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# **MORPHOLOGY AND STRUCTURE OF BACTERIAL CELL**

**The 2nd lecture for 2nd-year students  
February 23, 2015**

# Objects of the Medical Microbiology – revision

- a) **Pathogenic microbes** (causing diseases of human beings or animals)
- b) **Normal microflora** (microbes commonly present in healthy persons or animals)
- c) **Mutual relationship between microbes and their hosts** (how we defend themselves against the microbes or how we utilize their presence)
- d) **Relationship between microbes and the environment** (including methods how to eradicate the microbes)

# Different objects and sections of microbiology – revision

- **bacteria** **bacteriology**
- **micromycetes (moulds & yeasts)** **mycology**
- **(algae)** **(algology)**
- **parasites** **parasitology**
  - **protozoa** **protozoology**
  - **helminths** **helminthology**
  - **arthropods** **entomology**
- **viruses** **virology**

**General microbiology**

**special microbiology**

# “Must-knows” about microbes for an E mark – revision

## Pathogenicity

1. Which diseases or syndromes does the microbe in question cause?
2. How are they called in Latin?

## Etiology

3. Which microbe is the etiological agent of the infectious disease in question?
4. Which microbes (bacteriae, yeasts, moulds, viruses or parasites) are the most important causes of the syndrome in question?

## Treatment

5. What is the treatment of choice?
6. If it is an antibiotics, which one?

# Shape of bacteria – I

## Spherical shape: cocci

regular sphere: staphylococci



flattened: gonococci, meningococci

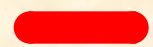


pointed (lancet-like): pneumococci



## Elongated shape: rods

straight: majority (e.g. *Escherichia coli*)

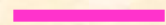


short (coccobacilli): acinetobacters



long (fibers): mainly old cultures

slender: *Mycobacterium tuberculosis*



robust: majority of bacilli, lactobacilli,  
*Clostridium perfringens*



(to be continued)

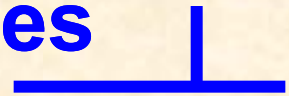
# Shape of bacteria – II

(rods, continued:)

**with split ends:** bifidobacteria



**branched:** nocardiae, actinomycetes



**curved:** vibria, campylobacters



**with flat ends:** *Bacillus anthracis*



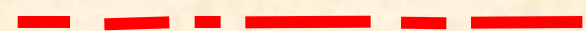
**spindle-shaped:** fusobacteria



**club-shaped:** corynebacteria



**pleomorphic:** haemophili



# Shape of bacteria – III

## Spirals:

thick: *Spirillum*



uneven: *Borrelia*



regular: *Treponema*



slender with bend ends: *Leptospira*



# Size of bacteria

Pathogenic bacteria: mainly around 1 – 5  $\mu\text{m}$   
(1  $\mu\text{m}$  =  $10^{-3}$  mm)

Genus *Staphylococcus*: the diameter circa 1  $\mu\text{m}$

Relatively **big**: genera *Bacillus* and *Clostridium*  
(robust rods around 1 – 2 – 10  $\mu\text{m}$ )

Relatively **long**: old cultures of most rods  
(fibers up to 50  $\mu\text{m}$  long)

Relatively **small**: genus *Haemophilus*  
(in the sputum approximately 0.3 – 0.6  $\mu\text{m}$ )

Even smaller:

