Lection 1

Medical microbiology and immunology, its goals and tasks, stages of development. Systematics and classification of microorganisms. Classification, morphology and ultrastructure of bacteria, fungi, protozoa and viruses

Microbiology

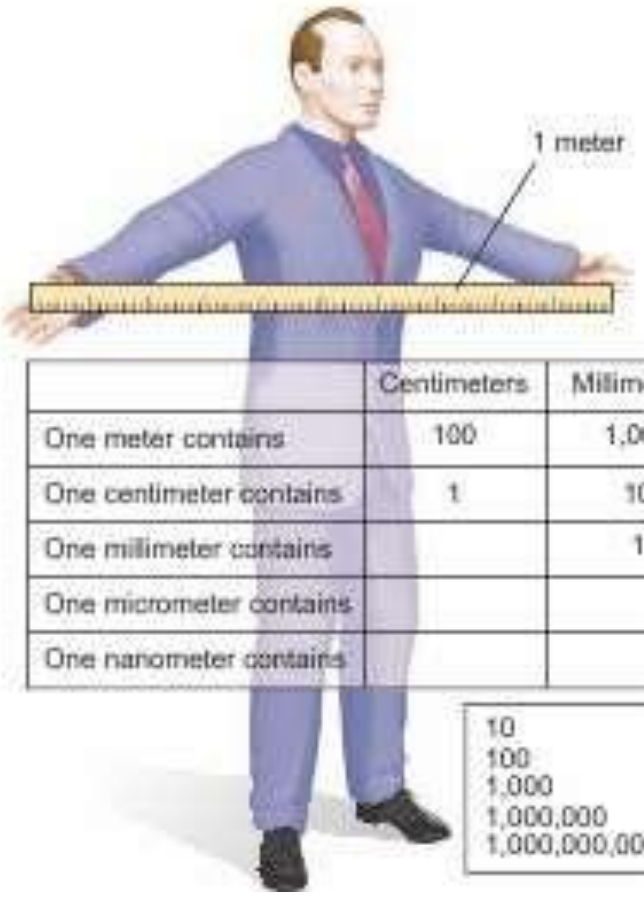
Microbiology – ***«mikros»-small, «bios»-*** **life,** ***«logos»-the study.***

Science of pattern, life activity and ecology of the microbes – smallest life forms of flora and fauna origin, which are invisible for the naked eye.

The size of microbes are measured in micrometers (mm) and nanometers (nm).

Metric unit of length

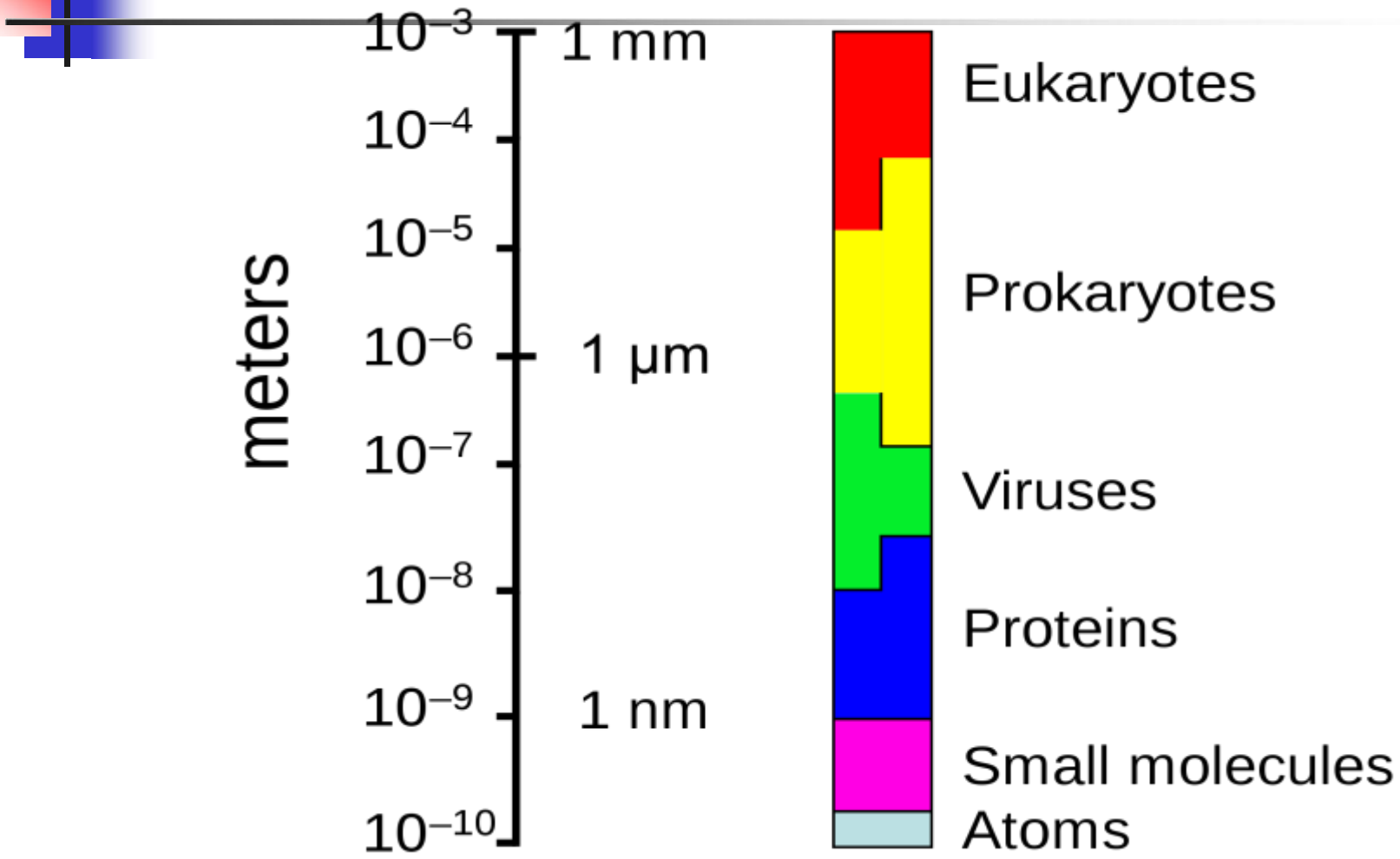
FIGURE 2-1. Representations of metric units of measure and numbers.



	Centimeters	Millimeters	Micrometers	Nanometers
One meter contains	100	1,000	1,000,000	1,000,000,000
One centimeter contains	1	10	10,000	10,000,000
One millimeter contains		1	1,000	1,000,000
One micrometer contains			1	1,000
One nanometer contains				1

$10 = 1 \times 10^1$
$100 = 1 \times 10^2$
$1{,}000 = 1 \times 10^3$
$1{,}000{,}000 = 1 \times 10^6$
$1{,}000{,}000{,}000 = 1 \times 10^9$

Relative scale for microbes

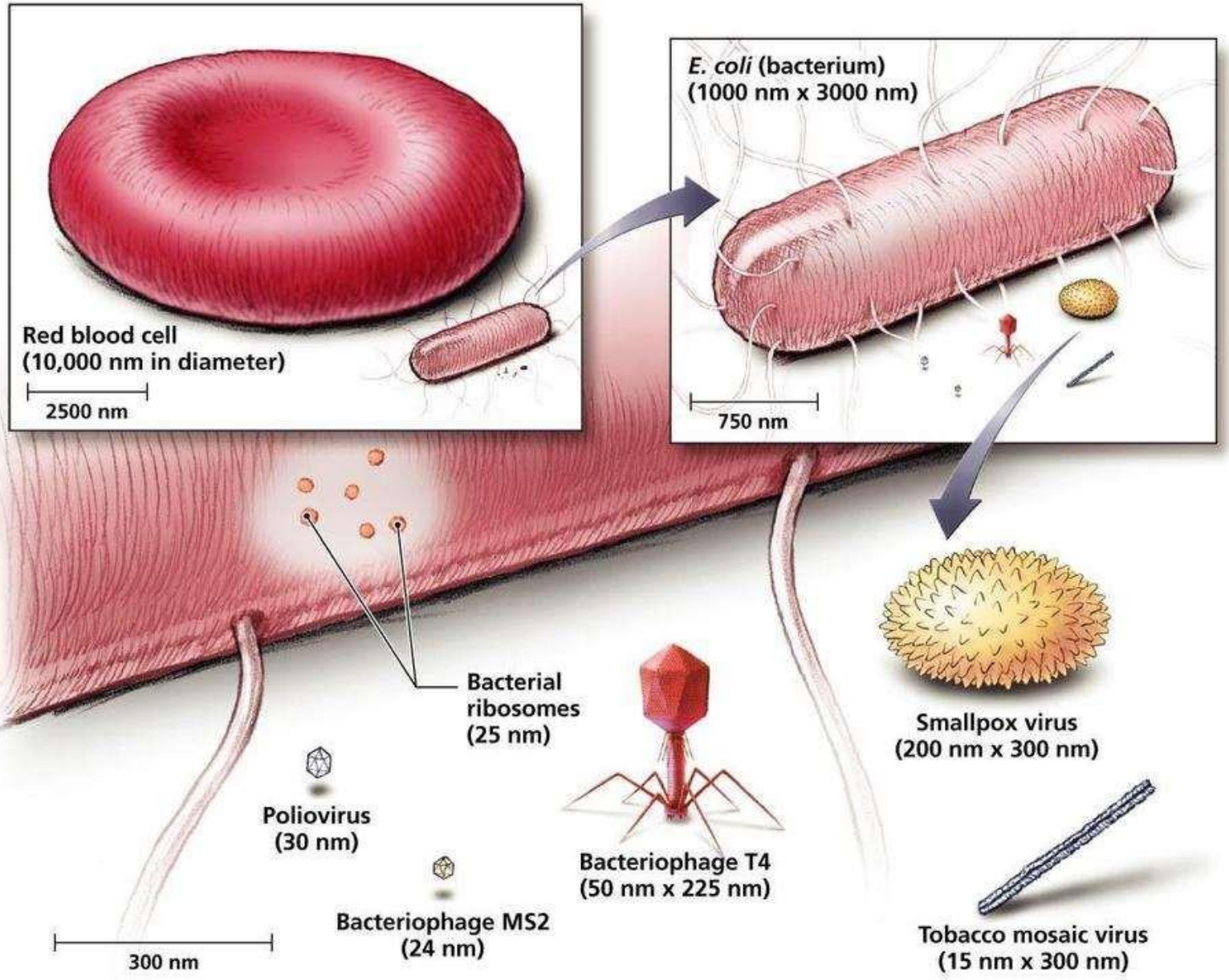


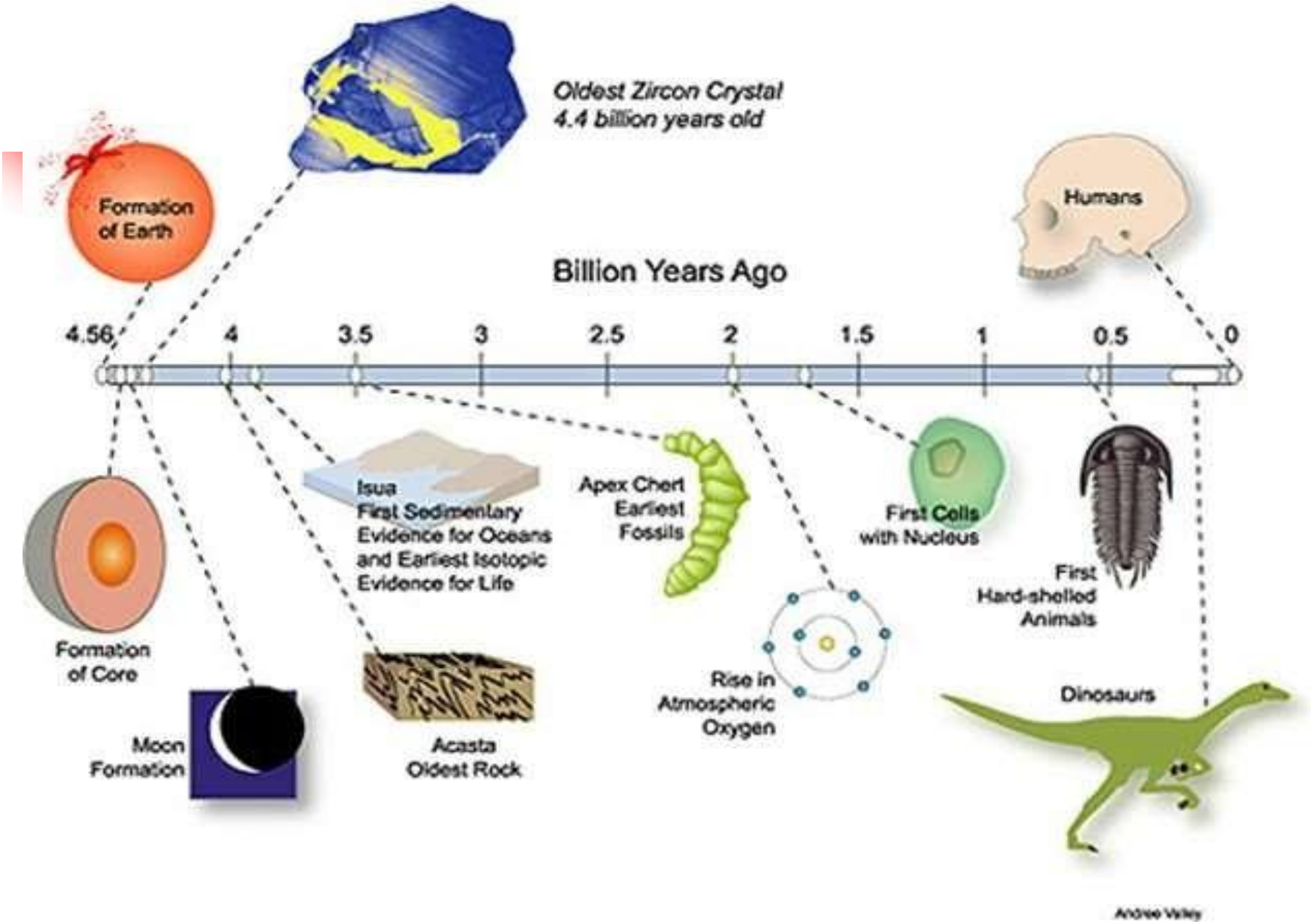
Sizes of microbes

TABLE 2-1 Relative Sizes of Microbes

MICROBE OR MICROBIAL STRUCTURE	DIMENSION(S)	APPROXIMATE SIZE (μm)
Viruses (most)	Diameter	0.01–0.3
Bacteria		
Cocci (spherical bacteria)	Diameter	average = 1
Bacilli (rod-shaped bacteria)	Width × length	average = 1 × 3
	Filaments (width)	1
Fungi		
Yeasts	Diameter	3–5
Septate hyphae (hyphae containing cross-walls)	Width	2–15
Aseptate hyphae (hyphae without cross-walls)	Width	10–30
Pond water protozoa		
Chlamydomonas	Length	5–12
Euglena	Length	35–55
Vorticella	Length	50–145
Paramecium	Length	180–300
Volvox[a]	Diameter	350–500
Stentor[a]	Length (when extended)	1,000–2,000

[a]These organisms are visible with the unaided human eye.




Oldest Zircon Crystal
4.4 billion years old
Formation of Earth
Humans
Billion Years Ago
4.56
4
3.5
3
2.5
2
1.5
1
0.5
0
Isua
First Sedimentary Evidence for Oceans and Earliest Isotopic Evidence for Life
Apex Chert
Earliest Fossils
First Cells with Nucleus
First Hard-shelled Animals
Formation of Core
Moon Formation
Acasta
Oldest Rock
Rise in Atmospheric Oxygen
Dinosaurs

Fields of Microbiology

- Medical
- Veterinary
- Agricultural
- Marine
- Space
- Technical

Medical Microbiology

- **Aims** – The study of pathogens for humans microorganisms and also diseases which are caused by them, pathogenesis of those illnesses, their laboratory diagnosis, treatment and prevention.
- **Objectives:**

-Further study of roles of particular species of pathogen microbes in the etiology and in the pathogenesis of different human diseases.

-Study of mechanisms of immunity formulation;

-Development of diagnostics methods.

-Method development of specific prevention and treatment.

Medical Microbiology

Common medical microbiology

- Structure (morphology) of microbes
- Physiology of microbes
- Biochemistry of microbes
- Genetics of microbes
- Evolution of microbes
- Microbe ecology

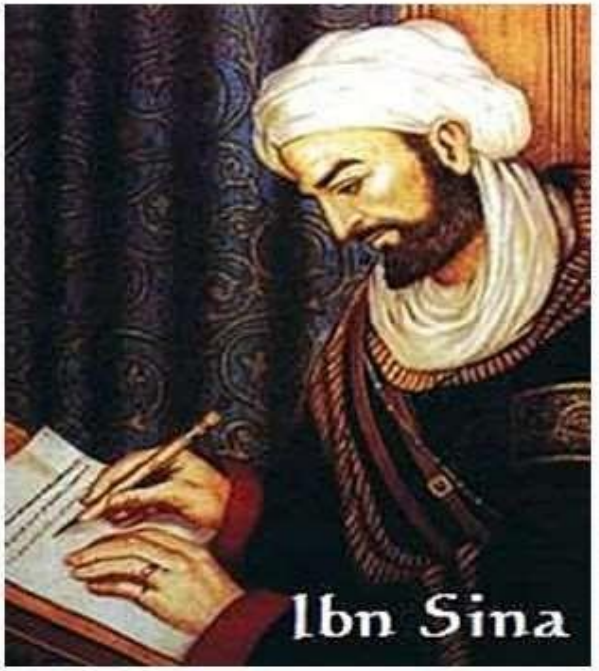
- **Special medical microbiology**
- Bacteriology
- Virology
- Mycology
- Protozoology
- Sanitary microbiology
- Clinical microbiology

Basics in medical microbiology.

- Virology – science about viruses.
- Protozoology- science about simple organism
- Immunology- studies preventive processes in organism.
- Micology- science about fungies.
- Sanitar microbiology- studies micro organisms living in outer environment .
- Clinical-role of normal flora in formation of diseases, diagnostics and prevention.
- Pharmaceutical- studies technologies of getting microbiological, preventive and healing drugs.

History of Microbiology

- **Abū Alī al-Ḥusayn ibn Abd Allāh ibn Sīnā (Ibn Sina) (368-424 H , 980-1037 G).**
- His book ***The Canon of Medicine*** was one of the best references in medicine and pharmacology know for describing infectious diseases and quarantine them as control procedures.
In Pharmacology, he discussed how to effectively test new medicines.



Proof that microbes cause disease

- 1546: Hieronymus Fracastorius (Girolamo Fracastoro) wrote "On Contagion" ("De contagione et contagiosis morbis et curatione"), the the first known discussion of the phenomenon of contagious infection.

- 1835 Agostino Bassi de Lodi showed that a disease affecting silkworms was caused by a fungus - the first microorganism to be recognized as a contagious agent of animal disease

Nature study of infection diseases. (1)

- D.S. Samoylovic in the second half of XVIII century suggested that “plague is caused by special and absolutely excellent creature” and for warning the organism of upcoming disease it is suggested to inject weakened infectious onset. In 1771 he injects himself with infectious material taken from the human being recovering form plague.
- In 1796 E. Jenner showed that injects to the people of pathogen cowpox, prevent them of being infected by smallpox.

The first vaccination against smallpox made by E. Jenner.

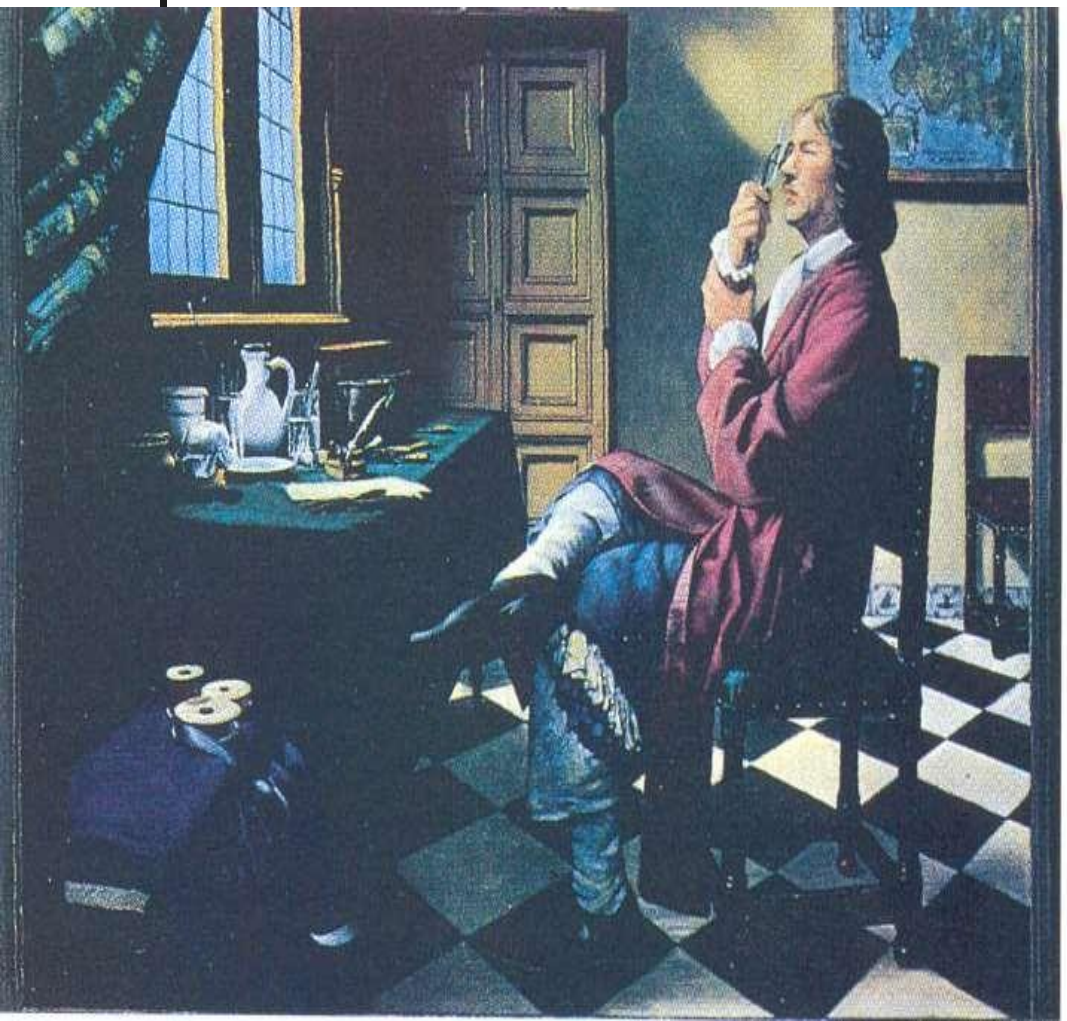
Antony Van Leeuwenhoek (1632-1723)

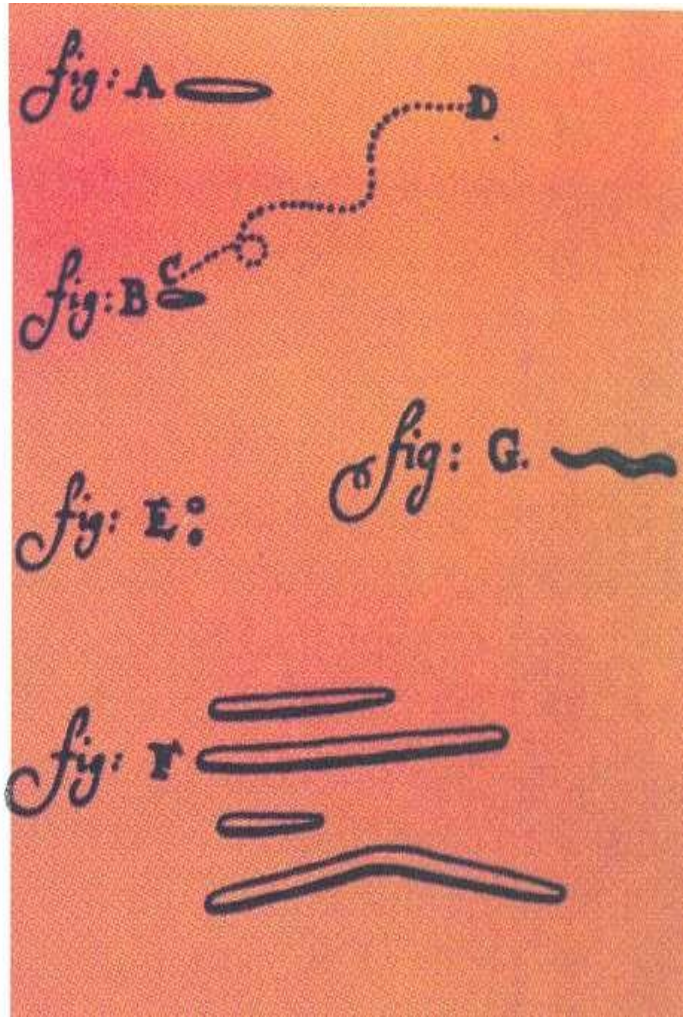
1. As a draper (merchant who sells cloth and dry goods), he used lenses to examine cloth. This probably led to his interest in lens making.
2. He assembled hundreds of microscopes, some of which magnified objects 270 times.
3. As he looked at things with his microscopes, he discovered "micro" organisms - organisms so tiny that they were invisible to the naked eye.
4. He called these tiny living organisms "animalcules". He first described bacteria, protozoans and many cells of the human body

Antonie van Leeuwenhoek

With the first microscope

On 17th of 1683 year took a smear from the tooth scurf (report in London's royal society)





Physiology period.

From mid XIX century

Luis Pasteur

- **XIX-XX centuries**

(Robert W. Cox)

Physiology period.
Golden age of microbiology (from XVII-XIX centuries)

GOLDEN ERA

Louis Pasteur

- Father of medical Microbiology
- In his famous experiment, he took a ***Swan Neck Flask*** and boiled nutrient rich broth inside it. He pointed that no growth took place in the flask as dust and germs had been trapped on the walls of the curved neck.

LOUIS PASTEUR

- **Louis Pasteur** was a French chemist and microbiologist who was one of the most important founders of **medical microbiology.**
- He is remembered for his remarkable breakthroughs in the causes and preventions of diseases .
- His discoveries reduced mortality from **puerperal fever**, and he created the first **vaccines** for **rabies** and **anthrax.**

** Louis Pasteur **
**27/12/1822 - 28/9/1895 **

Louis Pasteur experience

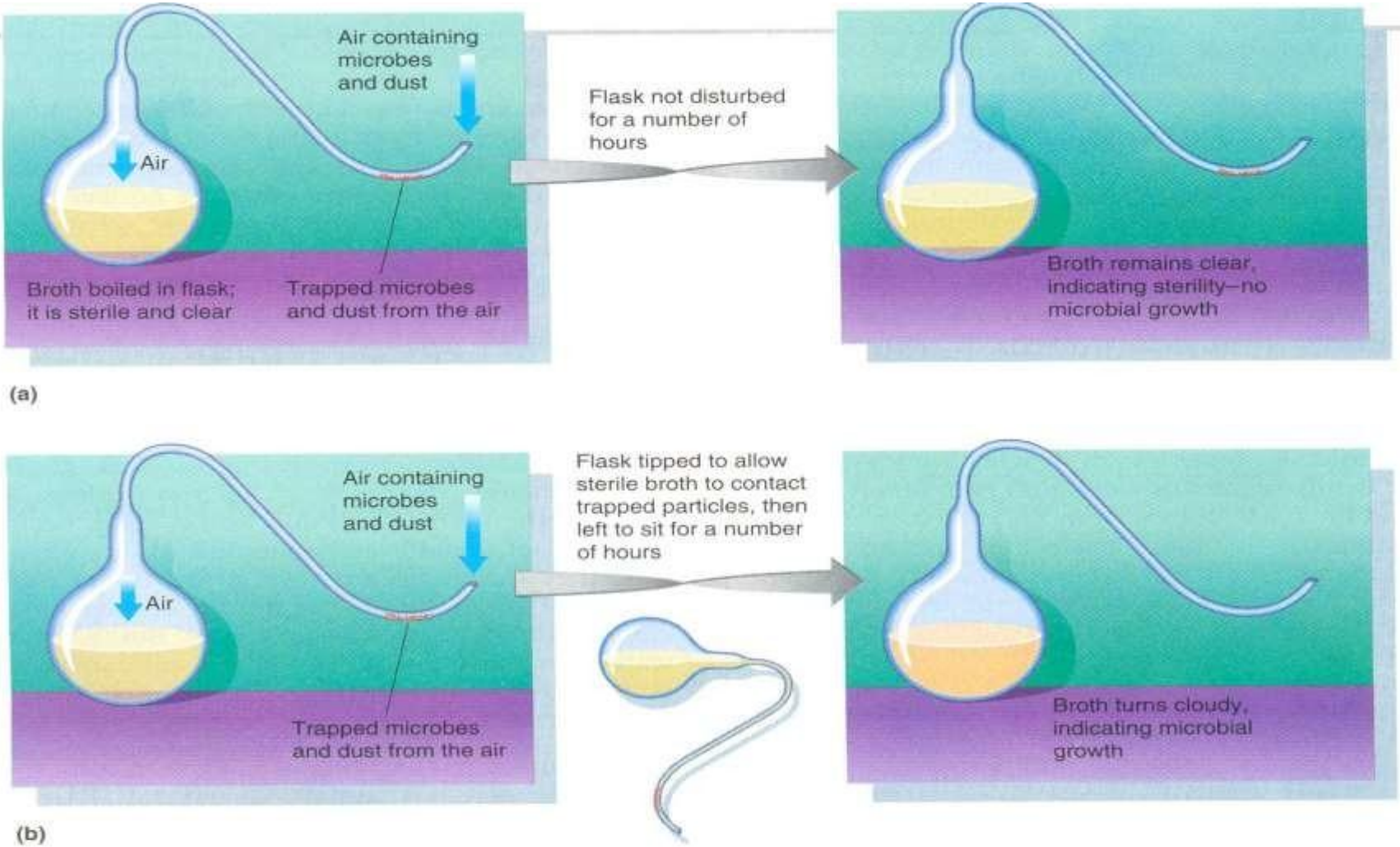
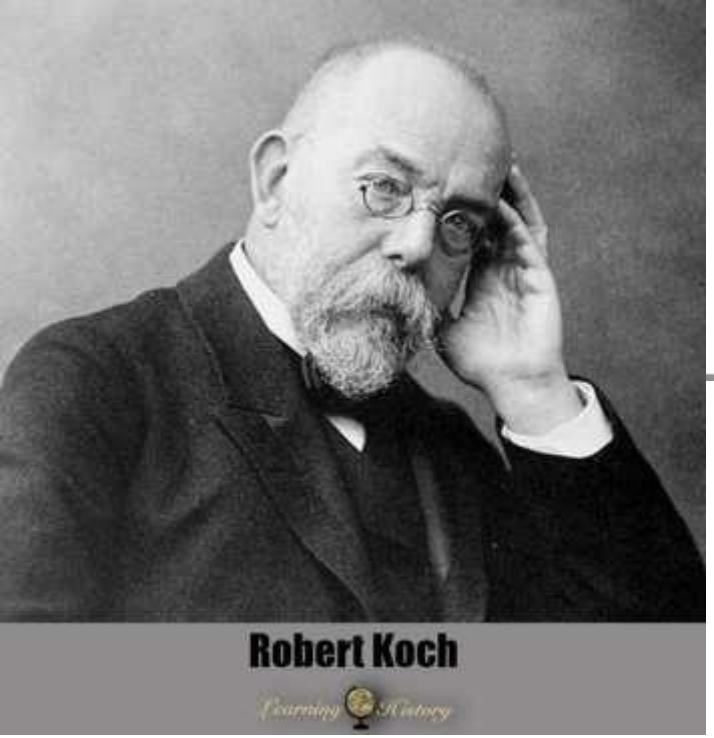


FIGURE 1-3 Swan-necked Pasteur flask. Dust settles in the neck of the flask, trapping particles and microorganisms while allowing unaltered air to reach the nutrient medium. (*a*) The broth remains clear and sterile. (*b*) If the flask is tilted so the broth flows into the neck and reaches the trapped particles, the liquid becomes cloudy within hours, indicating microbial proliferation.



Robert Koch discoveries:

•Method of stressing out of clean cultures on hard nutrition environments (included the practice of using Petri cups)

• Methods of coloring bacteria's

•Discovered pathogen of anthrax, cholera, tuberculosis

•Developed techniques of microscopy.

Got Nobel laureate for physiology and medicine in 1905 for tuberculosis research.

Robert Koch's Triad

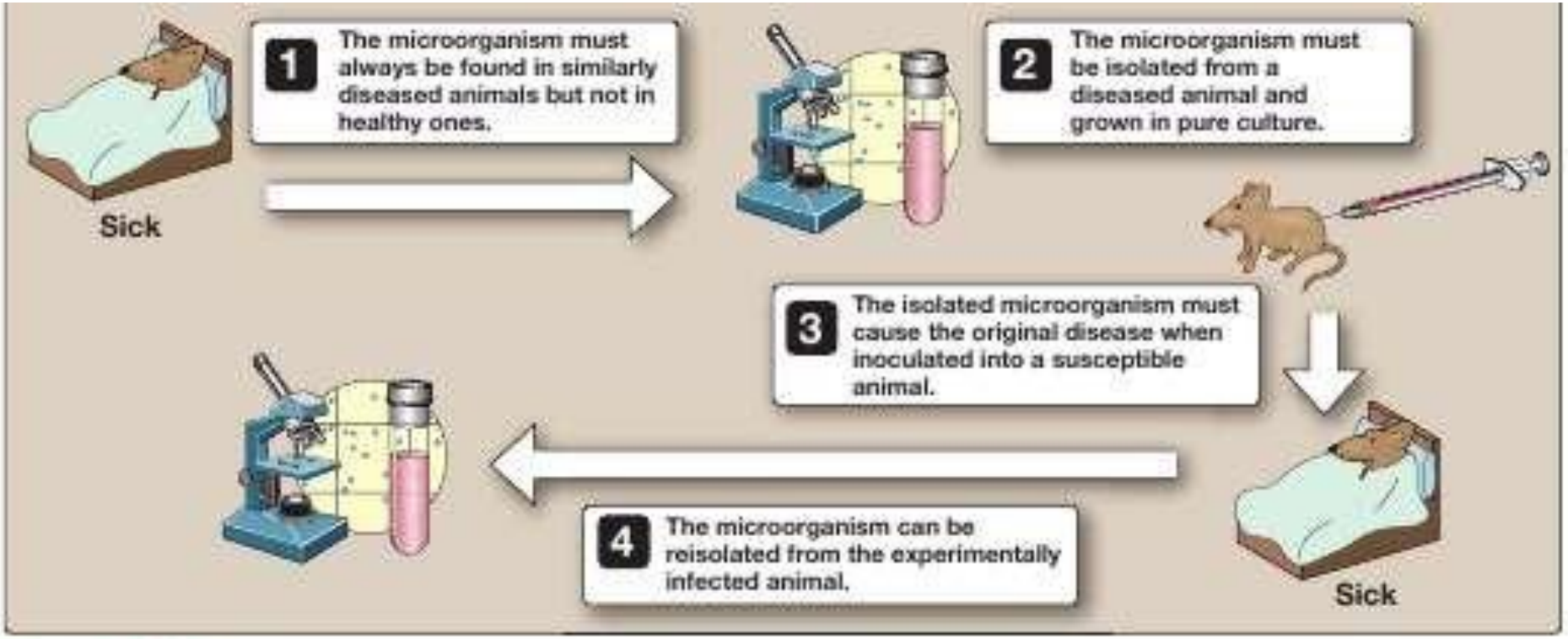


FIGURE 1-10. **Koch's Postulates: proof of the germ theory of disease.** (From Harvey RA et al. Lippincott's Illustrated Reviews, Microbiology, 2nd ed. Philadelphia: Lippincott Williams & Wilkins, 2007.)

Study of natural infectious diseases(2)

- 1839 year – I.Shenleyl set that scab (favus) causes a pathogenic fungus.
- 1843 year – D. Grubi discovered ringworm (trichophytosis)
- 1849r – A. Pollender and others discovered a pathogen of anthrax
- 1859r – D. Lambl discovered giardia.

Introduction of antiseptics rules.

