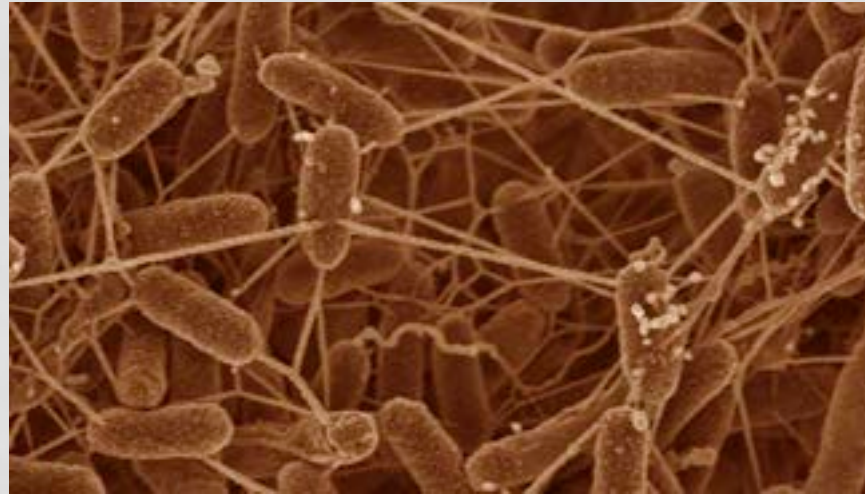




MICROBES FIGHT POLLUTION

SUPER-BUGS TURN TOXIC METALS TO ROCKS



RIZLAN BERNIER-LATMANI
ENVIRONMENTAL MICROBIOLOGY LABORATORY

TOP TEN TOXIC POLLUTANTS

The Top Ten Toxic Pollution Problems(*)

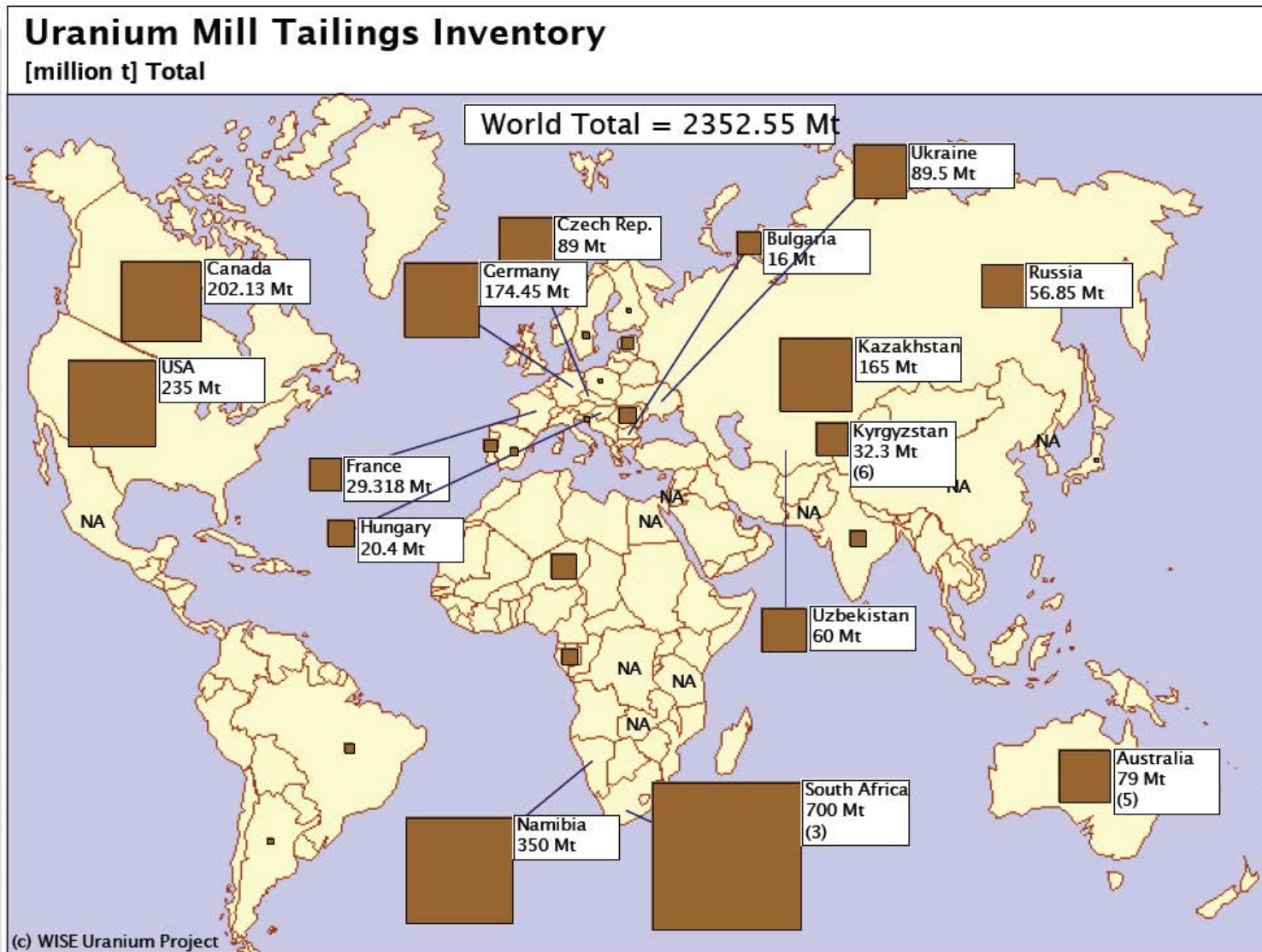
Key Pollutant and Source Industry	Estimated Population at Risk
1. Artisanal Gold Mining <i>Mercury Pollution</i>	3,506,600
2. Industrial Estates <i>Lead Pollution</i>	2,981,200
3. Agricultural Production <i>Pesticide Pollution (considering only local impact)</i>	2,245,000
4. Lead Smelting <i>Lead Pollution</i>	1,988,800
5. Tannery Operations <i>Chromium Pollution</i>	1,848,100
6. Mining and Ore Processing <i>Mercury Pollution</i>	1,591,700
7. Mining and Ore Processing <i>Lead Pollution</i>	1,239,500
8. Lead-Acid Battery Recycling <i>Lead Pollution</i>	967,800
9. Naturally Occurring Arsenic in Ground Water <i>Arsenic Pollution</i>	750,700
10. Pesticide Manufacturing and Storage <i>Pesticide Pollution</i>	735,400

The Rest of the Toxic Twenty

- 11. Chemical Manufacturing**
Chromium Pollution
- 12. Chemical Manufacturing**
Mercury Pollution
- 13. Dye Industry**
Chromium Pollution
- 14. Industrial Estates**
Chromium Pollution
- 15. Industrial and Municipal Dump Sites**
Lead Pollution
- 16. Mining and Ore Processing**
Arsenic Pollution
- 17. Mining and Ore Processing**
Cadmium Pollution
- 18. Mining and Ore Processing**
Cyanide Pollution
- 19. Product Manufacturing**
Lead Pollution (especially from plating, electronics manufacture and battery manufacture)
- 20. Uranium Mining and Ore Processing - Radionuclide Pollution**

Populations estimates are preliminary and based on an ongoing global assessment of known polluted sites.