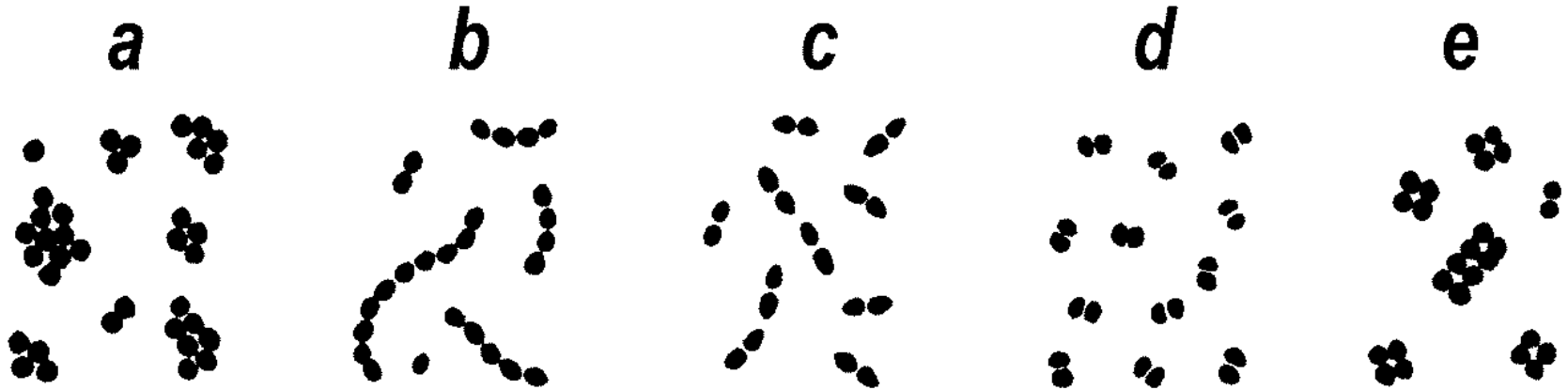
rickettsiae (circa 0.5  $\mu\text{m}$ )

chlamydiae (elementary bodies circa 0.3  $\mu\text{m}$ )

mycoplasmas (circa 0.2 – 0.25  $\mu\text{m}$ )



# Arrangement and shape of cocci



a) in **clumps**: *Staphylococcus aureus*

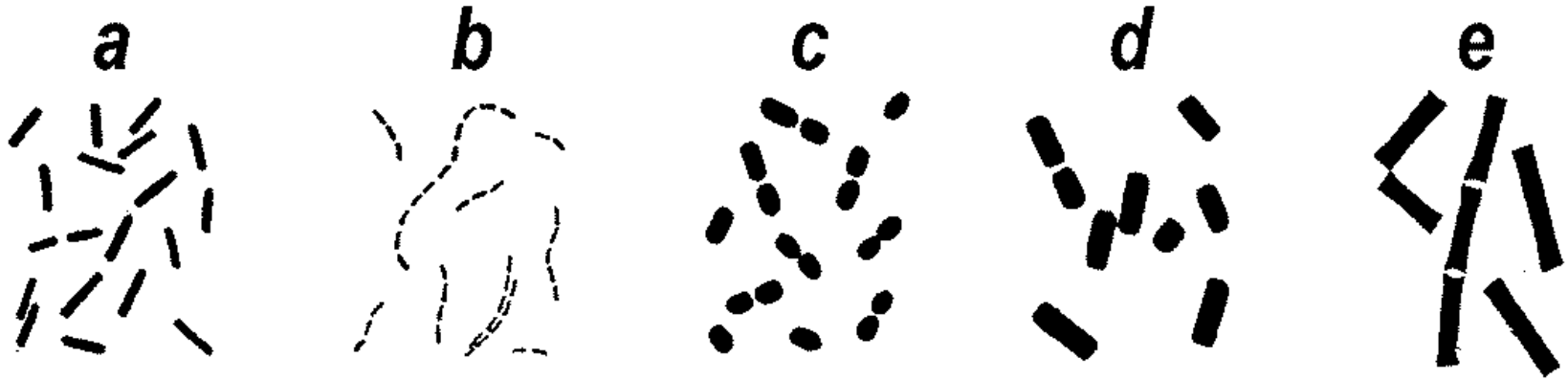
b) in **chains**: *Streptococcus pyogenes*