Use of phenol for prevention of wound infections in the hospitals by Joseph Lister(1827-1912)

Period of Immunology
(secind half of XIX century)

- Luis Pasteur (1822-1895)

  (Vaccination)

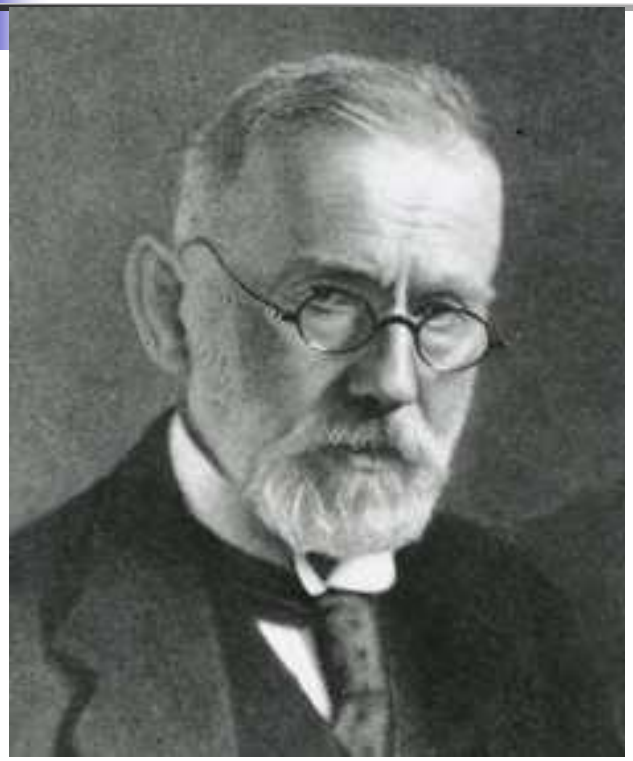
- I. I. Mechnikov (1843-1916)

  (Phagocytic theory- base of cell immunology)

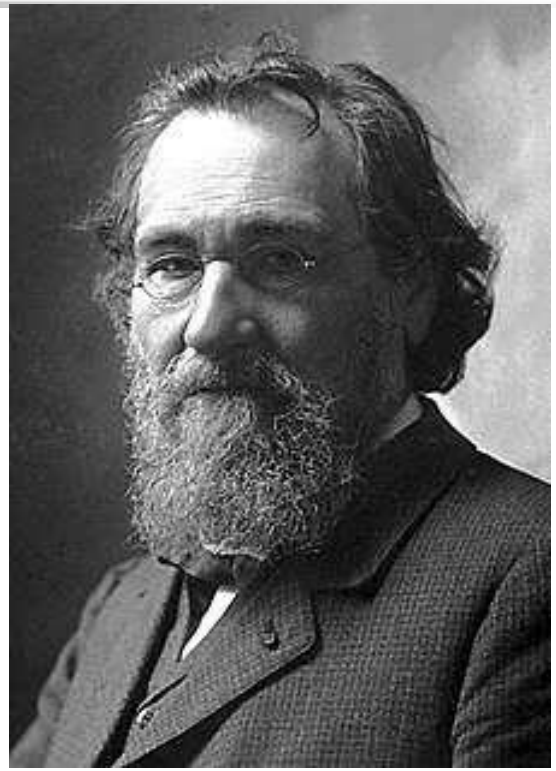
- Paul Erlich(1843-1916)

  (Antibodies – base of humoral theory of immunity)

Period of immunology.



Paul Elrich 1854-1915
Developed humoral theory of immunity.

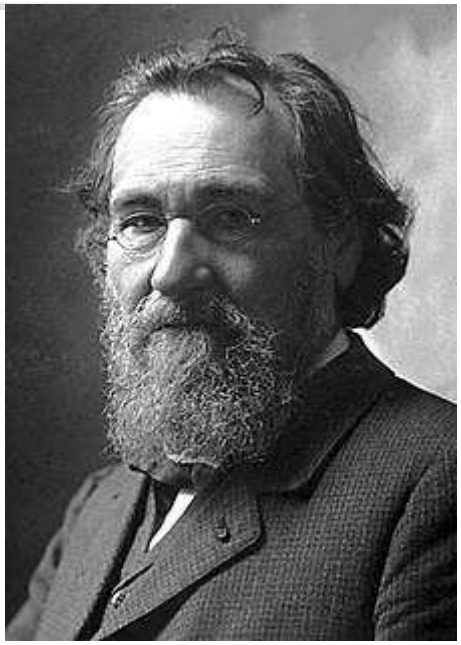


Ilya Mechnikov 1845-1916

In proceeding decades of fruitful disputes and discussions between phagocytosis and humoral theories, the mechanisms of immunity was discovered and the new science Immunology appeared.

Immunology period.

E.Jenner (1729-1723)
In 1796 year proved that vaccinating people with cow pox causes resistance to smallpox.



Ilya Mechnikov 1845-1916
“Poet of microbiology”
Developed the theory phagocytosis and cell theory of immunity.

Immunology

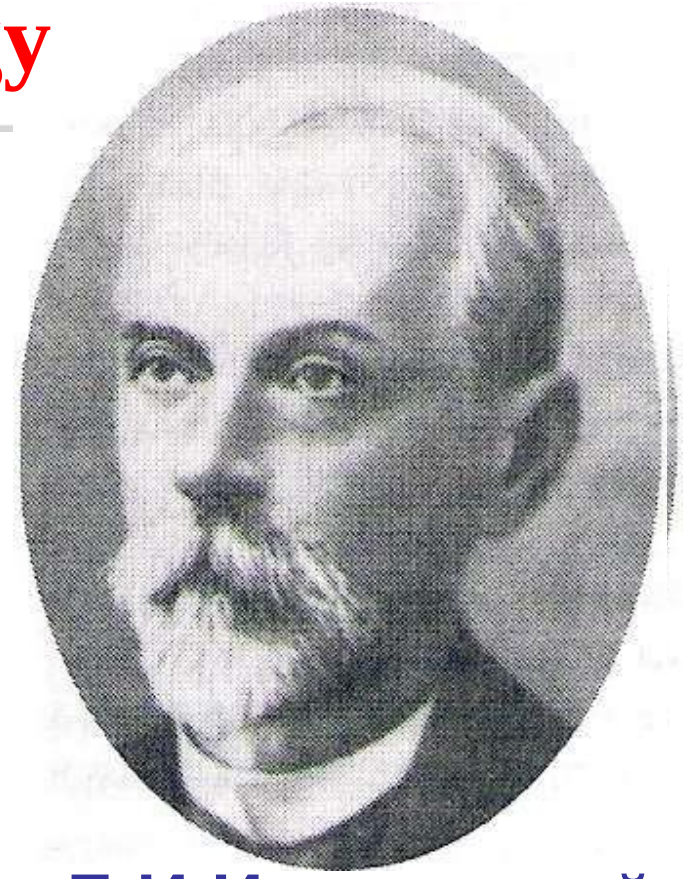
- Studies mechanisms and methods of protection against genetic alien substances– antigens with the aim to support and save homeostasis, structural and functional integrity of organisms and also antigen individuality of each organism and species as a whole.

Major discoveries in the field of microbiology

1892 year- D. I. Ivanovskiy- discovery of viruses

1906 year, P. Erlich – chemotherapy (salvarsan)

1928 year. – A. Fleming – penicillin

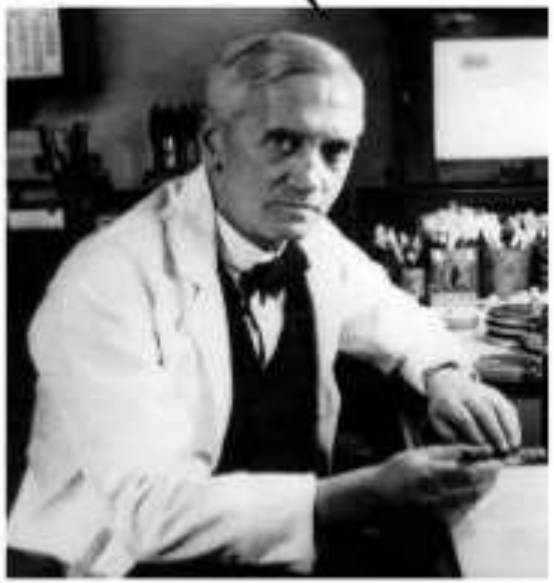


Д.И.Ивановский (1864-1920)

Dmitri Ivanovsky

Dmitri Iosifovich Ivanovsky (alternative spelling Dmitrii or Dmitry Iwanowski; Russian: Дми́трий Ио́сифович Ивано́вский; 1864–1920) was a Russian botanist, one of the discoverers of filterable nature of viruses (1892) and thus one of the founders of virology.

Penicillin (Alexander Fleming)



Sir Alexander Fleming, a Scottish biologist, pharmacologist and botanist. He wrote many articles on bacteriology, immunology, and chemotherapy. His best-known discoveries are the enzymelysozyme in 1923 and the antibiotic substance penicillin from the mould Penicillium notatum in 1928, for which he shared the Nobel Prize in Physiology or Medicine in 1945 with Howard Florey and Ernst Boris Chain.

Chain Ernst Boris (1906-1976)
English biochemical

Flory Howard Wolter
(1898-1968) Pathologist
Microbiologist

- In 1938 discovered penicillin in injection form.
- Became Nobel Laureate on physiology and medicine in 1945 along with Alexander Fleming for discovery and synthesis of penicillin.

Molecular-genetic period (second half of XX century)

- Using the methods of molecular biology and genetics on bacterial and viral models, the role of DNA as a substrate of heredity has been established, the genetic mechanism of protein synthesis and mutagenesis has been deciphered.
- Disclosed molecular-genetic bases of pathogenesis and immune protection ,studied system is histocompatibility.
- With the help of genetic engineering and biotechnologies we got recombinant strains of microbes produced by biologic active substances (antigens, interferon, antibodies, hormones etc.), gained by genetic- engineering and synthetic vaccines, different immunomodulators.

The modern molecular-genetic stage.

- Achievements of genetic and molecular biology
- Creation of electronic microscope.
- Evidence of the DNA role in transfer of hereditary traits.
- Usage of bacteria, viruses and plasmids as the objects of molecular- biologic and genetic researches.

Development of microbiology in Azerbaijan.

Academician P.F.Zdrodovskiy
•head of the department of microbiology of the medical faculty of ASU.
•Scientific activity - research of rickettsiosis

P.F.Zdrodovskiy
1890-1976

Development of microbiology in Azerbaijan.

Academician L.A. Zilber, 1930-1932 - Head of the Department of Microbiology of the Medical Faculty of ASU. Scientific activity - study of the mechanism of viral carcinogenesis.

L.A. Zilber

Development of microbiology in Azerbaijan.

Associate Professor F.A. Yagubov 1933-1971 - Head of the Department of Microbiology, AMI. Scientific activities - the development of early diagnosis of syphilis, the study of the antimicrobial properties of fractions of naphthalan, the study of the epidemiology of plague in the republic.

Professor F.A. Yagubov

Development of microbiology in Azerbaijan.

Professor N.D. Aliyev 1971-1988 - Head of the Department of Microbiology, AMI Scientific activity - the study of the antimicrobial activity of naphthalan oil and phytoncides obtained from the flora of Azerbaijan.

N.D. Aliev
(1911-2004)

Development of microbiology in Azerbaijan.

Professor G.G. Ibragimov 1988-2003 - Head of the Department of Microbiology, AMU. Scientific activity - study of the antimicrobial activity of volatile from the flora of Azerbaijan, the study of fungi of the genus Candida.

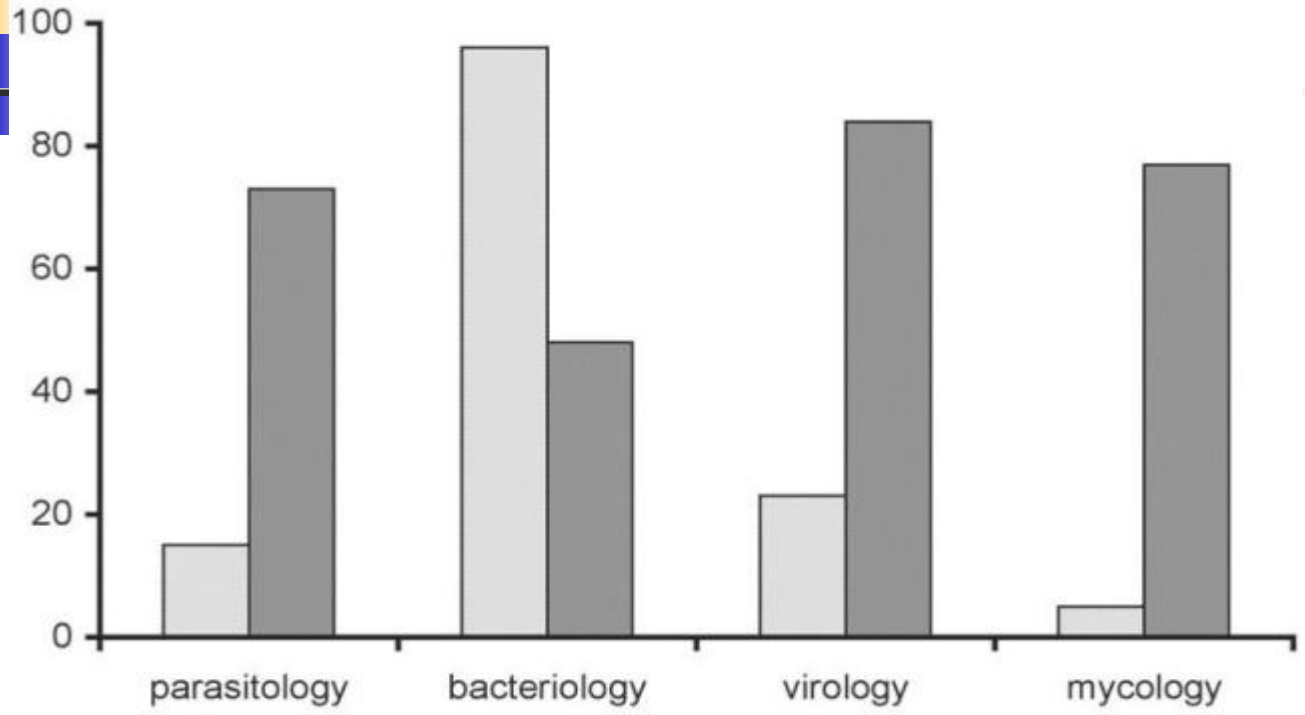
G.G. Ibragimov **(1939-2003)**

Development of microbiology in Azerbaijan.

Professor Z.O. Garayev

2003 - 2018 - Head of the Department of Microbiology, AMU. Scientific activity - the study of fungi of the genus Candida.

Study of microbiology



Areas in microbiology requiring more training or understood proficiently. Survey summaries of subdisciplines of microbiology that respondents feel they understand proficiently or require more training in. Bacteriology is the most understood (96%) and yet 48% feel they still require further training. Fewer than 25% feel they understand the other areas proficiently. [Ethics approval for questionnaire was obtained from the University of Waterloo, Office of Research Ethics, ORE # 15747.]

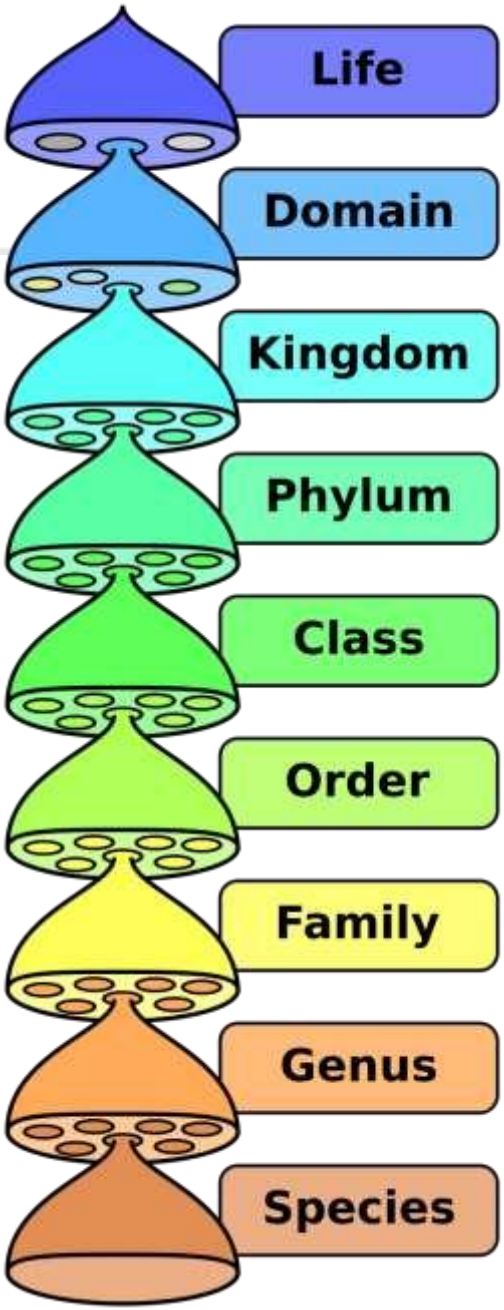
Systematic of microbiology.

- **Systematic-** biological science, studies diversity of microorganism on the Earth and their relationships between each other.
- Systematic includes 3 parts:

- **taxonomy** – study of principles and methods of classification living creatures in the hierarchic plan.
- **classification** –process of division of many organisms on the basis of common properties to the certain taxonomy groups.
- identification –establishment of belonging of the studied organism to one or another taxon.

Taxon

- The term "taxon" is used to refer to hierarchically subordinate units, the system of which makes up the classification of microorganisms.
- A taxon of the highest category of microorganisms is a domain uniting in a hierarchical order a system of taxa of a lower rank: kingdom, type, class, order, family, genus, species, subspecies.



Stages of classification of microorganisms

- The first step was the determination in the system of other organisms of the place of bacteria that became known before other microbes.
- In 1854, Kon attributed the bacteria to lower plants, and in 1957 the Negeli to schizomycetes.
- In 1866, E. Höckel, bacteria were classified as protists.
- In 1896, K. Lehman and R. Neumann compiled a classification of bacteria containing 3 families (cocci, bacteria, spirils).

Bacteria classification principles

- Basics of modern classification of bacteria's was established by David Bergey in 1923 (Bergey's Manual of Systematic Bacteriology).
- It is built on principals of identification, based on differentiation of cell wall structure and relation to Gram strain.

David Bergey

Strain of bacteria's by Gram

- The coloring method was proposed in 1884 by the Danish scientist G.H. Gram.
- Depending on the structure of the cell wall, bacteria are divided into:
- - gram-positive (blue-violet)
- - gram-negative (red)

Hans Cristian Gram

The principals of coloring by Gram

- Gram positive-bacteria's which keeps gentian and violet in complex with iodine-violet color bacteria's

Gram negative -bacteria's after the effect of alcohol loose their color, become colorless and when treated with fussion they color become red

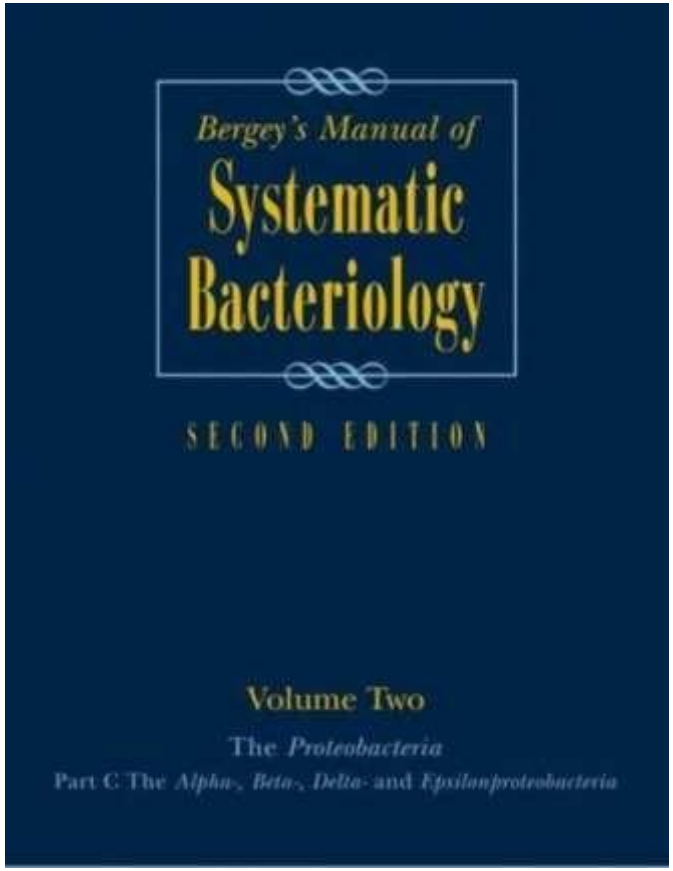
Classification of microorganisms

- In 1923 year- American society of bacteriologists published first international "Bacterium determinant" by D.Bergie
- Comity of Bergey's manual Trust:

- "Bergey's Manual of Determinative Bacteriology"

-"Bergey's Manual of Systematic Bacteriology"

Qualifier of Bergie



Modern bacteria identification indicators.

- Phenotypic indicators: Gram stain, morphological and cultural properties, biochemical reactions, antigenic properties, etc.
- Genotypic indicators: the ratio of guanine + cytosine, DNA hybridization, plasmid analysis, ribotyping, etc.
- Phylogenetic indicators: rRNA sequence analysis, RNA-RNA hybridization, DNA amplification, etc.

Modern classification of microorganisms

- Microorganisms are represented by pre-cellular forms (viruses, viroids, prions) and cellular forms. Cellular forms are divided into 3 domains:
- - Bacteria - prokaryotes, true bacteria;
- - Archaea - prokaryotes, archaebacteria;
- - Eukaria - eukaryotes, which include 3 kingdoms:
- Mushrooms (Fungi) * Animals (Animalia), which include protozoa (Protozoa) * Plants (Plantae)

Taxonomic categories ,applied in classification of microbes	
Domain	Domain
Kingdom	Kingdom
Type (Phylum)	Phylum
Class	Class
Order	Order
Family	Family
Gender	Genus
Species	Species

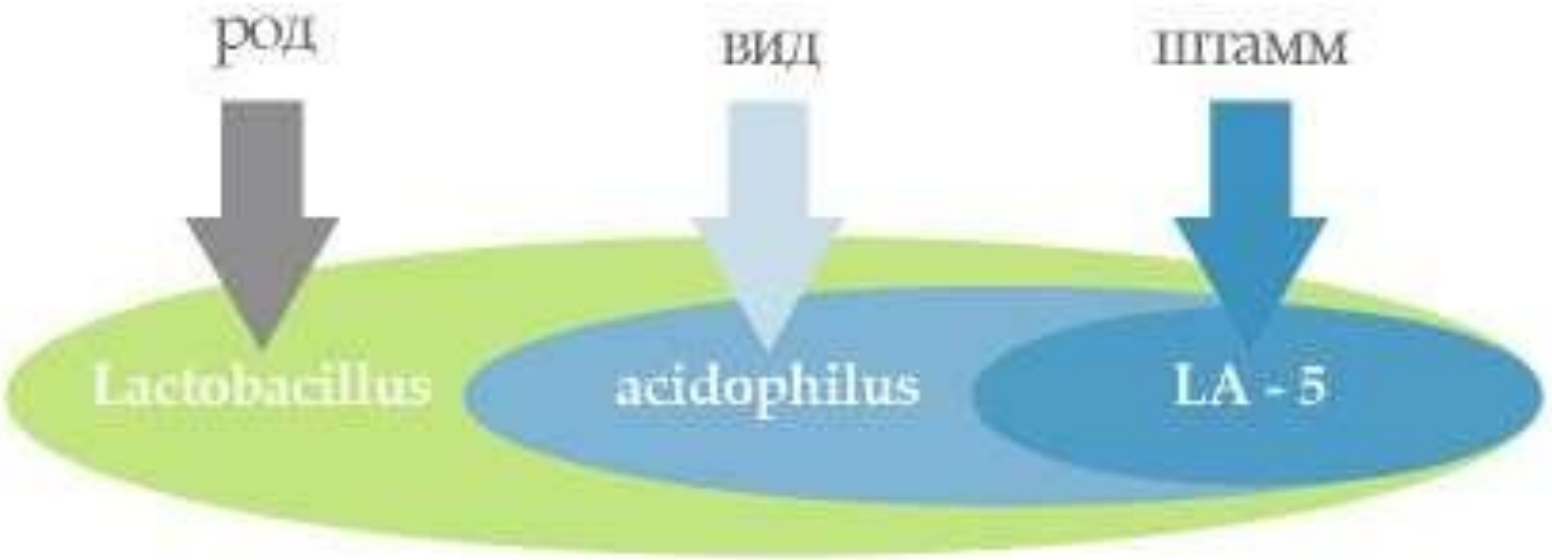
Microbe species

- Species - a collection of individuals having a common origin and genotype, similar in biological characteristics and possessing a hereditarily fixed ability to cause qualitatively defined processes under standard conditions.
- A subspecies, or variant (var) - microbes that differ in certain signs:
- - morphological - morphological,
- - serological - serovar,
- - biological - biovar,
- - biochemical - chemovar,
- - sensitivity to bacteriophages - phagovar.

Microbiological terms for microbes

- Pure culture - a collection of microbes of one species grown on a nutrient medium.
- A strain is a pure culture of microbes isolated from a specific source.
- A clone is a population of microbes derived from a single cell.
- A population is a collection of individuals of a certain type, within which there are no insulating barriers and free crossing occurs between individuals.

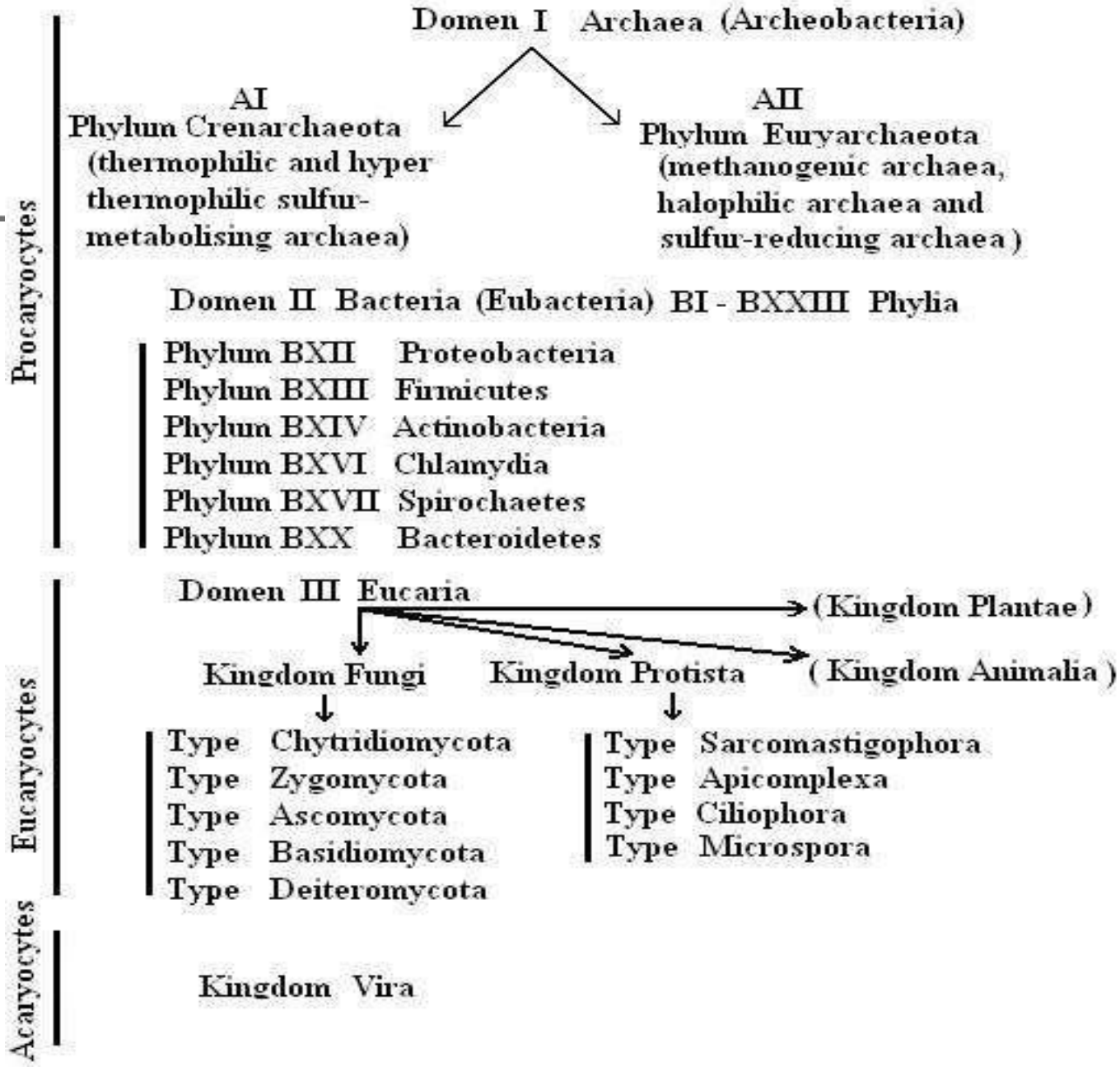
The ratio of genus, species and strain.



Modern classification of bacteria.

- According to the 2001 Bergey Manual (George M. Garrity, Julia A. Bell, Timothy G. Lilburn; Taxonomik Outline of the Prokaryotes. Bergey's Mannual of Sistematic Bacteriology, Second Edition, May, 2004), the bacteria are divided into 2 Domain: Bakteria and Archea, 26 types, 42 classes, many families and genera. The domain "Bakteria" includes 24
- The "Bakteria" domain includes 24 types and 33 classes of gram-negative bacteria with a thin cell wall (Gracilicutes), gram-positive bacteria with a thick cell wall (Firmicutes) and bacteria without a cell wall (Tenericutes). Representatives of 7 types have medical value.

Types of germs included in domains.



ТОНКОСТЕННЫЕ, ГРАМОТРИЦАТЕЛЬНЫЕ БАКТЕРИИ		ТОЛСТОСТЕННЫЕ, ГРАМПОЛОЖИТЕЛЬНЫЕ БАКТЕРИИ	
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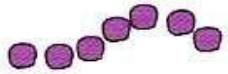
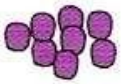
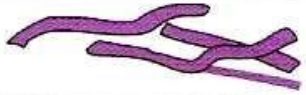
Гонококки		Стрептококки	
Вейлонеллы		Стафилококки	
Палочки		Палочки	
Вибрионы		Бациллы*	
Кампилобактерии, Хеликобактерии		Клостридии*	
Спириллы		Коринебактерии	
Спирохеты		Микобактерии	
Риккетсии		Бифидобактерии	
Хламидии		Актиномицеты	

*Расположение спор: 1 – центральное, 2 – субтерминальное, 3 – терминальное

microorganisms or microbes

(can't see with naked eye)

bacteria

- good & bad types
- single cell
- eat what's around them
- antibiotics are a bacteria killing bomb!
- vitamin C kills

viruses

- only BAD
- parasite
- 100x smaller than bacteria
- vitamin C kills

fungi

- mold & yeast

algae

- tiny plants

protozoa

multi-cellular & found every-where!

archaea

survive in extreme environ-ments

Some distinctive features of prokaryotes and eukariyotes

Features	Prokaryote cell	Eukaryote cell
Size	1-10 mkm	10-100 mkm
Nucleotide membrane	Absent	Presents
Chromosome	One	several
Histones	Absent	Present
Type of division	Binary	Mitotic
Specialized membrane structure	Absent	Present
Cell wall	Haves peptidoglycan	Haves chitin or cellulose
Steroids of cell	Absent	Present
Ribosome's	70 S	80 S
Anaerobic respiratory	Can be	Usually absent
Nitrogen Fixation	Can be	Cannot be

Typical prokaryote and eukaryote cells

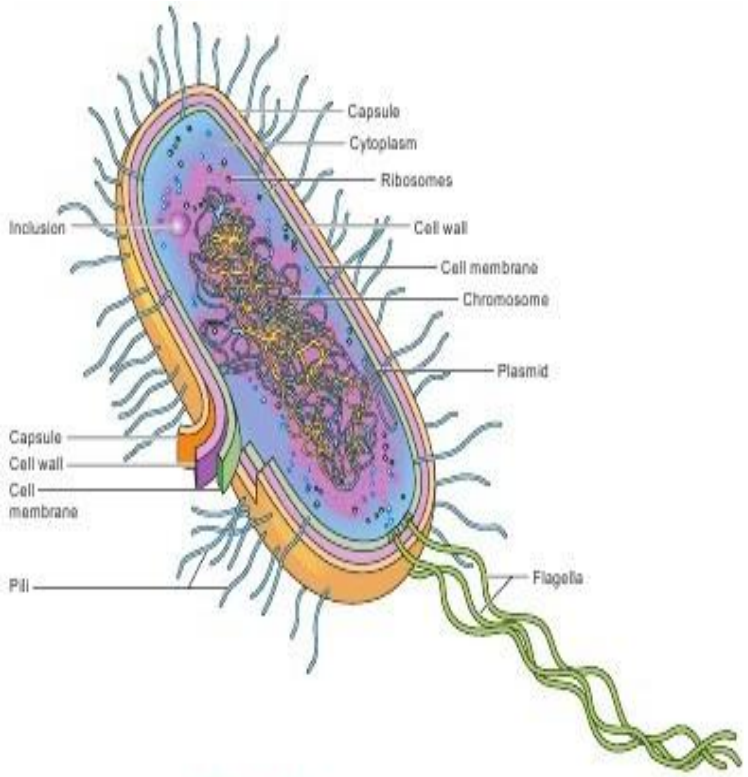


FIGURE 3-6. A typical procaryotic cell.

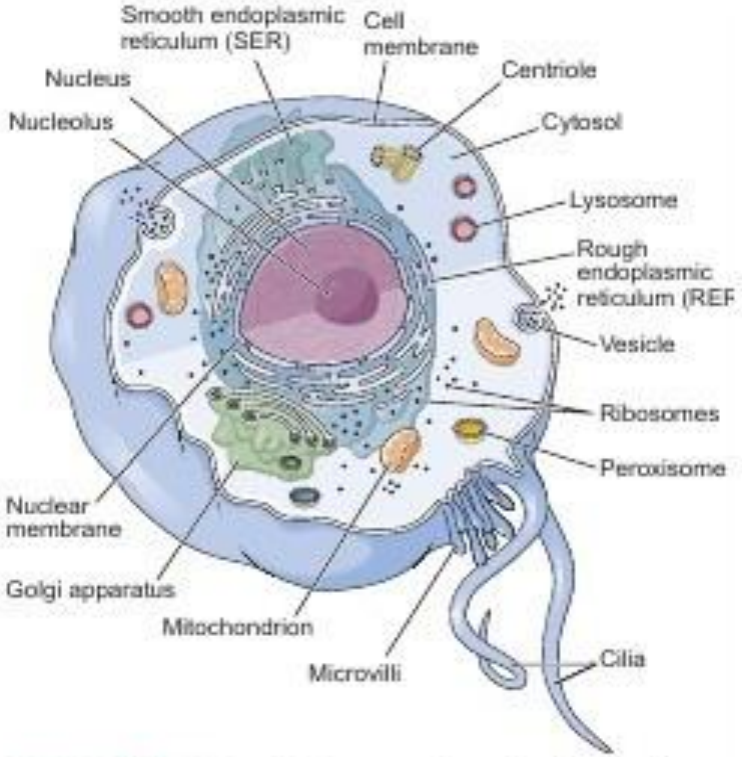
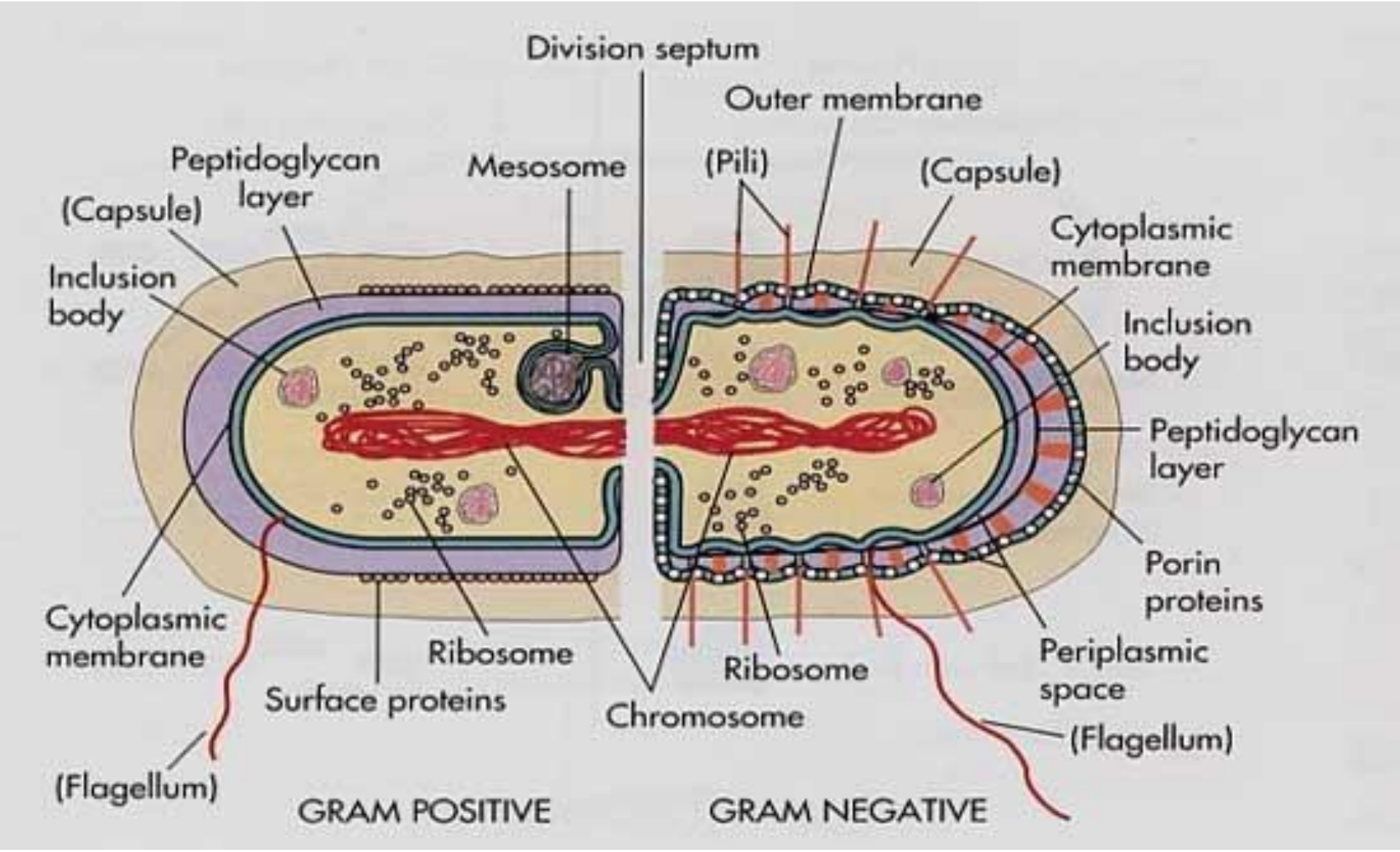


FIGURE 3-2. **A typical eucaryotic animal cell.** (From Cohen BJ. Memmler's The Human Body in Health and Disease, 11th ed. Philadelphia: Lippincott Williams & Wilkins, 2009.)