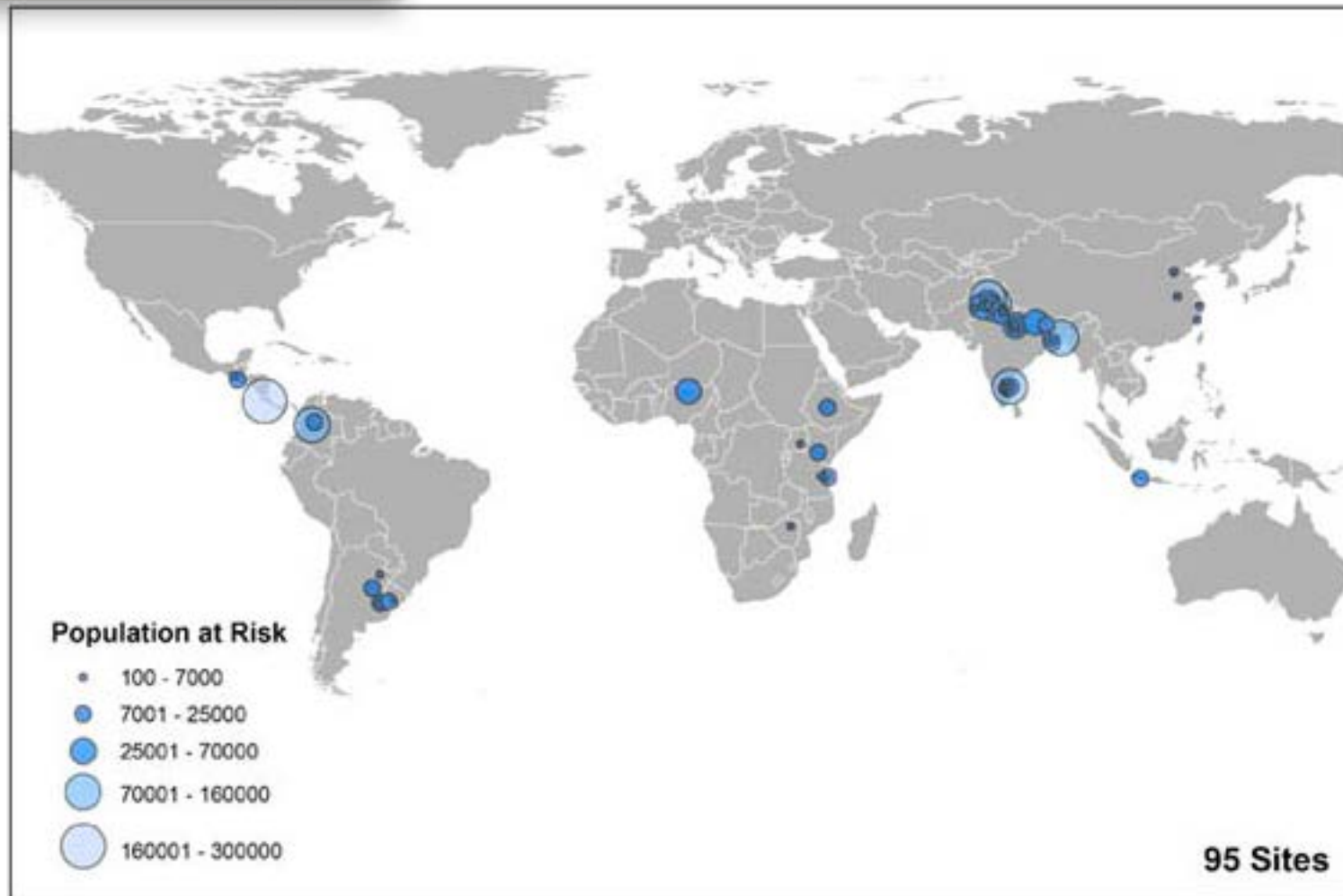
URANIUM: A GLOBAL CONTAMINANT

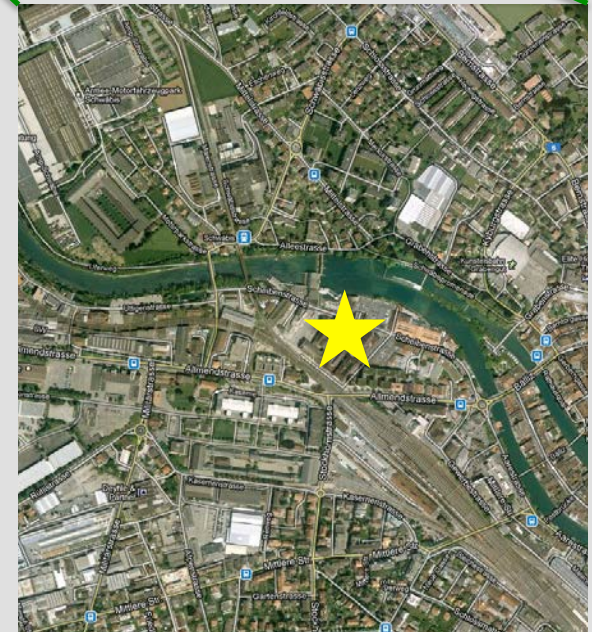
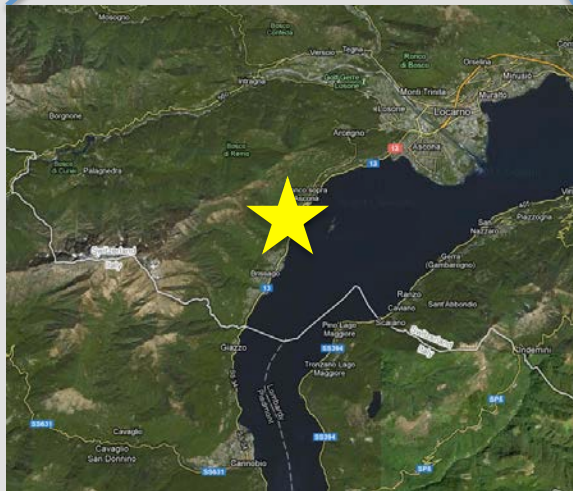
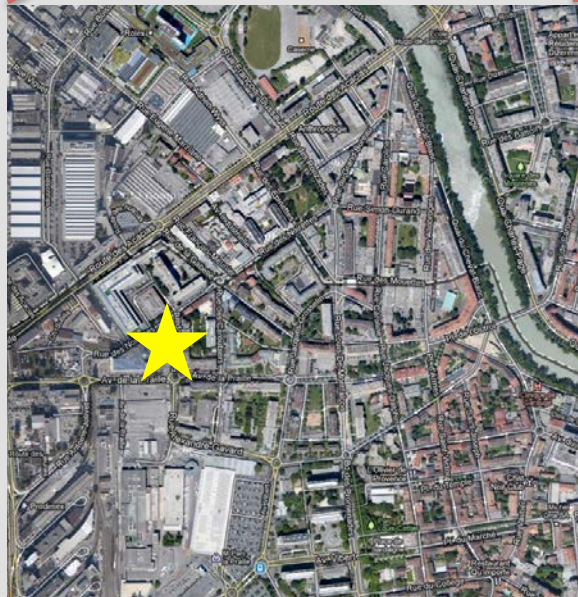


