Chemical structures of bacteria

- Bacterial cells are similar to plant and animal cells in their contents of biogenic and trace elements, as well as in basic chemical substances.

The basic substances can be divided into two subgroups:

- The subgroup of small molecules
  - water, aminoacids, nucleotides, monosaccharides, oligosaccharides, glycerids and other
- The subgroup of great molecules
  - proteins, DNA, RNA, polysaccharides, lipoproteins, lipopolysaccharides, peptidoglycan

- Water is the main basal substance.
- Vegetative forms of bacteria content from 75% to 85% of water.
  - A majority of it is free and so can be engaged in biochemical reactions.
  - A minority of bacterial water is bound to different cellular structures.
- Spores contain only 15% of bound water.
  - They lack free water and therefore have no metabolic activity.

- Proteins are predominant constituents of dry material from microbes.
- Lipids represent only small proportion of dry material.
- Lipids in bacteria occur mainly as:
  - glycerids,
  - phospholipids,
  - high–molecular alcohols.

- Polysaccharides consist of building units, which represent sources of energy and building material of bacterial cells.

- Polysaccharides occur in microbial plasma (glycogen), in cell wall (peptidoglycan, teichoic acid, chitin, celulose) and in capsule.

Pigments

- Some species of microbes form pigments inside cells (so called endopigments) or outside cells in the outer environment (so called exopigments).

Bacterial metabolism

- Bacterial metabolism is a complex of all reactions realized in bacterial cells.
- The main goal of all these biochemical reactions is the yield of energy and building material.
- The main characteristic of all live bacterial cells is the ability of their own reproduction. This capability is insured by two metabolic processes:
  - assimilation or anabolism
  - catabolism

- All bacterial cells require a constant supply of energy to survive. This energy, typically in the form of adenosine triphosphate (ATP), is derived from the controlled breakdown of various organic substrates (carbohydrates, lipids, proteins). This process of substrate breakdown and conversion into usable energy is known as **catabolism**.

- The energy produced may then be used in the synthesis of cellular constituents (cell wall, proteins, fatty acids, and nucleic acids), a process known as **anabolism**.

The division of bacteria according to the way of acquisition of energy and building material:

- **Autotrophic bacteria**
  - Autotrophs (or litotrophs) are able, like plants, to use carbon dioxide as the main source of carbon.
  - Energy is obtained in these microorganims by the oxidation of anorganic compounds or from sunlight.

The division of bacteria according to the way of acquisition of energy and building material:

- **Heterotrophic bacteria**

  (organotrophs)

  – All medical important bacteria are heterotrophs.

  – They obtain energy by the breakdown of suitable organic nutrients.

Classifications of bacteria

- Classifications based on nutritional requirements:
  - heterotrophic
  - autotrophic

Heterotrophic bacteria

- Energy source: organic compounds
- Carbon source: organic compounds
- Types of heterotrophs
  - aerobic bacteria - need free dissolved oxygen
  - anaerobic bacteria - oxidize organics in complete absence of oxygen
  - facultative bacteria - use oxygen when available but can function without oxygen

    (example: *E. coli*)

Autotrophic bacteria

- Energy source: inorganic compounds
- Carbon source: CO_2
- Example: Nitrifying bacteria

The division of bacteria according to the contents of their enzymes and to the relationship to air oxygen:

- Aerobic microbes (obligate aerobes)
- Anaerobic microbes (strict anaerobes)
- Anaerobic microbes (aerotolerant)
- Facultative anaerobes
- Micro-aerophilic microbes

The main source
of energy in bacteria
are sugars
—
above all glucose.