (refute) the matter of *spontaneous generation* (生命"自然发生说", ***living organisms could be directly generated from nonliving matters***)



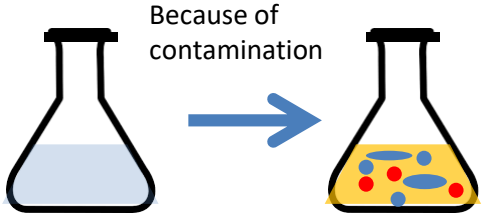
Aristotle

Larvae of fly generated from rotten meat

Francesco Redi
1626-1697

Seal the rotten food and larvae do not present

1745, John Needham



Freshly boiled and sealed broth

Cloudy because of presence of microorganisms

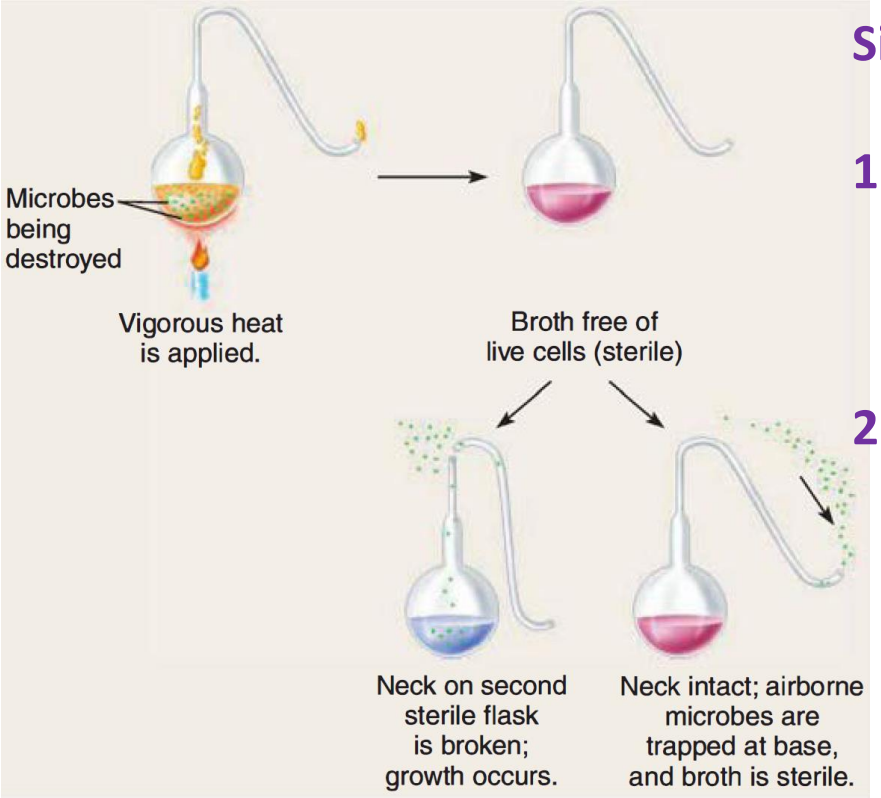
Lazzaro Spallanzani

Use tightly sealed flask
No growth !
Need air for change?

Use cotton to filtrate air

→ **No growth !** **Georg Schroder**

→ **Growth!** **Felix Pouchet**



Significances of this contribution:

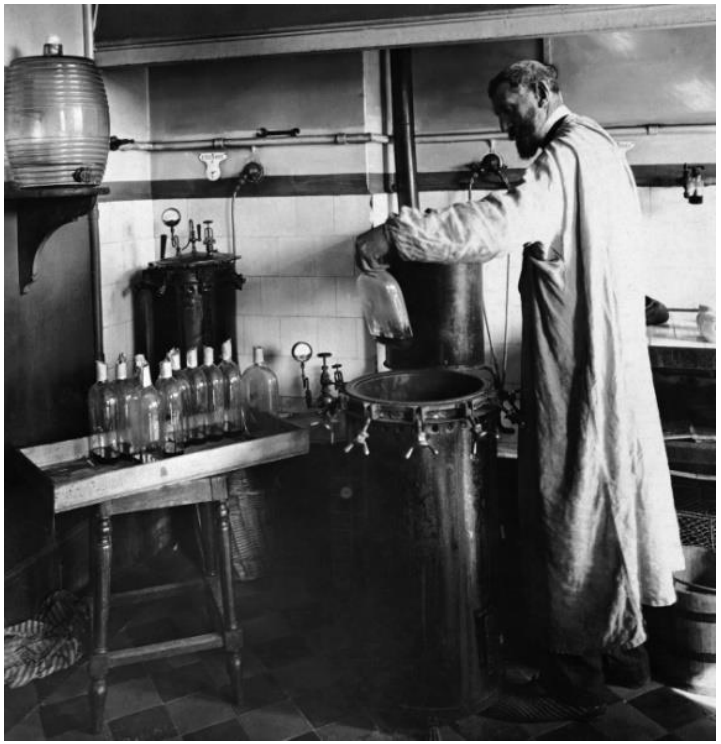
1. **Break the obstacle to the development of microbiology as a scientific discipline**

2. **Developed liquid media for culturing microbes and methods for sterilizing media and maintaining their sterility**