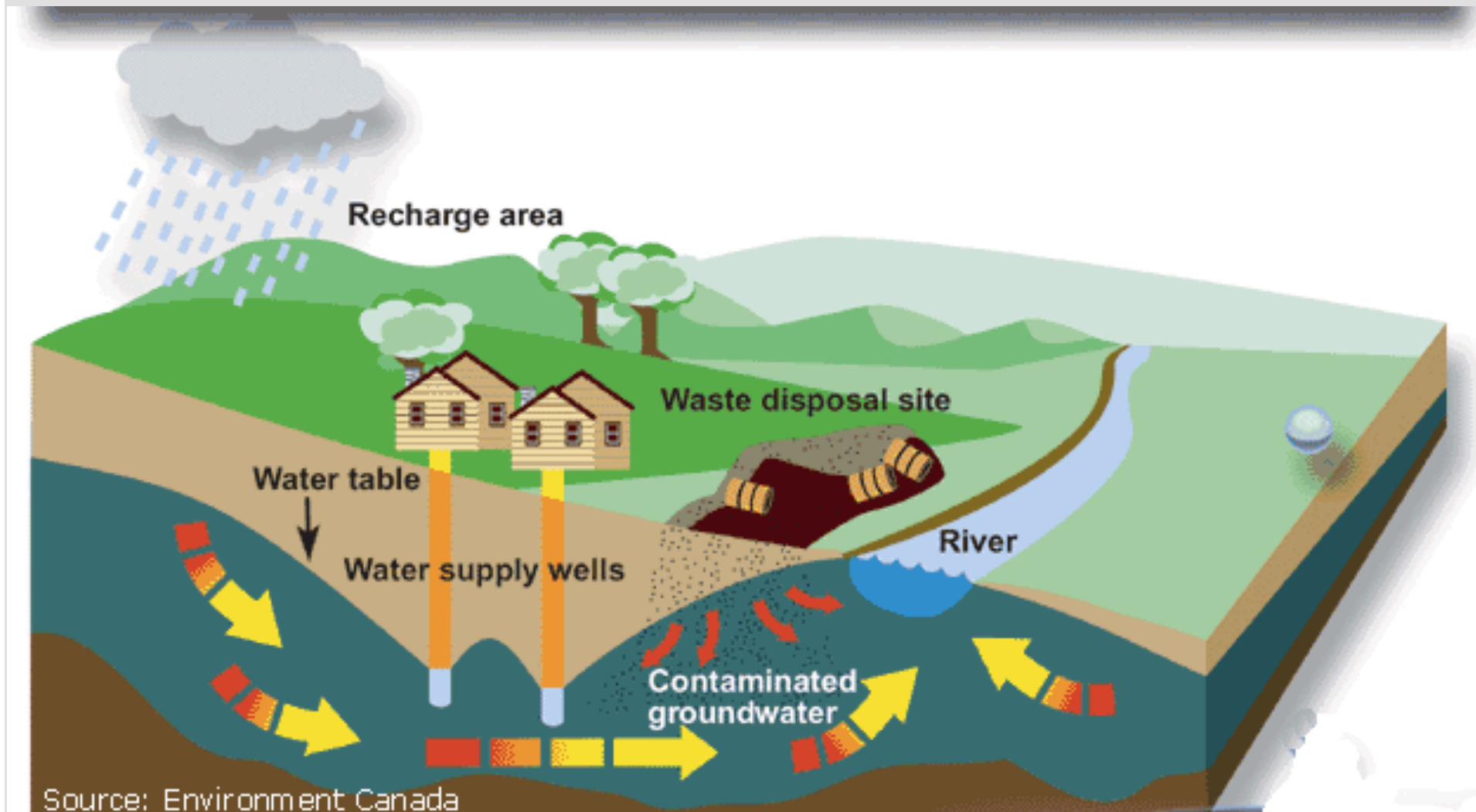
CHROMIUM THREATENS DRINKING WATER

Chromium Pollution from Tanneries

world map of chromium pollution





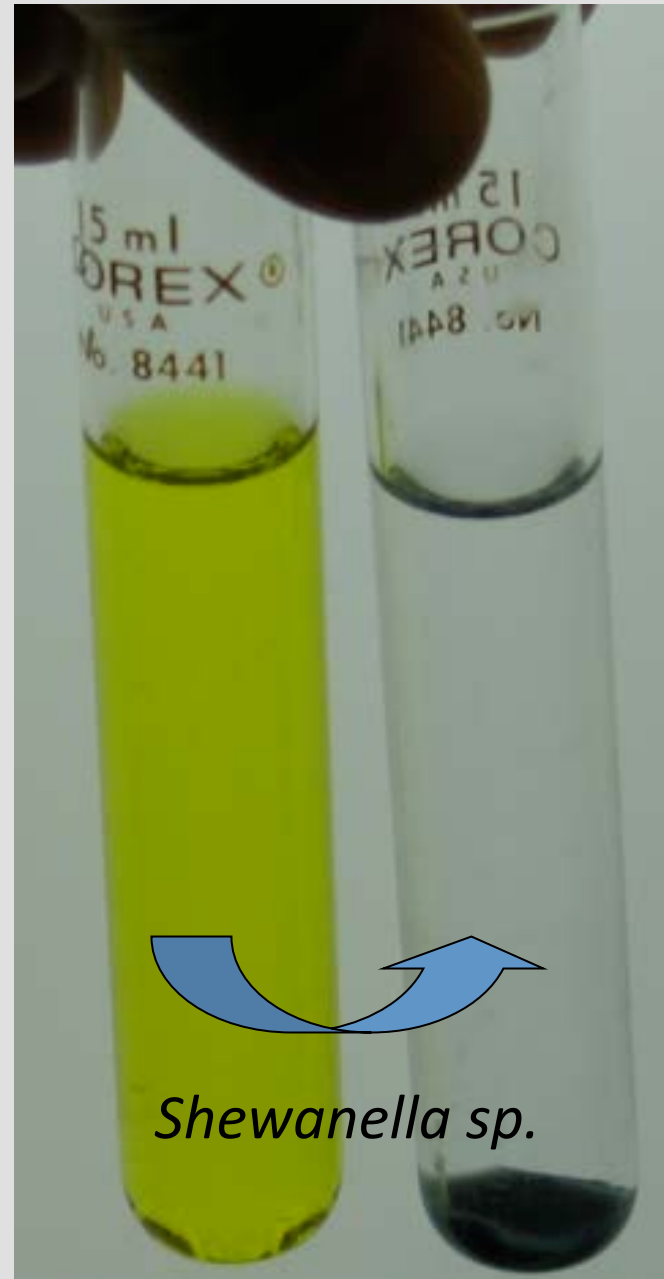


Hexavalent chromium:

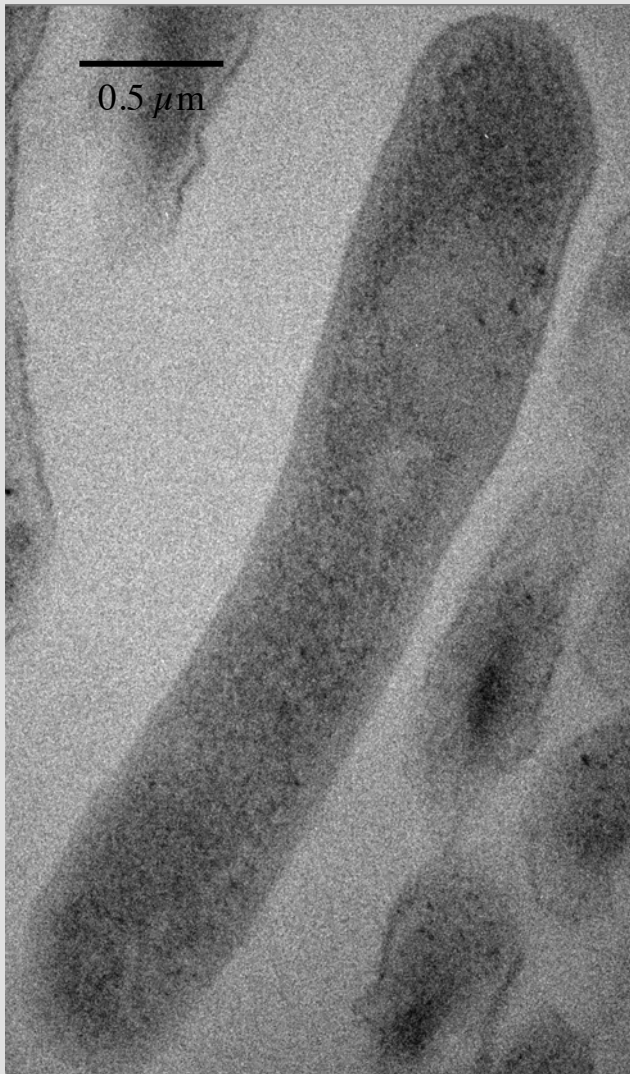
- Cr(VI)
- Toxic
- Soluble
- Causes kidney failure

Trivalent chromium:

- Cr(III)
- Less toxic
- Insoluble



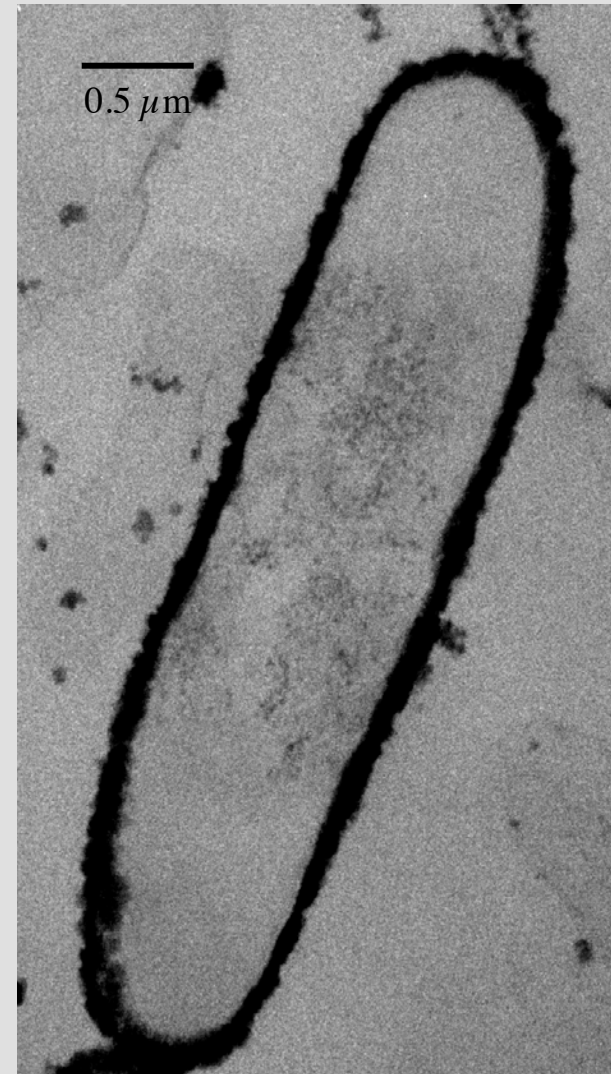
Oxidized Cr = Cr(VI)



Electron donor
(food)