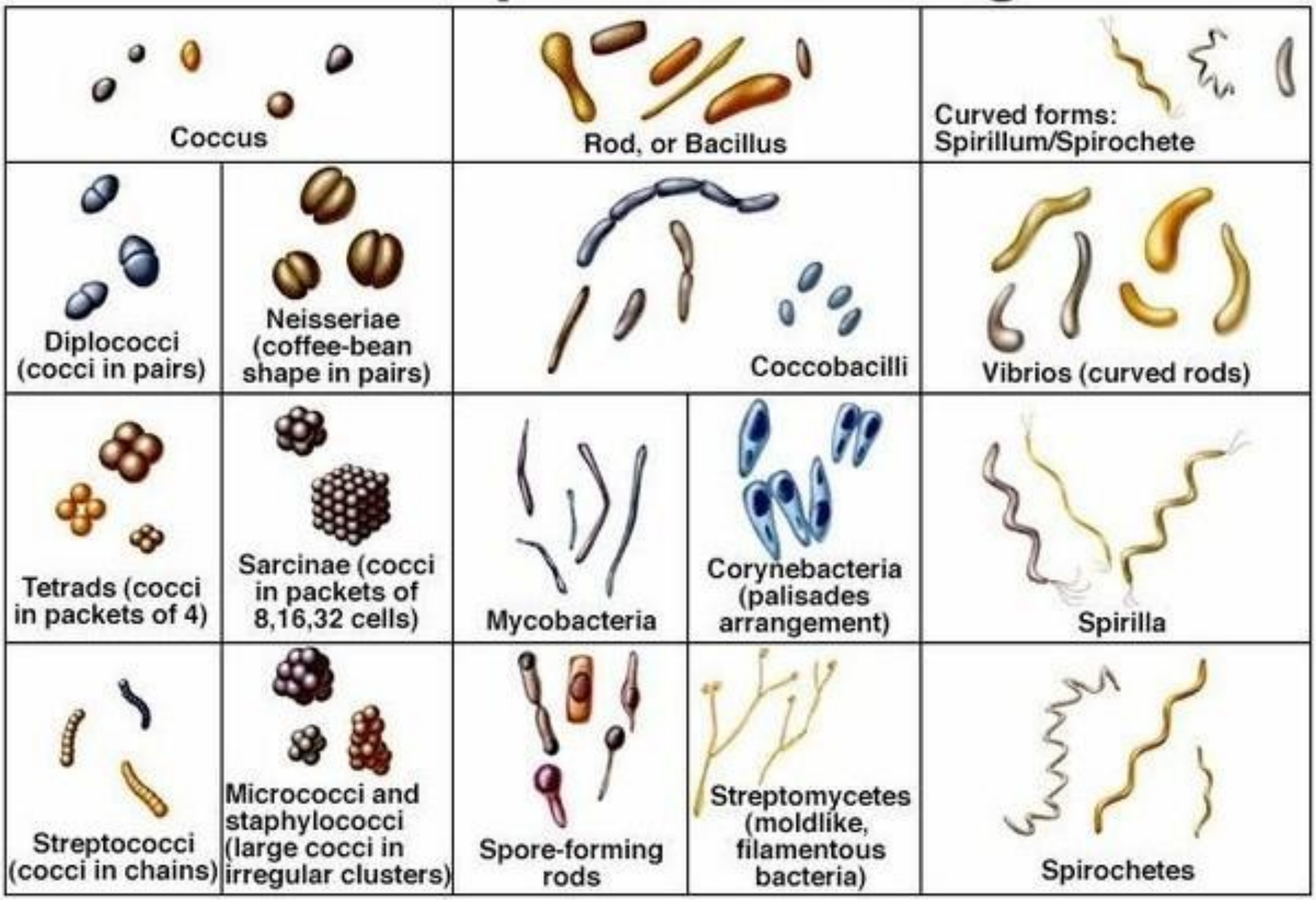
Bacteria

- Microscopic, predominantly one celled microorganisms, related to the kingdom of prokaryites.
- They have a primitive nucleus without a shell, nucleolus and histones, do not have highly organized organelles (mitochondria, Golgi apparatus, lysosomes, endoplasmic reticulum).
- The length of bacteria varies from 0.1-0.2 microns * (mycoplasmas) to 10-15 microns (clostridia), sometimes more, the thickness is from 0.1 to 2.5 microns. * - 1 microne = 1/1000 mm or 10^{-6} m

Bacteria


Division septum
Outer membrane
Peptidoglycan layer
Mesosome
(Pili)
(Capsule)
(Capsule)
Cytoplasmic membrane
Inclusion body
Inclusion body
Peptidoglycan layer
Porin proteins
Cytoplasmic membrane
Ribosome
Surface proteins
Ribosome
Chromosome
Periplasmic space
(Flagellum)
(Flagellum)
GRAM POSITIVE
GRAM NEGATIVE

Bacterial shapes and arrangements



The sizes of the major form of bacteria's

- Cocciform (0,5-1.5 мкм)
- Rod-shaped (0,3-10 microns)
- Twisted (до 20 microns)
- Threadlike (до 10-50 microns)

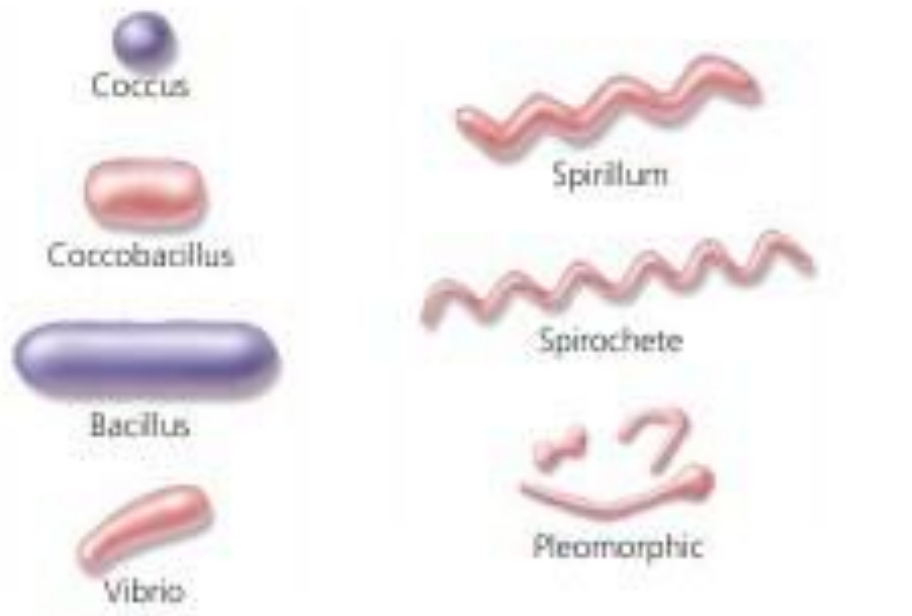


Figure 11.1 Typical prokaryotic morphologies. *What is one difference between a spirillum and a spirochete?*

Cocci-form bacteria. Types of cocci depending **on the division plane.**

Micrococci's
Dyplococci's
Tetracoccis
Sarcins
Staphyloccoccus
Streptococcus

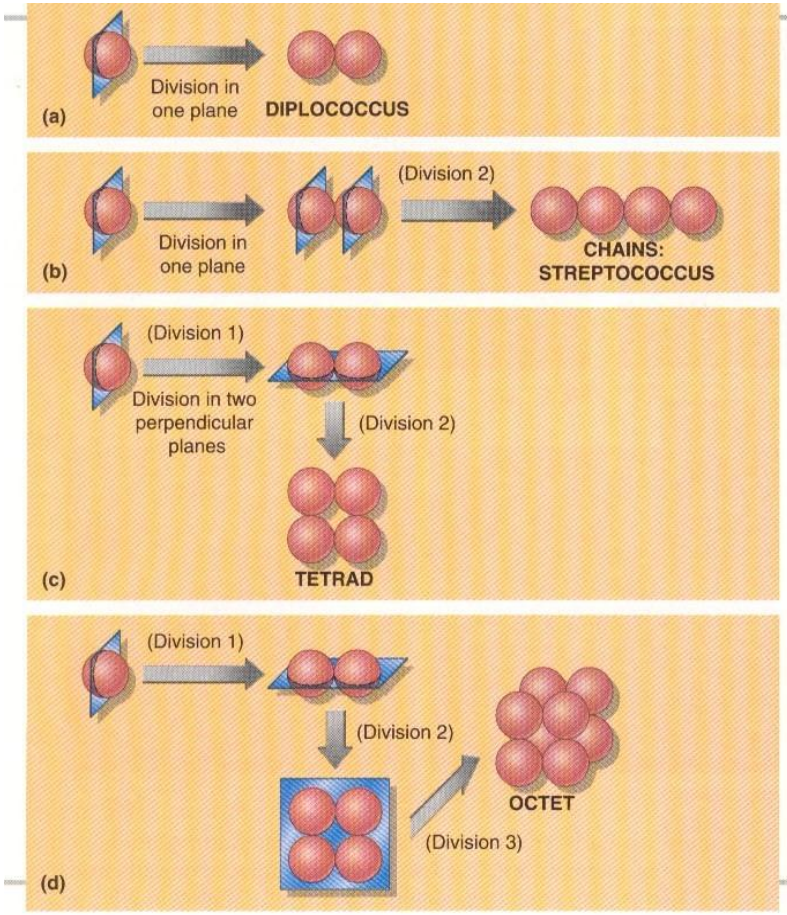


FIGURE 4-5 Cell arrangements. Bacteria grow in characteristic arrangements, from random single cells to complex assemblages formed when bacteria divide and fail to separate from each other. The plane of division determines the arrangement. Division along a single axis can produce diplococci (*a*) or streptococci (*b*). Tetrads (*c*) are produced by organisms that divide along two axes, perpendicular to each other. Octets (*d*) result from division in three planes. (*e*) Staphylococci divide along random axes, producing clusters with no symmetry (*staphyle* is a Greek word meaning "a bunch of grapes").

Rod shaped bacteria's

- **By the presence of the spores and its size**: bacteria, bacilli clostridia
- **By size:**

short, medium, long

- **By width:**

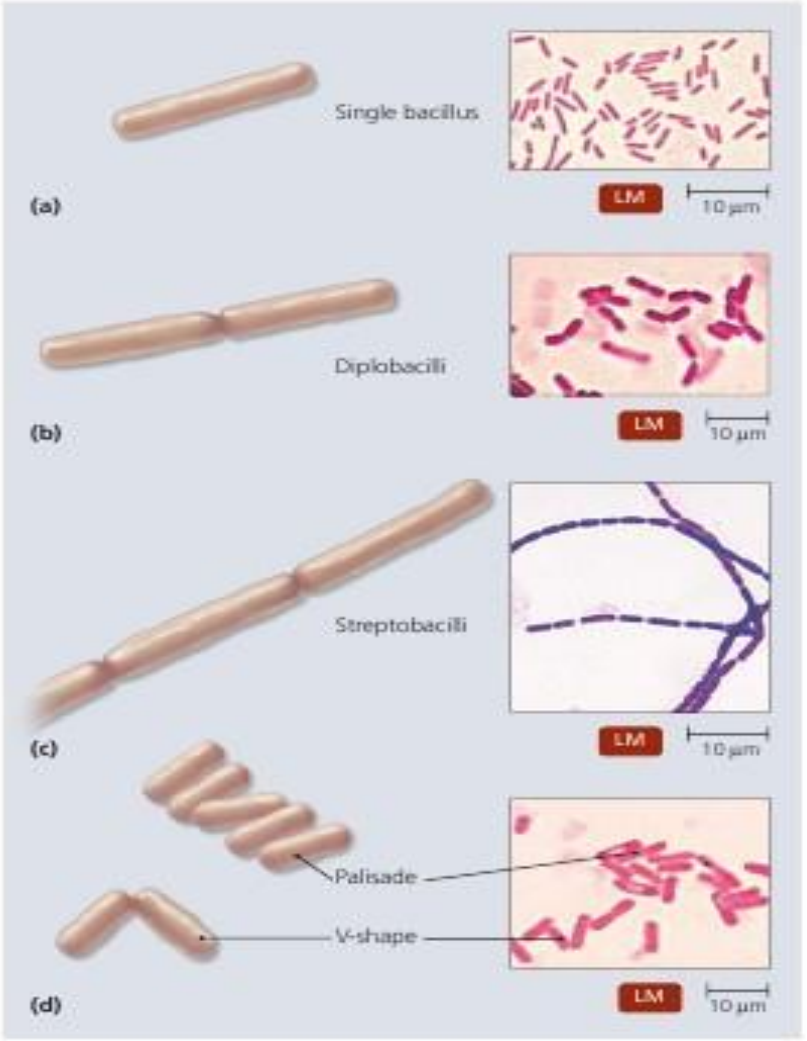
thin and thick

- **The shape of the ends of the cell :**

rounded, pointed, cropped, thickened

- **By location:**

single, in pairs, at an angle, chain



▲ **Figure 11.7 Arrangements of bacilli.** **(a)** A single bacillus of *Escherichia coli*. **(b)** Diplobacilli in a young culture of *Bacillus cereus*. **(c)** Streptobacilli in an older culture of *Bacillus cereus*. **(d)** V-shape and a palisade of *Corynebacterium diphtheriae*.

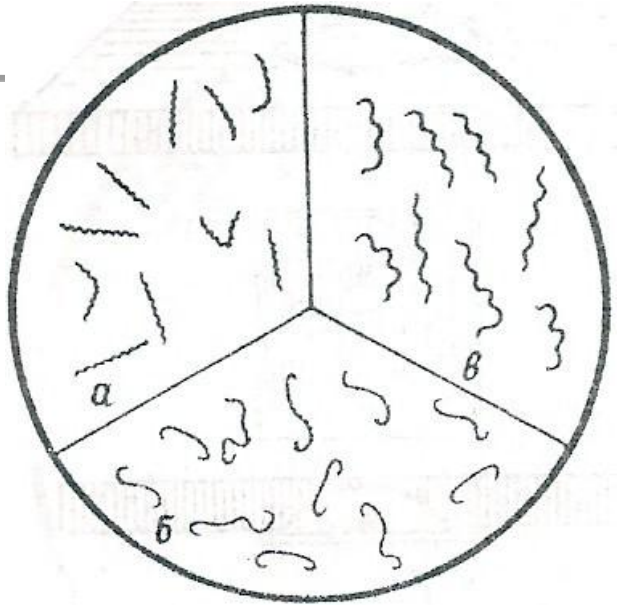
Twisted and threaded bacteria

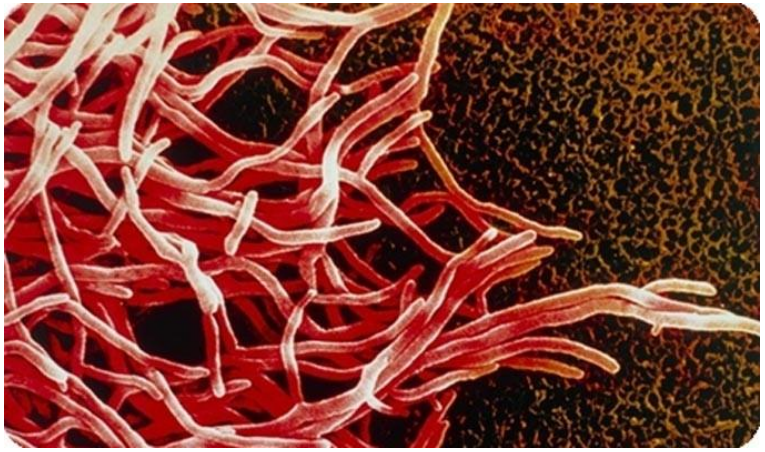
Twisted

- Spirillas
- Spirochetes

Threaded

- Actinomycetes





Structure of bacterial cell

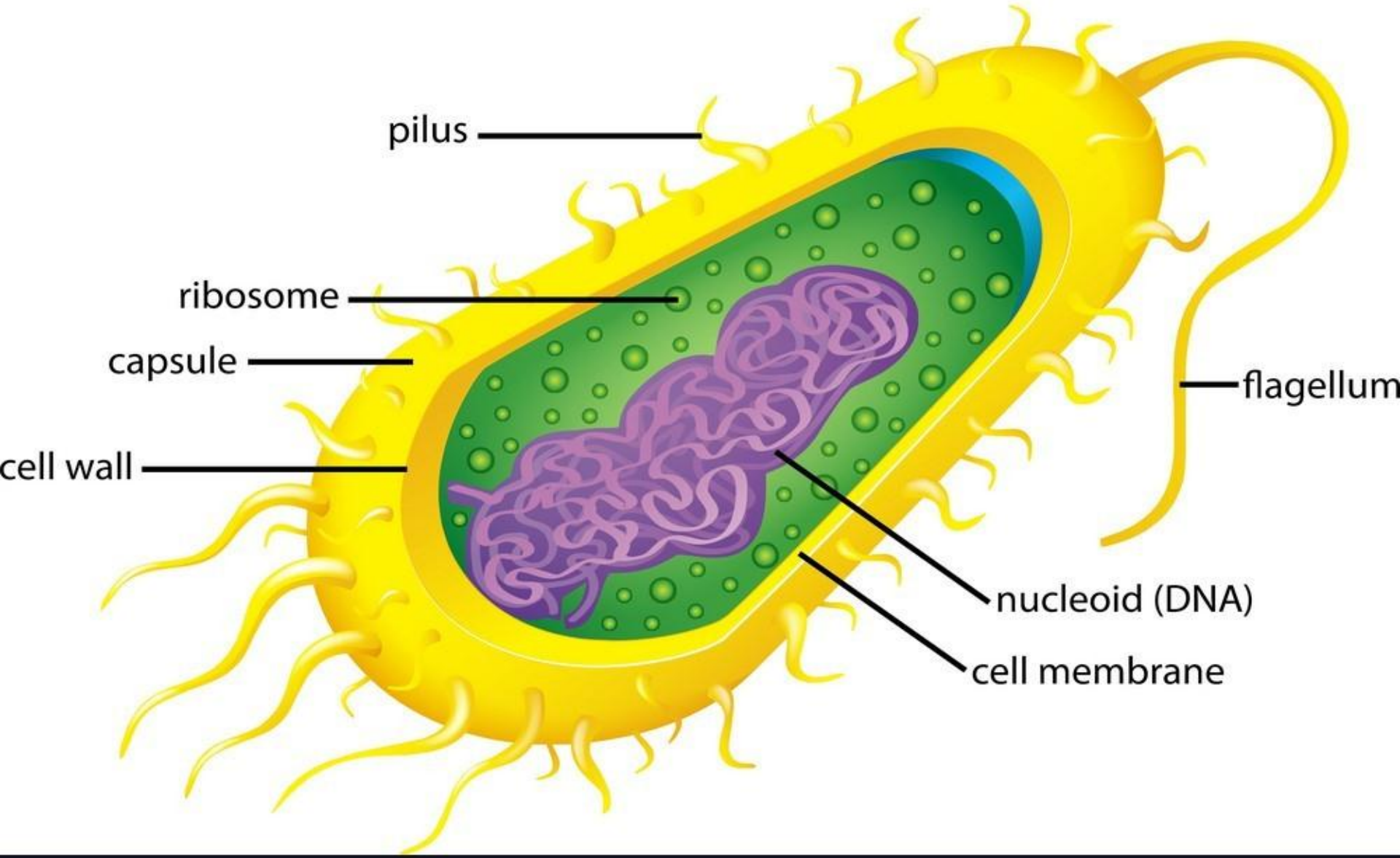
permanent structures:

- Nucleoid, organelle cytoplasm
- shell

Additional structures:

- Inclusion capsule
  Microcapsule
  flagella drank
- spores
-
-
-

Bacteria Cell Anatomy



Structure of bacteria (electronic microphotogram of listeria)

Necleoid of bacterial cell

- A nucleoid in bacteria is a prototype nucleus.
- It does not have a nuclear membrane, nucleolus and histones.
- It is represented by one chromosome.
- It consists of double-stranded DNA, closed in a ring and twisted into a ball.
- In addition to the nucleoid, the carrier of hereditary information are plasmids — circular DNA molecules in the cytoplasm.

Cytoplasm and organelles of a bacterial cell

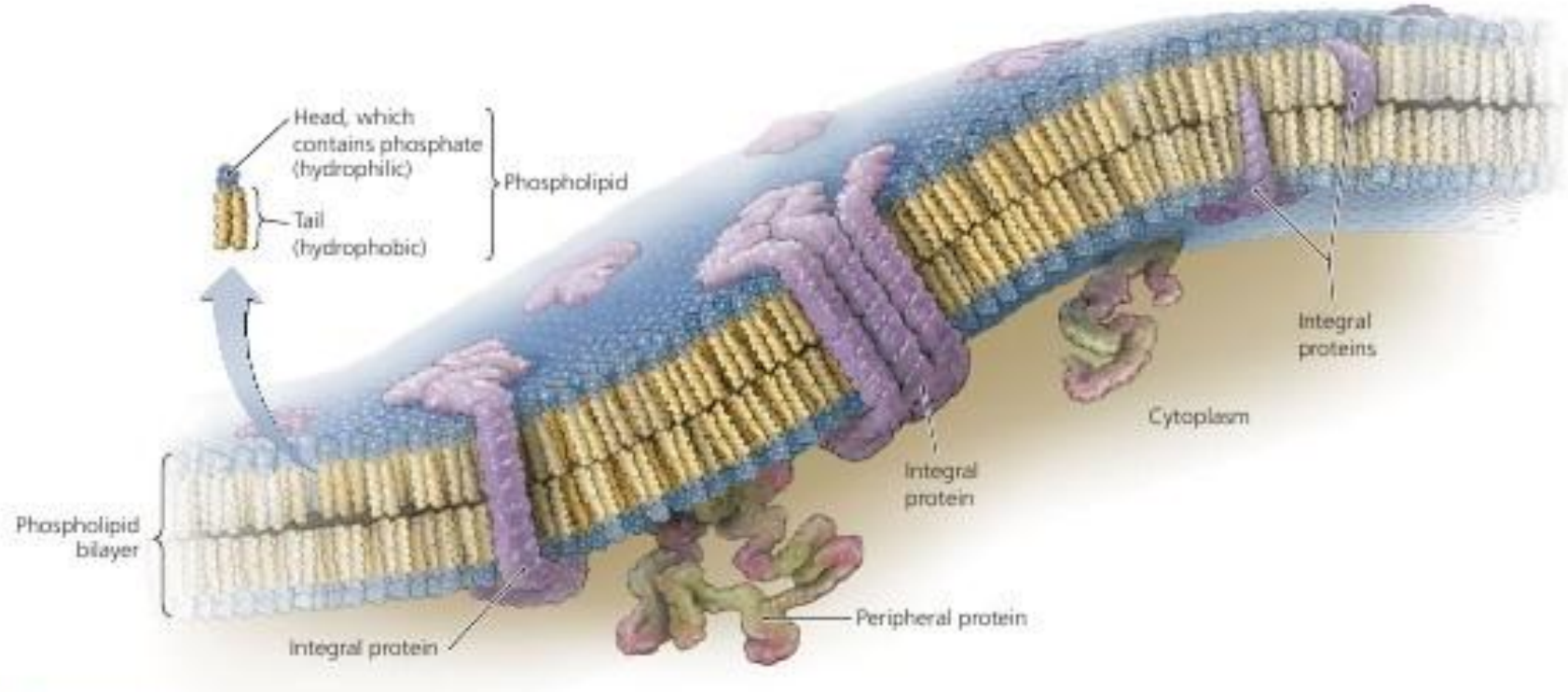
- The cytoplasm is a colloid consisting of soluble proteins, RNA, inclusions and ribosomes.
- Bacterial ribosomes with a size of 20 nm with a sedimentation constant of 70 S (subunits 50 S and 30 S).
- Ribosomal RNAs (16 S and 23 S) are the most conserved elements of bacteria. Their determination (especially 16 S) is based on the bacterial gene systematics.
- Inclusions (granules of glycogen, polysaccharides, lipids, polyphosphates) are accumulated by the bacterial cell as a supply of nutrient and energy substances.

Bacterial cell membrane

Membrane of bacterial cell consists of:

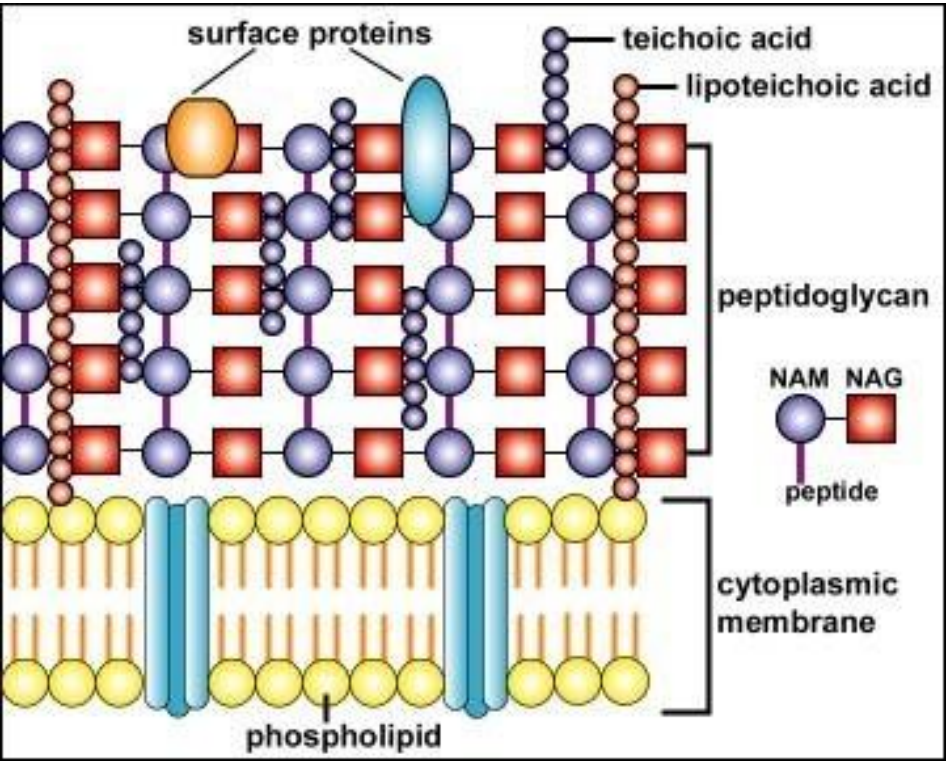
- Cytoplasmic membrane.
- Cell wall (in gram-negative bacteria - with an outer membrane).
- Some bacteria on the outside have an additional structure - the capsule layer.

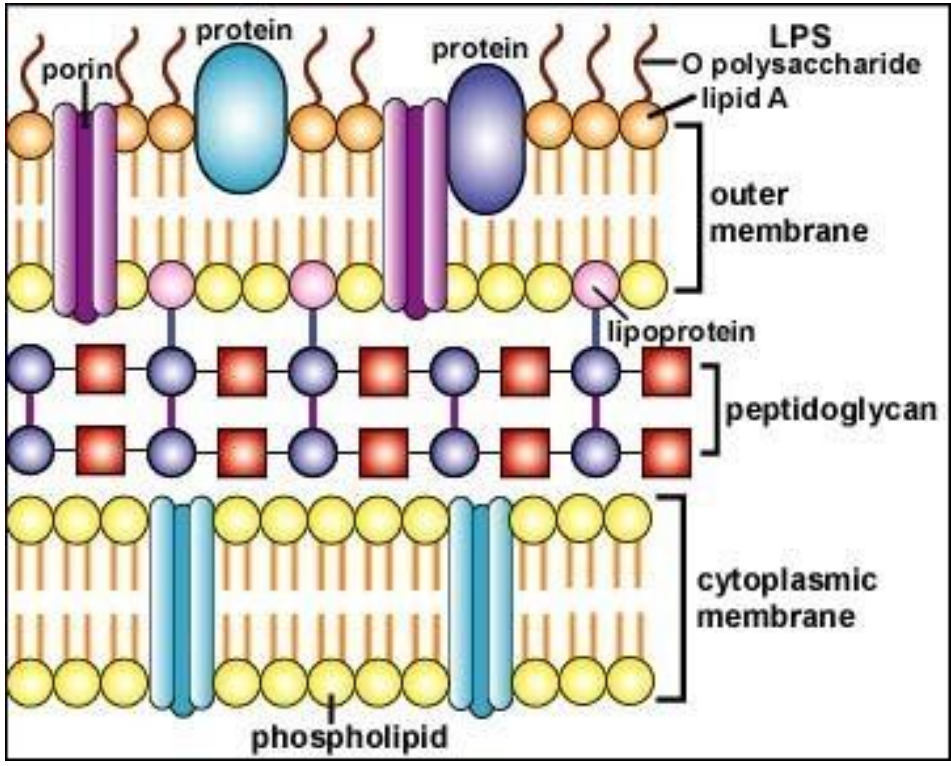
Structure CPM



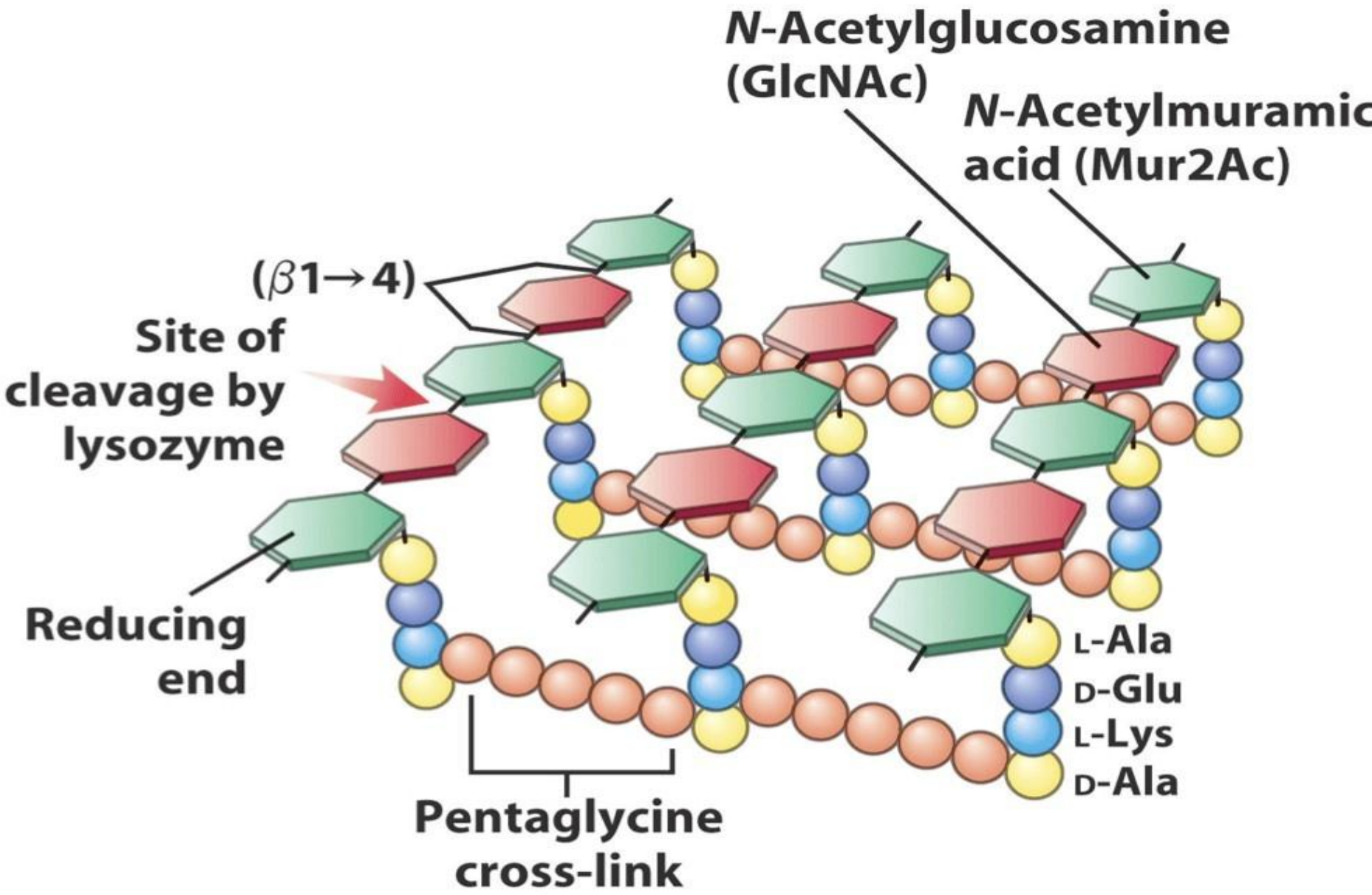
▲ **Figure 3.16**
The structure of a prokaryotic cytoplasmic membrane: a phospholipid bilayer.

Membrane structure of Gram+ and Gram – of bacteria.

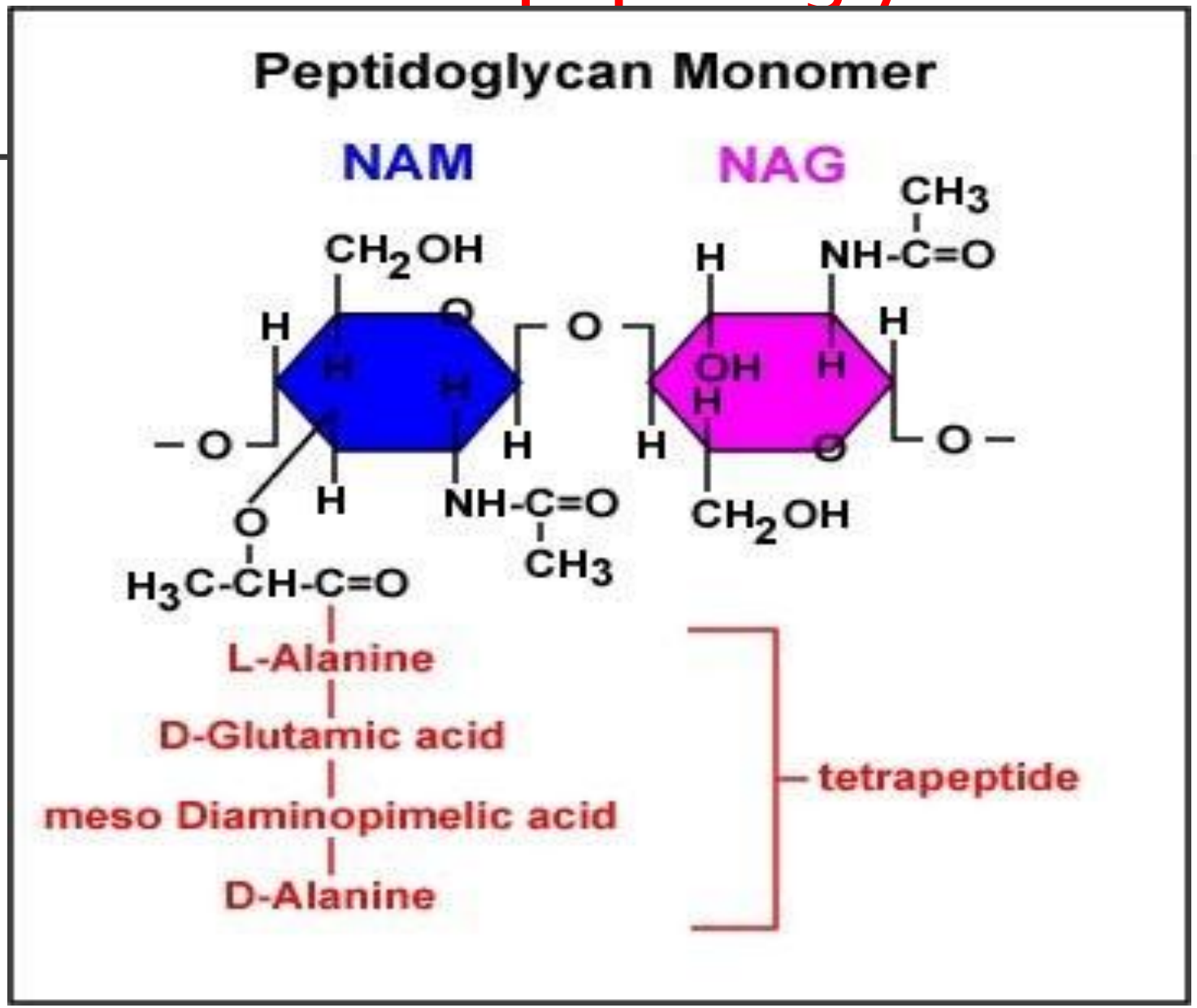




Structure of peptidoglycan.



Structure of peptidoglycan.



Gram stains stages.