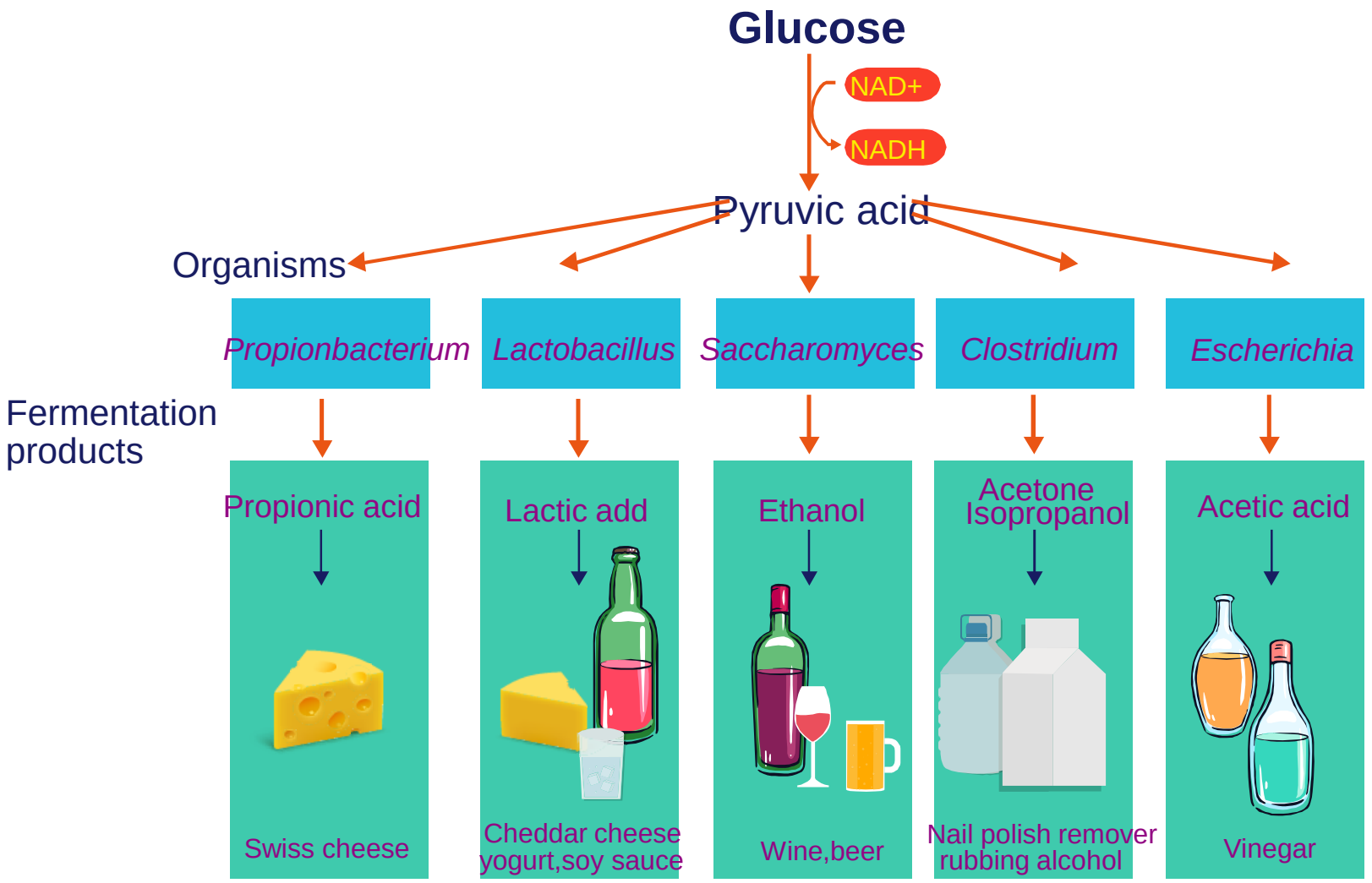
Only rigorous and well-designed experiments give reliable conclusions!

II. Fermentation by microorganisms

Fermentation is a metabolic process that consumes sugar in the absence of oxygen



Fermentation products from different microorganisms

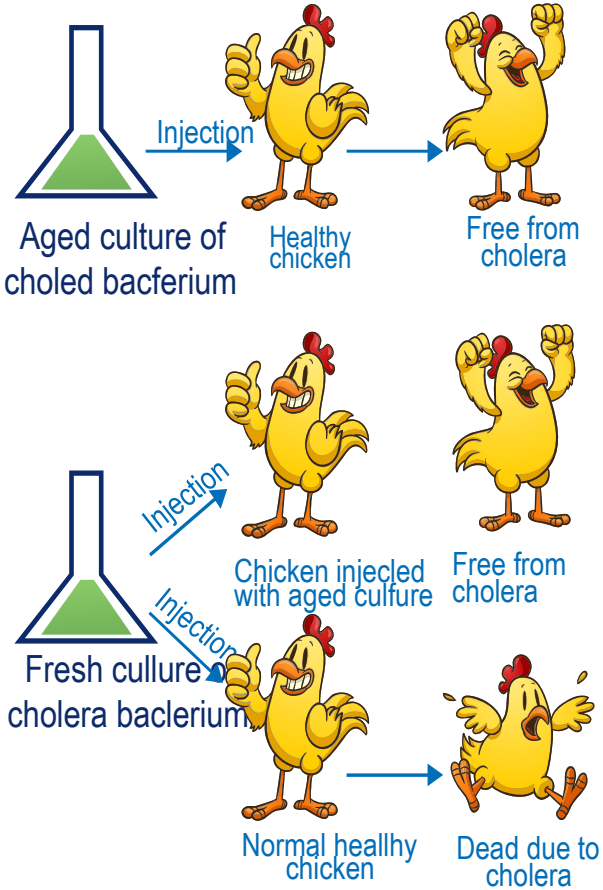


Industrial market helps the development of microbiology.

III. Invention of vaccine as a pioneer of immunology

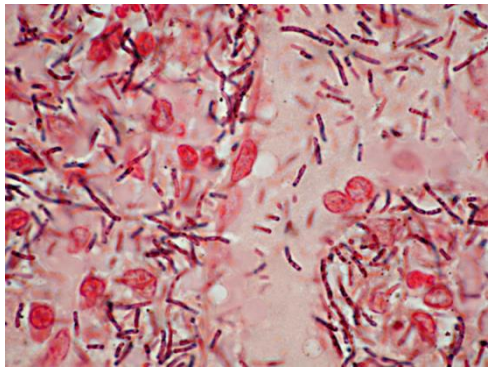
*In 1770s, **Edward Jenner** had used material from cowpox (牛痘) lesions to protect people against smallpox (天花)*

Vaccine for chicken cholera

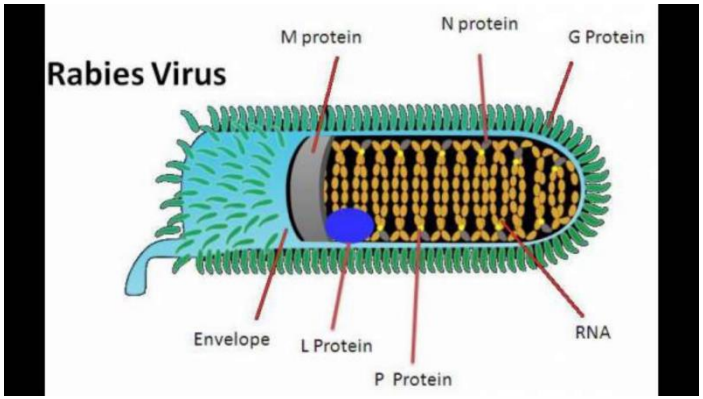


In the fields of observation chance favors only the prepared mind.

Louis Pasteur



Pasteur invented **anthrax vaccine (炭疽疫苗)** and **rabies vaccine (狂犬疫苗)** lately



Koch‘s contributions:

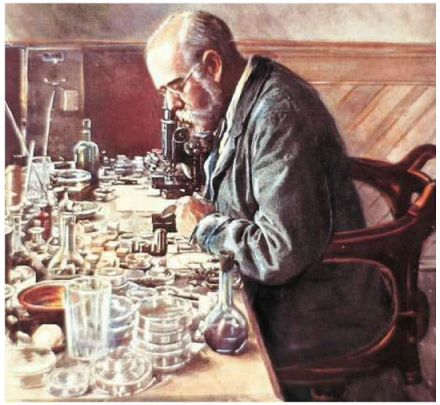
I. Pure culture on agar plate

The pure culture is the foundation for all research on infectious disease.