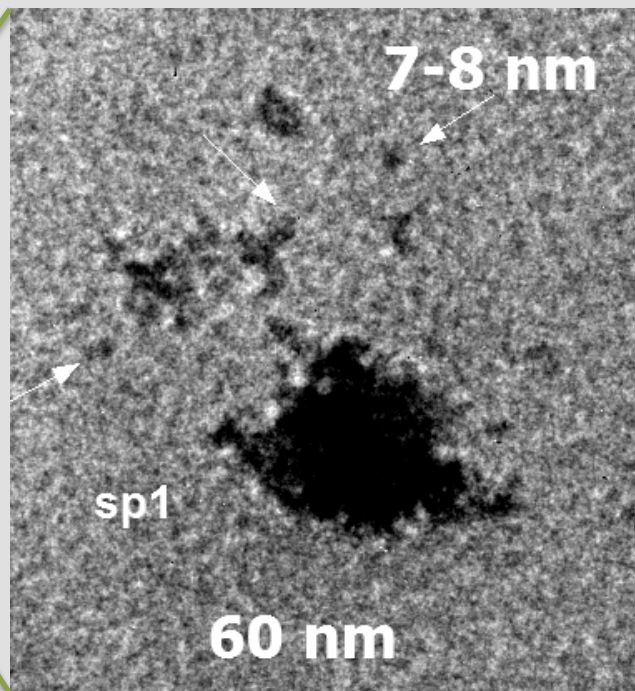
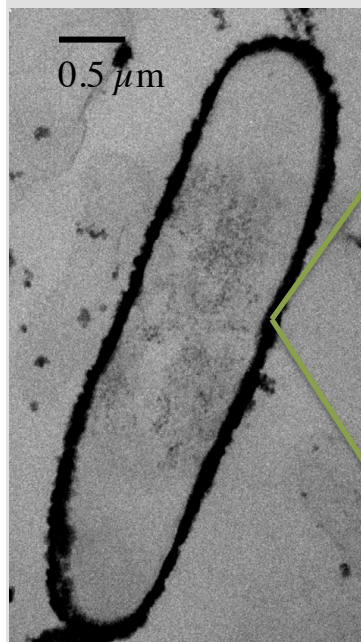


Reduced Cr = Cr(III)



Reduced Cr =
Cr(III)