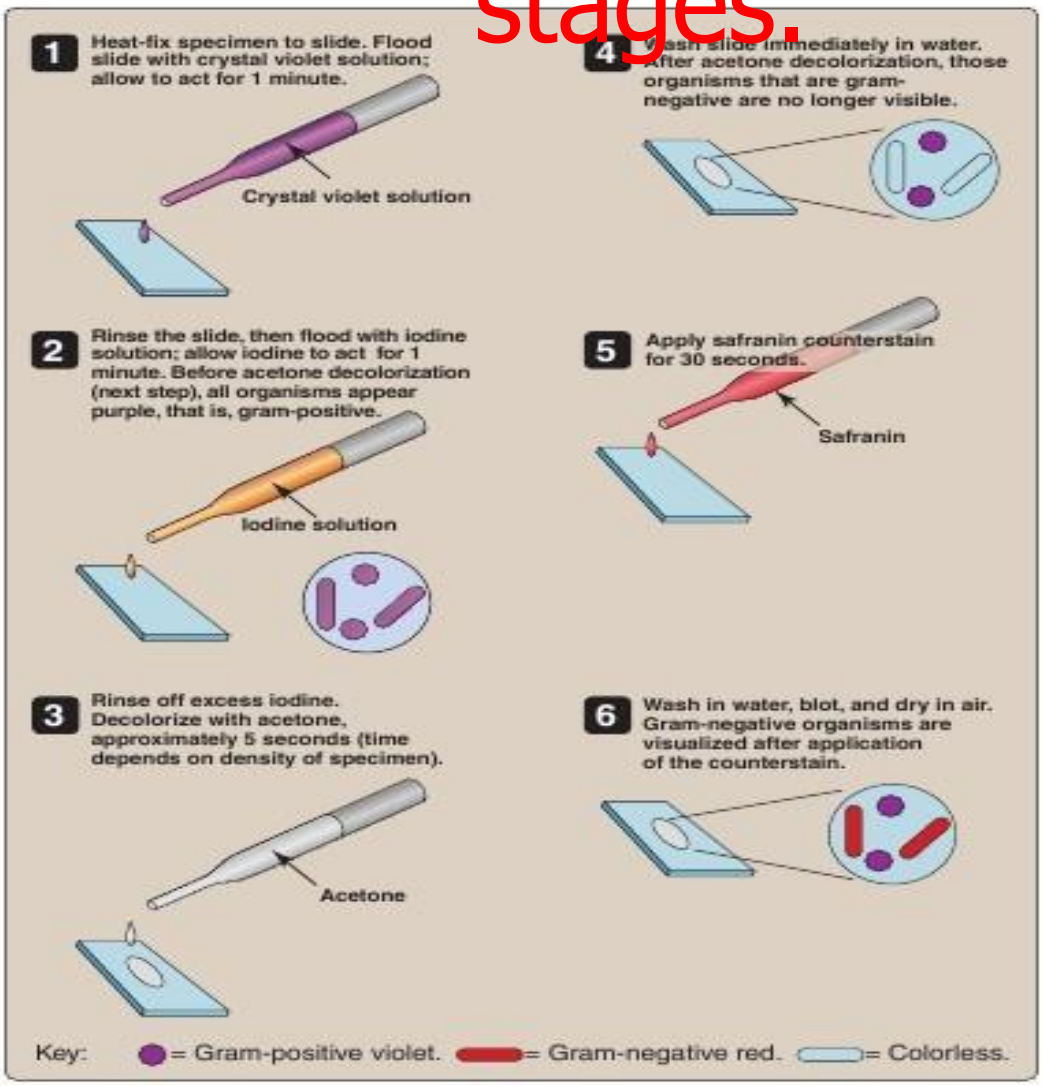
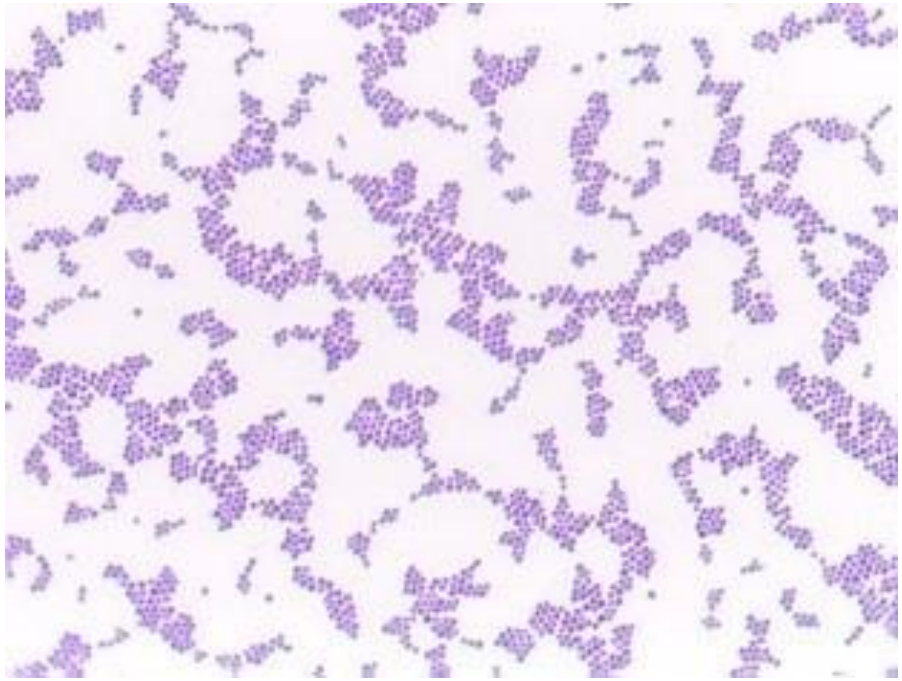
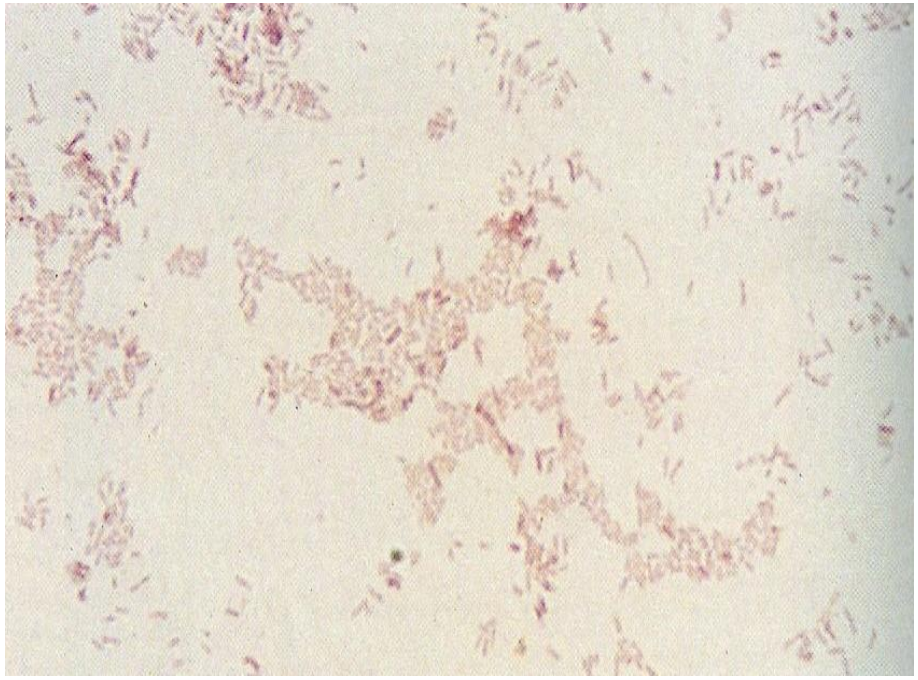


FIGURE 4-21. Steps in the Gram staining technique. (From Harvey RA et al. Lippincott's Illustrated Reviews: Microbiology, 2nd ed. Philadelphia: Lippincott Williams & Wilkins, 2007.)

Microbes stained by the method of Gram.

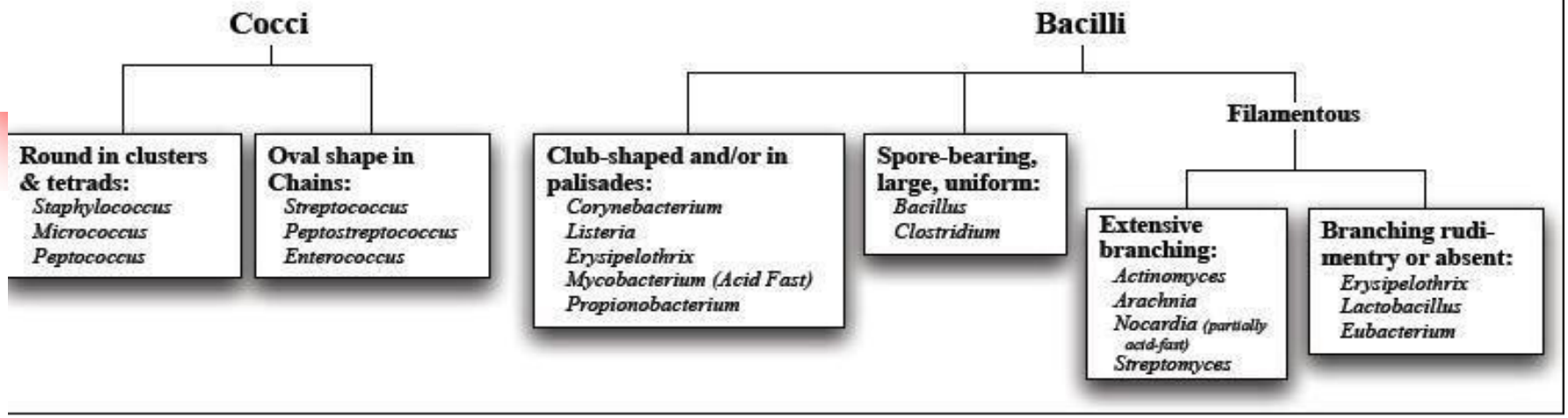




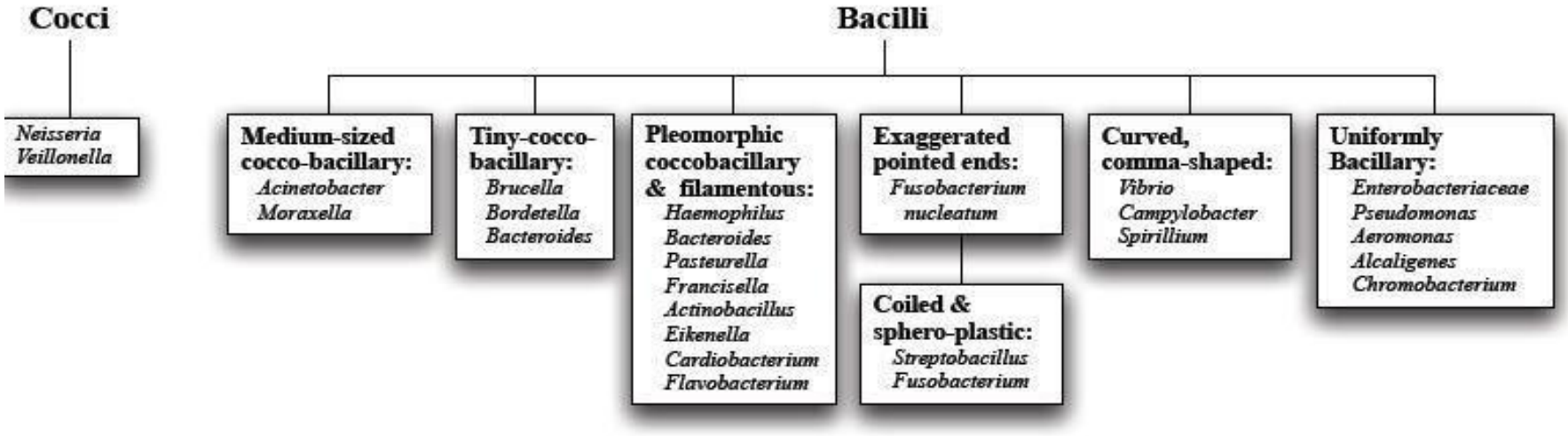
Грам +

Грам -

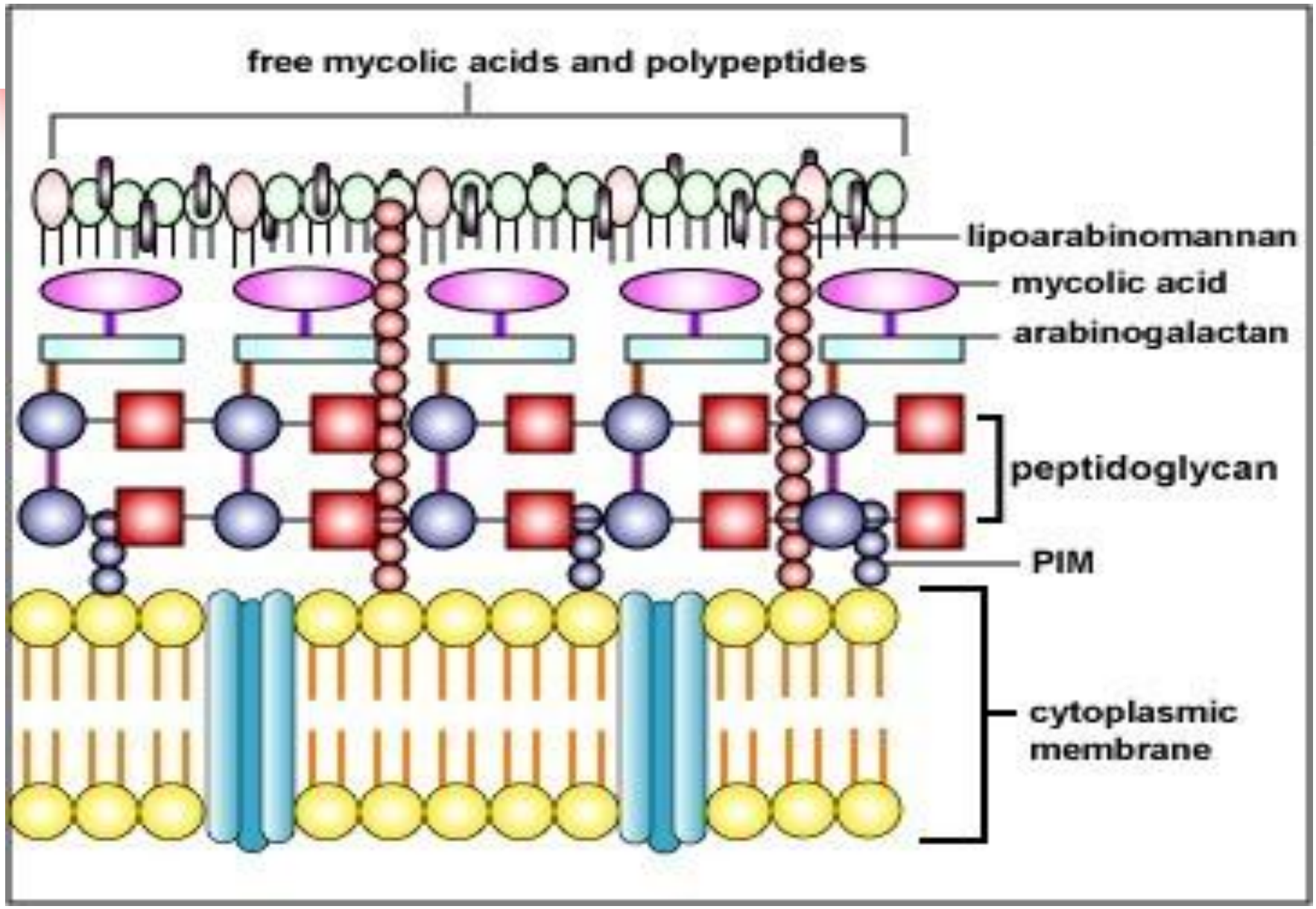
Gram Positive



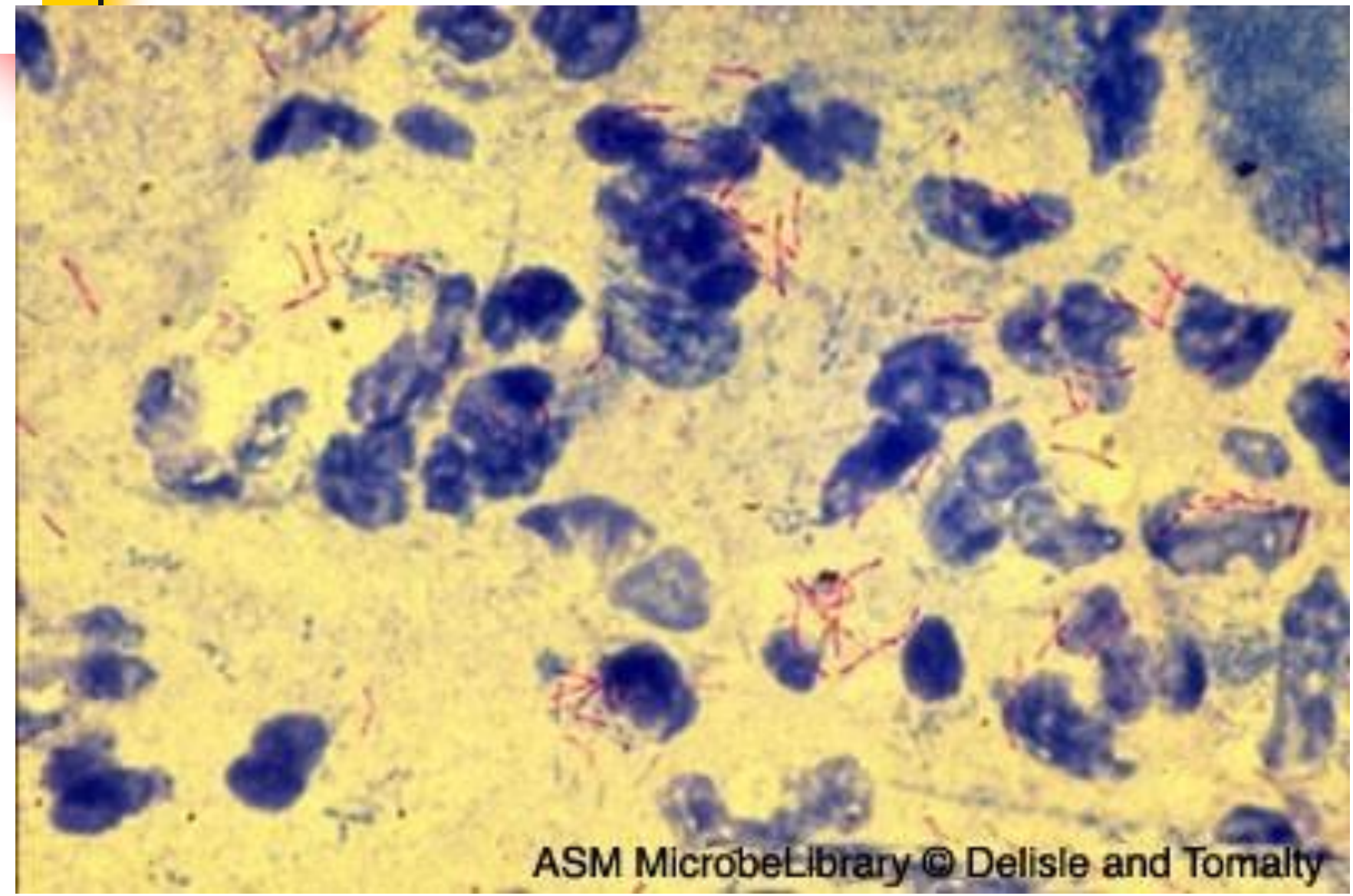
Gram Negative



Structure of the acid resistant bacteria's cell wall.



Staining by the method of Ziehl- Nelseen.

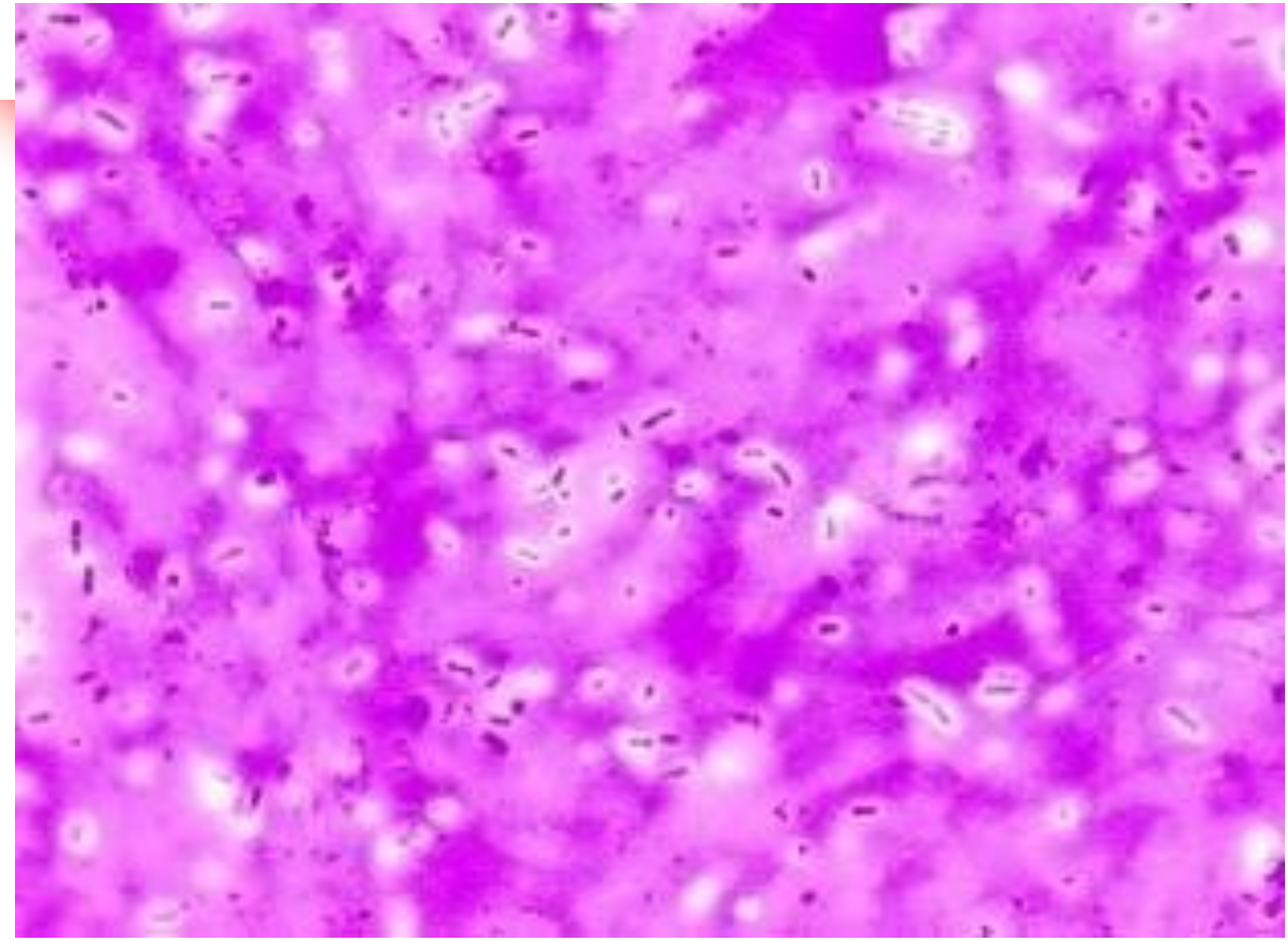


Химический состав капсул бактерий

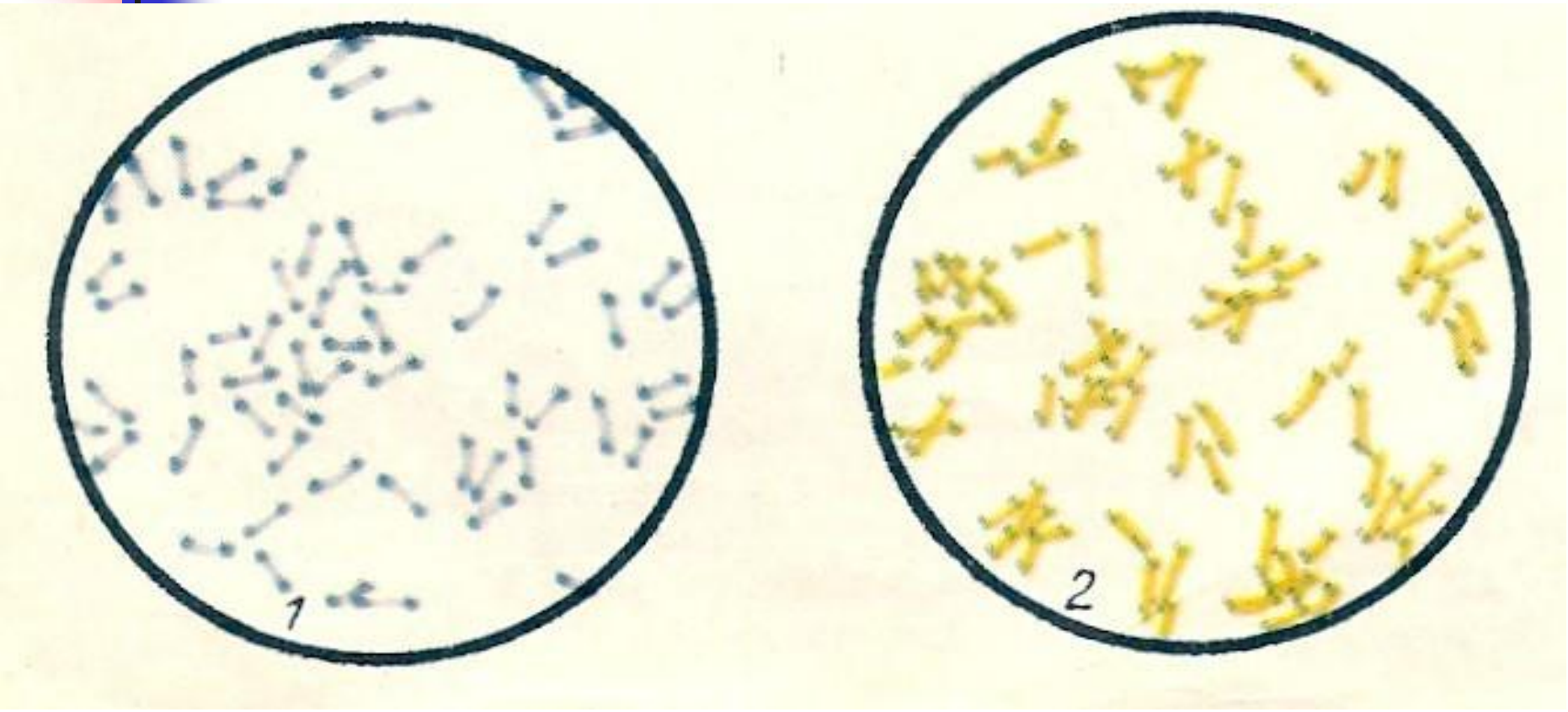
Chemical Composition of Capsules

Bacterium	Capsule composition	Structural subunits
Gram-positive Bacteria		
Bacillus anthracis	polypeptide (polyglutamic acid)	D-glutamic acid
Bacillus megaterium	polypeptide and polysaccharide	D-glutamic acid, amino sugars, sugars
Streptococcus mutans	polysaccharide	(dextran) glucose
Streptococcus pneumoniae	polysaccharides	sugars, amino sugars, uronic acids
Streptococcus pyogenes	polysaccharide (hyaluronic acid)	N-acetyl-glucosamine and glucuronic acid
Gram-negative Bacteria		
Acetobacter xylinum	polysaccharide	(cellulose) glucose
Escherichia coli	polysaccharide (colonic acid)	glucose, galactose, fucose glucuronic acid
Pseudomonas aeruginosa	polysaccharide	mannuronic acid
Azotobacter vinelandii	polysaccharide	glucuronic acid
Agrobacterium tumefaciens	polysaccharide	(glucan) glucose

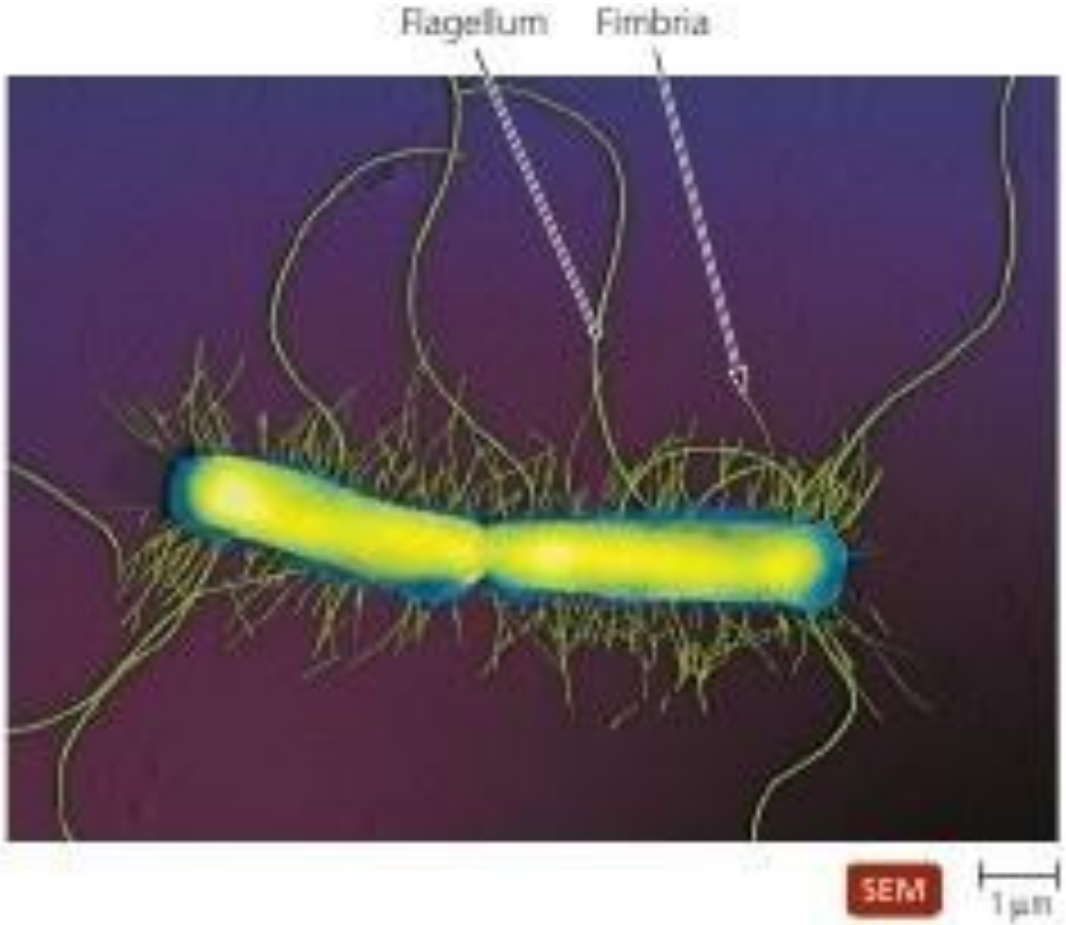
Detection of capsule by the method of Burry-Gins



Volutin grains dyed with methylene blue and Neisser.

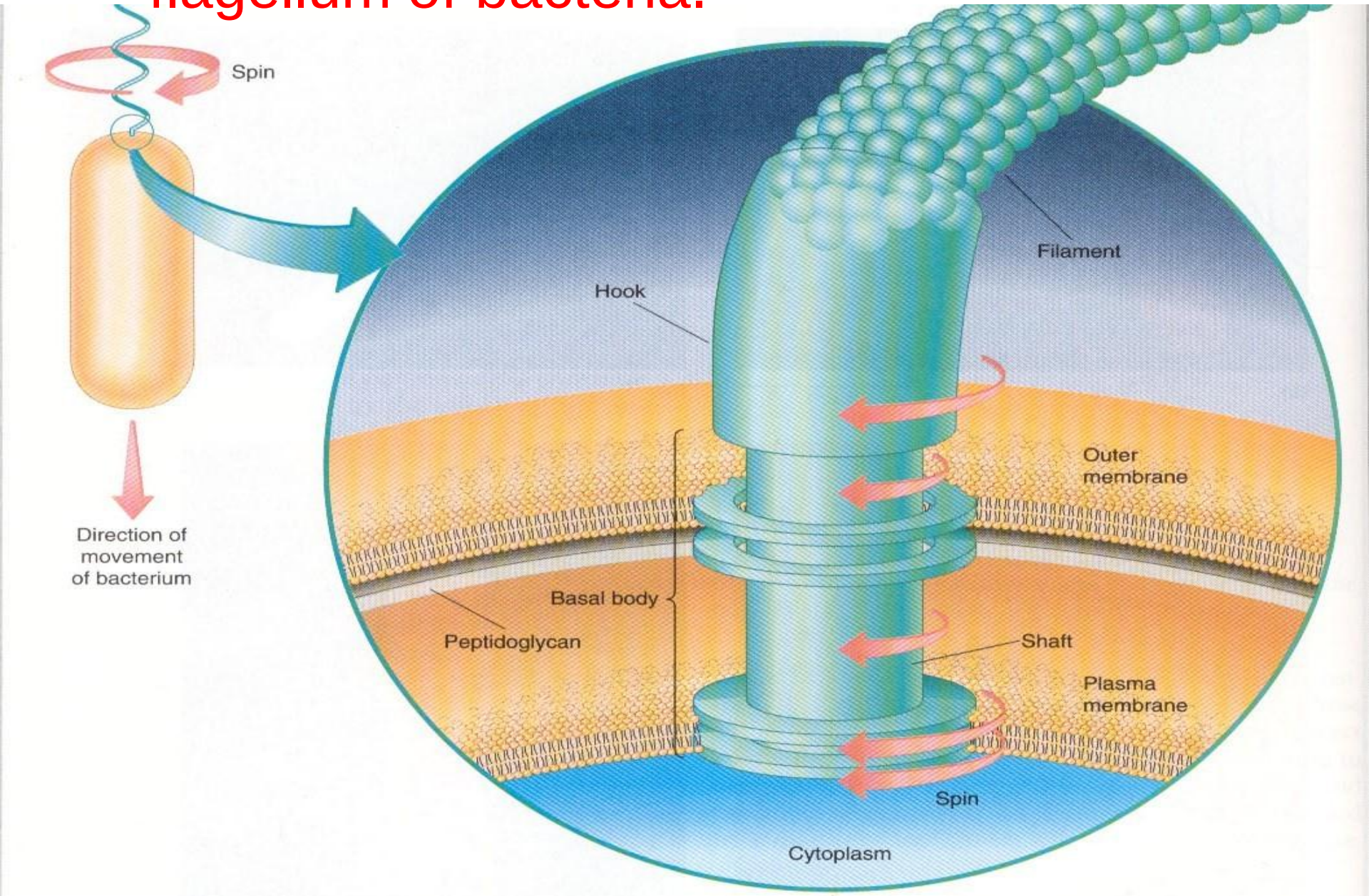


Flagella and fimbriae (drank) in bacteria.

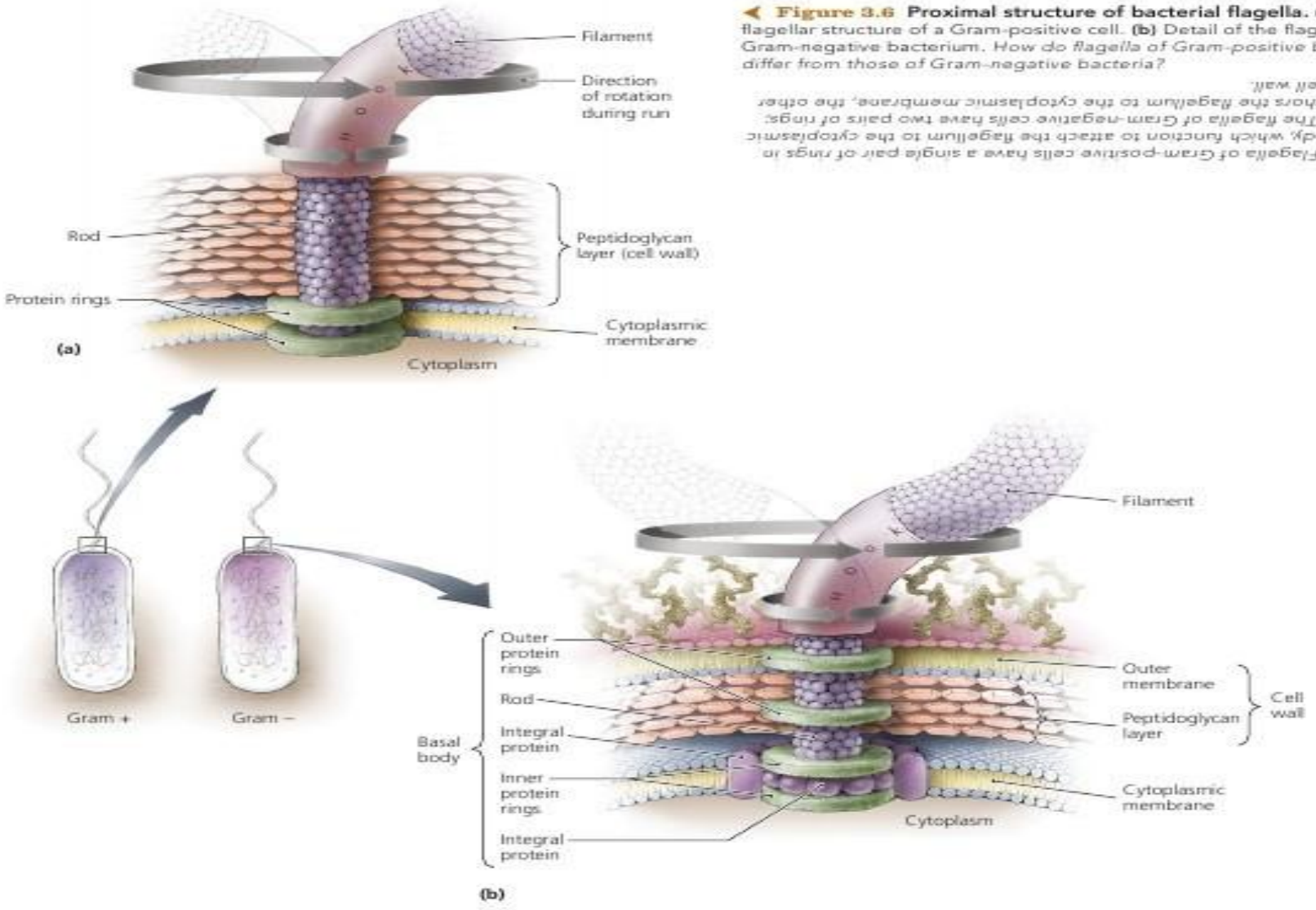


▲ **Figure 3.10 Fimbriae.** *Proteus vulgaris* has flagella and fimbriae.