----Robert Koch

Utilized by many microbes and melt at 37°C

Microorganisms are changed from time to time in broth medium. (contamination)



Potato slice → **Gelatin** → **Agar**

Not suitable for growing many microorganisms!

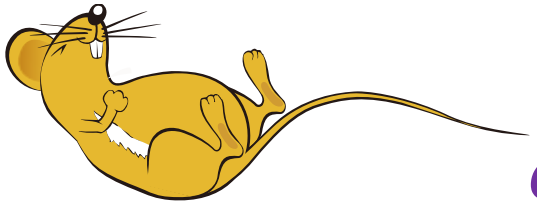
Polysaccharide from algae
Not degradable for most microbes
Not melt below 90-100°C
Transparent

Koch‘s contributions:

II. Koch’s Postulates to determine the causative microorganism of a disease

Postulate 1

The same microorganisms are present in every case of the disease.

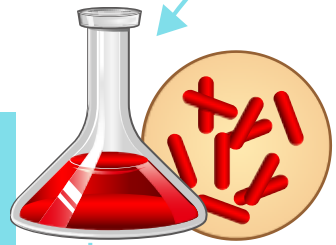


Universality
(普遍性)

Golden standard for determining pathogen!

Postulate 2

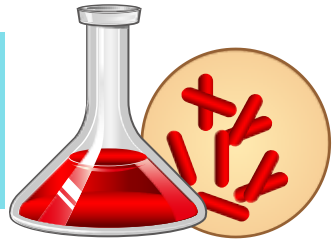
Microorganisms could be isolated in pure culture

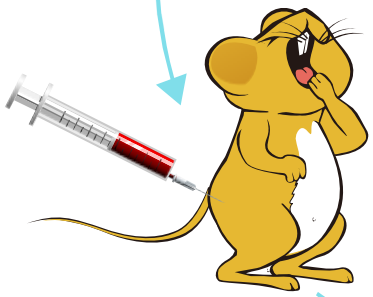


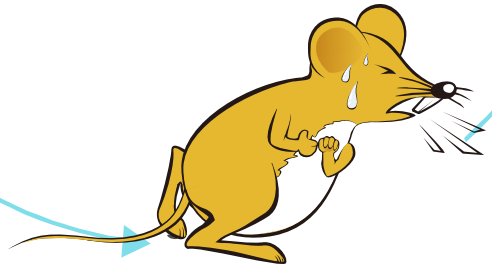
Uniqueness
(唯一性)

Postulate 4

The identical microorganisms are isolated and re-cultivated from the tissue specimens of the experimental animal.







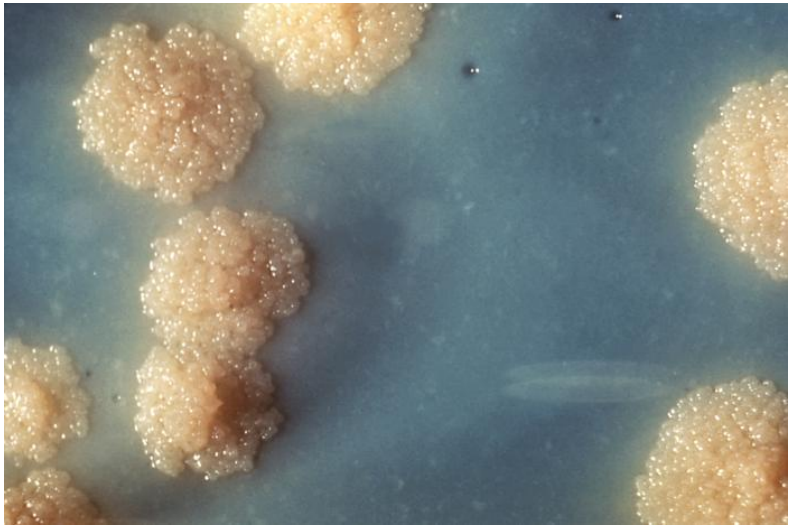
Postulate 3

Microorganisms form the pure culture are inoculated into a healthy, susceptible animal. The disease is reproduced.

