

# Syntéza nanočástic živými organismy

## Synthesis of nanoparticles in living organisms

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# Princip syntézy nanočástic u organismů

## The principle of the synthesis of nanoparticles with organisms

### **Extracelulární syntéza**

jsou ionty kovů zachyceny na povrchu buněk a redukovány za pomoci enzymů

### **Extracellular synthesis**

metal ions are captured on the cell surface and reduced using enzymes

### **Intracelulární syntéza**

zahrnuje transport iontů do buňky a tvorbu částic za přítomnosti enzymů

### **intracellular synthesis**

includes the transport of ions in the cell and the formation of particles in the presence of enzymes

### **Faktory ovlivňující syntézu nanočástic živými organismy**

pH, koncentrace a stáří biomasy, typu prekursoru kovu a jeho koncentrace, teplota, času reakce (doba kontaktu buněk s prekurzorem), ozáření, ...

### **Factors affecting the synthesis of nanoparticles by living organisms**

pH, concentration and the age of the biomass, the type of precursor metal and its concentration, temperature, reaction time (contact time with the precursor cells), irradiation, ...

# Organismy schopné syntetizovat nanočástice

## Organisms capable of synthesizing nanoparticles

### Rostliny / Plants

- Zelená syntéza/ Green Synthesis

- Nanočástice produkované rostlinami jsou více stabilní, a rychlost syntézy je rychlejší, než v případě jiných organismů

- Nanoparticles produced by plants are more stable, and the rate of synthesis is faster than in case of other organisms

- Rostliny s vysokým obsahem fenolických sloučenin

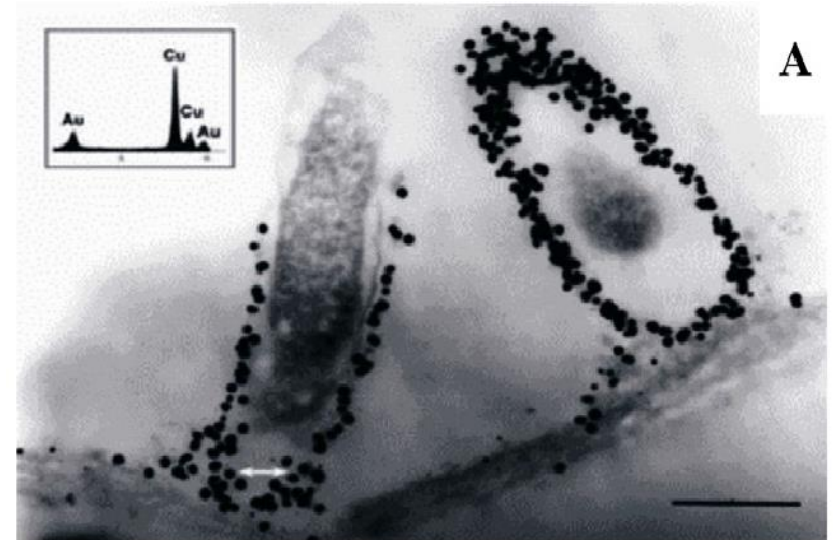
- Plants with high content of phenolic compounds

Ag - *Pinus eldarica* (borovice kalabrijská)

Pt - *Diospyros kaki*

Au - *Aloe ferox*

Pd - *Gardenia jasminoides*



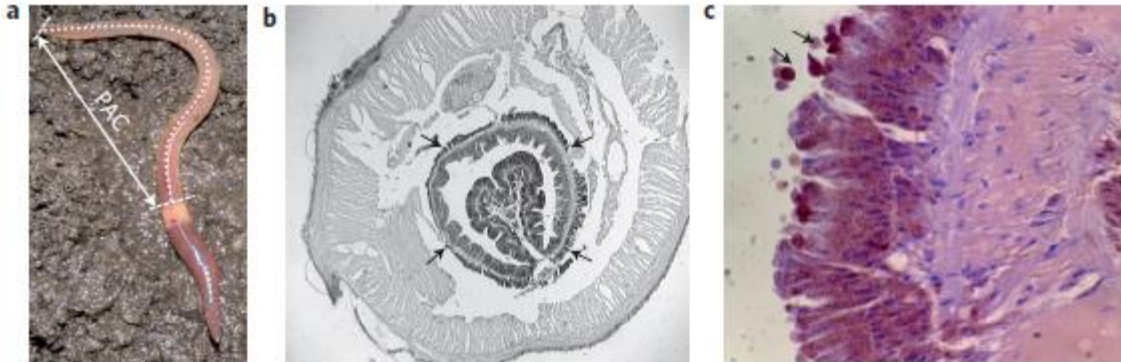
(A) TEM image of *Sesbania drummondii* root showing gold nanoparticles surrounding organelles (magnification=60,000 $\times$ ; scale marker=500 nm). The inset on the top left shows EDAX spectrum with gold and copper peaks (copper peaks arise from the copper grid that holds the plant tissue)