Very small particles of a
mineral

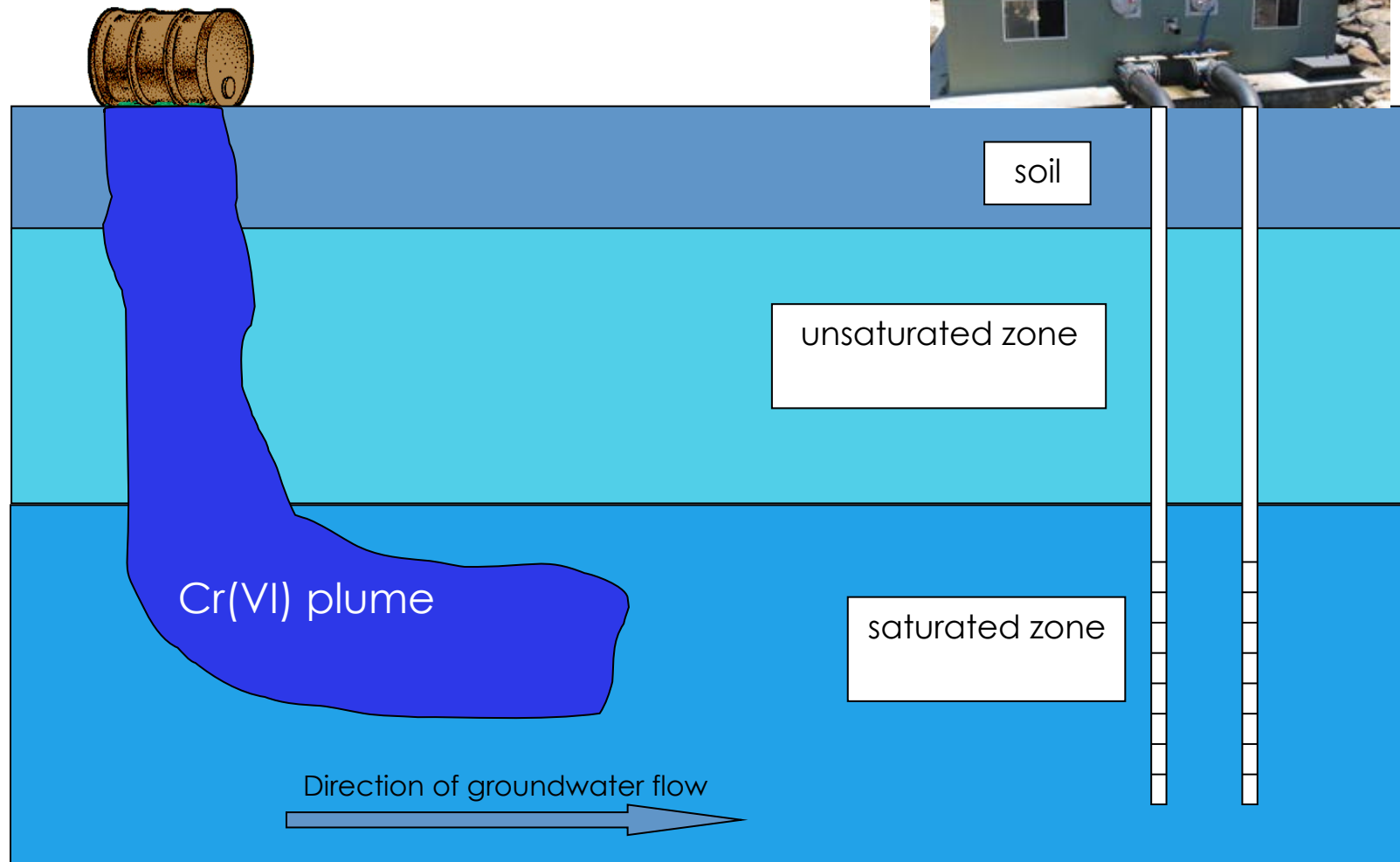


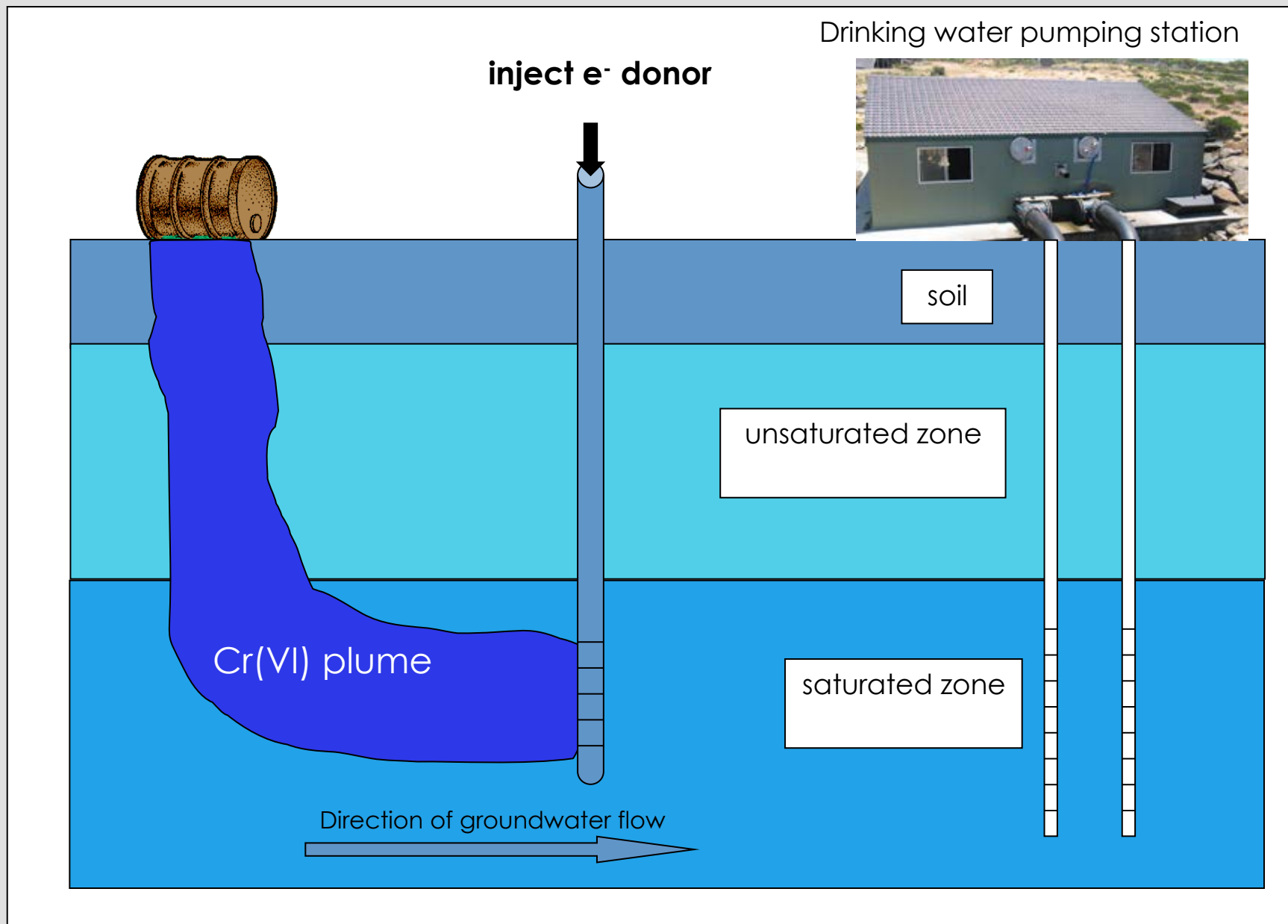