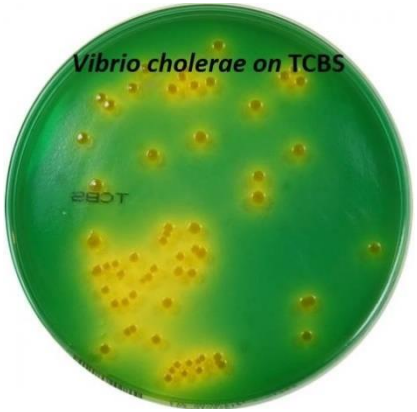
Reproducible causality
可重复的因果性

Pathogens isolated by Koch

Bacillus anthraci (炭疽杆菌)
Pathogen for **anthrax**



Mycobacterium tuberculosis (结核分支杆菌)
Pathogens for **tuberculosis**

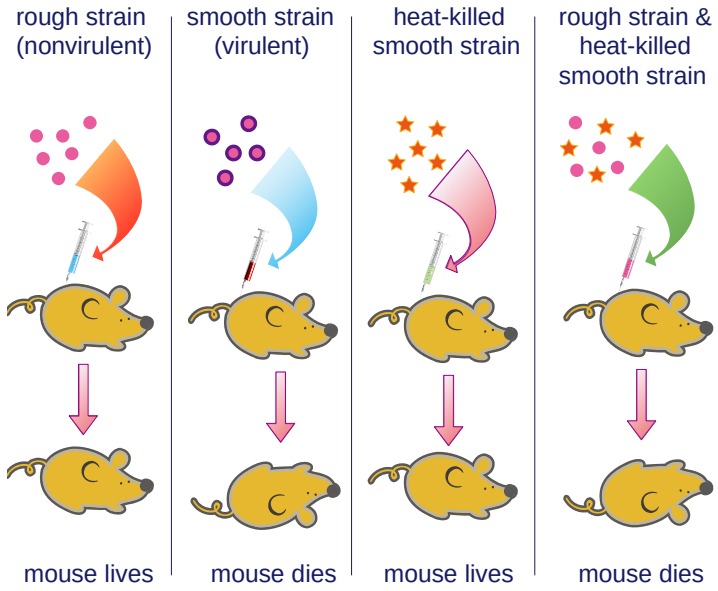


Vibrio cholerae 霍乱弧菌; Pathogen for **cholera**

Other Milestones in Microbiology

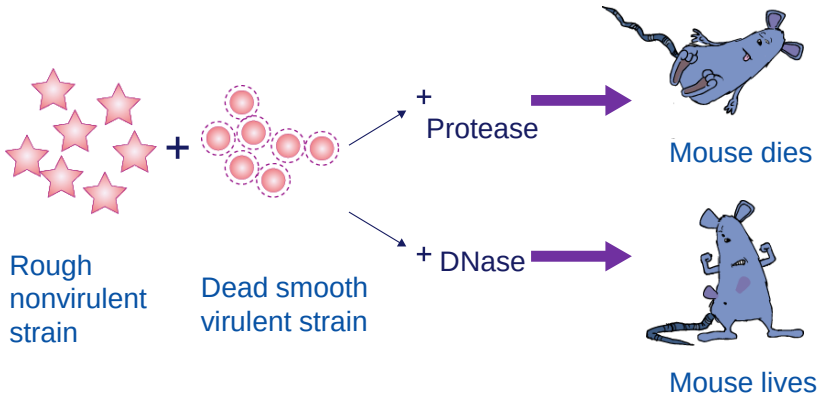
(Details will be introduced in corresponding chapters)

In 1928, **Griffith's** experiment, reported by Frederick Griffith, suggests that bacteria are capable of transferring genetic information through a process known as transformation.

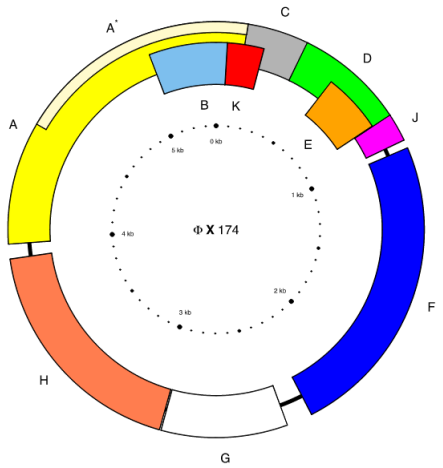


In 1929, Penicillin was discovered by **Alexander Fleming**.

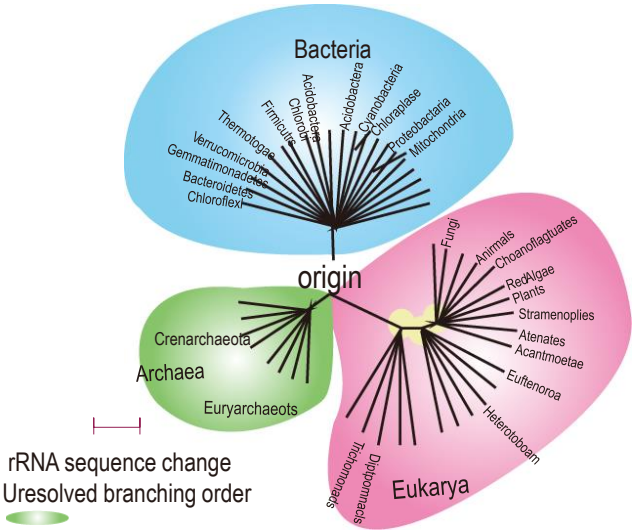
In 1944, **Oswald Avery** verified DNA was the carrier of genes in cells



In 1977, **Frederick Sanger** sequenced the first genome of bacteriophage ϕX174.



Carl Woese
(1928—2012)



Universal phylogenetic tree of life based on **rRNA gene sequence**

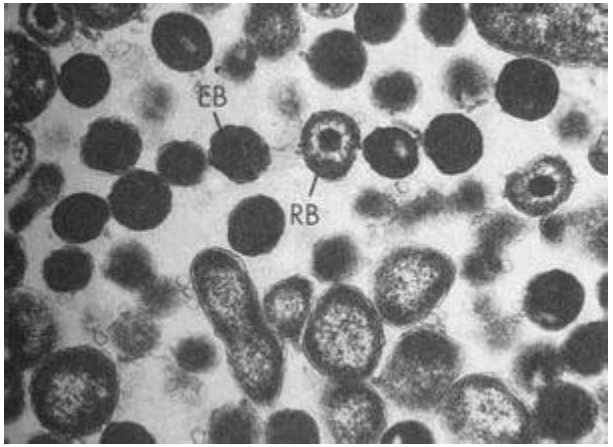
From 1995, the genomics era

- 1995, the first Bacteria genome
- 1996, the first Archaea genome
- 1997, the first fungi genome
- ……

In 1977, the three domains of all cell organisms

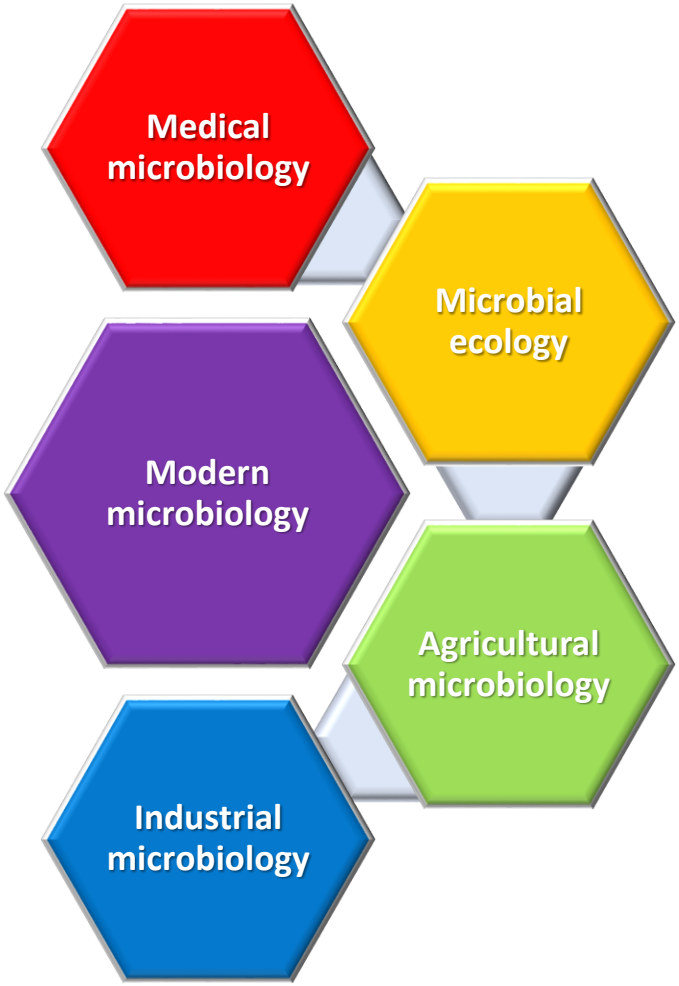
Chinese microbiologist：汤飞凡（1897-1958）

“衣原体之父”