# Organismy schopné syntetizovat nanočástice

## Organisms capable of synthesizing nanoparticles

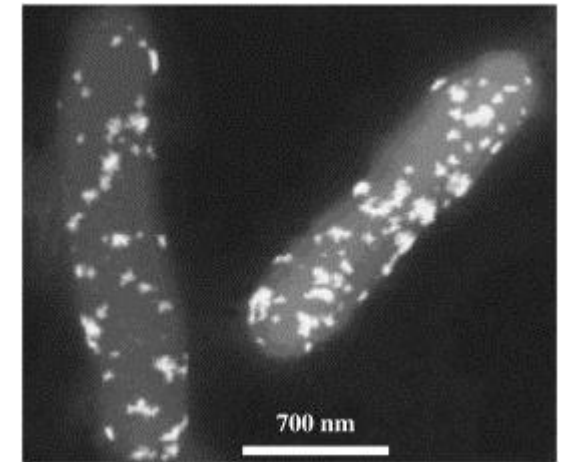
Živočichové /Mikroorganismy    Animals / microorganisms

CdTe quantum dots -*Lumbricus rubellus* (žížala)



Schematics of the earthworm used and optical characterization of the quantum dots. **a**, The earthworm *Lumbricus rubellus*. The gut section following the thickened glandular clitellum is termed the posterior alimentary canal (PAC). **b**, Cross-section of the posterior section of the earthworm. The chloragogenous tissue surrounds the PAC (indicated by arrows). **c**, The chloragogenous tissue harvested for analyses is also the predominant location of metallothionein accumulation, as determined by immunoperoxidase histochemistry performed with an earthworm-specific metallothionein antibody<sup>12</sup>. These figures highlight the anatomy of the worm and the regions where the metallothionein is generated and where the quantum dots are synthesized.

*Shewanella algae*



Dark-field TEM image of *S. algae* cells showing the presence of platinum nanoparticles deposited in periplasmic space (reproduced from [44] with permission from Elsevier publishers).

Biological Synthesis of Metal Nanoparticles by Microbes, Kannan Badri Narayanan, Natarajan Sakthivel, Advances in Colloid and Interface Science, Volume 156, Issues 1–2, 22 April 2010, Pages 1–13

Biosynthesis of luminescent quantum dots in an earthworm, S. R. Stürzenbaum, M. Höckner, A. Panneerselvam, J. Levitt, J-S. Bouillard, S. Taniguchi, L-A. Dailey, R. Ahmad Khanbeigi, E. V. Rosca, M. Thanou, K. Suhling, A. V. Zayats and M. Green NATURE NANOTECHNOLOGY | VOL 8 | JANUARY 2013 | www.nature.com/naturenanotechnology