Diagram of the structure of the flagellum of bacteria.



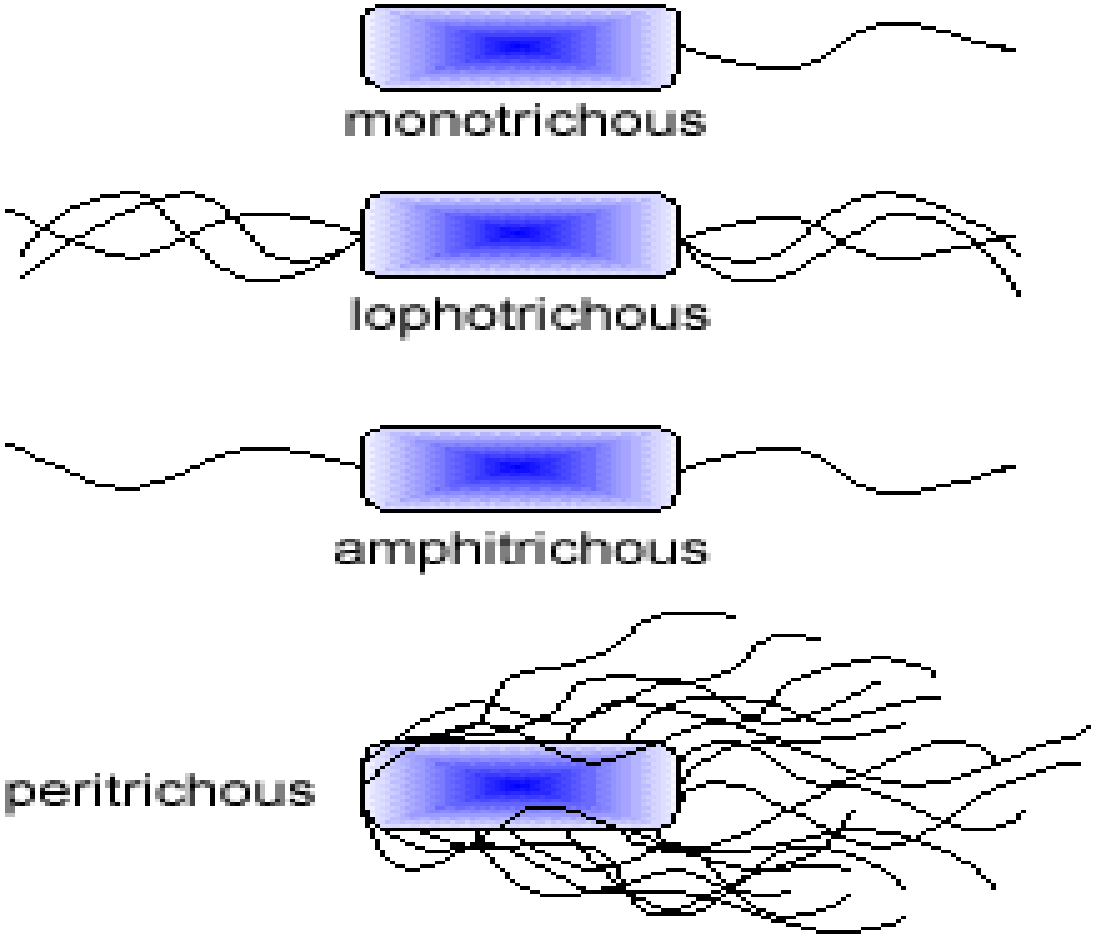
Attachment of flagella in Gr + and Gr-bacteria.



◀ **Figure 3.6 Proximal structure of bacterial flagella.** (a) Detail of flagellar structure of a Gram-positive cell. (b) Detail of the flagellum of a Gram-negative bacterium. *How do flagella of Gram-positive bacteria differ from those of Gram-negative bacteria?*

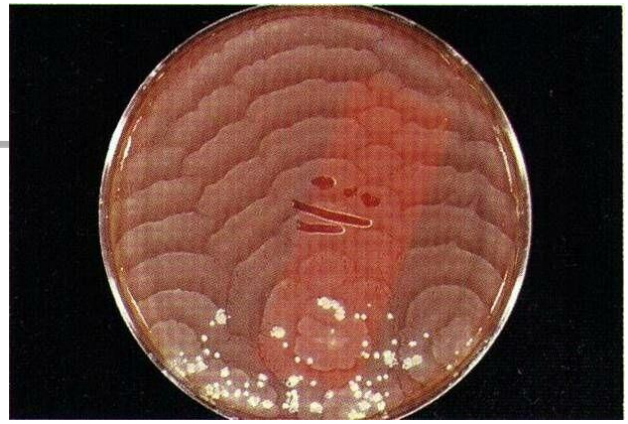
Figure 3.6 Flagella of Gram-positive cells have a single pair of rings in the basal body, which function to attach the flagellum to the cytoplasmic membrane. The flagella of Gram-negative cells have two pairs of rings: one pair anchors the flagellum to the cytoplasmic membrane, the other pair to the cell wall.

Different arrangement of flagella in bacteria.



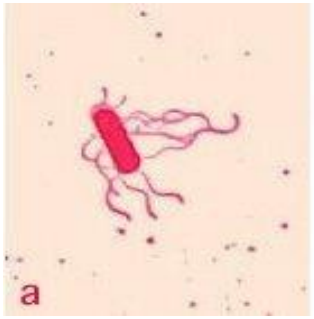
Determination of bacterial motility.

- The phenomenon of swarming in the environment →

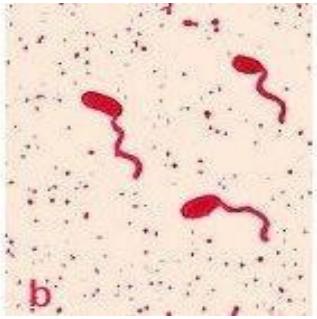


Proteus spp.

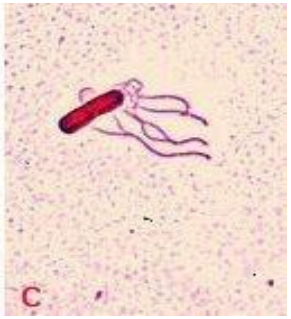
- Special stain



B. cereus

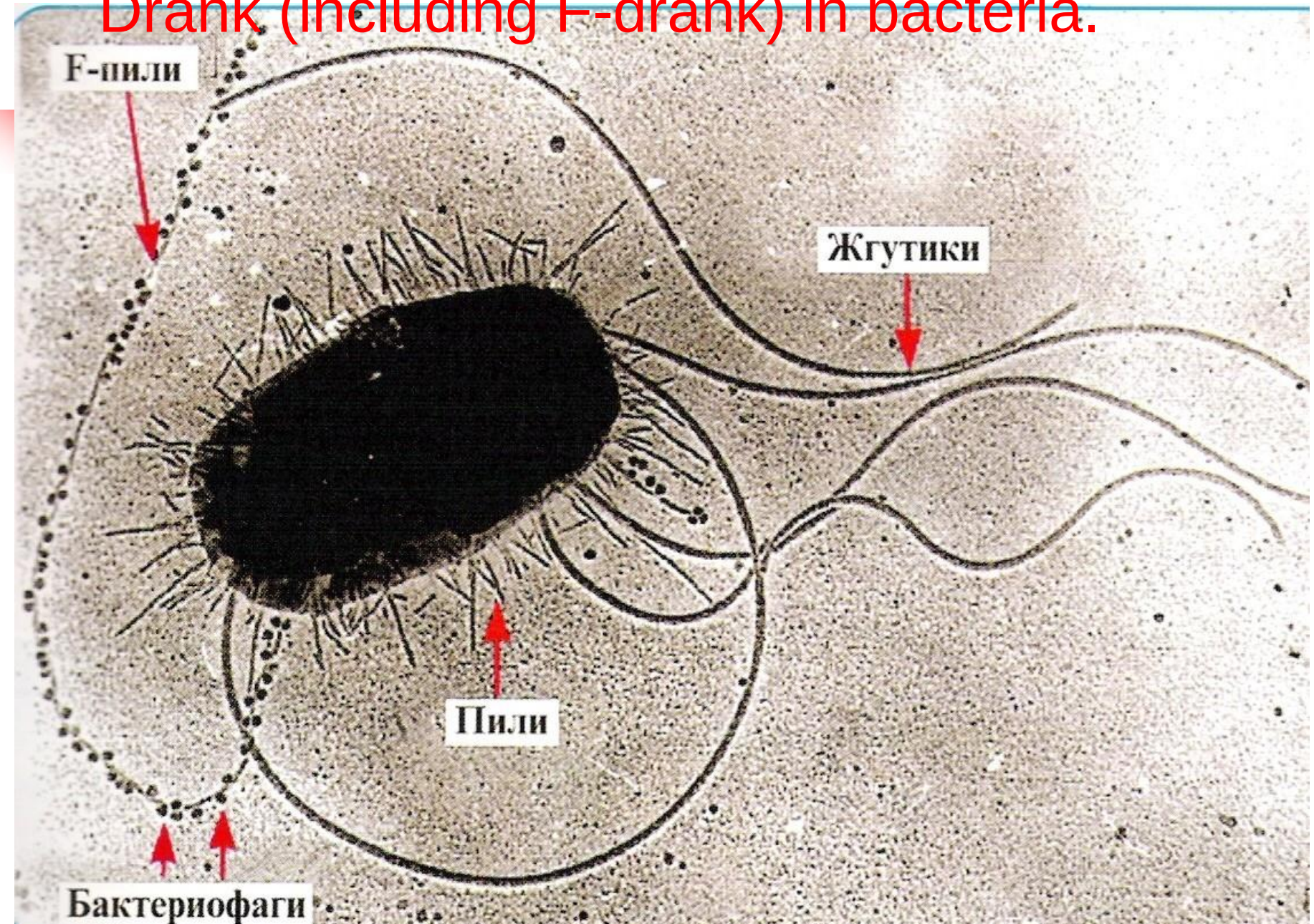


V. cholerae



B. brevis

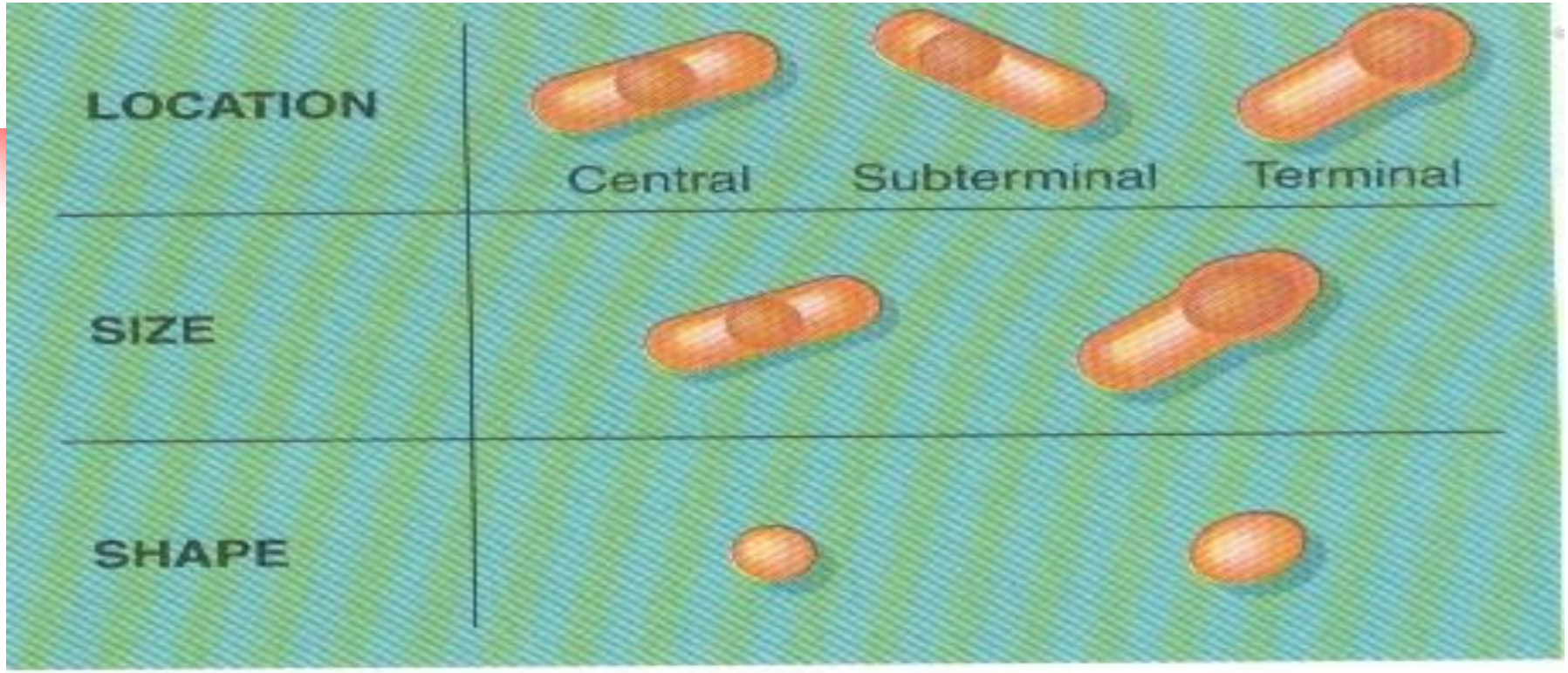
Drank (including F-drank) in bacteria.



Conjugation drank bacteria.

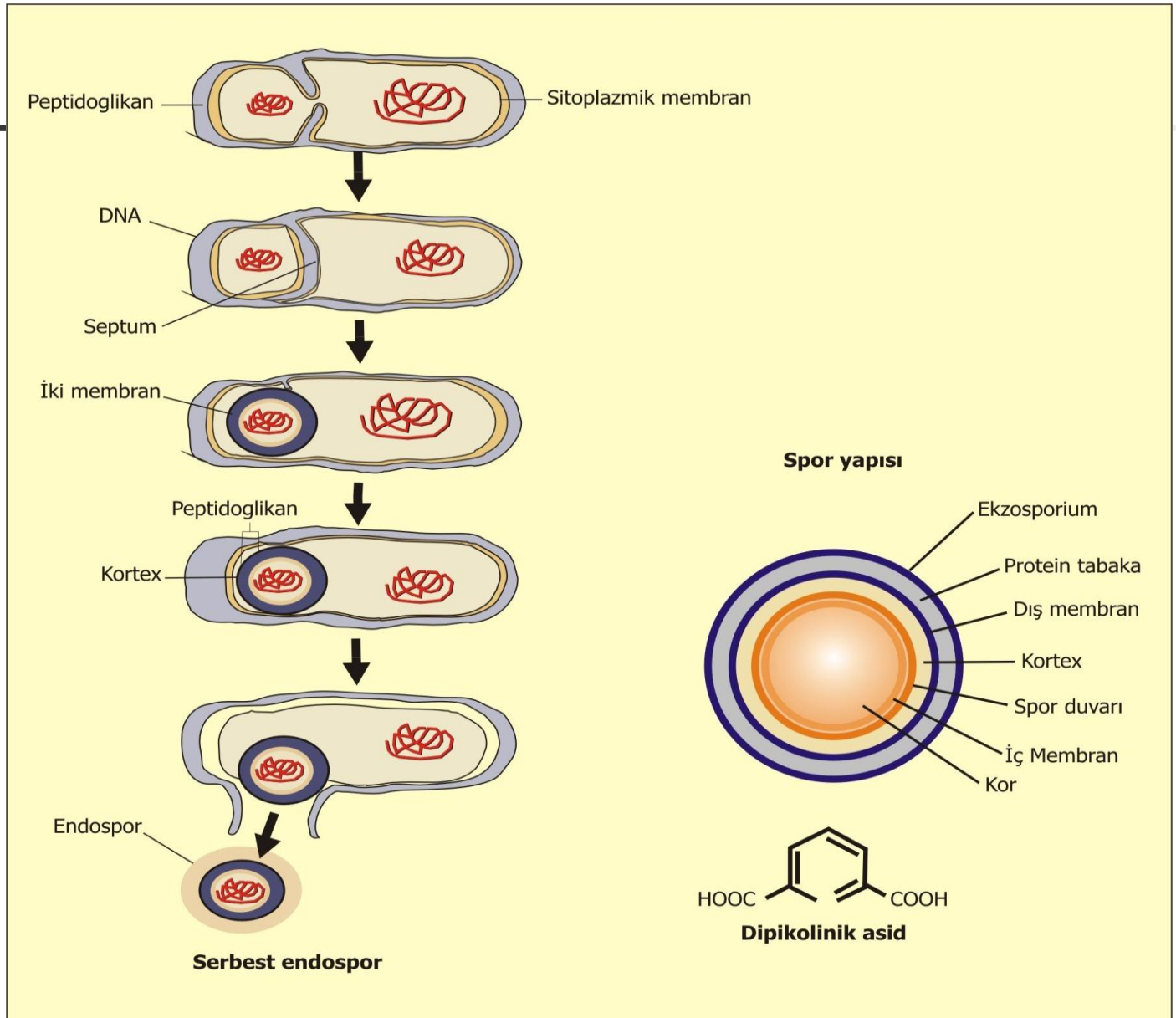
▲ **Figure 3.11** **Pili.** Two Salmonella cells are connected by conjugation pili. *How are pili different from bacterial flagella?*

Bacteria spores (sizes and location)



(a)

Stages of spore formation



Turning of spores into a vegetative form.

Spores of the causative agent of anthrax (method Ozeshko)

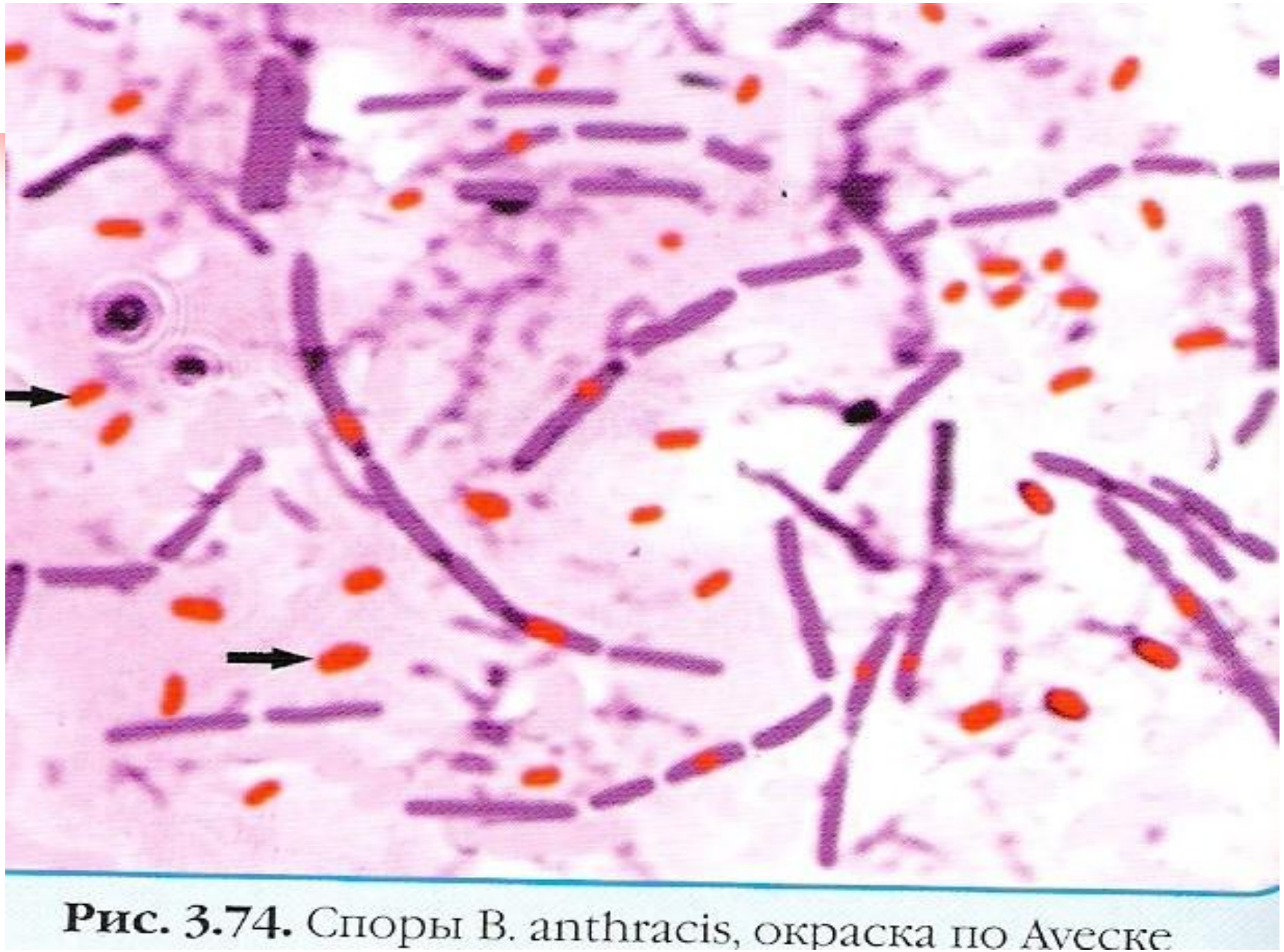


Рис. 3.74. Споры B. anthracis, окраска по Ауеске

Spirochetes

- Thin, mobile, spirally crimped batteries from 3 to 20 microns in length, characterized by mobility due to flexion changes in cells.
- Cells consist of a protoplasmic cylinder intertwined with one or more axial fibrils extending from subterminal attachment disks located at the ends of the cylinder (which brings them closer to the simplest).

Taxonomy of Spirochetes

- Type – Spirochaetes
- Class – Spirochaetes
- Order – Spirochaetales
- Family - Spirochaetaceae

Gender – Spirochaeta

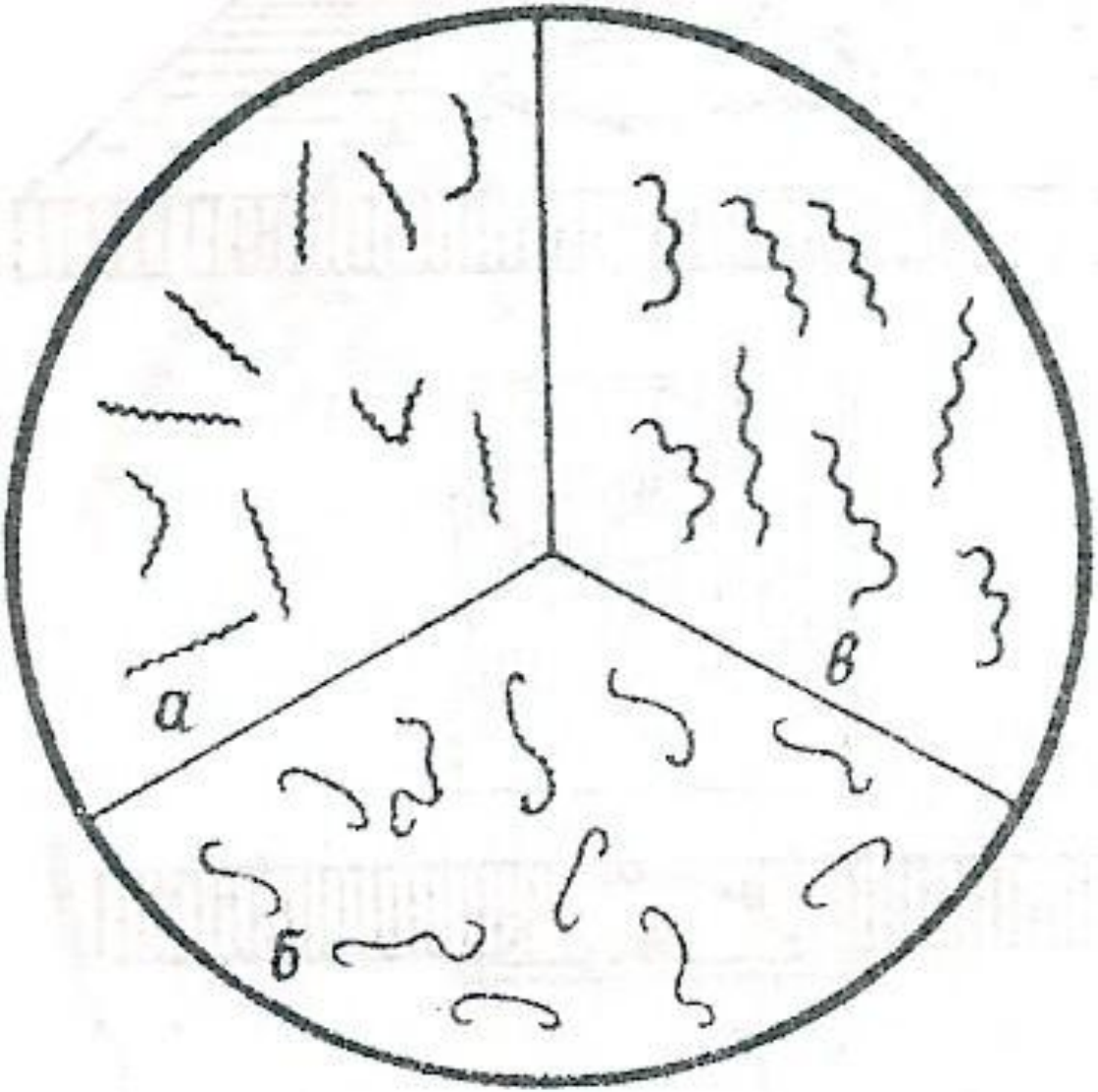
Treponema (more than 10 types of species and subspecies)

Borrelia (more than 20 species)

- Family – Leptospiraceae

Gender - **Leptospira** (more than 200 serovars)

Spirochetes genders ofTreponema (а), **Leptospira (б) , Borrelia (в)**



Treponema.

Types of treponema pathogen for human beings:

1) **T.pallidum**

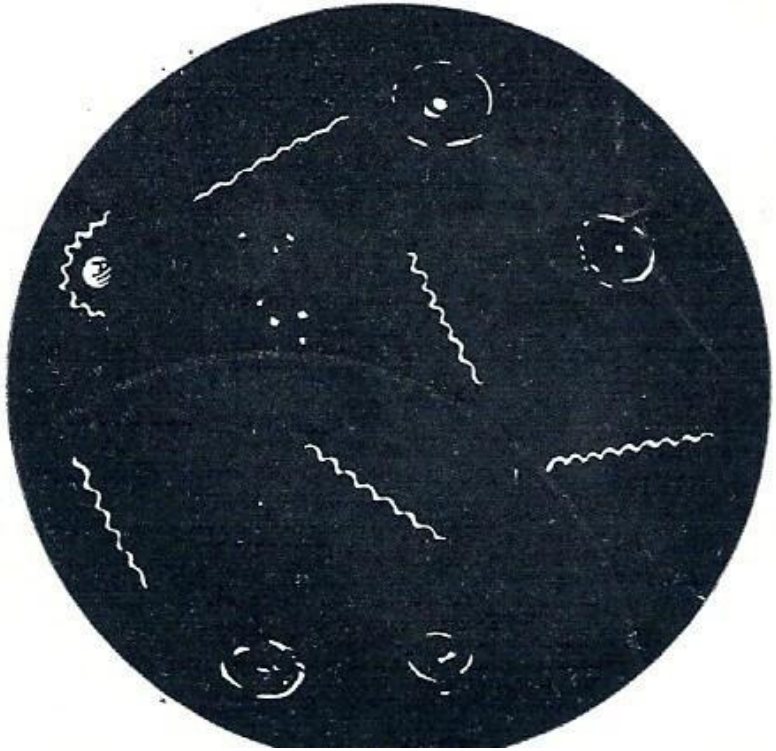
subspecies: pallidum (causative agent of syphilis)
endemicum (begel pathogen)

pertenue (causative agent of frambesia)

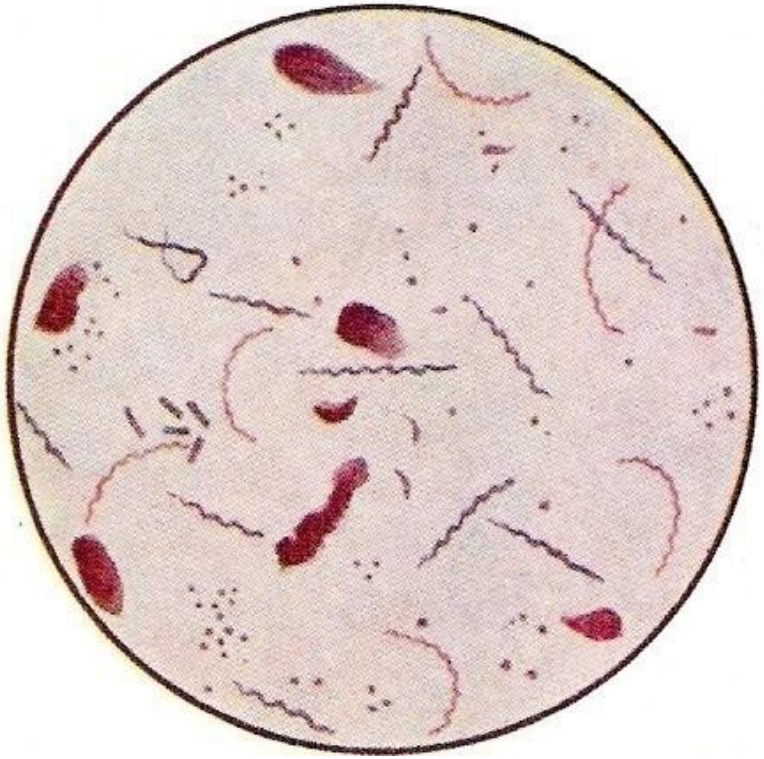
2) **T.carateum** (pint pathogen)

3) **T.vincentii** (together with fusobacteria, the causative agent of ulcerative necrotic tonsillitis Simanovsky-Vincent-Plaut)

Treponema



Dark field microscopy



Staining by the method of Gimzi

Treponema of syphilis (electron micrography)

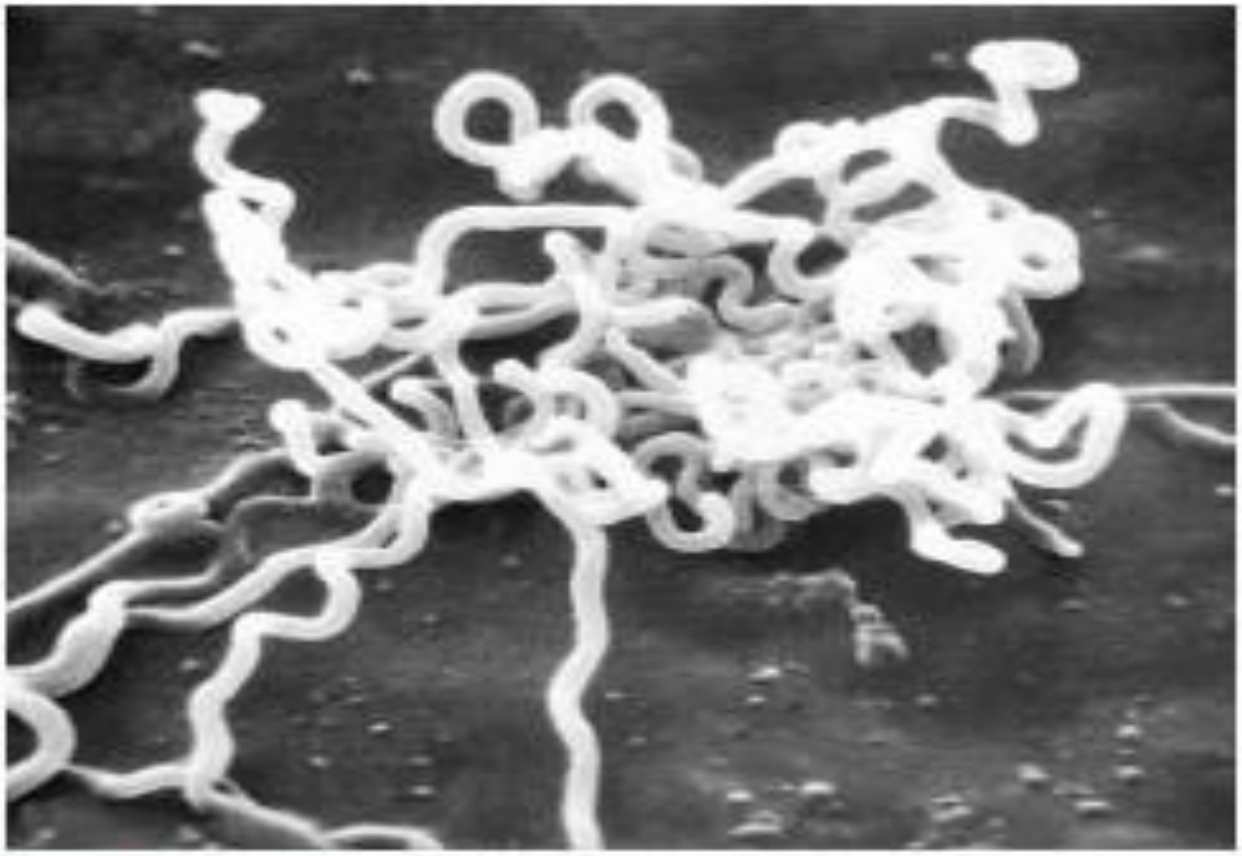


FIGURE 4-18. **Scanning electron micrograph of *Treponema pallidum*, the bacterium that causes syphilis.** (Courtesy of Dr. David Cox and the Centers for Disease Control and Prevention.)

Borrelia.