Chlamydia trachomatis
沙眼衣原体

Major branches in modern microbiology

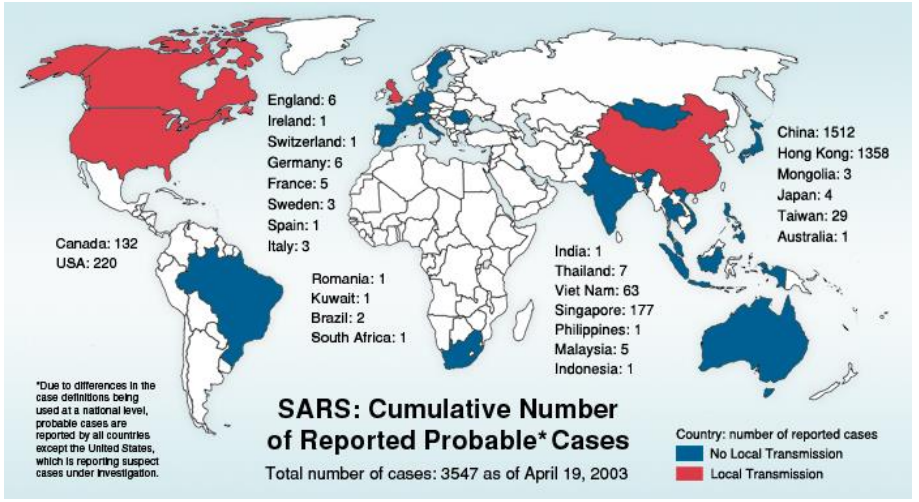


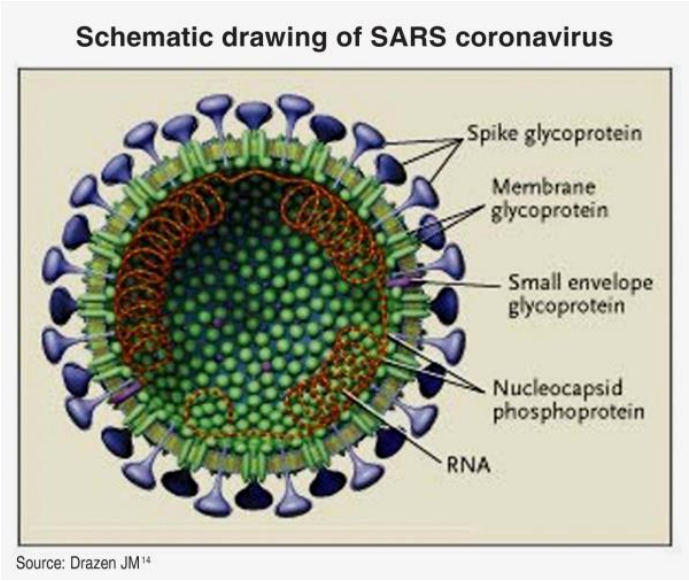
Medical microbiology

Infection is the invasion of an organism's body tissues by disease-causing agents, their multiplication, and the reaction of host tissues to these organisms and the toxins they produce.

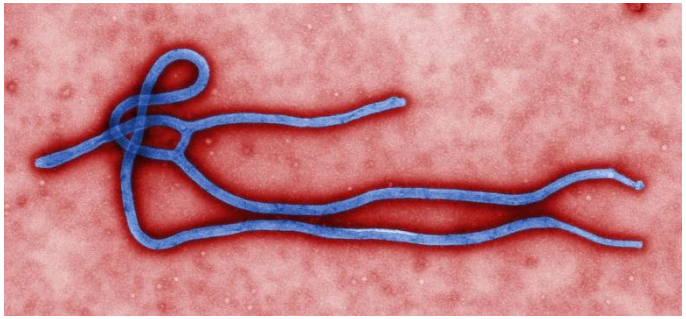
In 2010 about 10 million people died of an infectious disease. (from Wikipedia)

Severe acute respiratory syndrome (SARS, 2003)

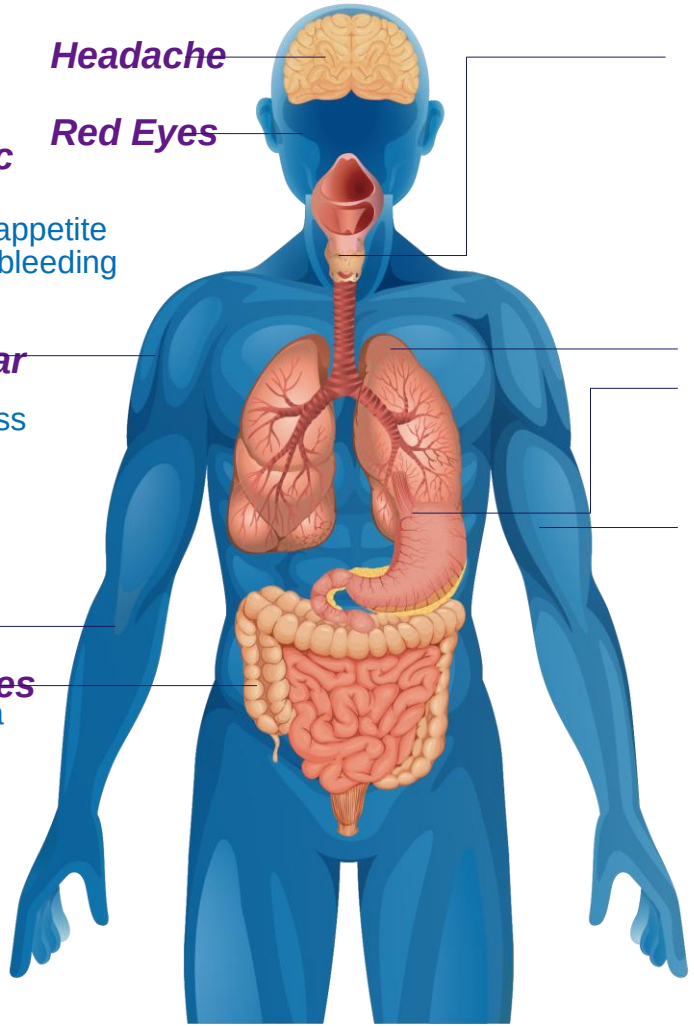




Ebola virus



Symptoms of Ebola



Headache

Red Eyes

Sysemic
- Fever
- Lack of appetite
- Internal bleeding

Muscular
- Aches
- Weakness

Joints
- Aches

Intestines
- Diarrhea

Pharynx and lugs
- Hiccups
- Sore throat
- Difficulty breathing
- Difficulty swallowing