c) lancet-like **diplococci**: *Streptococcus pneumoniae*

d) flattened **diplococci**: *Neisseria gonorrhoeae*

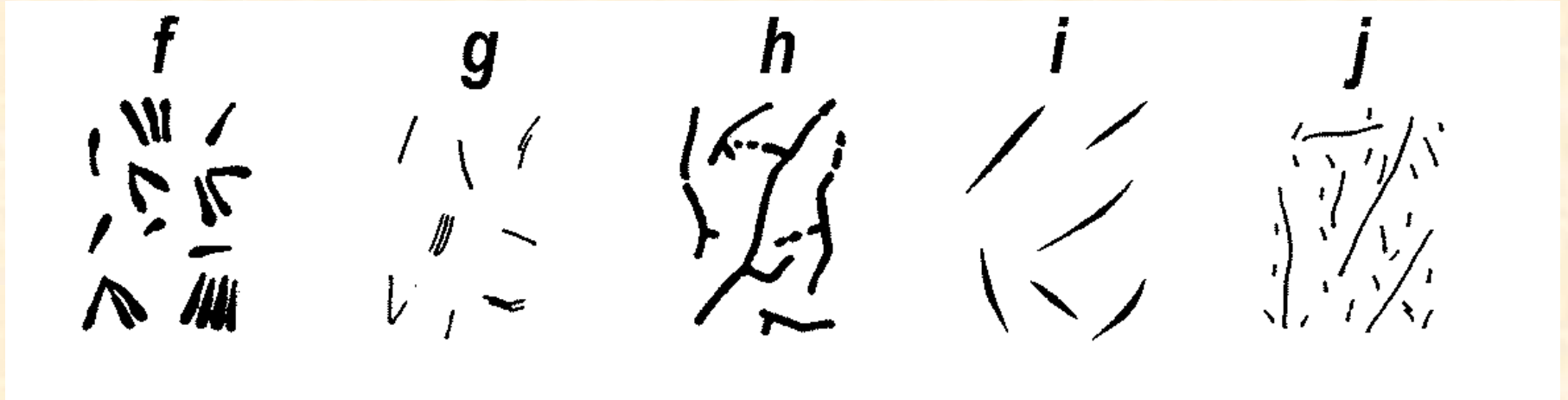
e) cocci in **tetrads**: *Micrococcus luteus*

# Arrangement and shape of rods – I



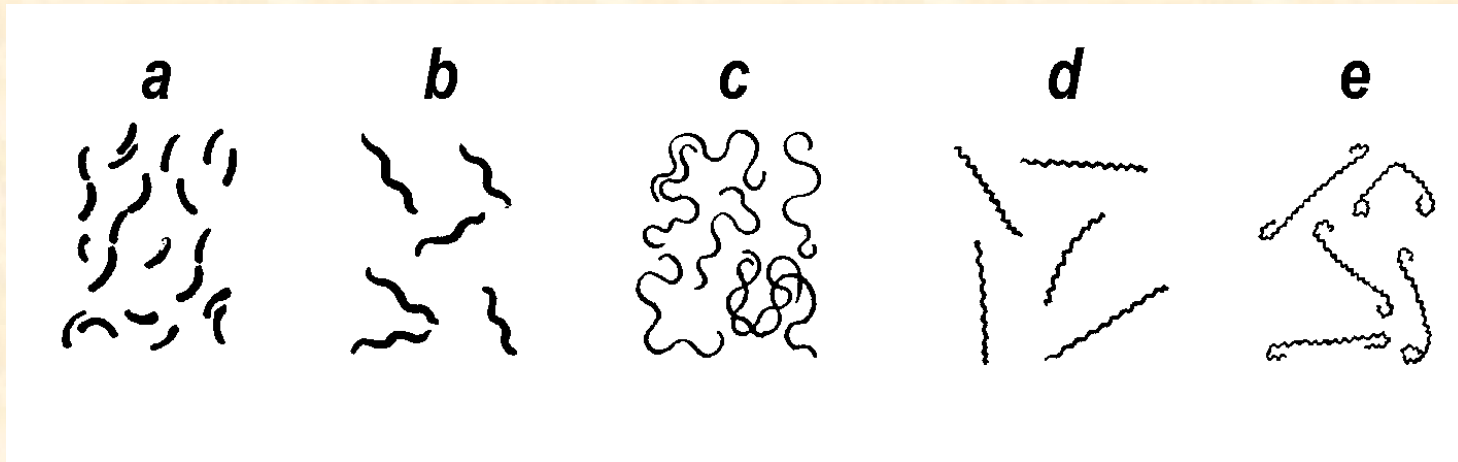
- a) absolute **majority** of rods: e.g. *Escherichia coli*
- b) delicate **streptobacilli**: *Haemophilus ducreyi*
- c) **coccobacilli** in pairs or **diplobacilli**: *Moraxella lacunata*
- d) robust rods, **rounded ends**: *Clostridium perfringens*
- e) robust rods, **flat up to concave ends**, bamboo cane-like chains: *Bacillus anthracis*