Gender of Contains more than 20 types, list of which below show the pathogen ones for the human beings:

B.recurrentis -
causative agent of anthroponous epidemic relapsing fever

B.duttoni - causative agent of zoonotic endemic (tick-borne) relapsing fever

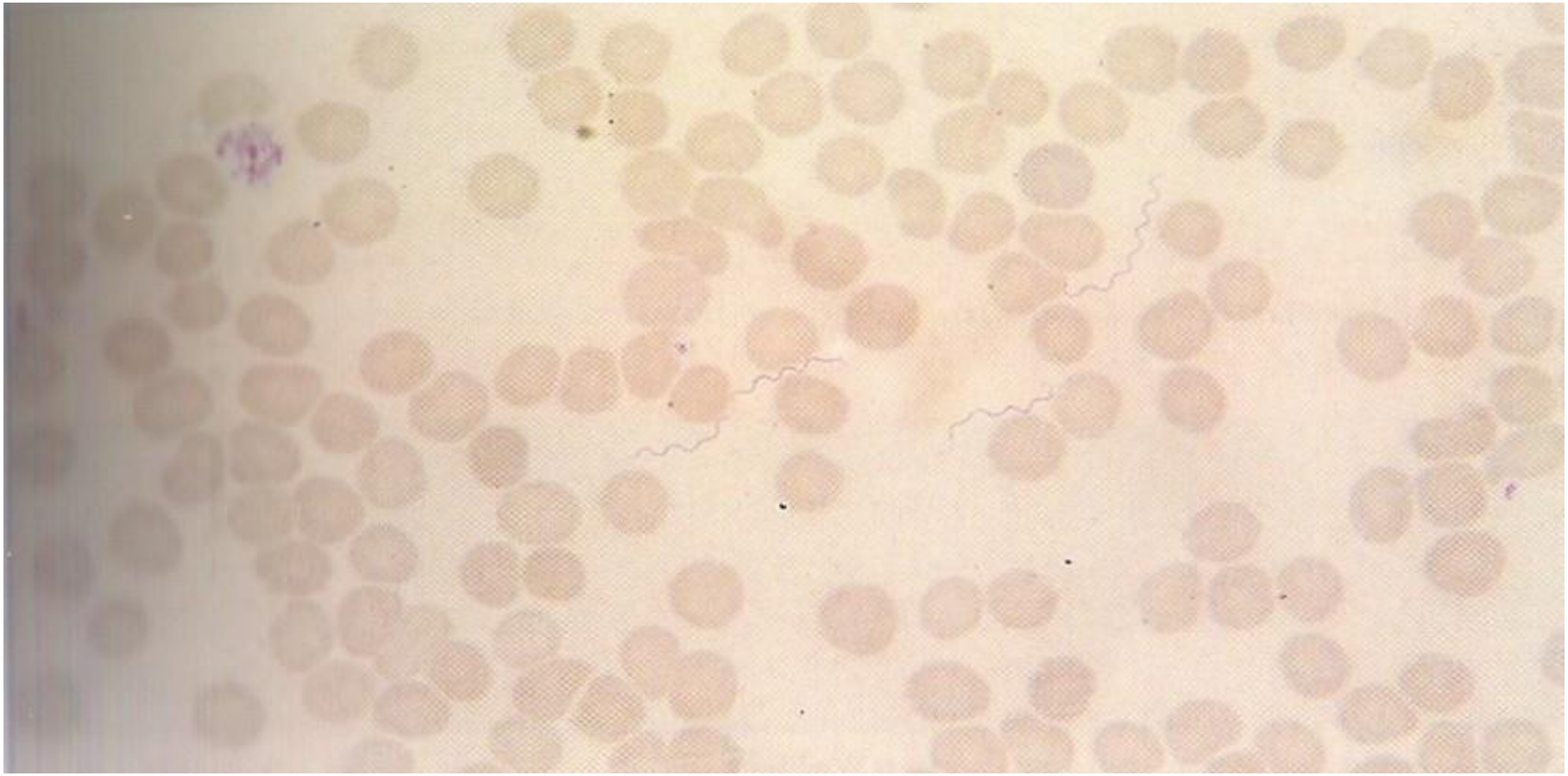
B.persica - causative agent of zoonotic endemic (tick-borne) relapsing fever

B.burgdorferi - Lyme disease pathogen in North America

B.garini - causative agent of Lyme disease on the Euro-Asian continent

B.afzelii - causative agent of Lyme disease on the Euro-Asian continent

Borrelia recurrentis
blood smear (Giemsa stain)



Leptospira

The genus Leptospira contains one species, L.interrhogans, which includes 38 serogroups and more than 200 leptospira serovars.
Leptospira 13 serogroups and 27 serovars are found in the CIS countries.
The most commonly identified leptospira serovars are:

L.icterohaemorrhagiae – causative agent of Vasiliev-Weil disease (icteric leptospirosis)

L.grippotyphosa - causative agent of swamp fever or marsh fever

L. canicola – causative of canine leptospirosis

L.pomona - swine pathogen causative

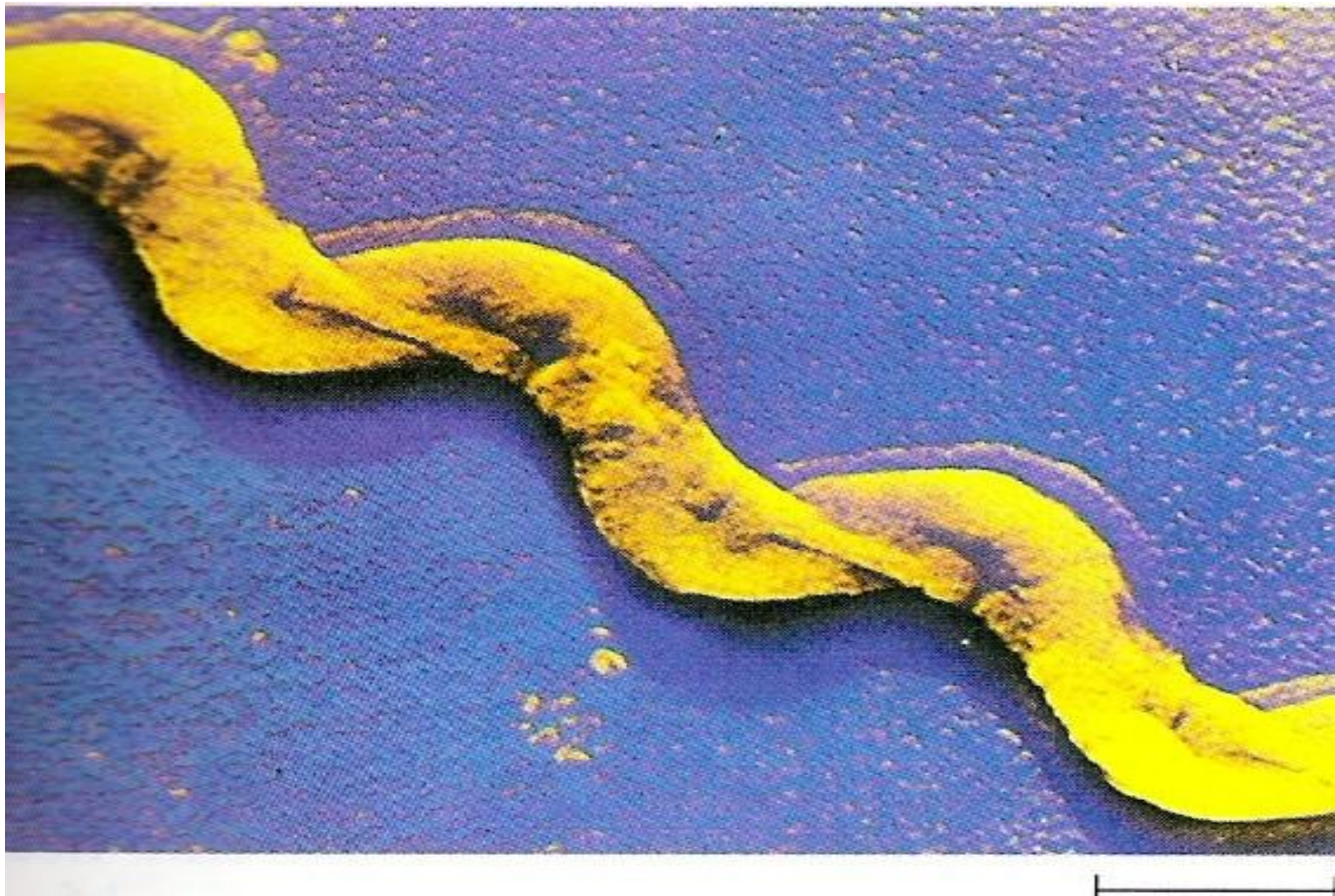
L.mitis - swine pathogen causative

L.hebdomatis - causative agent of Japanese or 7-day fever

L.autumnalis - causative agent of shin fever or Fort Bragg fever

L.australis - causative agent of Australian or 7-day fever

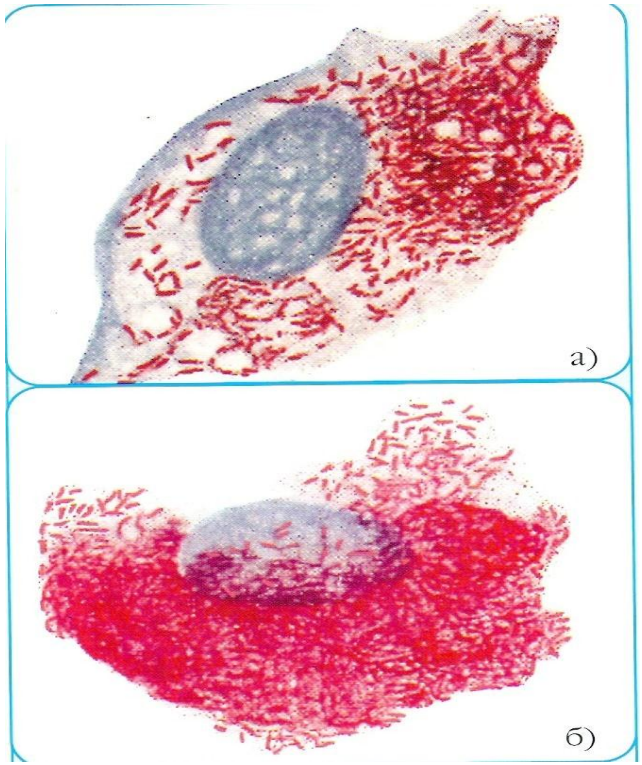
Leptospira (electron microscopy)



Leptospira interrogans

Rickettsia.

- Small gram-negative bacteria, obligate intracellular parasites
- The macroergic compounds necessary for their reproduction are obtained from the host cell
- The form is cocci or short sticks with a size of 0.3-2.0 microns, but long sticks and filiform shapes can be found.



Rickettsia inside cell

Taxonomy of ricketsia.

- Type – Proteobacteria
- Class – Alphaproteobacteria

Genders – **Rickettsia** (causative of typhus and spotted fevers)
Orientia (causative of Tsutsugamushi fever)
Ehrlichia (caus. Ehrlichiosis Sennetsu et al.)
Bartonella (caus. of diseases -cat scratches, trench fever, etc.)

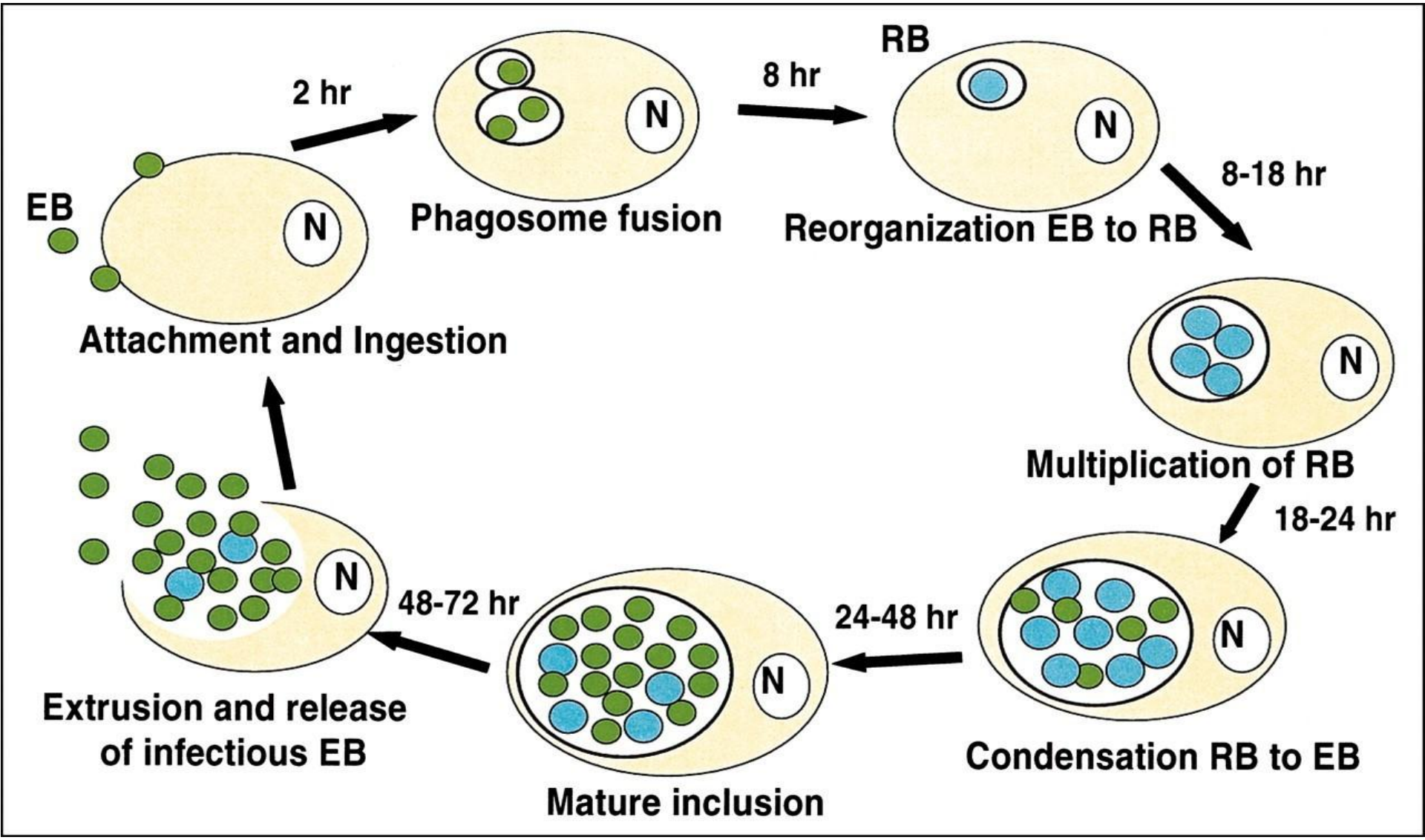
- Class – Gammaproteobacteria

Genders - **Coxiella** (caus. fever ku)

For humans are pathogen: **10 types of ricketsia**,
1 type of oriensia, 3 species of Ehrlichia, 5 species of Bartonella and 1 species of coxiella.

Chlamydia

- Small gram-negative bacteria, obligate intracellular parasites with a special development cycle.
- They are energy parasites: they do not synthesize adenosine triphosphate (ATP) and guanosine triphosphate (GTP)
- The development cycle includes the stages of elementary (0.2-0.3 μm)and reticular (0.8-1.2 μm) bodies
- Almost no N-acetylmuramic acid


EB
N
Attachment and Ingestion
2 hr
N
Phagosome fusion
8 hr
RB
N
Reorganization EB to RB
8-18 hr
N
Multiplication of RB
18-24 hr
N
Condensation RB to EB
24-48 hr
N
Mature inclusion
48-72 hr
N
Extrusion and release
of infectious EB

Taxonomy of Chlamydia

- Type– Chlamydiae
- Class – Chlamydiae
- Gender – **Chlamydia**

  Type - **C.trachomatis** (causative of trachoma, urogenital chlamydia and venereal lymphogranuloma)

  Gender - **Chlamydophila**

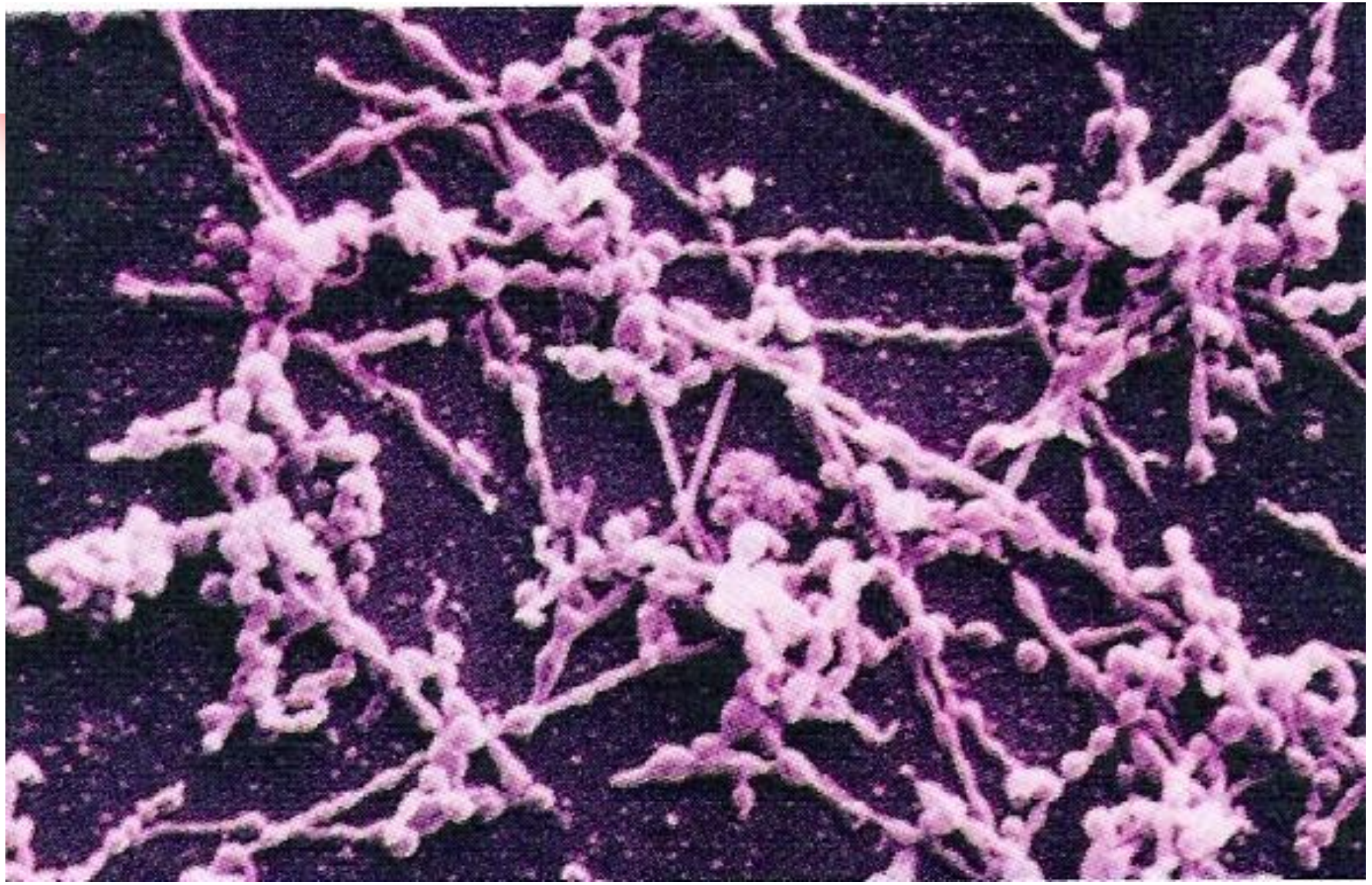
  Types – **C.psittaci** (caus. ornithosis)

  C.pneumoniae (caus. pneumonia, atherosclerosis, bronchial asthma, etc.)

Mycoplasmas.

- Small gram-negative bacteria, devoid of the cell wall and surrounded only by the cytoplasmic membrane, the main component of lipids of which is cholesterol.
- Due to the absence of a rigid cell wall, they are polymorphic, plastic and osmotically sensitive, resistant to substances that inhibit cell wall synthesis.
- Propagated by binary division, budding, fragmentation of filaments and spherical formations.
- They are the smallest among free-living bacteria (0.15-1.0 microns).

Mycoplasmas



Colonies of mycoplasmas on nutrition environment

Figure 11.15 The distinctive "fried egg" appearance of *Mycoplasma* colonies. This visual feature is unique to this group of bacteria, growing on an agar surface.

Taxonomy of mycoplasmas.

- Type – Firmicutes
- Class - Mollicutes
- Gender – **Mycoplasma**

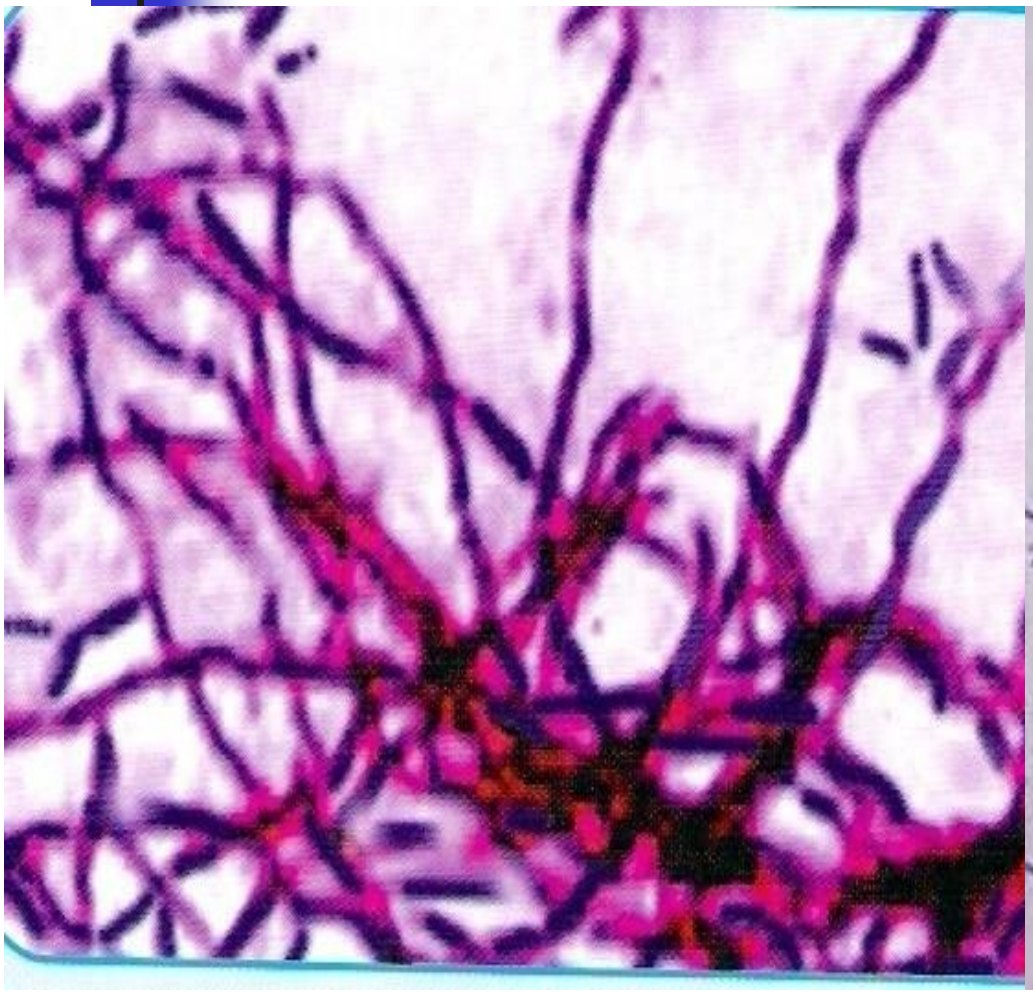
  Types – **M.pneumoniae** (caus. pneumonia), **M.hominis, M.fermentans, M.genitalium** (urogenital mycoplasmas)
- Gender - **Ureaplasma**

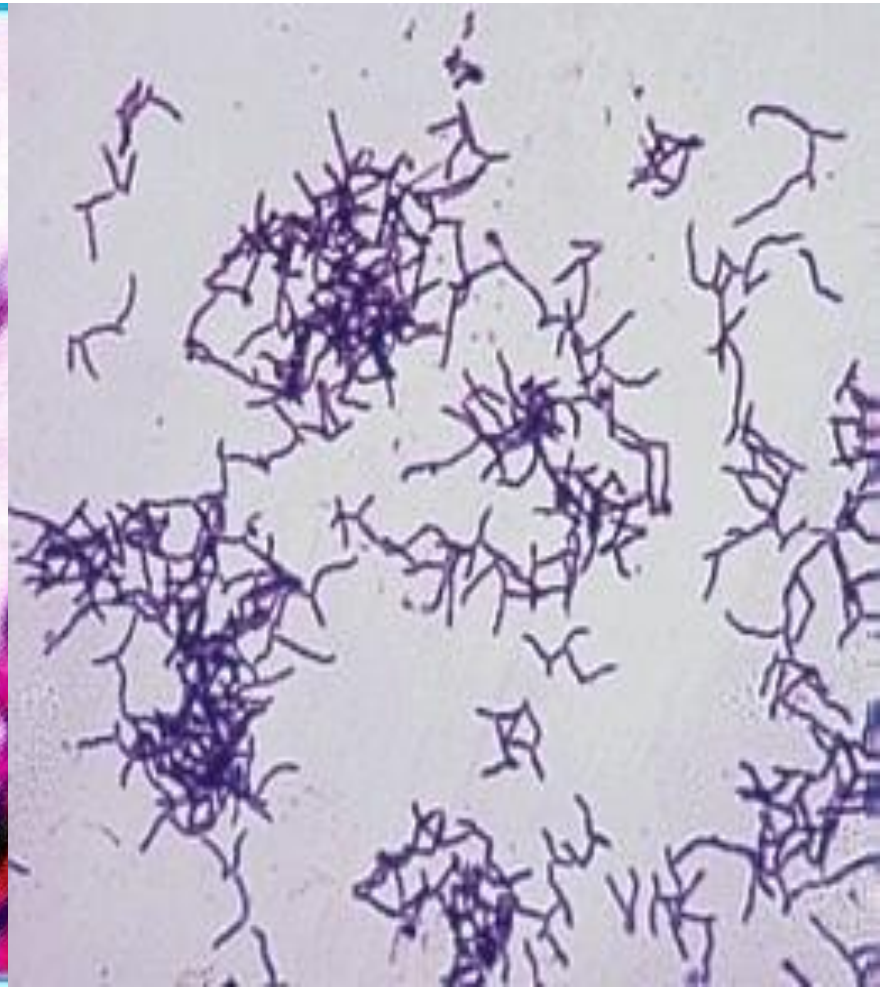
  Type – **U.urealyticum** (urogenital mycoplasmas)

Actinomycetes.

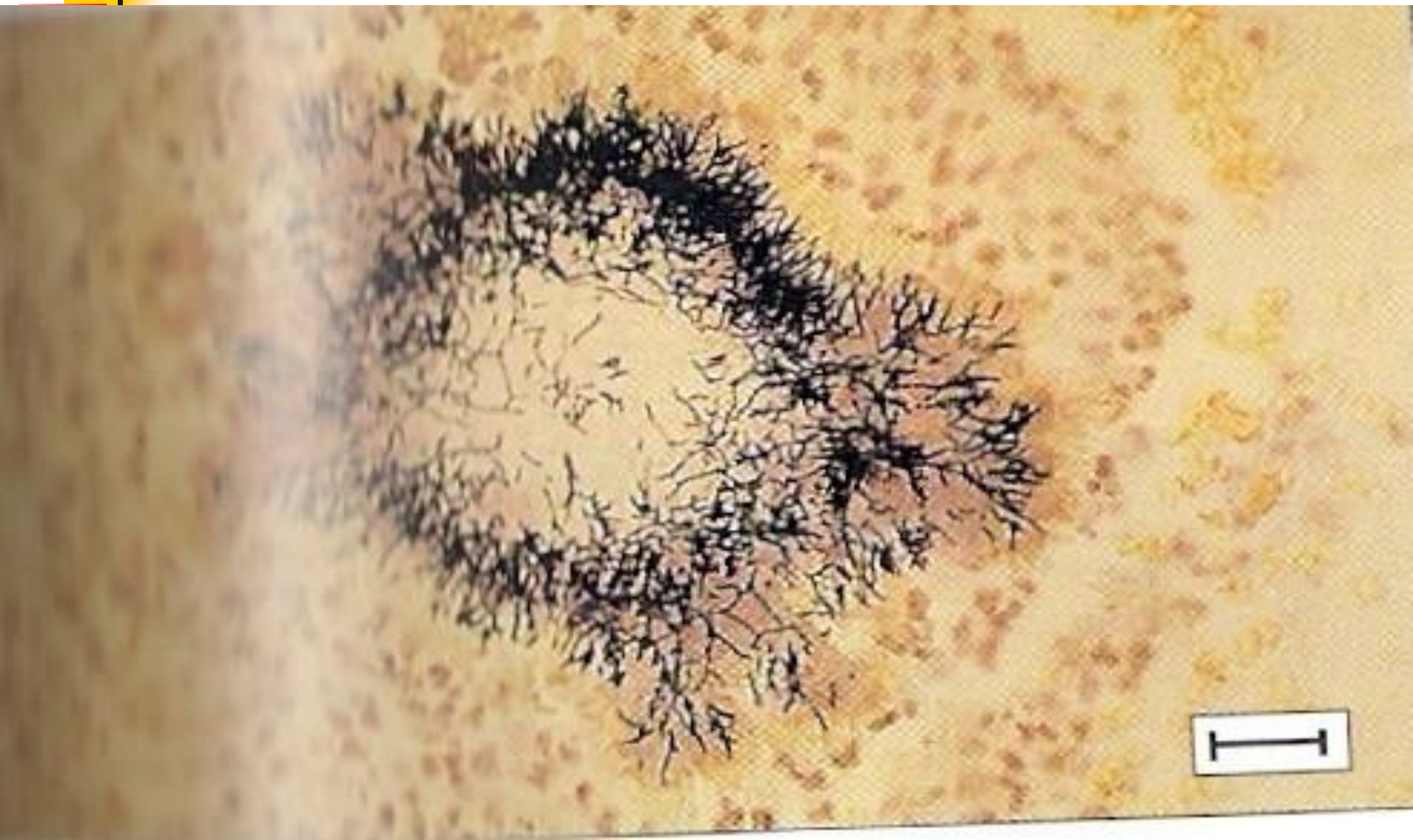
- Gram-positive branching filiform or rod-shaped bacteria.
- Like fungi, they form a mycelium, consisting of interwoven thin filaments (hyphae), however, unlike fungi, they do not contain chitin or cellulose in the cell wall.
- Druze form in the affected tissues.

Actinomycetes





Druse (in a smear of pus)



Taxonomy of Actinomycetes

- Type – Actinobakteria
- Class - Actinobakteria
- Gender – **Actinomyces**

  Types - **A.israelii, A.bovis, A. odontolyticus, A.viscosus, A.naeslundii** (pathogens of actinomycosis)

Fungi's

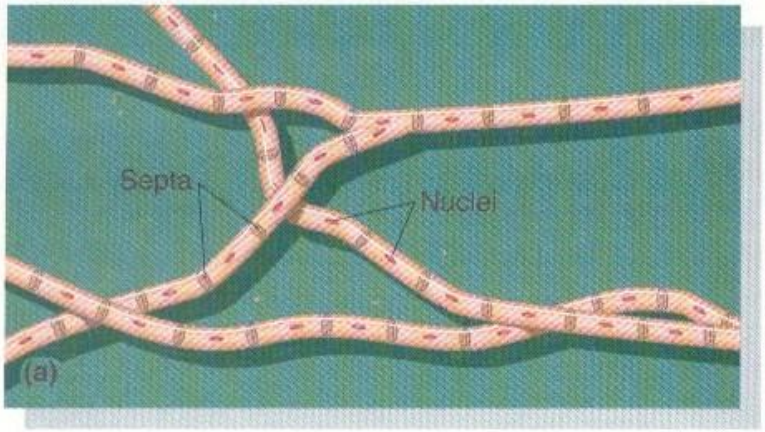
- Single or multicellular chlorophyll-free plant microorganisms that are eukaryotic
- Belong to the kingdom of Fungi (Mycetes, Mycota)
- Hyphal (2-100 microns) and yeast (2-5 microns) mushrooms are distinguished.
- By structure - lower (without partitions) and higher (septated)
- By the nature of reproduction - perfect (sexual reproduction) and imperfect (asexual reproduction).

Hyphae fungi.

- Fungi's form thin, windy hyphae that fly into a tomb or mold. The thickness of the hyphae ranges from 2 to 100 microns. They grow into a nutrient substrate, are called vegetative hyphae (nutrition of the fungus), and those growing above the substrate surface are called air and reproductive hyphae (responsible for asexual reproduction)

Hyphae of lower fungi do not have a partition. They are represented by multinucleated cells and are called coenocytic. Hyphae of higher fungi are divided by partitions.

Hyphae's of higher and lower fungi's.



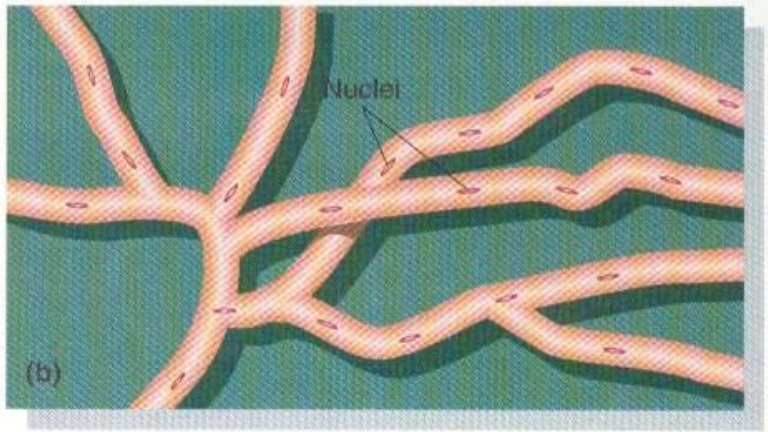


FIGURE 11-4 Characteristic hyphal structures. (*a*) Septate hyphae; (*b*) aseptate hyphae. (Note the absence of septa between nuclei.)

Yeast Fungi.

CHARACTERISTICS OF FUNGI

1. Yeasts

- Unicellular fungi, nonfilamentous, typically oval or spherical cells. Reproduce by mitosis:
  - Fission yeasts: Divide evenly to produce two new cells (*Schizosaccharomyces*).
  - Budding yeasts: Divide unevenly by budding (*Saccharomyces*).

    Budding yeasts can form pseudohypha, a short chain of undetached cells.

    Candida albicans invade tissues through pseudohyphae.
- Yeasts are facultative anaerobes, which allows them to grow in a variety of environments.
  - When oxygen is available, they carry out aerobic respiration.
  - When oxygen is not available, they ferment carbohydrates to produce ethanol and carbon dioxide.

Yeast fungi's

Saccharomyces cerevisiae

Fungi dimorphism

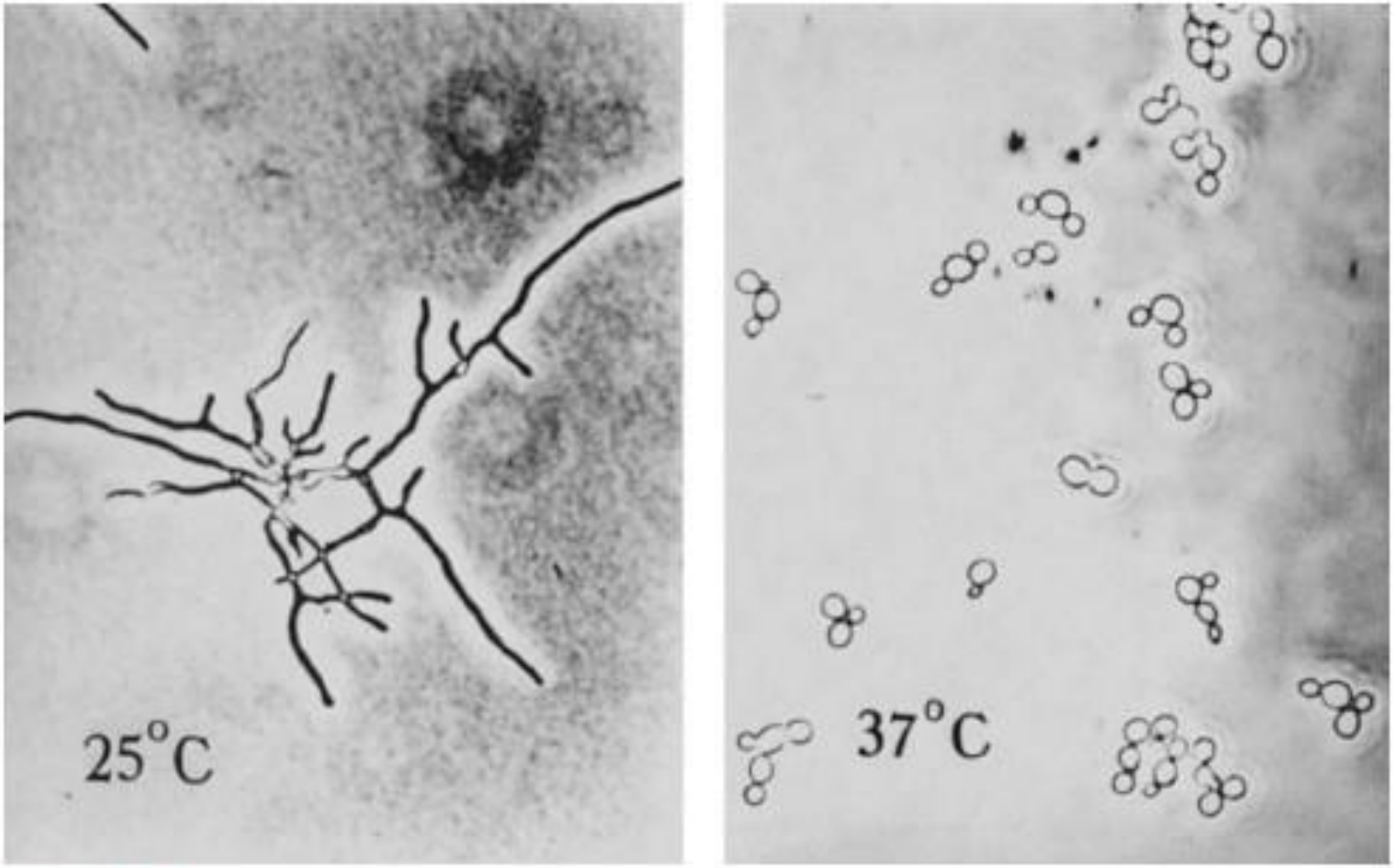


FIGURE 5-13. Dimorphism. Photomicrographs illustrating the dimorphic fungus, *H. capsulatum*, being grown at 25°C (left photo) and at 37°C (right photo). (From Schaeter M, et al., eds. Mechanisms of Microbial Disease, 3rd ed. Philadelphia: Lippincott Williams & Wilkins, 1999.)

Multiplication of fungi's

- Sexual reproduction - the formation of germ cells (gametes), the formation of sex spores (zygospores, ascospores, basidiospores);
- Asexual reproduction - budding, hyphae fragmentation, the formation of asexual spores (sporangiospores, conidia: arthroconidia, blastoconidia, chlamydoconidia).

Asexual multiplication of fungi's

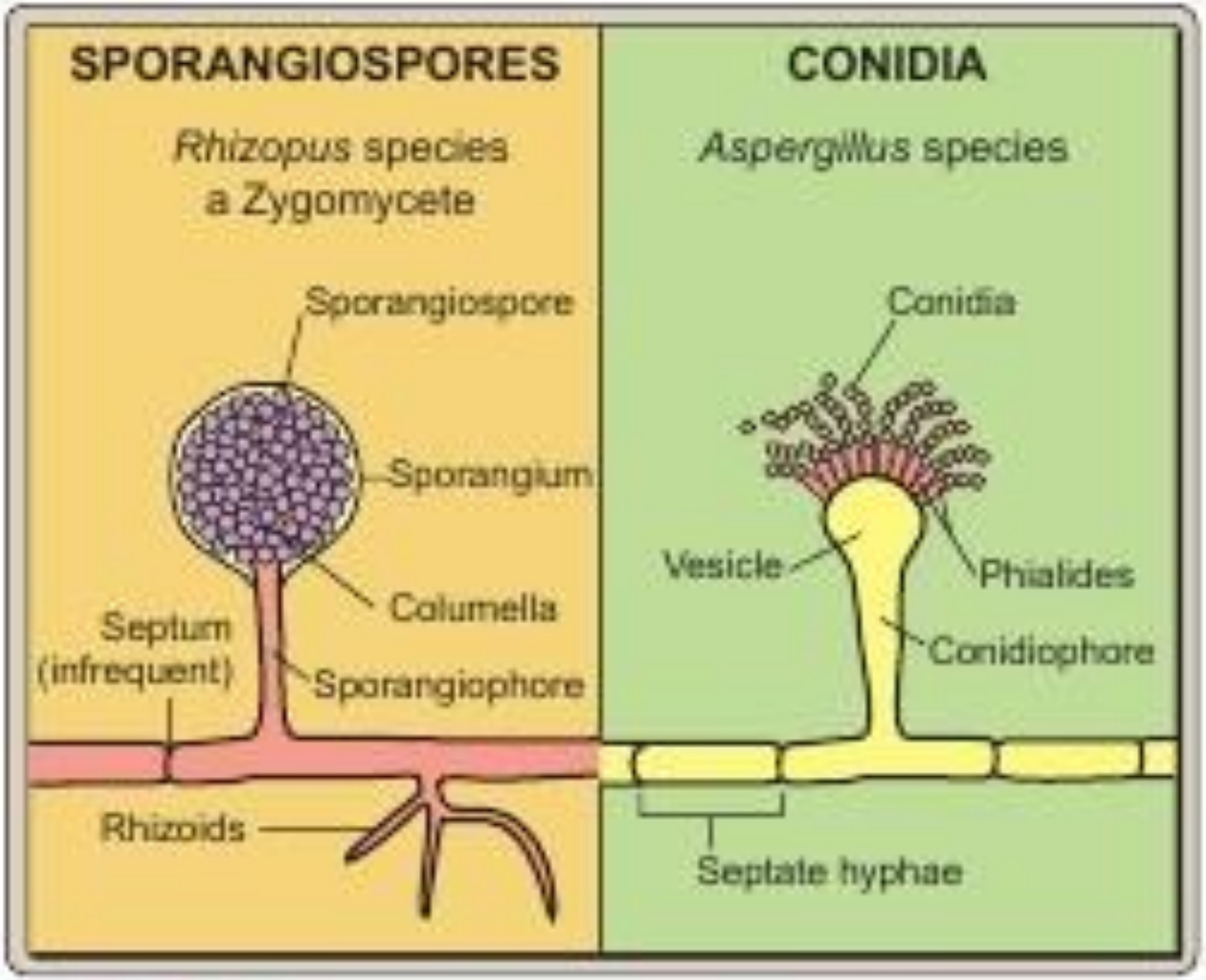


FIGURE 5-7. **Asexual reproduction in *Rhizopus* and *Aspergillus* moulds.** Illustrating the types of structures within and upon which asexual spores are produced.