Chest pain

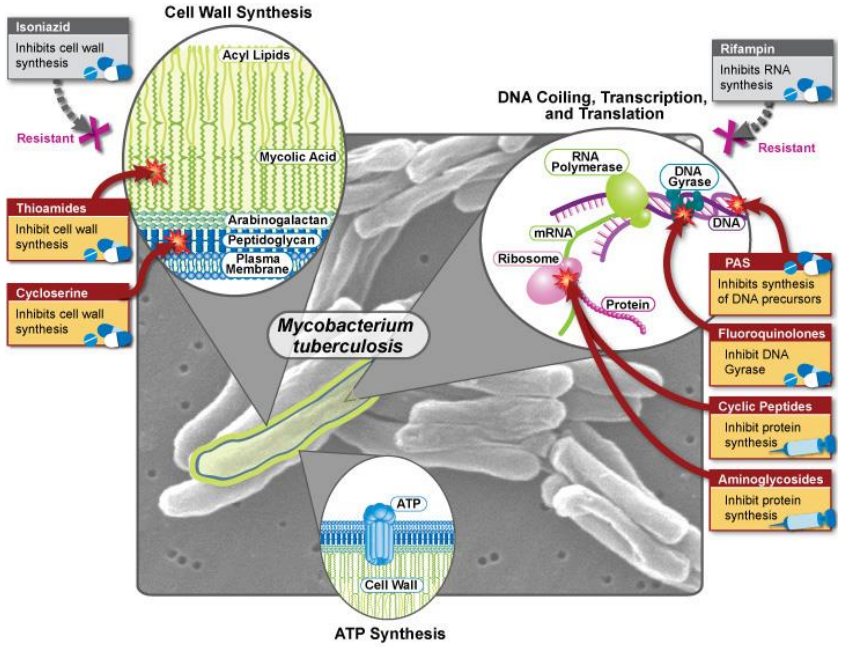
Stomach
- Pain
- Vomiting

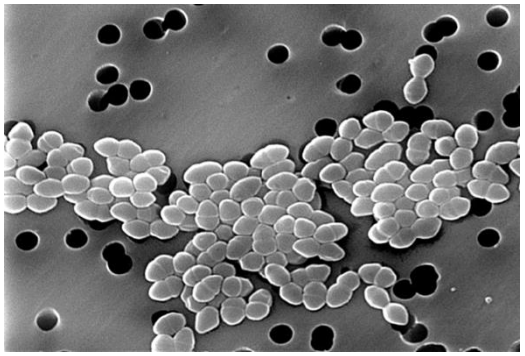
Skin
- Rash
- Bleeding

Antibiotic resistance pathogens

Super bacteria, also referred to as super bugs, are bacteria that have grown resistant to most antibiotics.

MRSA 耐甲氧西林葡萄球菌 **化脓感染**





VRE 抗万古霉素肠球菌 **败血症**

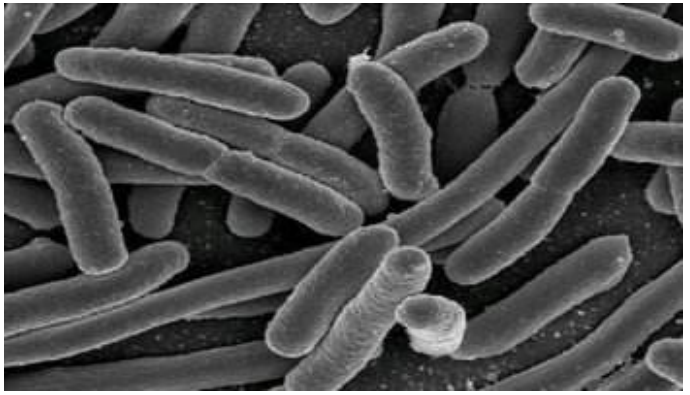
Resistance to antibiotics could lead to the deaths of ten million people a year globally by 2050.

MDR-TB
多重抗药性结核分支杆菌
结核病

“伤寒玛丽”的故事

“健康带菌者”

