

Bacterial Spores

A spore is a **dormant stage** in which the bacterium can survive despite unfavourable external conditions. The spore is characterized by zero metabolism, high chemical and physical resistance, high lightfastness and low water content. An **endospore** is a spore that forms from inside a bacterial cell, unlike an **exospore**. Endospores are formed by some G+ bacteria, specifically the genera *Bacillus* and *Clostridium*. Exospores are formed by the class *Actinobacteria*.

Sporation and spore structure

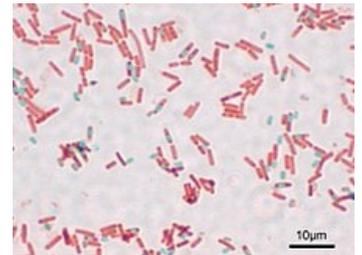
Sporulation

The process of sporulation begins with DNA replication and asymmetric cell division. The smaller part forms a double-membrane-coated spore. The larger part is called the sporangium and lyses when the spore is finished forming.

Structure of the Bacterial Spore

The spore is a **protoplast**, contains a genome, a small amount of proteosynthetic apparatus and large amounts of calcium and K. Dipicolin, cytochromes are absent. Energy is provided by glycolysis. The spore contains almost no water. Water is replaced by calcium, forming calcium-dipicolinate bridges. The envelope is made up of several layers:

1. inner cytoplasmic membrane
2. a layer of peptidoglycans,
3. cortex - concentric layers of peptidoglycans - provides resistance,
4. outer membrane,
5. spore coat (protein rich in cysteine, insoluble in water) - provides resistance to UV and ionizing radiation.



Spores of *Bacillus subtilis* (green)

Examples of bacterial spore morphology

Shape

- Oval - often; *Bacillus anthracis*, *Clostridium botulinum*;
- Round - *Clostridium tetani*.



1, 4 - central; 2, 3, 5 - terminal; 6 - Lateral; 3-6 Spora bubbling rod

Relative size to cell thickness

- Spora bubbling rod - *C. botulinum*, *C. tetani*;
- Spora non-bubbling rod - *B. anthracis*.

Placement

- Terminal - *C. tetani*;
- subterminal (paracentral) placement - *C. botulinum*;
- central placement - *C. novyi*.

Germination

Germination is the process by which a spore turns back into a vegetative cell. The whole process has 3 stages:

1. **Spore activation** - activation requires disruption of the spore shell structure. Disruption can occur e.g. mechanically, by pH, by temperature change
2. **Germination** (germination) - water uptake, hydrolysis of the cortex, loss of resistance, breakdown of stabilizing proteins.
3. **Differentiation** phase - formation of new proteins - formation of vegetative cell.

Spore resistance

Spore resistance is very high. For example, *C. tetani* spores require a 90-minute boil (at 100 °C), *C. botulinum* spores require a five-hour boil. The spores also withstand disinfectants such as ethanol, phenol, surfactants. **Sporicidal** agents include e.g. ethylene oxide, beta-propiolactone, concentrated alkalis and acids, with prolonged exposure also formaldehyde, chloramine, peracetic acid, autoclaving (20 min. hot steam at a pressure of 2 atm and 120 °C). They are so resistant because they contain high concentrations of potassium, stabilising macromolecules



Spore formation of the genus *Bacillus* (phase contrast)

and almost **no water**. In the form of spores, bacteria can survive for **hundred of years**, as evidenced, among other things, by the fact that Patočka revived bacterial spores from the intestinal contents of mummified medieval corpses in Klatovy.

Links

Sources

- JANSKÝ, Petr. *Zpracované otázky z mikrobiologie* [online]. [cit. 2012-01-30]. <https://www.yammer.com/wikiskripta.eu/uploaded_files/3804405>.

Bibliography

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- HURYCH, Jakub, et al. *Lékařská mikrobiologie*. 2020. edition. 2020. ISBN 978-80-7553-844-4.