Types of mushrooms of medical importance.

- It is stressed out 3 types of fungi's, which have sexual reproduction, so called complete fungi's: Zygomycota, Ascomycota, Basidiomycota. Apart from them there is conditional, formal type/group- Deiteromycota, which have asexual method of reproduction.

The main groups of fungi's of medical importance

Group	Hyphae	Sexual Spores	Commonly Observed Asexual Spores	Some Medically Important Genera
Zygomycetes	Nonseptate	Zygospores	Sporangiospores	*Mucor* *Rhizopus*
Ascomycetes	Septate	Ascospores	Conidia Arthrospores Blastospores	*Aspergillus* *Histoplasma* *Trichophyton* *Penicillium*
Basidiomycetes	Septate	Basidiospores	Characteristically none	*Cryptococcus* *Amanita* ("death angel" mushroom)
Deuteromycetes	Septate	None	Conidia Arthrospores Blastospores Chlamydospores	*Candida* *Sporothrix* *Coccidioides*

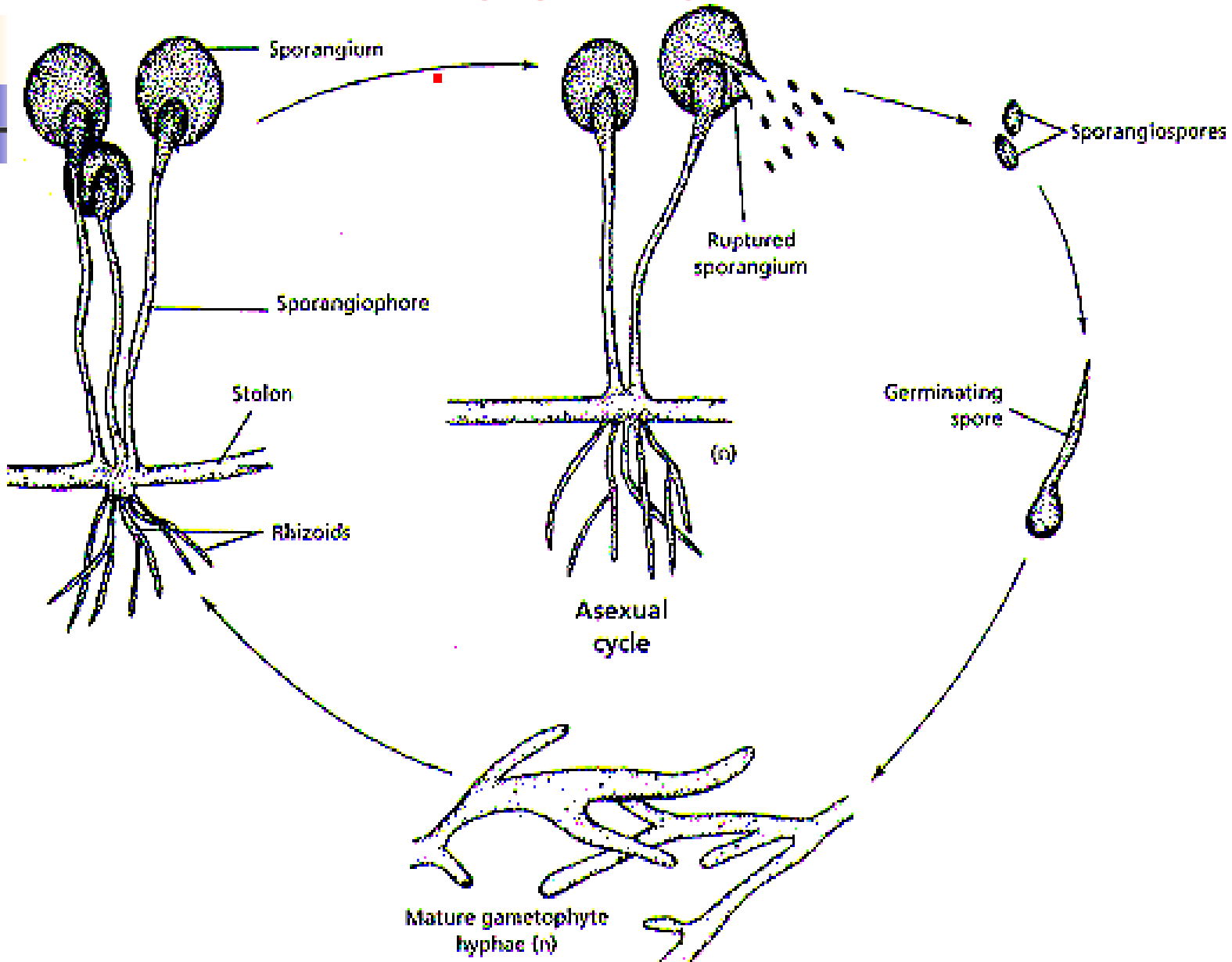
Таблица 6.1. Основные представители царства грибов, имеющих медицинское значение*

Таксоны	Основные роды	Болезни людей
ЗИГОМИЦЕТЫ (Тип Zygomycota, класс Zygomycetes)		
Порядок Mucoralis	Mucor, Rhizopus, Rhizomucor, Absidia, Cunninghamella, Saksenaea	Зигомикоз
Порядок Entomophthorales	Basidiobolus, Conidiobolus	
АСКОМИЦЕТЫ (Тип Ascomycota)		
Класс Ascomycetes		
Порядок Saccharomycetales	Дрожжи: Saccharomyces, Pichia (телеоморфы Candida spp.)	Многочисленные микозы
Порядок Onygenalis	Arthroderma (телеоморфы Trichophyton и Microsporum spp.)	Дерматомикозы
Порядок Eurotiales	Телеоморфы некоторых Aspergillus и Penicillium spp.	Аспергиллез, пенициллиоз, гиалогифомикоз
Порядок Microascalis	Pseudallescheria boydii (телеоморфа Scedosporium apiospermum)	Мицетома, гиалогифомикоз
Порядок Pyrenomycetes	Nectria, Gibberella (телеоморфы многих Fusarium spp.)	Кератоз, гиалогифомикоз
Класс Archiascomycetes		
Порядок Pneumocystidales	Pneumocystis carinii	Пневмония
БАЗИДИОМИЦЕТЫ (Тип Basidiomycota, класс Basidiomycetes)		
Порядок Agaricales	Amanita, Agaricus	Отравление ядовитыми грибами
Порядок Tremellales	Дрожжи: Filobasidiella (телеоморфы Cryptococcus neoformans)	Криптококкоз
ДЕЙТЕРОМИЦЕТЫ (Тип Deiteromycota)		
Порядок Cryptococcales	Несовершенные дрожжи: Candida, Cryptococcus, Trichosporon, Malassezia	Многочисленные микозы
Порядок Moniales, сем. Monialiaceae	Epidermophyton, Coccidioides, Paracoccidioides, Sporothrix, Aspergillus	Многочисленные микозы
Порядок Moniales, сем. Dematiaceae	Phialophora, Fonsecaea, Exophiala, Wangiella, Cladophialophora, Bipolaris, Exserohilum, Alternaria	Хромобластикоз, мицетома, феогифомикоз
Порядок Sphaeropsidales	Phoma	Феогифомикоз

Zygomycetes

- Zygomycetes- belong to lower fungi's. They contain the representatives of geners like Mucor, Rhizopus, Rzizomucor, Absidia, Basidiobolus, Conidiobolus. Spread in the soil and air. Can cause Zygomycetes of lungs, brain and other organs of human being.
- During asexual reproduction of zygomycetes sporangia are formed on the fruiting hyphae- spherical with a shell containing numerous sporangiospores

Zygomycetes

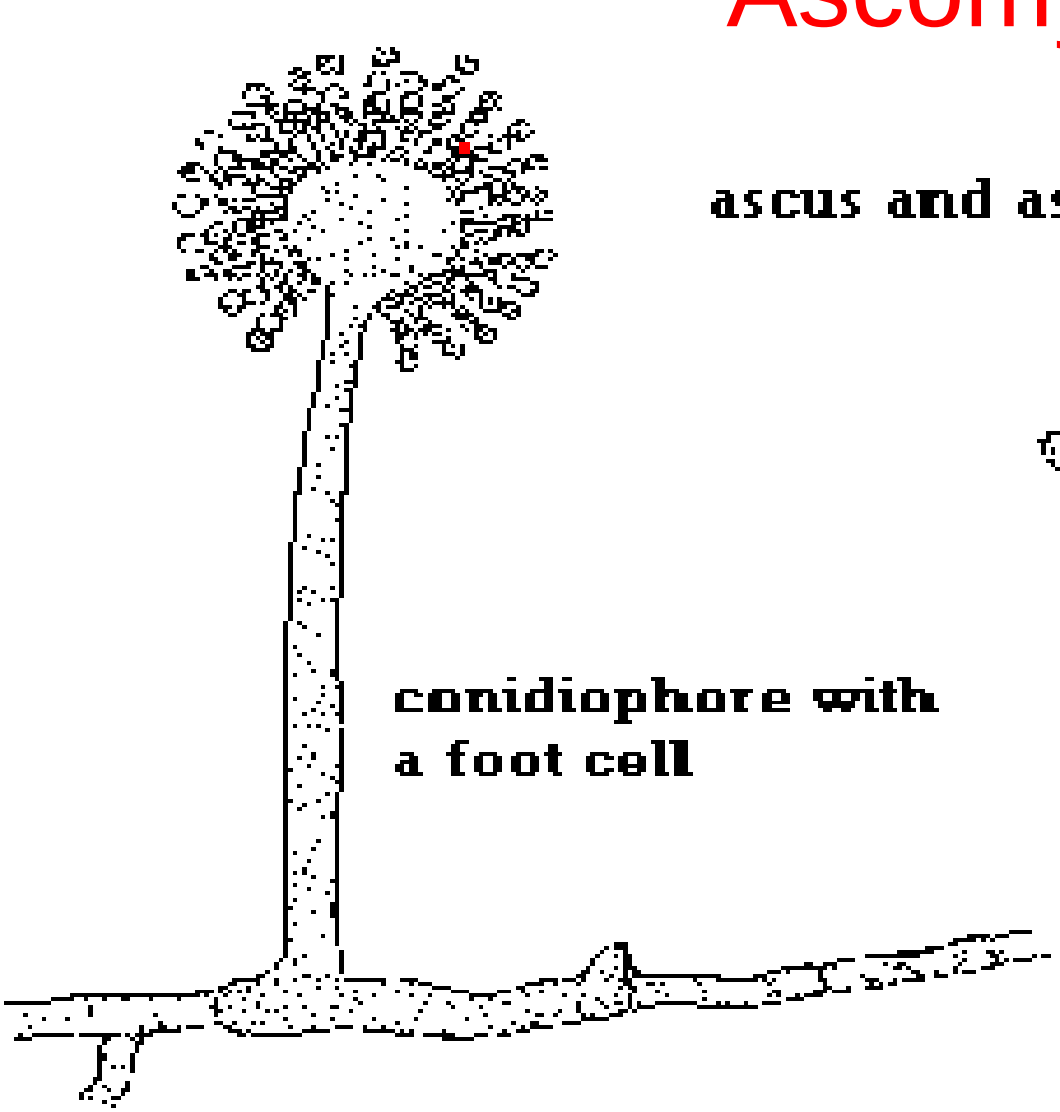


Ascomycetes.

Ascomycetes(marsupial fungi's) have septic mycelium (besides one celled yeasts). Their name they got from bearing- bags which contain 4 or 8 haploid genital spores (Ascospores). Most of the fungis from Aspergillus genre are anamorphs, multiplicate only by asexual method of reproduction, with the help of asexual spores- comidiy's.

Mold

Ascomycetes



Дрожжевые аскомицеты (возбудитель гистоплазмоза)

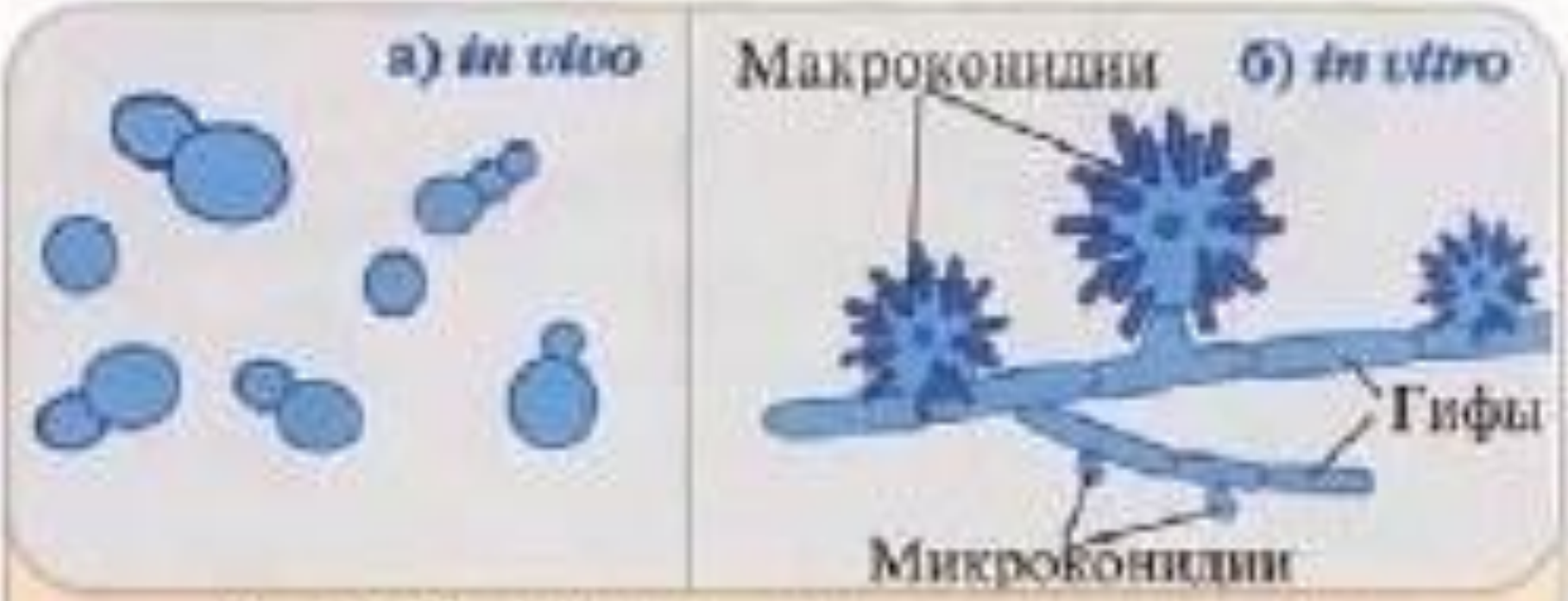


Рис. 6.33 а, б. H. capsulatum *in vivo* и *in vitro*

Basidiomycetes.

- Basidiomycetes- have septic mycelium. They create genital spores- basidiomycetes by the way of peeling off from basidio- end cells of mycelium, homological asku. Some of the yeast are releted to basidiomycetes, for example Cryptococcus neoformans.

Базидиомицеты (возбудитель криптококкоза)

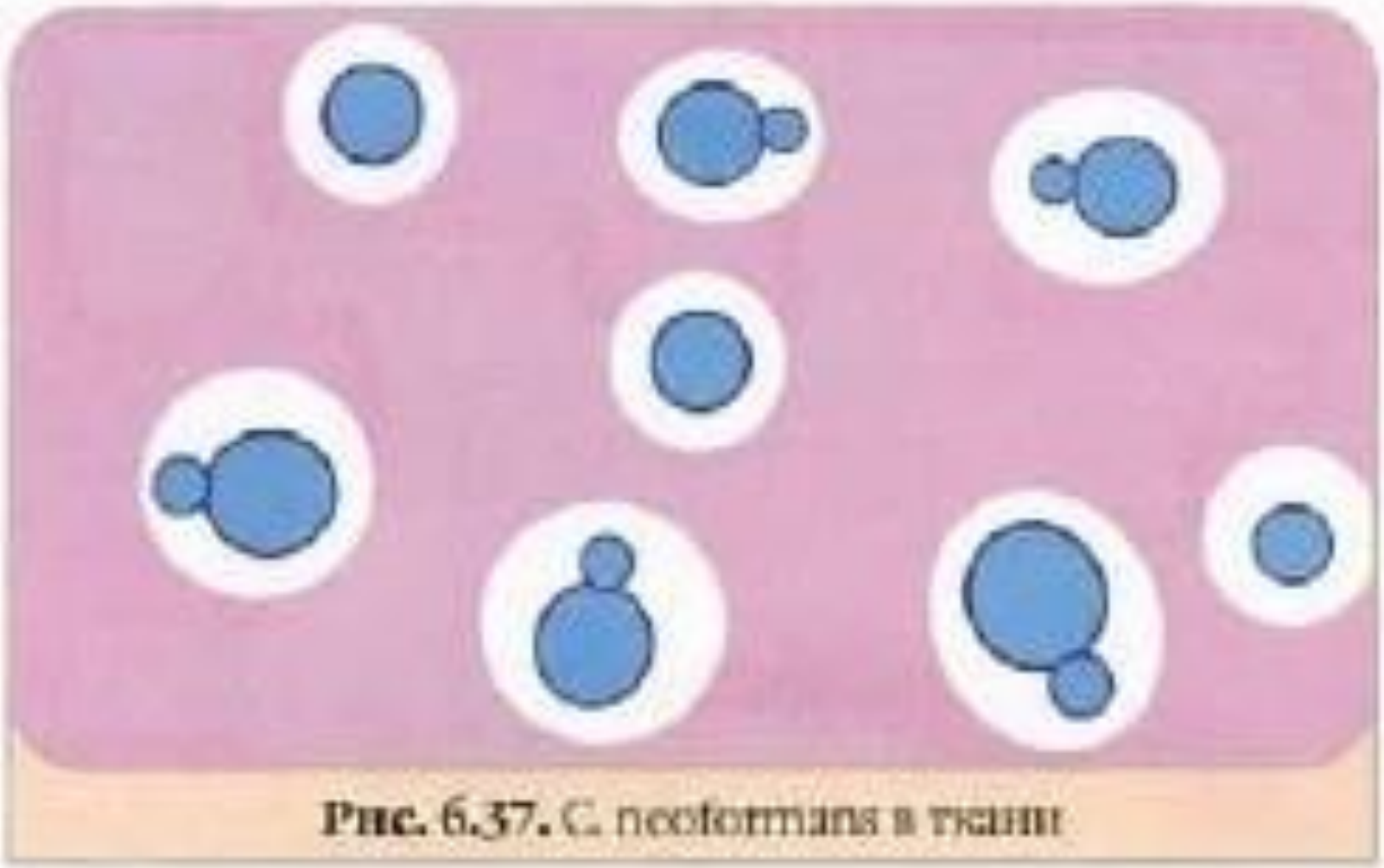
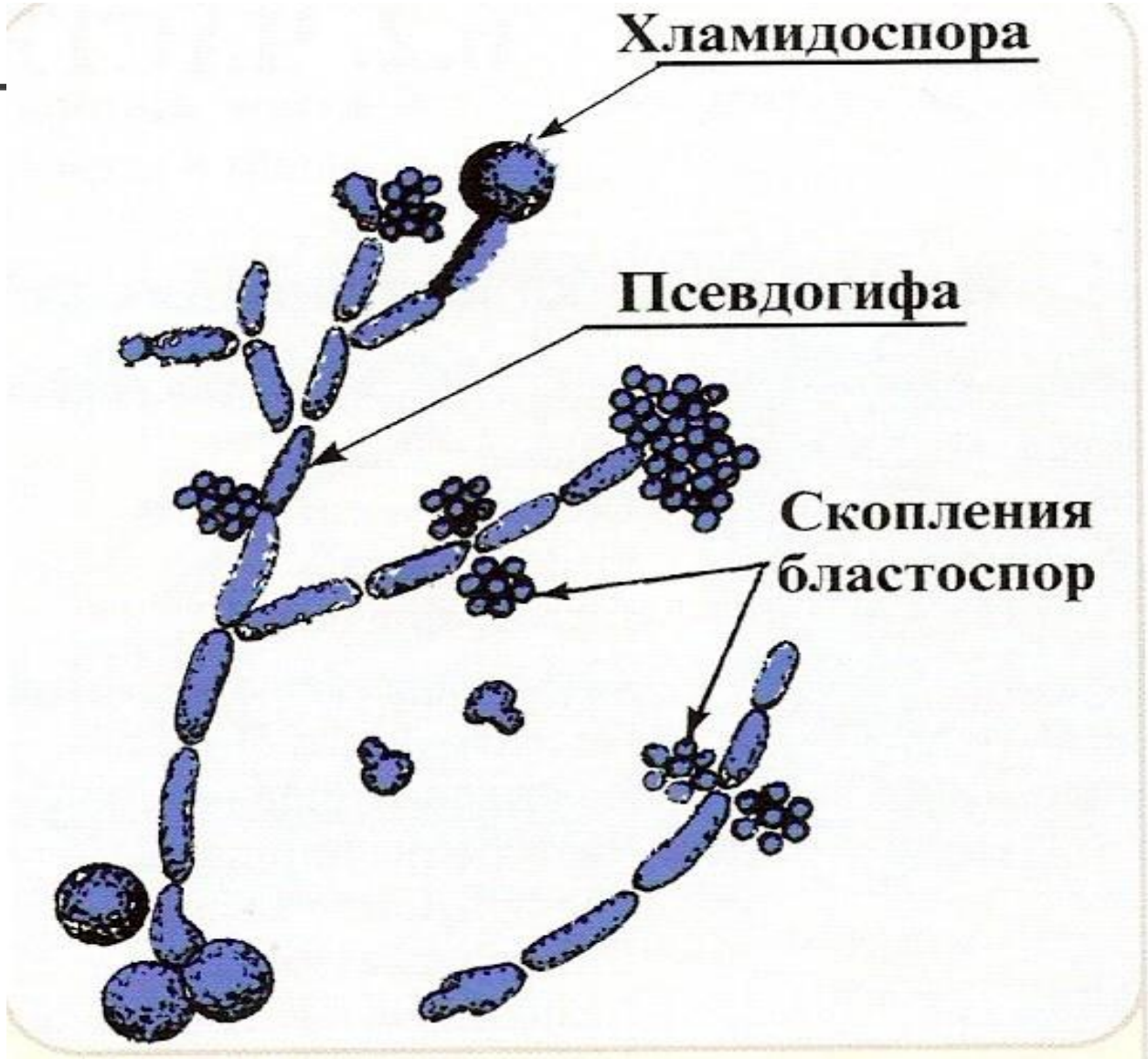


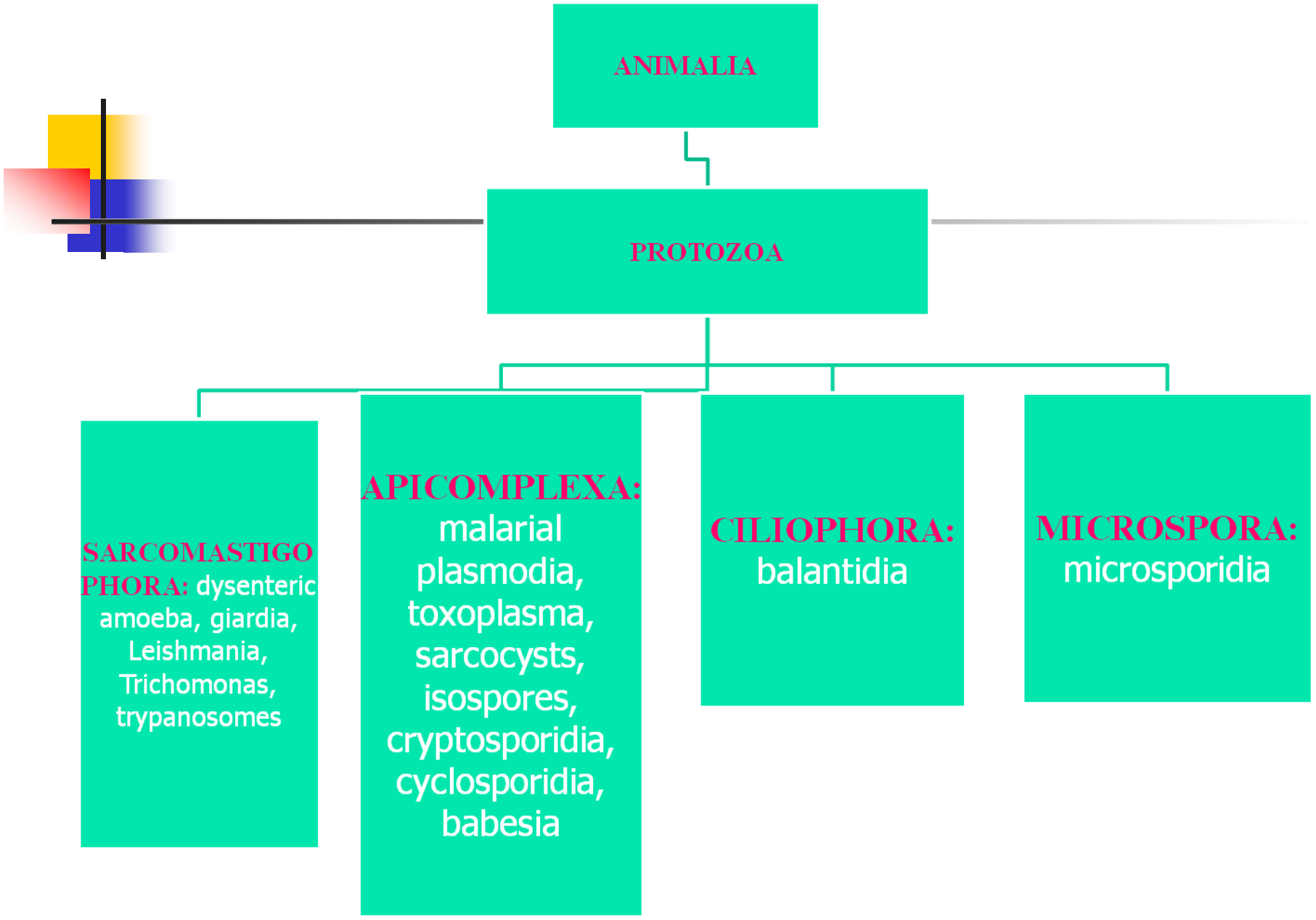
Рис. 6.37. C. neoformans в ткани

Дрожжеподобные дейтеромицеты (грибы рода Candida)



Simples

- Unicellular animal microorganisms belonging to the kingdom of Protozoa
- They belong to the Eukariya domain and have the typical structure of eukaryotes. Outside they are surrounded by a pellicle.
- Sizes 2-100 microns


ANIMALIA
PROTOZOA
SARCOMASTIGOPHORA: dysenteric amoeba, giardia, Leishmania, Trichomonas, trypanosomes
APICOMPLEXA: malarial plasmodia, toxoplasma, sarcocysts, isospores, cryptosporidia, cyclosporidia, babesia
CILIOPHORA: balantidia
MICROSPORA: microsporidia

Тип Sarcomastiqophora

Тип Sarcomastigophora состоит из подтипов Sarcodina и Mastigophora.

Подтип Sarcodina (саркодовые) включает: дизентерийную амебу — возбудителя амебной дизентерии человека; свободноживущие амебы родов неглерия, акантамеба и др.; непатогенные амебы (кишечная амеба и др.). Эти простейшие передвигаются путем образования псевдоподий, с помощью которых происходит захват и погружение в цитоплазму клеток питательных веществ. Половой путь размножения у амеб отсутствует. При неблагоприятных условиях они образуют цисту.

Тип Sarcomastiqophora

Подтип Mastigophora (жгутиконосцы) включает: трипаносомы — возбудителей африканского трипаносомоза (сонной болезни) и болезни Шагаса; лейшмании — возбудителей лейшманиозов; лямблию — возбудителя лямблиоза; трихомонаду влагалищную — возбудителя трихомоноза. Эти простейшие характеризуются наличием жгутиков. Например, у лейшманий — один жгутик, у трихомонад — 4 свободных жгутика и один жгутик, соединенный с короткой ундулирующей мембраной.

Тип Apicomplexa

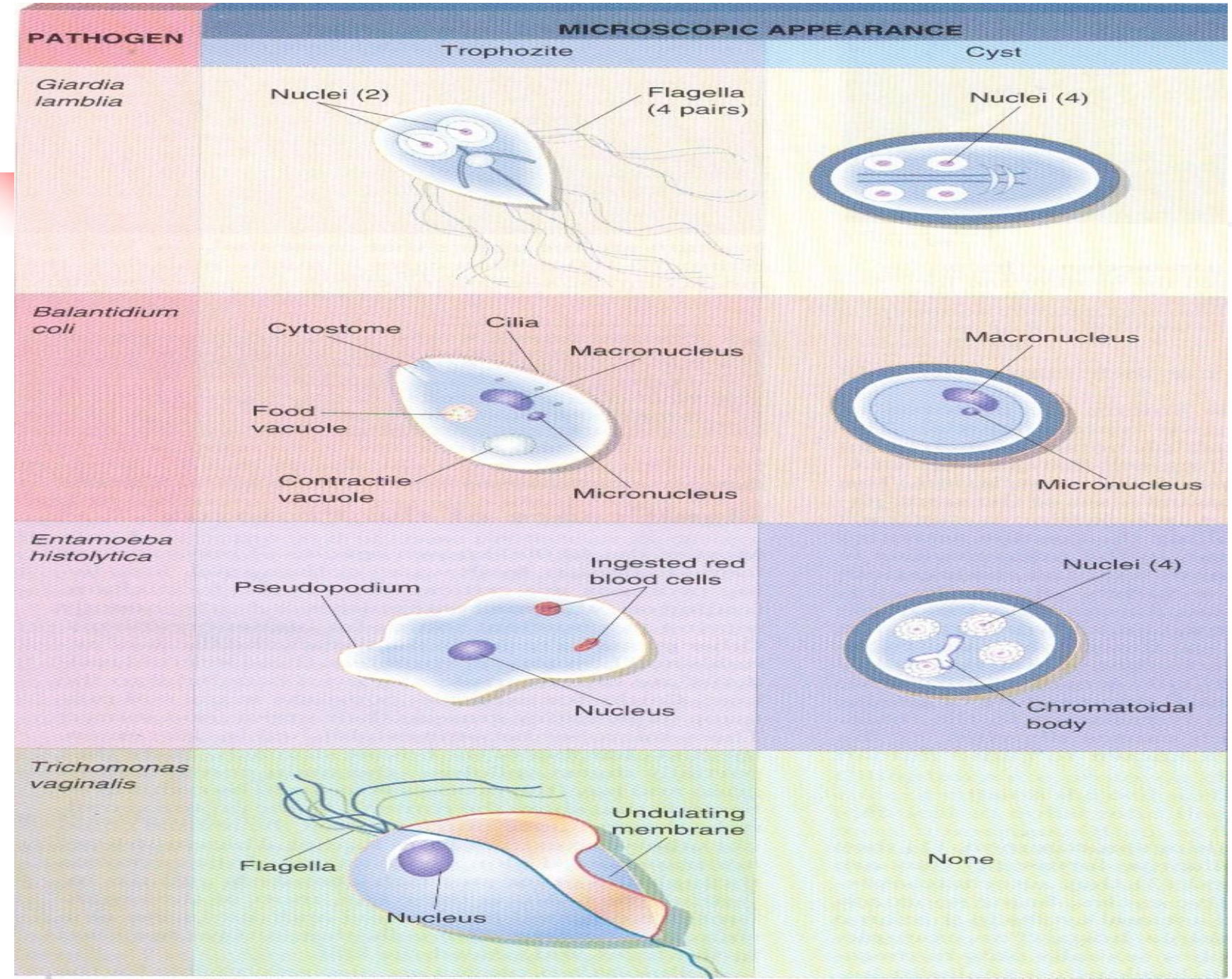
Тип Apicomplexa. Патогенные представители входят в класс Sporozoa (споровики): плазмодии малярии — возбудители малярии (3 дневной, 3 дневной типа овале, 4 дневной, тропической); токсоплазмы — возбудители токсоплазмоза; саркоцисты — возбудители саркоцистоза; изоспоры — возбудители изоспороза; криптоспоридии — возбудители криптоспоридиоза; циклоспоры — возбудители циклоспоридиоза; бабезии — возбудители пироплазмоза. Паразиты имеют апикальный комплекс, который позволяет им проникнуть в клетку хозяина для последующего внутриклеточного паразитизма. Каждый из этих представителей имеет сложное строение и свои особенности жизненного цикла. Так, например, жизненный цикл возбудителя малярии характеризуется чередованием полового размножения (в организме комаров Anopheles) и бесполого (в клетках печени и эритроцитах человека, где они размножаются путем множественного деления).

Ciliophora type

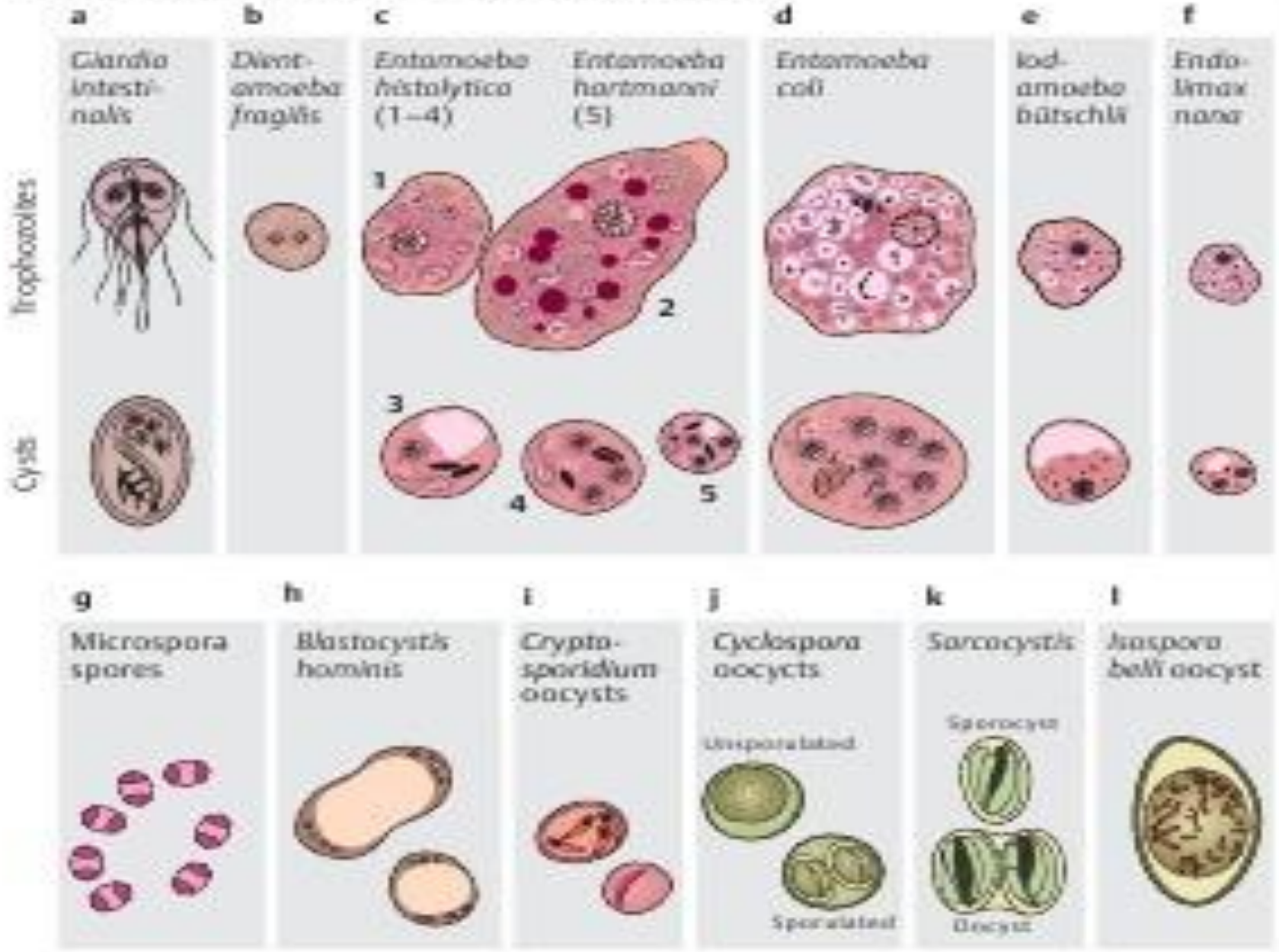
- Ciliophora type- Pathogen representatives of ciliary balantidia, which cause colon of human being. Balantidia’s are movable and have’s many ciliary’s, more thin and short than flagellas.