Microscopic scale

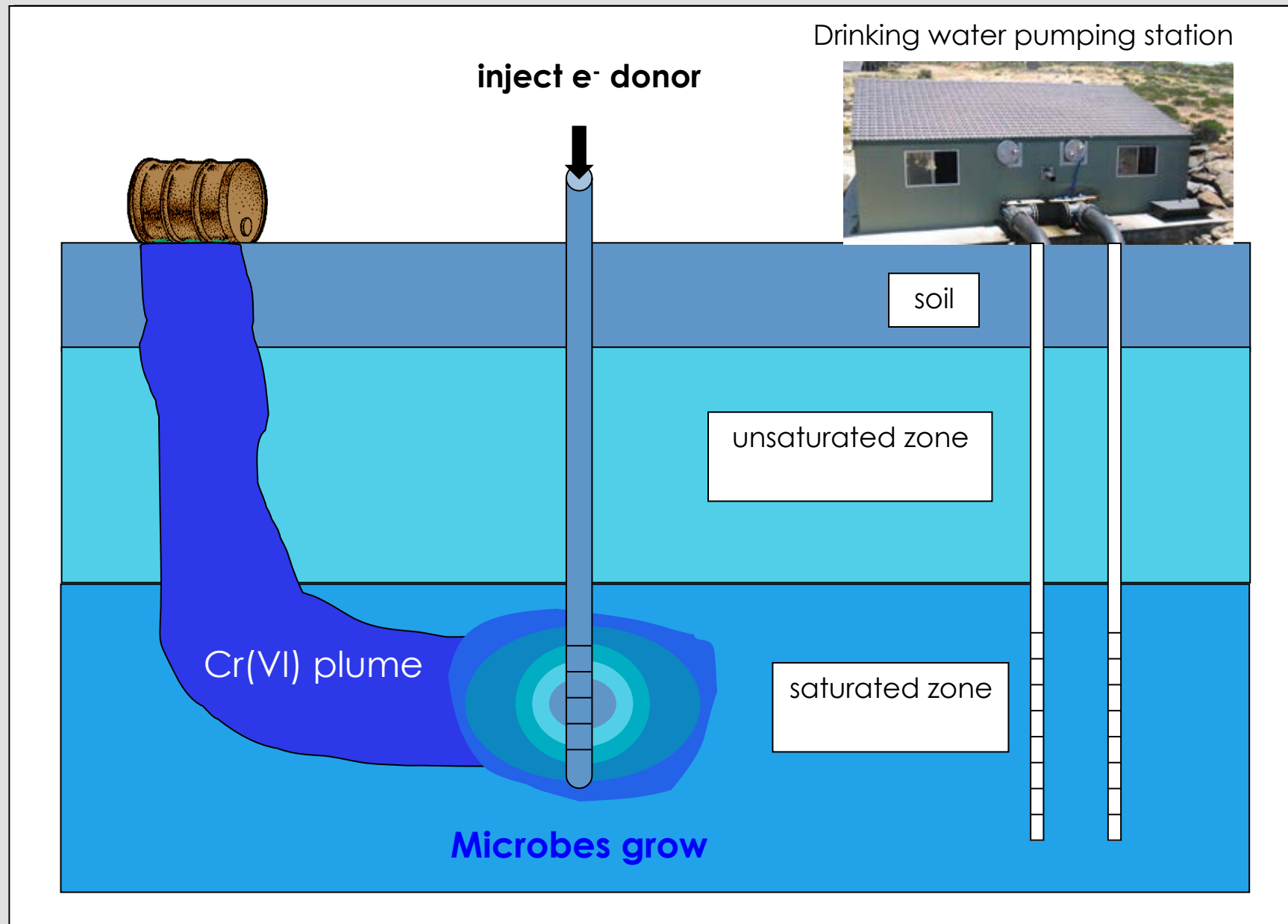