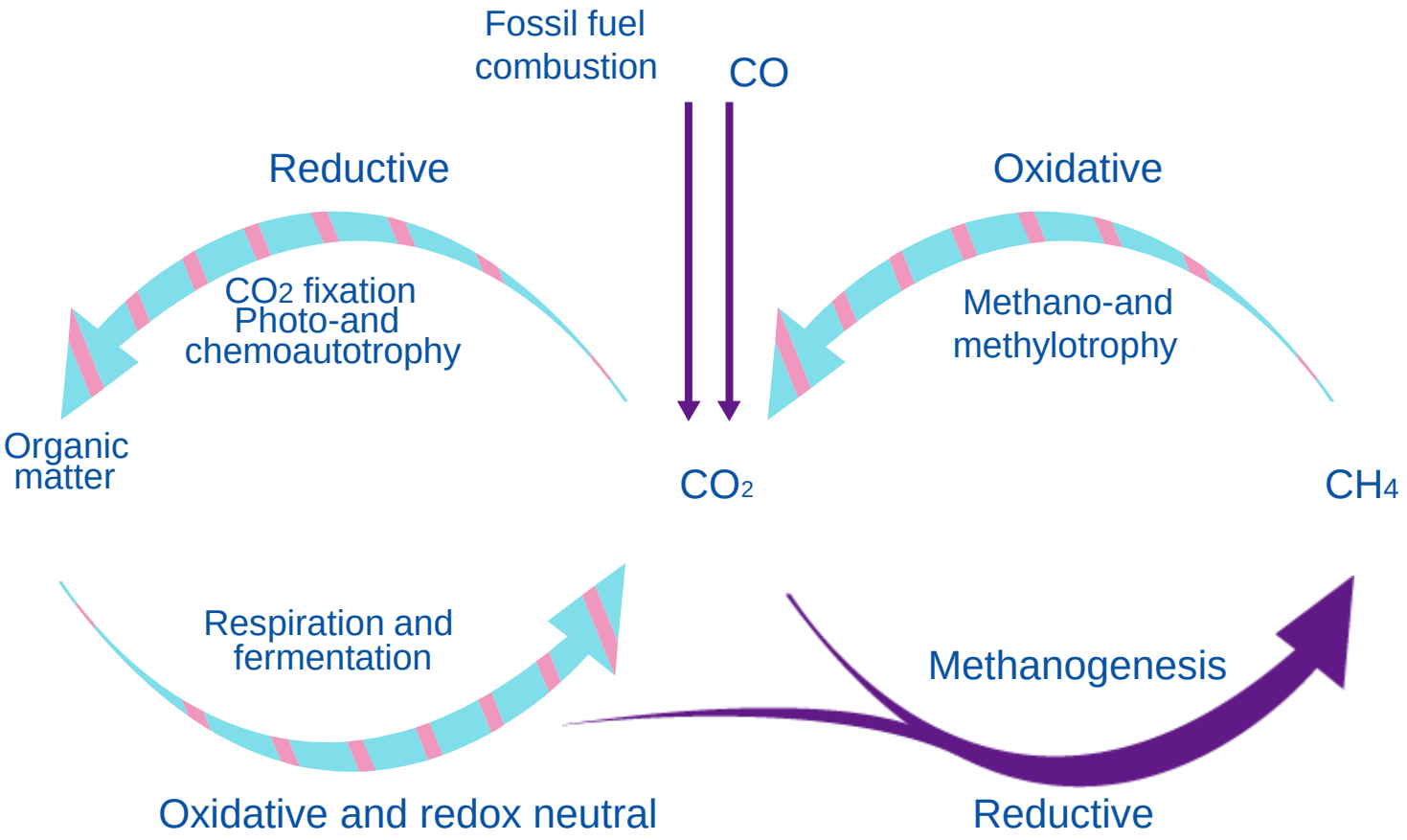
1869-1938



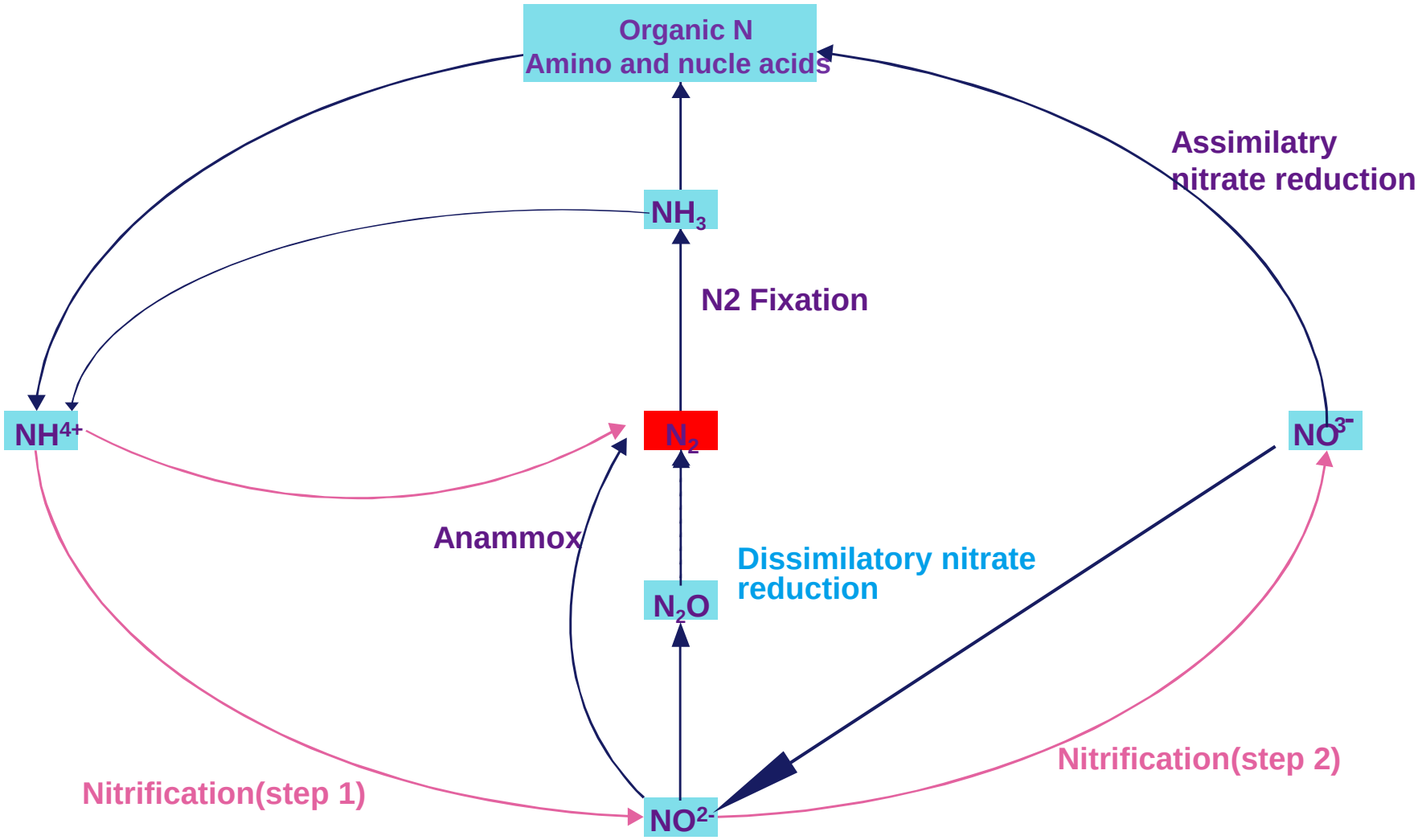
Salmonella typhi

At least three deaths were attributed to her, …
some have estimated that she may have caused 50 fatalities