Type Microspora

- Microspora type includes microsporidias- small obligate intracellular parasites, wide spread among animals and causes weakness of human beings, diarrhea and causes different human organs. Those parasites have specifi spores with infected material- sporeplasma.


PATHOGEN
MICROSCOPIC APPEARANCE
Trophozite
Cyst
Giardia lamblia
Nuclei (2)
Flagella (4 pairs)
Nuclei (4)
Balantidium coli
Cytostome
Cilia
Macronucleus
Food vacuole
Contractile vacuole
Micronucleus
Macronucleus
Micronucleus
Entamoeba histolytica
Pseudopodium
Ingested red blood cells
Nucleus
Nuclei (4)
Chromatoidal body
Trichomonas vaginalis
Flagella
Undulating membrane
Nucleus
None

Differential Diagnosis of Intestinal Protozoa

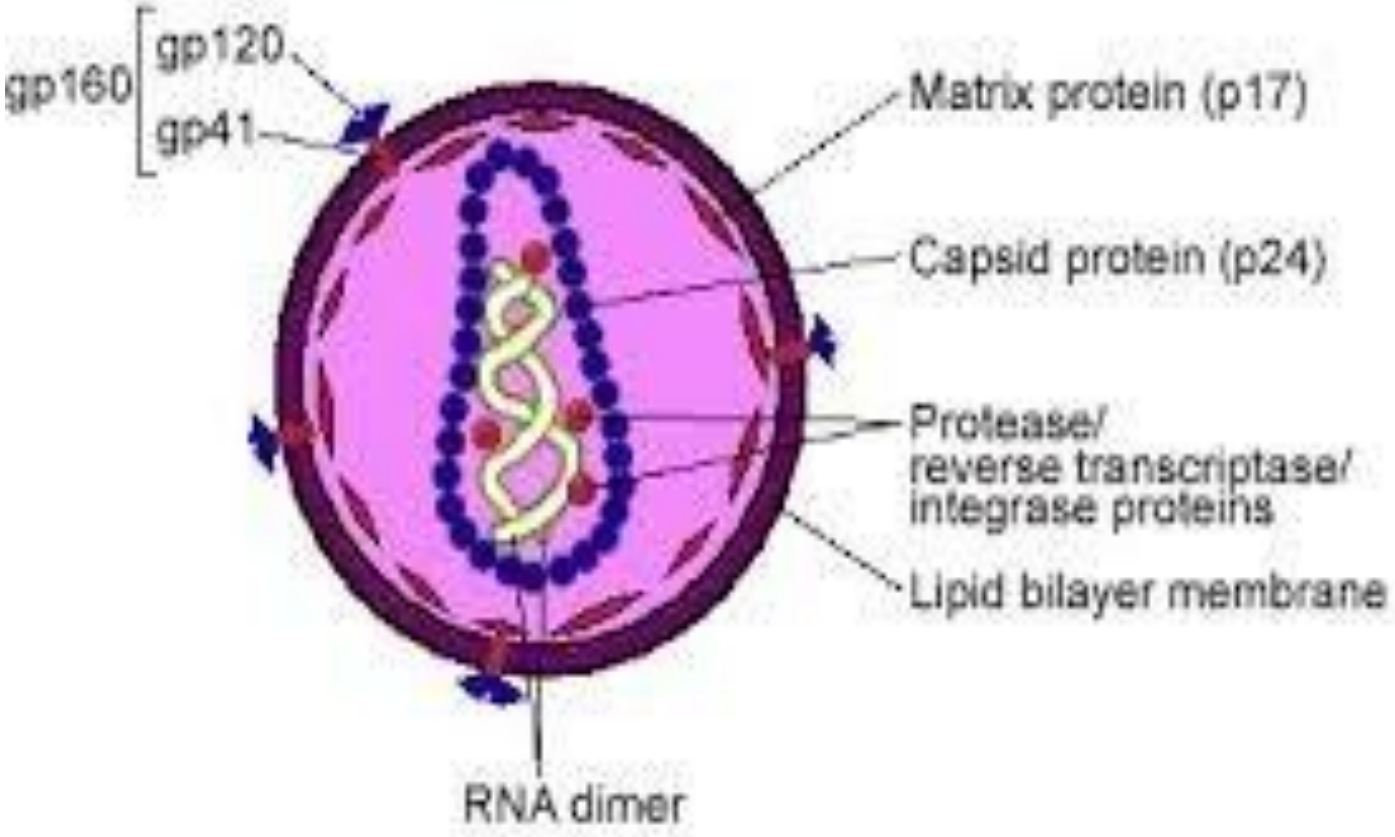


Viruses

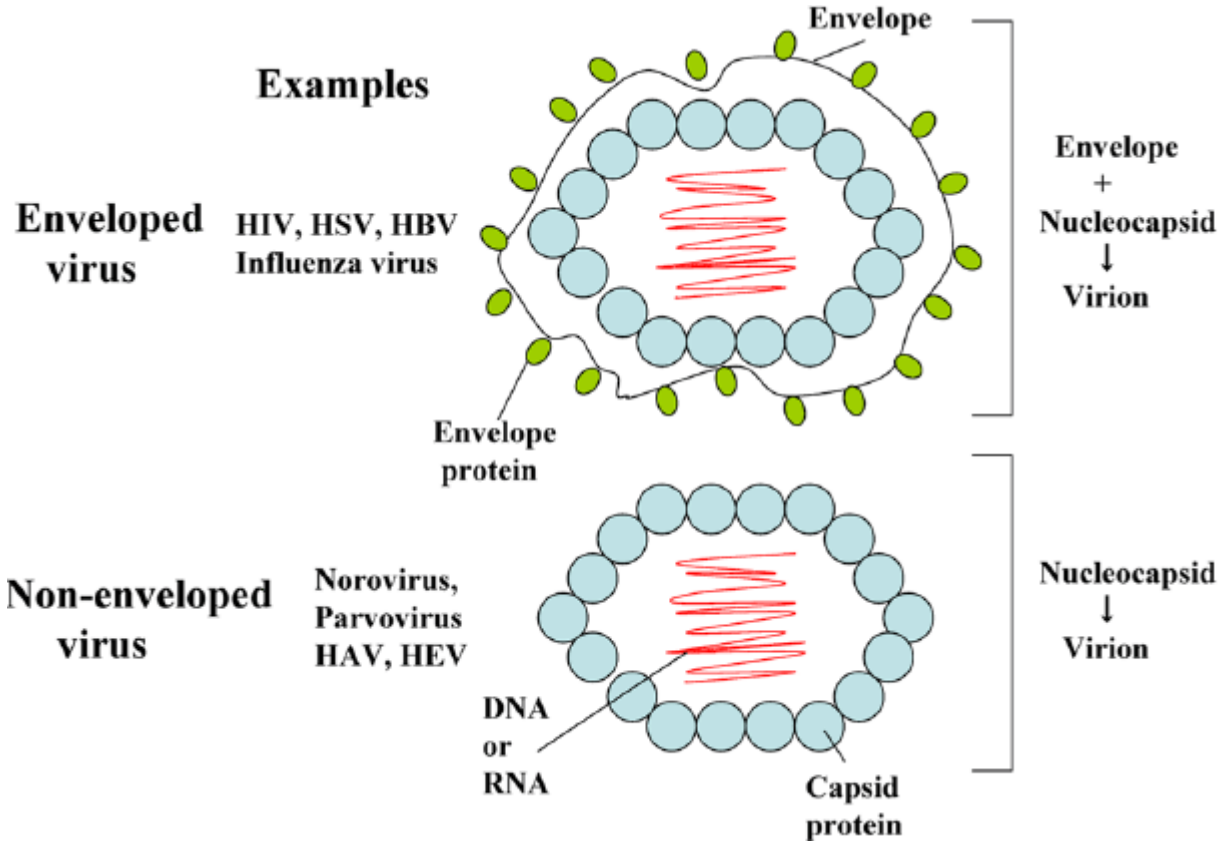
A special group of non-cellular life forms that belong to the kingdom of Vira and have a number of features:

- They do not have a cellular structure, they consist of a nucleoid in the form of a nucleic acid and a protein capsid;
- The genetic apparatus of viruses is represented by both DNA and RNA, both of which can be single and double stranded, linear and circular, continuous and fragmented;
- They are absolute intracellular parasites at the molecular level that do not have their own protein synthesis systems; reproduce by the disjunctive method of reproduction;
- They have very small sizes, calculated in nm (15-350);
- Some viruses (plants) can form crystals.

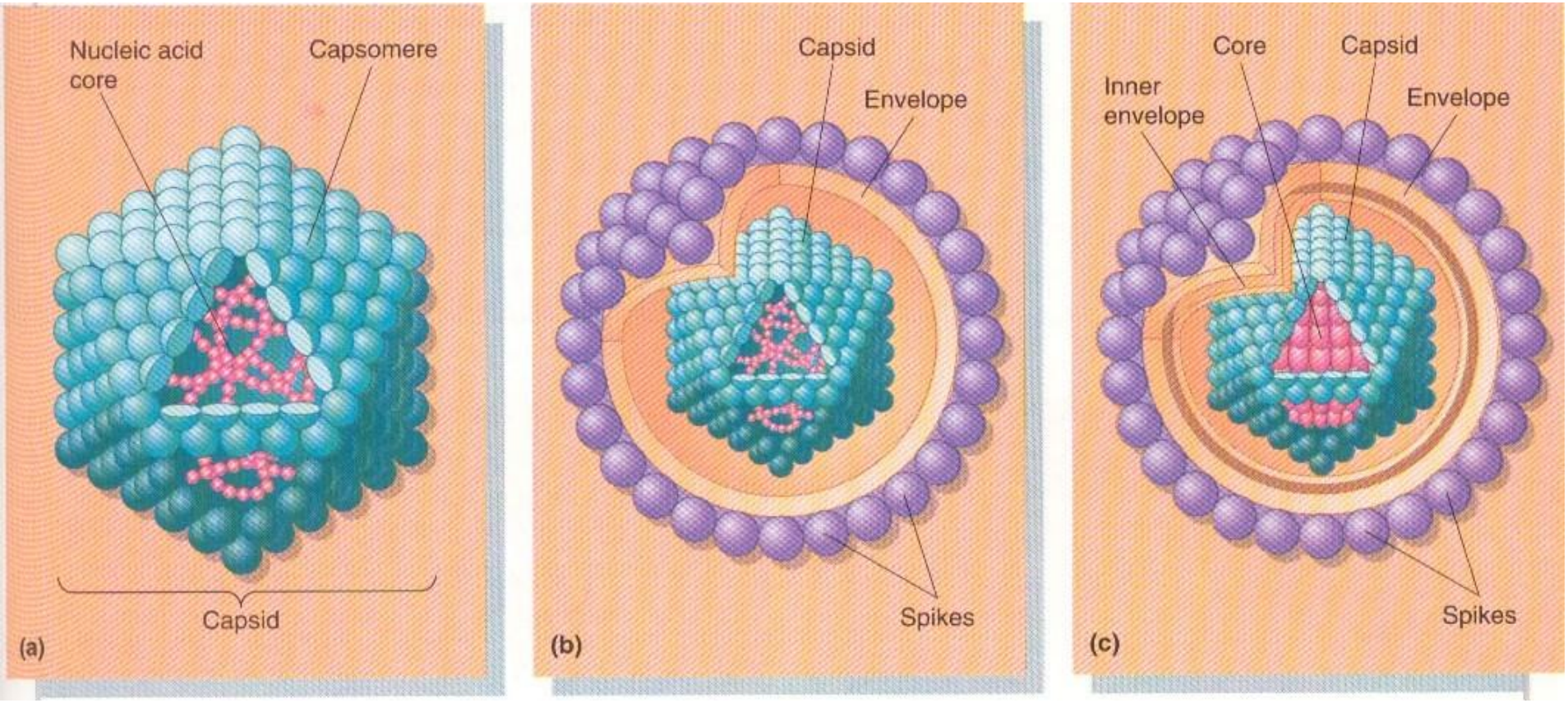
Scheme structure of viral particles



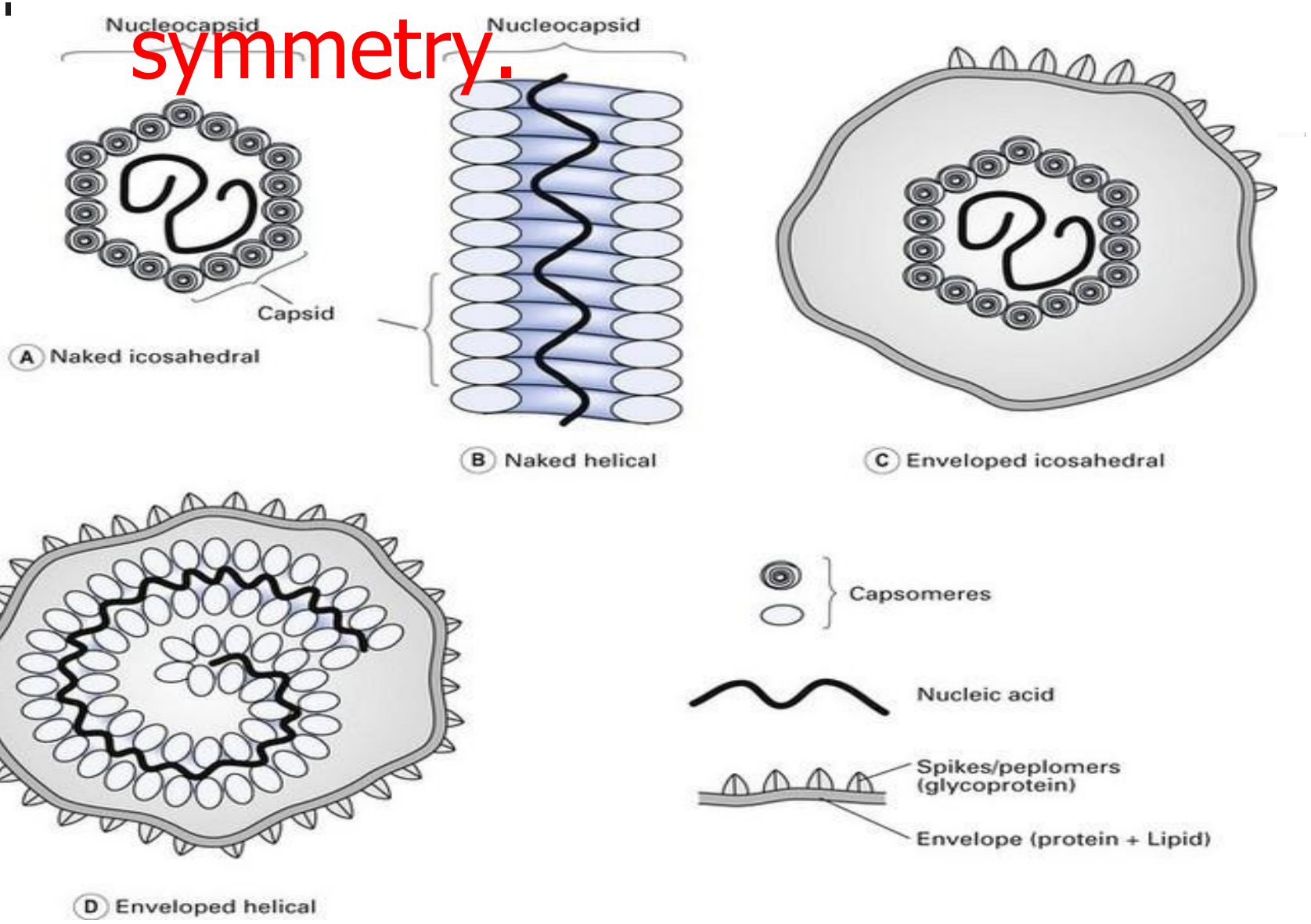
Structure of enveloped and non-enveloped viruses.



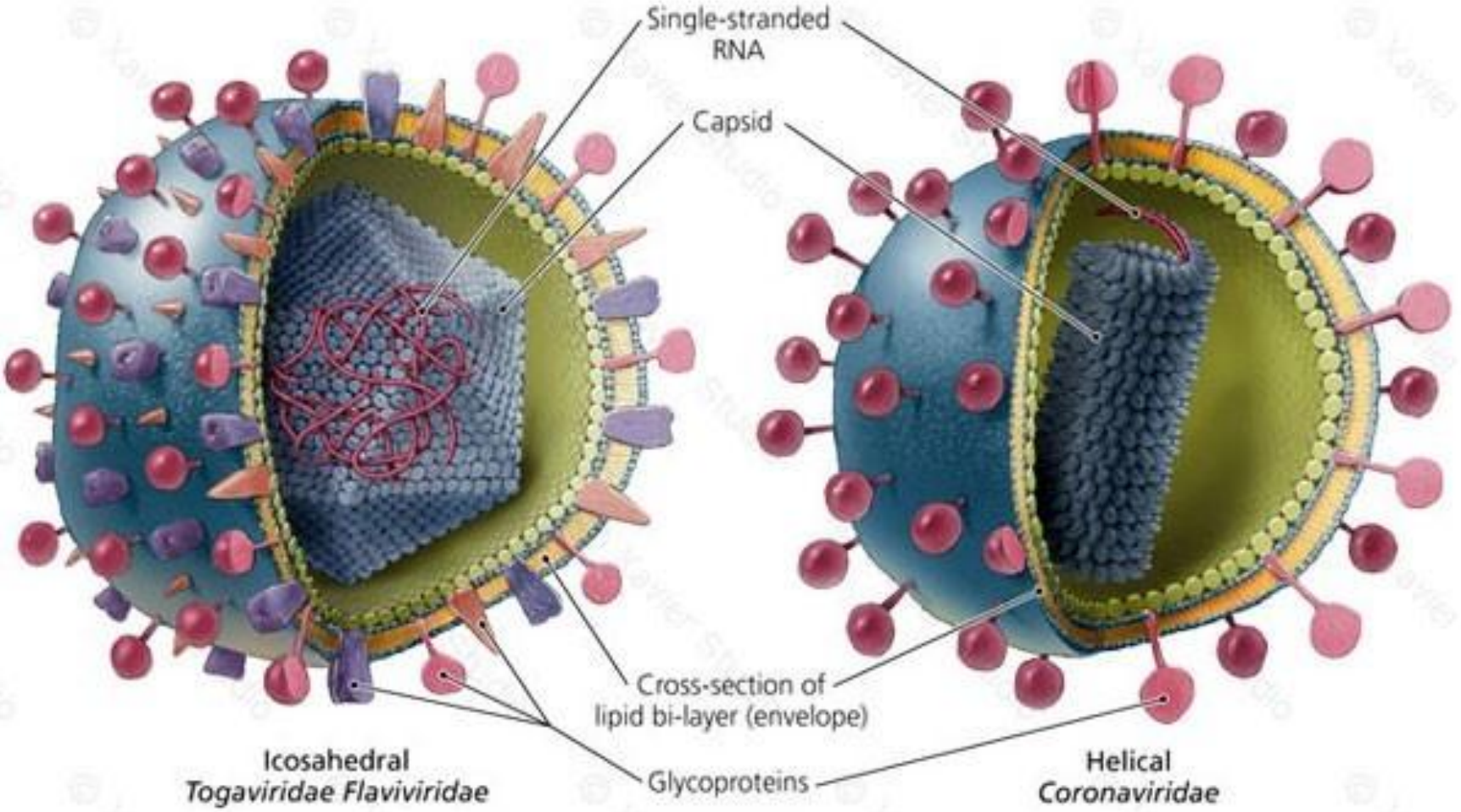
Scheme of the structure of various viruses: simple (a) and complex (b and c)

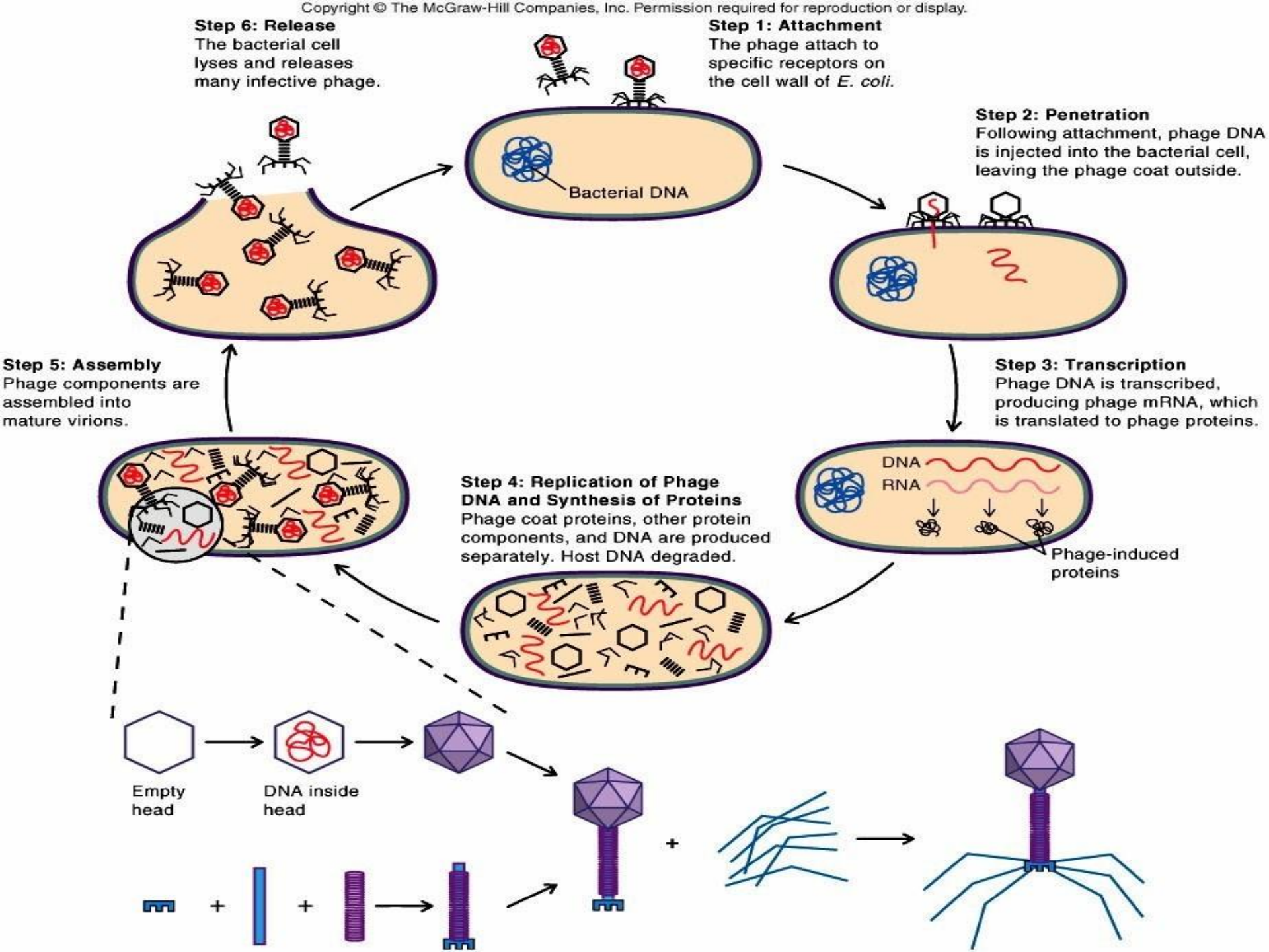


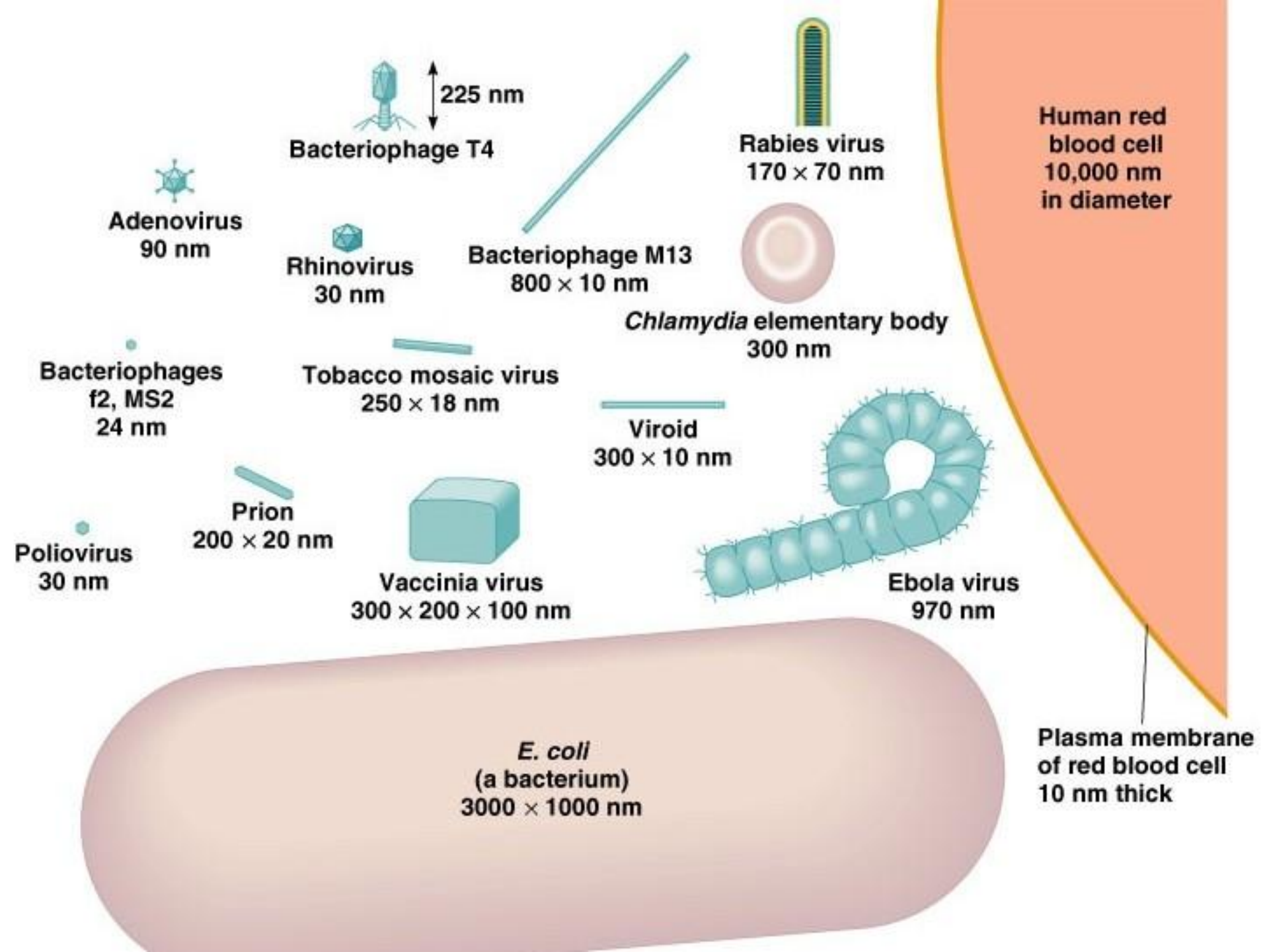
Types of capsid symmetry.



Types of Virion Symmetry.



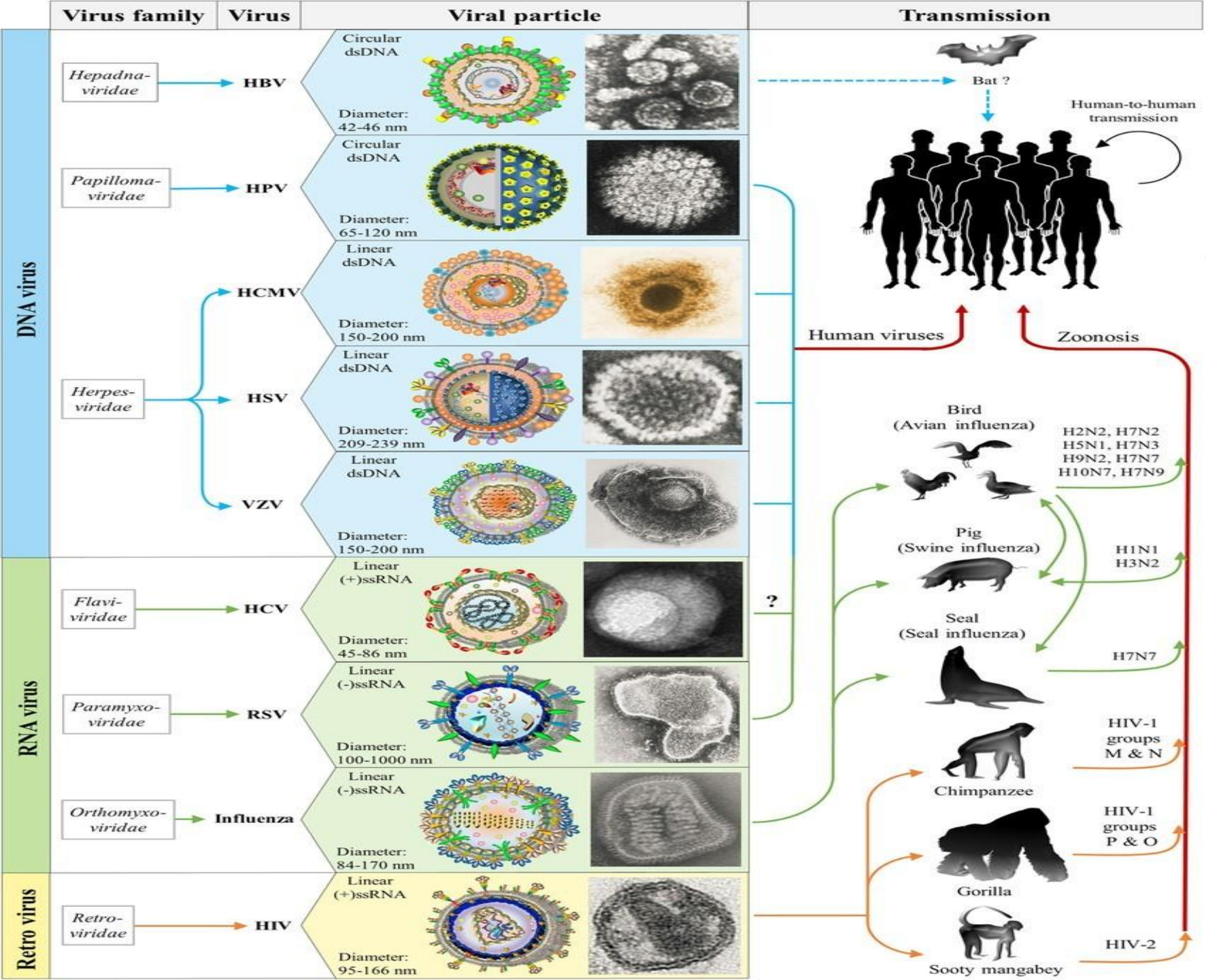



225 nm
Bacteriophage T4
Rabies virus
170 × 70 nm
Human red
blood cell
10,000 nm
in diameter
Adenovirus
90 nm
Rhinovirus
30 nm
Bacteriophage M13
800 × 10 nm
Chlamydia elementary body
300 nm
Bacteriophages
f2, MS2
24 nm
Tobacco mosaic virus
250 × 18 nm
Viroid
300 × 10 nm
Prion
200 × 20 nm
Poliovirus
30 nm
Vaccinia virus
300 × 200 × 100 nm
Ebola virus
970 nm
E. coli
(a bacterium)
3000 × 1000 nm
Plasma membrane
of red blood cell
10 nm thick

Classification principals of the viruses

- Type of nucleic acid, structure, number of threads, molecular weight;
- Morphology of the virion, the number of capsomeres, the type of capsid symmetry, the presence of a shell;
- Virion replication, genetic interactions;
- Antigenic properties;
- The range of susceptible hosts, pathogenicity, geographical prevalence.

Viruses are divided into viruses of vertebrates, invertebrates, plants, bacteria, fungi.


Virus family
Virus
Viral particle
Transmission
DNA virus
RNA virus
Retro virus
Hepadna-viridae
HBV
Circular dsDNA
Diameter: 42-46 nm
Papilloma-viridae
HPV
Circular dsDNA
Diameter: 65-120 nm
Herpes-viridae
HCMV
Linear dsDNA
Diameter: 150-200 nm
HSV
Linear dsDNA
Diameter: 209-239 nm
VZV
Linear dsDNA
Diameter: 150-200 nm
Flavi-viridae
HCV
Linear (+)ssRNA
Diameter: 45-86 nm
Paramyxo-viridae
RSV
Linear (-)ssRNA
Diameter: 100-1000 nm
Orthomyxo-viridae
Influenza
Linear (-)ssRNA
Diameter: 84-170 nm
Retro-viridae
HIV
Linear (+)ssRNA
Diameter: 95-166 nm
?
Bat ?
Human-to-human transmission
Human viruses
Zoonosis
Bird (Avian influenza)
H2N2, H7N2
H5N1, H7N3
H9N2, H7N7
H10N7, H7N9
Pig (Swine influenza)
H1N1
H3N2
Seal (Seal influenza)
H7N7
Chimpanzee
HIV-1 groups M & N
Gorilla
HIV-1 groups P & O
Sooty mangabey
HIV-2

Основные вирусы человека и животных (классификация и содержание)

Семейство/подсемейство	*Представители*	*Вызываемые болезни*
Группа I: ДНК(двунитевые)-вирусы		
Поксвирусы (Poxviridae)	Вирусы натуральной оспы, вакцины, оспы обезьян, Орф, контагиозного моллюска	Натуральная оспа. Оспоподобные заболевания Контагиозный моллюск
Герпесвирусы (Herpesviridae)	Вирус простого герпеса. Вирус ветряной оспы — опоясывающего герпеса Цитомегаловирус. Вирус Эпстайна—Барр Герпесвирус человека 6, 7 Герпесвирус человека тип 8	Герпес, энцефалит и др. Ветряная оспа, опоясывающий герпес Цитомегалия, инфекционный мононуклеоз Синдром хронической усталости Саркома Капоши?
Аденовирусы (Adenoviridae)	Аденовирусы человека	ОРВИ и другие
Папилломавирусы (Papillomaviridae)	Папилломавирусы человека	Бородавки (папилломы), рак
Полиомавирусы (Polyomaviridae)	Полиомавирусы человека (JC, BK)	Многоочаговая лейкоэнцефалопатия
Группа II: ДНК(однонитевые)-вирусы		
Парвовирусы (Parvoviridae)	Парвовирус человека B19	Инфекционная эритема, полиартрит
Circinoviridae	TT-вирус	Гепатит TT?

Группа III: РНК (двунитевые)-вирусы		
Реовирусы (Reoviridae)	Вирусы: Кемерово, колорадской клещевой лихорадки, ротавирусы человека	Клещевые лихорадки Гастроэнтерит
Группа IV: РНК (плюс однонитевые)-вирусы		
Пикорнавирусы (Picornaviridae)	Вирусы: полиомиелита, Коксаки А и В, ECHO Вирус гепатита А. Риновирусы человека Вирус ящура	Полиомиелит, герпангина, миокардит и др. Гепатит А, ОРВИ Ящур
Калицивирусы (Caliciviridae)	Вирусы гастроэнтерита группы Норволк	Гастроэнтерит
Гепатит Е-подобные вирусы	Вирус гепатита Е	Гепатит Е
Астровирусы (Astroviridae)	Астровирусы человека	Диарея
Коронавирусы (Coronaviridae)	Коронавирус человека	ОРВИ
Флавивирусы (Flaviviridae)	Вирусы: желтой лихорадки, японского энцефалита, лихорадки Западного Нила, Денге, клещевого энцефалита, ОГЛ Вирус гепатита С	Желтая лихорадка, японский энцефалит Лихорадка Западного Нила Лихорадка Денге, клещевой энцефалит Омская геморрагическая лихорадка Гепатит С
Неклассифицированный вирус	Вирус гепатита G	Гепатит G
Тогавирусы (Togaviridae)	Вирусы: энцефаломиелитов лошадей, Карельской лихорадки. Вирус краснухи	Энцефаломиелиты лошадей Карельская лихорадка, краснуха

Группа V: РНК (минус однонитевые)-вирусы		
Филовирусы (Filoviridae)	Вирус Марбург. Вирус Эбола	Африканские геморрагические лихорадки
Парамиксовирусы (Paramyxoviridae)	Вирусы: кори, парагриппа, эпидемического паротита, респираторно-синцитиальный	Корь, ПСПЭ, парагрипп, эпидемический паротит ОРВИ
Рабдовирусы (Rhabdoviridae)	Вирусы бешенства, везикулярного стоматита	Бешенство Везикулярный стоматит
Ортомиксовирусы (Orthomyxovirdae)	Influenzavirus типы A, B, C	Грипп
Буньявирусы (Bunyviridae)	Вирусы ГЛПС, Крым-Конго геморр. лихорадка	ГЛПС, Крым-Конго геморрагическая лихорадка
Deltavirus	Вирус гепатита D	Гепатит D
Аренавирусы (Arenaviridae)	Вирус ЛХМ. Вирусы Ласса. Гуанарито, Хунин и Мачупо	Лимфоцитарный хориоменингит, лихорадка Ласса Геморрагические лихорадки
Группа VI: РНК-вирусы (обратнотранскрибирующиеся)		
Ретровирусы (Retroviridae)	Вирус иммунодефицита человека	ВИЧ-инфекция (СПИД)
Группа VII: ДНК-вирусы (обратнотранскрибирующиеся)		
Гепаднавирусы (Hepadnaviridae)	Вирус гепатита B	Гепатит B