# Arrangement and shape of rods – II



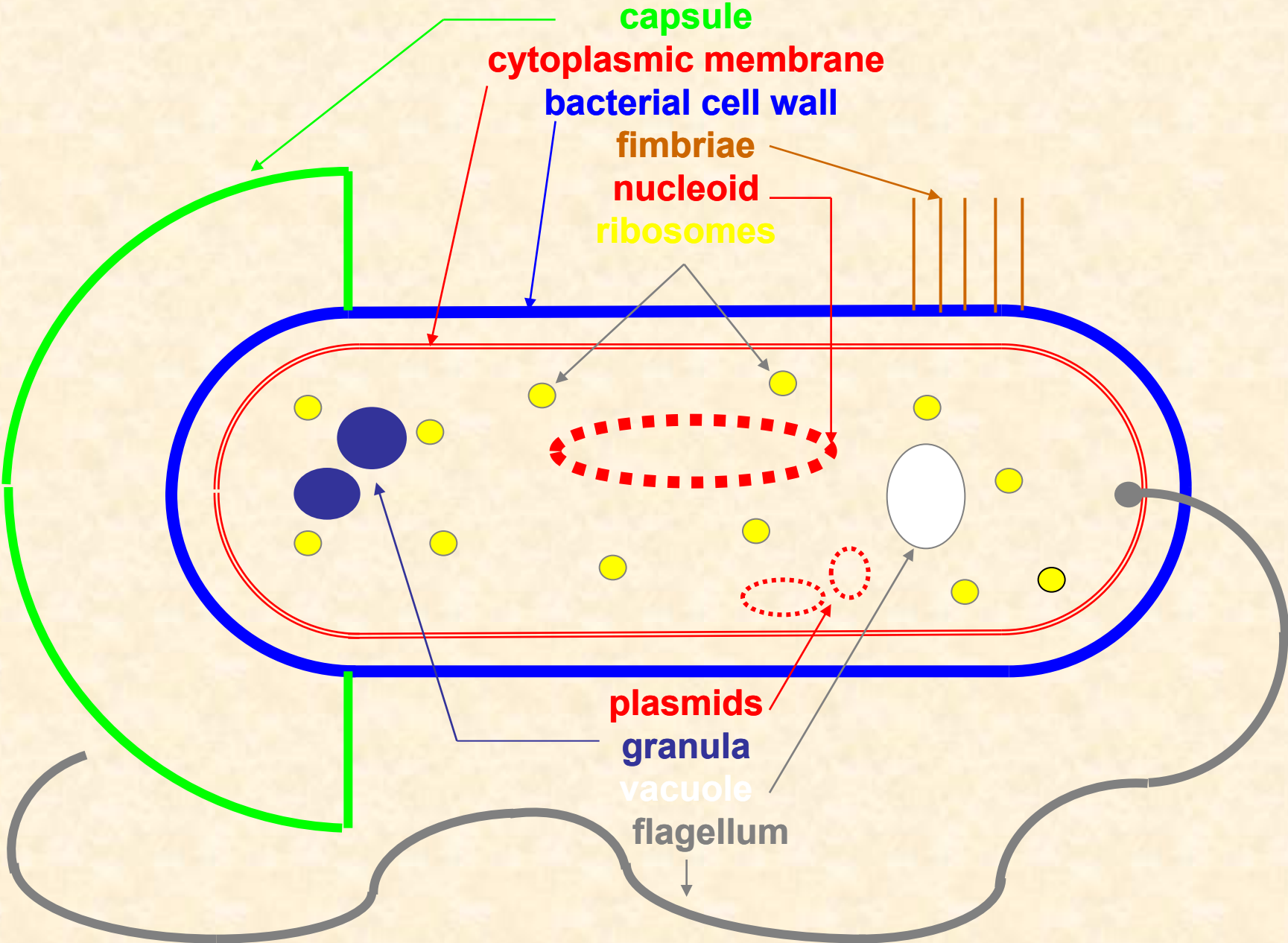
- f) club-like in **palisades**: *Corynebacterium diphtheriae*
- g) slender, in hinted **palisades**: *Mycobacterium tuberculosis*
- h) **branched**, fragmented: *Nocardia asteroides*
- i) **spindle-like**: *Fusobacterium fusiforme*
- j) minute, **pleomorphic**: *Haemophilus influenzae*