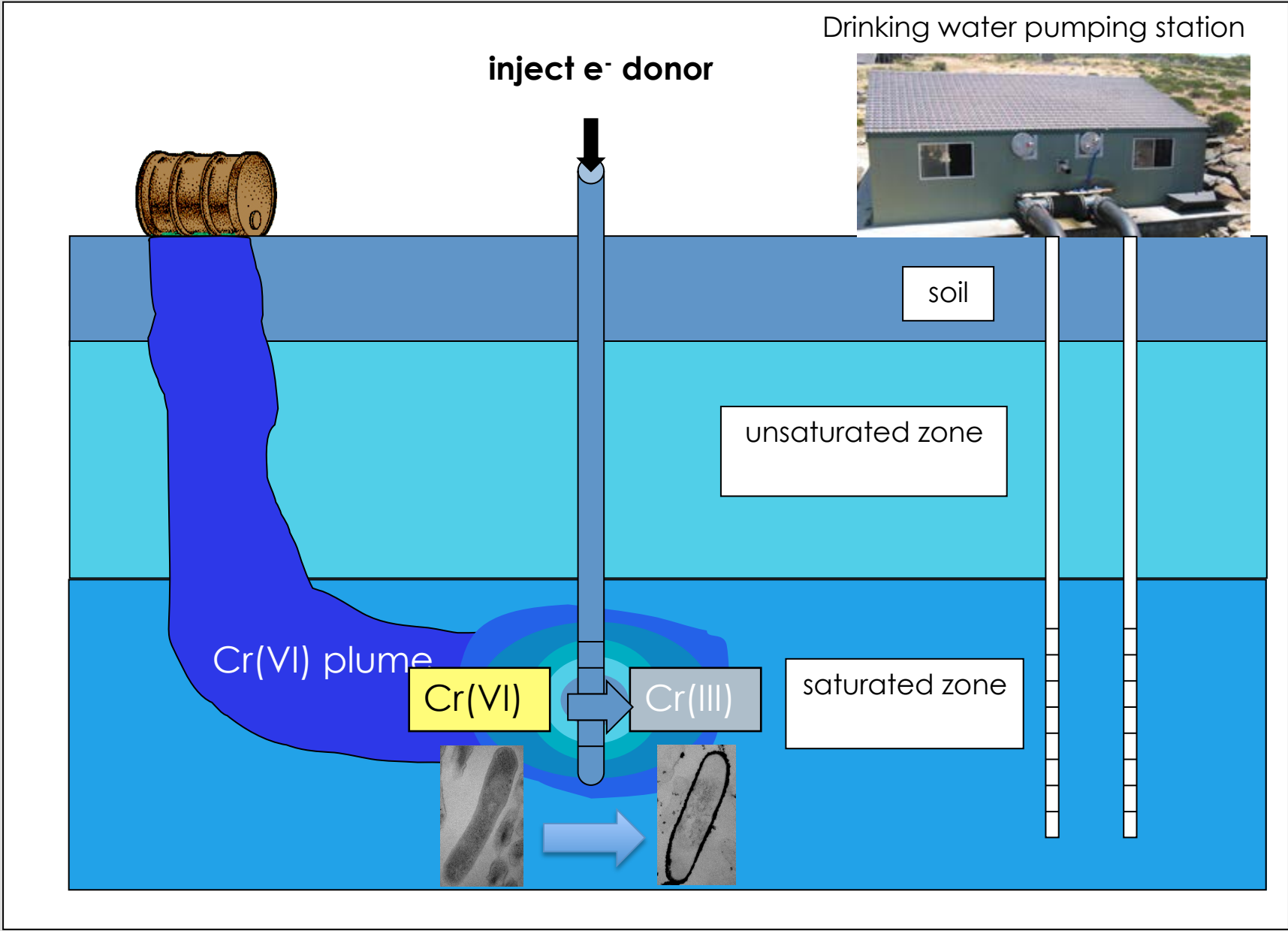
Macroscopic scale

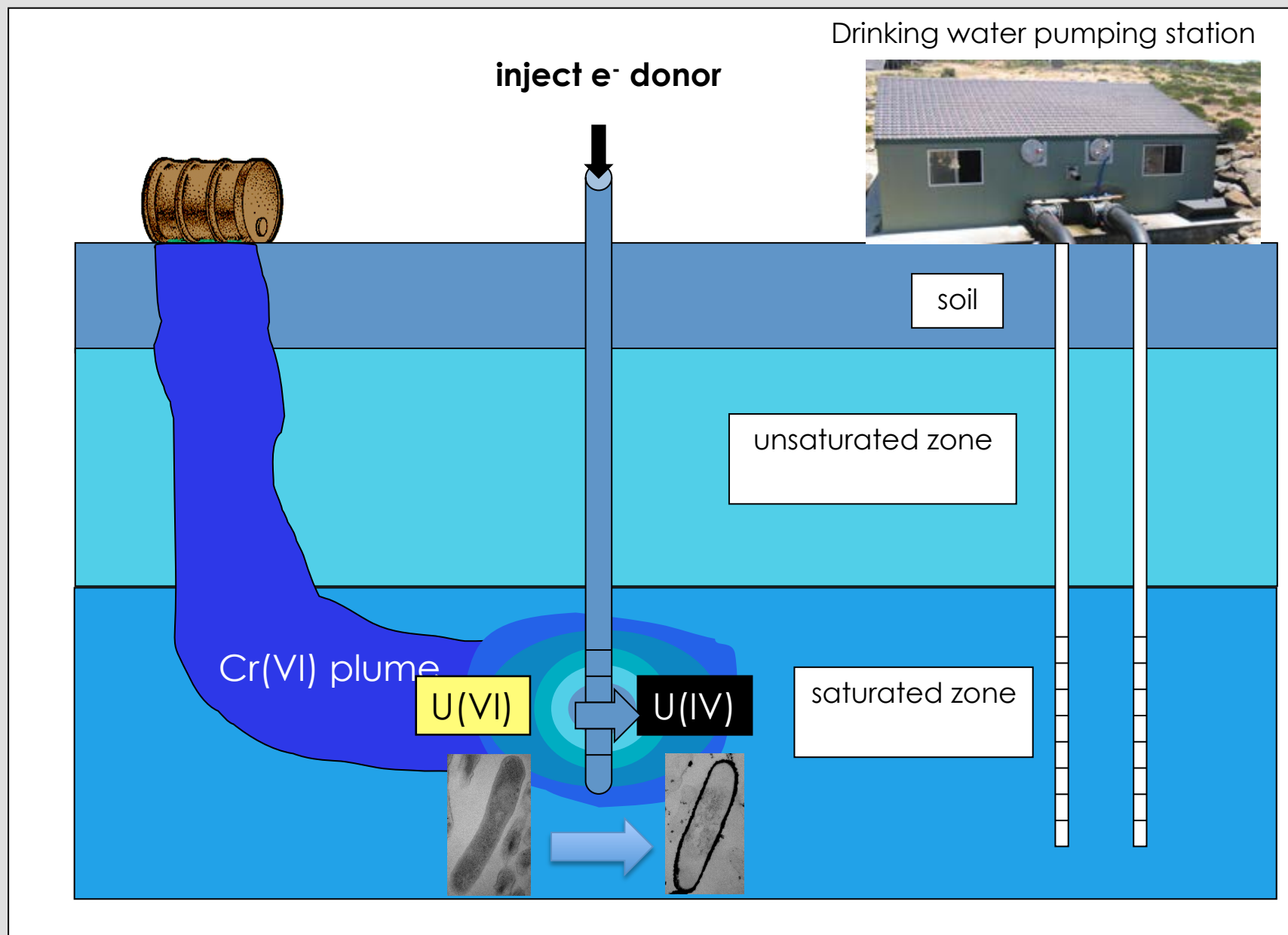
Drinking water pumping