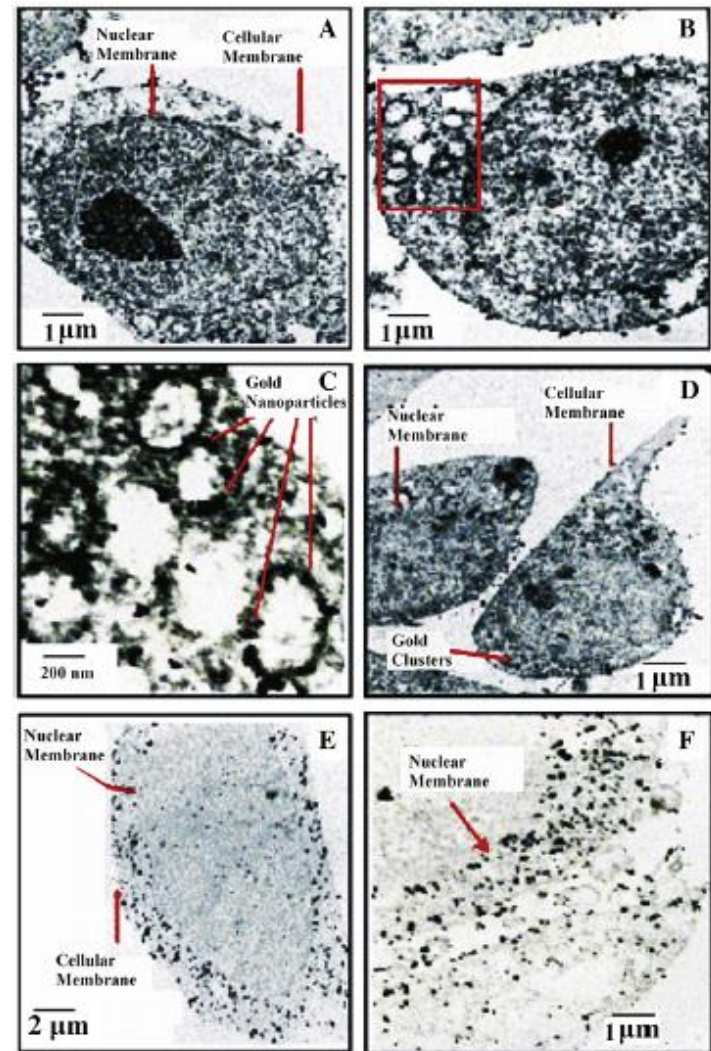
# Organismy schopné syntetizovat nanočástice

## Organisms capable of synthesizing nanoparticles

Tkáňové kultury

Tissue culture

Electron micrographs of growth of gold nanoparticles (A–C), HEK 293, (D), HeLa, (E), SiHa, and (F) SKNSH cells. The region in the box of (B) is enlarged in (C). The black dots spread across the cytoplasm of the cells are gold nanoparticles in the range of 50–100 nm. Smaller particles are seen in the nucleus (E). Reprinted from Anshup et al. [158] with permission from American Chemical Society, USA.



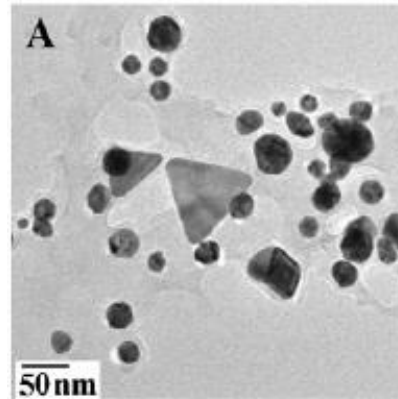


# Proč (ne) využívat k syntéze nanočástic živé organismy

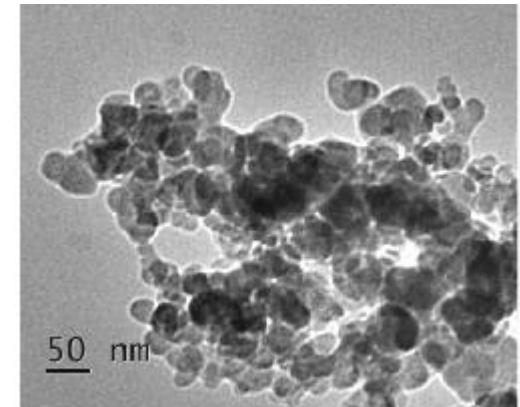
## Why (not) to use for the synthesis of nanoparticles living organisms

### Klady:/ Positives:

- Lepší vlastnosti než nanočástice připravené tradičními fyzikálními a chemickými metodami, např. vyšší katalytickou aktivitu, menší velikost, vyšší stabilitu, vyšší chemickou čistotu a biokompatibilitu
- Better features than the nanoparticles prepared by conventional physical and chemical methods, such as increased catalytic activity, smaller size, greater stability, high chemical purity and biocompatibility
- Netoxický a šetrný způsob syntézy
- Non-toxic and economical method of synthesis
- Proces šetrný k životnímu prostředí
- The process environmentally friendly
- Požadované složení
- The required composition
- Požadovaná velikost (1-500 nm)
- The required size (1-500 nm)
- Požadovaný tvar
- The desired shape



gold nanoparticles



silver nanoparticles


### Zápory:/ Negatives:

- Časová náročnost / - Time required
- Velké množství biologického materiálu / - Large amounts of biological material
- Extrakční techniky / - Extraction Techniques

# Děkuji za pozornost

# Thank you for your attention

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