# Curved and spiral rods

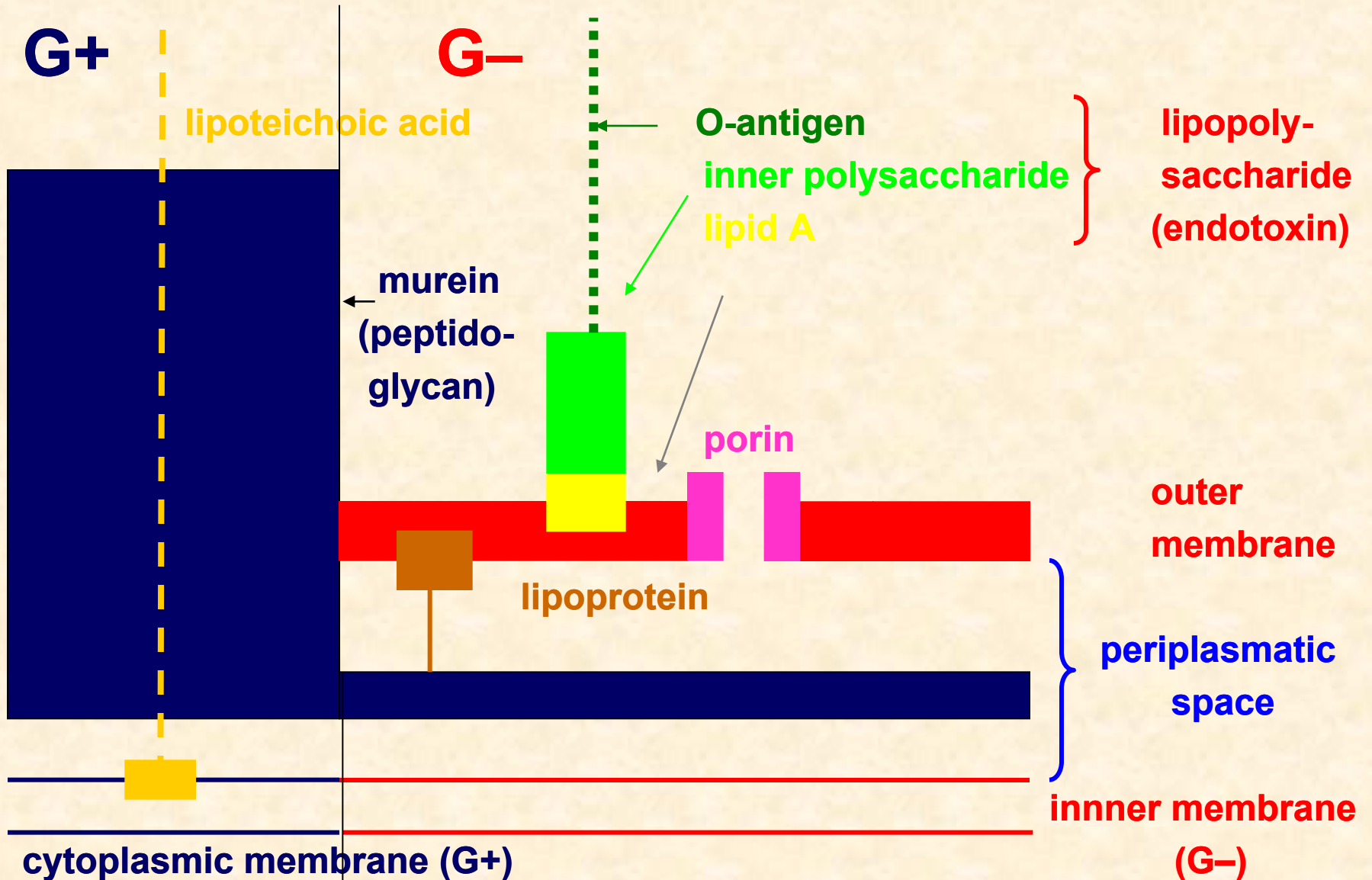


- a) **curved** rods, crescent-shaped: *Vibrio cholerae*
- b) **thick spirals**: *Spirillum minus*
- c) **uneven spirals**: *Borrelia recurrentis*
- d) **delicate, regular spirals**: *Treponema pallidum*
- e) **very fine spirals with bent ends**: *Leptospira icterohaemorrhagiae*





# Outline of bacterial cell



# Bacterial cell wall



# Gram staining

		<b>G+</b>	<b>G-</b>
<b>1. Fixation by flame</b>	<b>3 times</b>		
<b>2. Gram stain</b>	<b>20 s</b>		
<b>3. Lugol solution</b>	<b>20 s</b>		
<b>4. Alcohol</b>	<b>max. 20 s</b>		
<b>5. Aqua fontis</b>	<b>rinse</b>		
<b>6. Safranin</b>	<b>1 min</b>		
<b>7. Aqua fontis</b>	<b>rinse</b>		
<b>8. Drying</b>			

# Basis of Gram-positiveness

Rather a **puzzle** – but it is connected with the **structure of cell wall**

**The 1st theory:**

**Thick peptidoglycane (murein) layer contracts after the alcohol and slows down the washing of crystal violet and iodine complex out of Gram-positive cells**

**The 2nd theory:**

**Cell wall of Gram-negative bacteria contains more lipids, therefore the alcohol forms pores in the wall and the colored complex can be washed out easier**



# Examples of G+ and G- microbes

## Gram-positives

*Staphylococcus*

*Streptococcus*

*Bacillus*

*Lactobacillus*

*Clostridium*

*Listeria*

*Corynebacterium*

yeasts and moulds

## Gram-negatives

*Escherichia*

*Salmonella*

*Vibrio*

*Haemophilus*

*Pseudomonas*

All spirals

*Mycoplasma*

rickettsiae & chlamydiae

# Sensitivity to antibiotics

Effect mostly  
on Gram-positives:

beta-lactams (penicillin,  
oxacillin = methicillin)  
macrolides (erythromycin)  
lincosamides  
(lincomycin)  
glycopeptides  
(vancomycin)

Effect mostly  
on Gram-negatives:

aminoglycosides  
(gentamicin)  
monobactams  
(aztreonam)  
polypeptides (colistin)  
3rd gen. cephalosporins  
(cephtriaxon)

# Recommended reading material

**Paul de Kruif: Microbe Hunters**

**Paul de Kruif: Men against Death**

**Could you kindly supply me with another work in connection with microbes or at least medicine?**

**Please mail me your suggestions at:**

**[mvotava@med.muni.cz](mailto:mvotava@med.muni.cz)**

**Thank you for your attention**