Microbial ecology



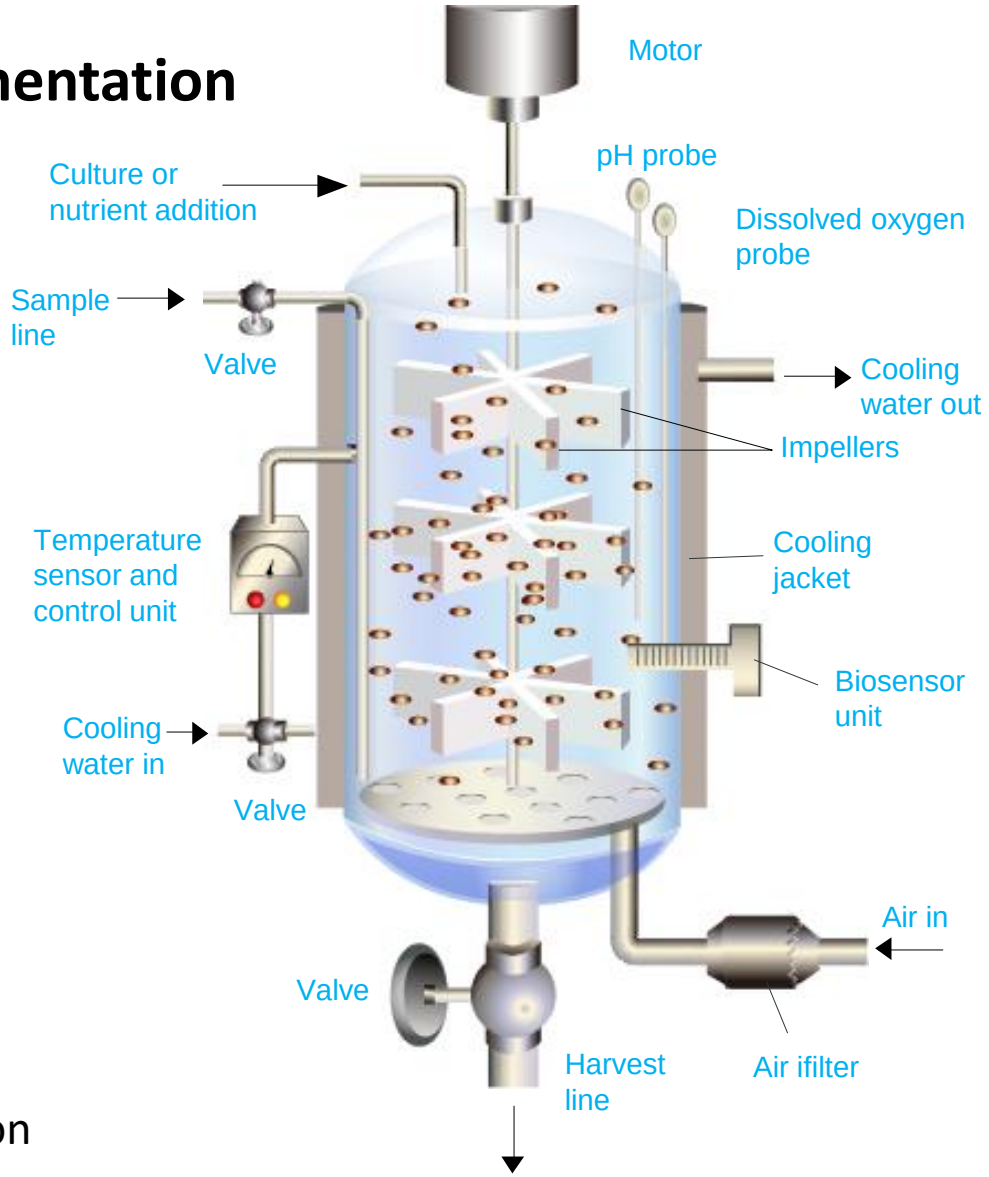
The Microbial Carbon Cycle



The Microbial Nitrogen Cycle

Industrial microbiology

Industrial fermentation



Food:

Critic acid
Lactic
Oils
Fatty acids
Polysaccharides
etc.

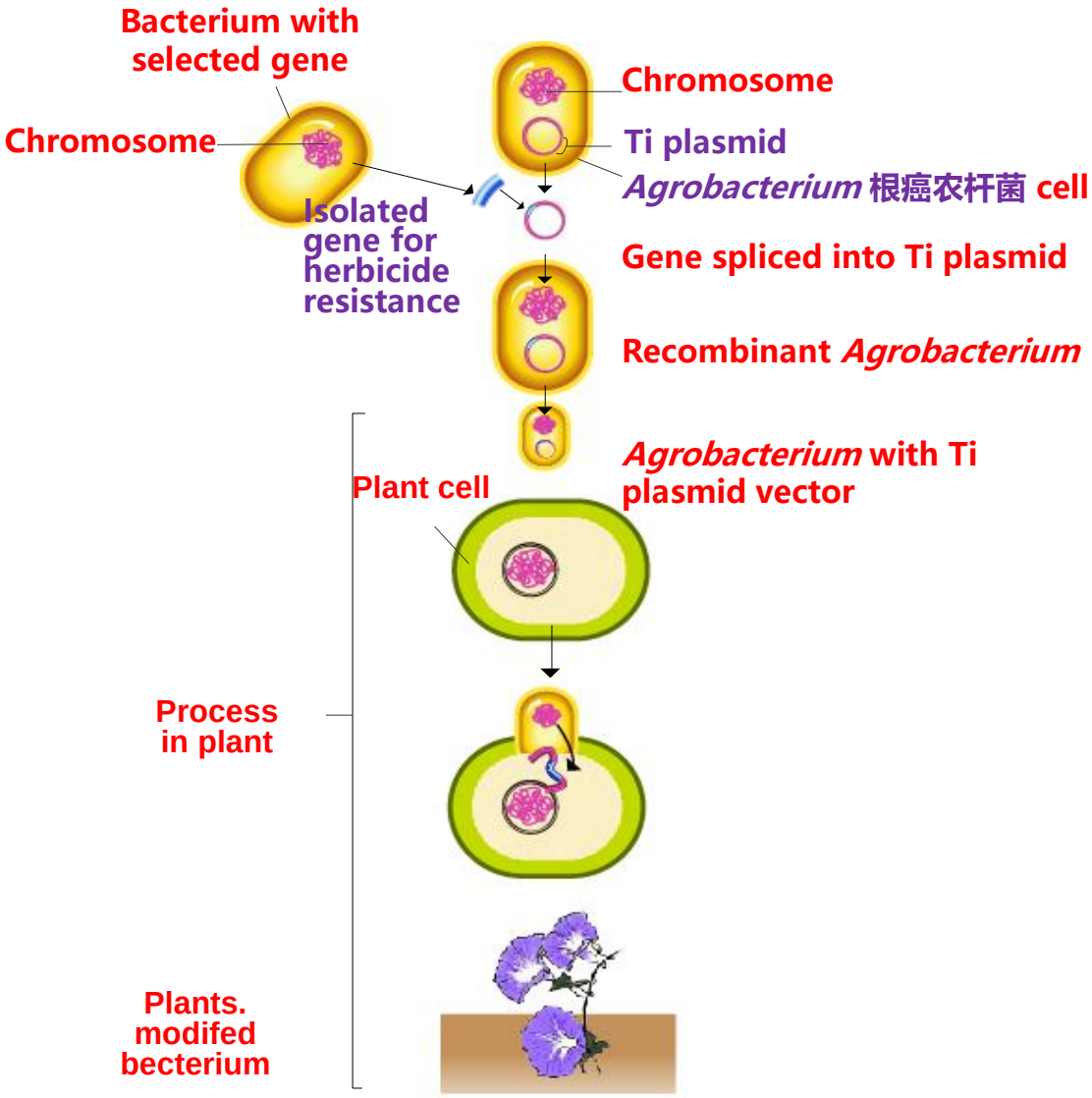
Control:

Temperature
pH
Dissolve oxygen
Stirring
Nutrient addition
etc.

Non-food:

Antibiotics
Vitamins
Amino acids
etc.

Agriculture microbiology



Genetic engineering of agriculture

Microorganisms are in

the air

water

food

ourselves

……

Microbiology are involved in all our life.

Homework

- Parasites (寄生虫) are objects of microbiology. Is it right? Why?

- 2016全球最受公众关注的科学成果中，生命科学部分的10个成果的2项与微生物学直接相关。其中“科学家人工合成仅473个基因的`最小` 细菌”，请查询资料并就你的理解，介绍该成果的意义。

The next lecture:
Bacterial Cell Structure