station





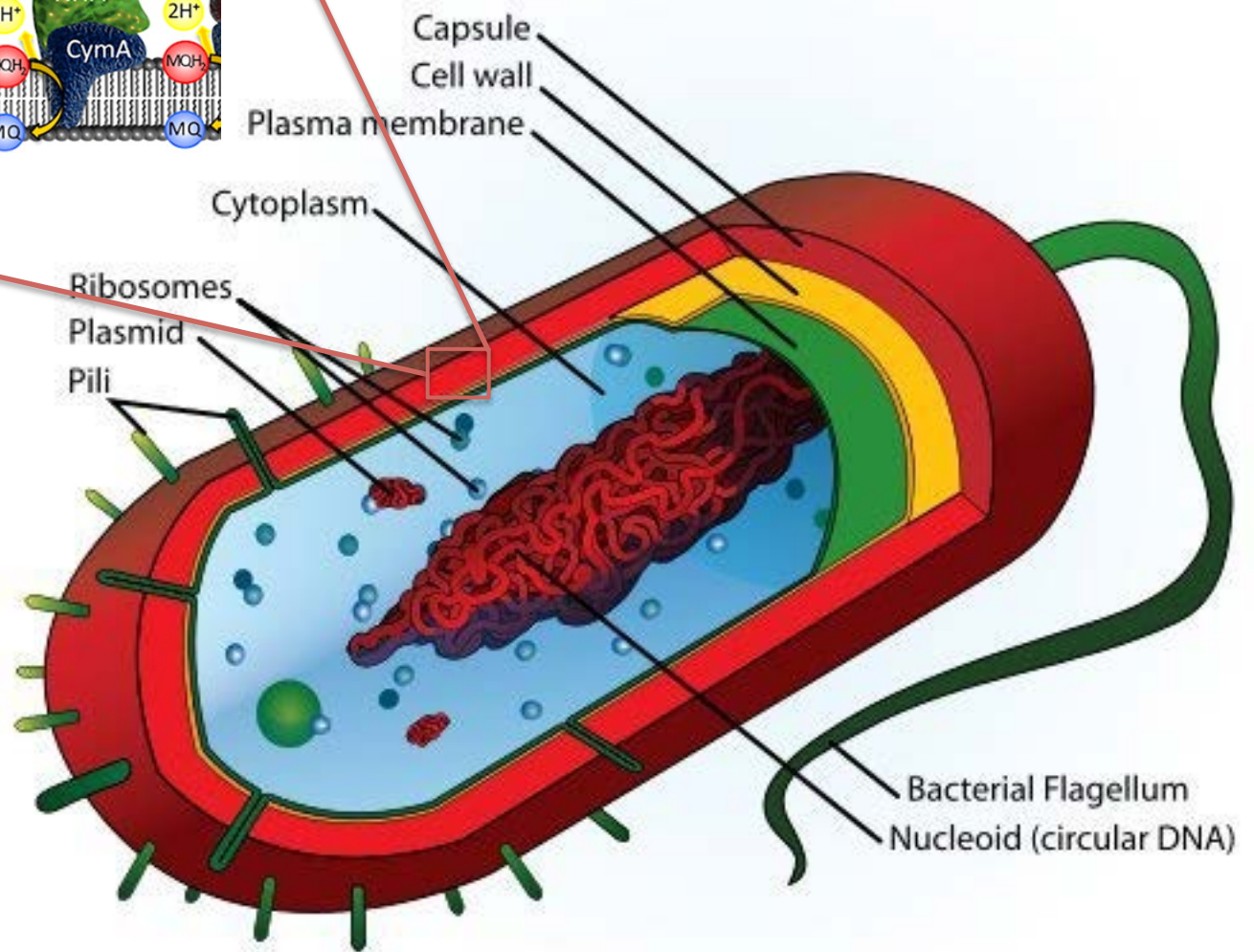
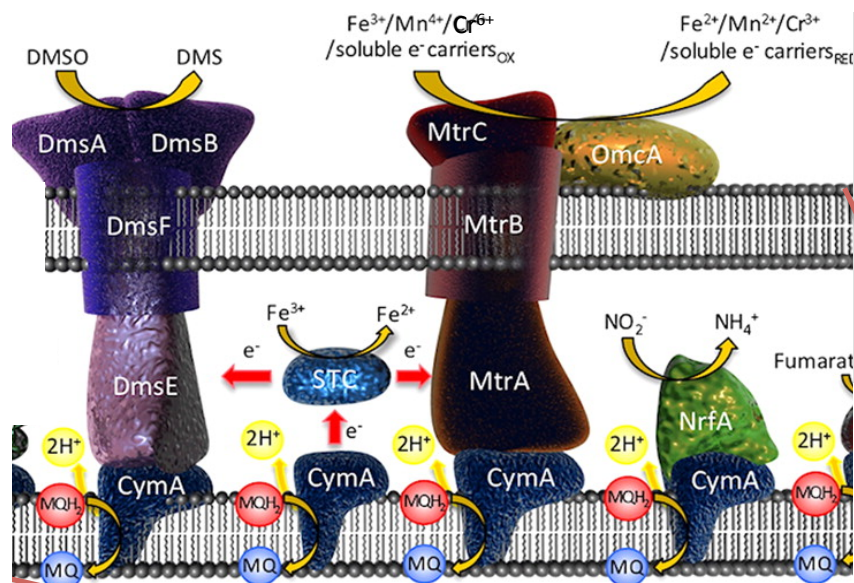


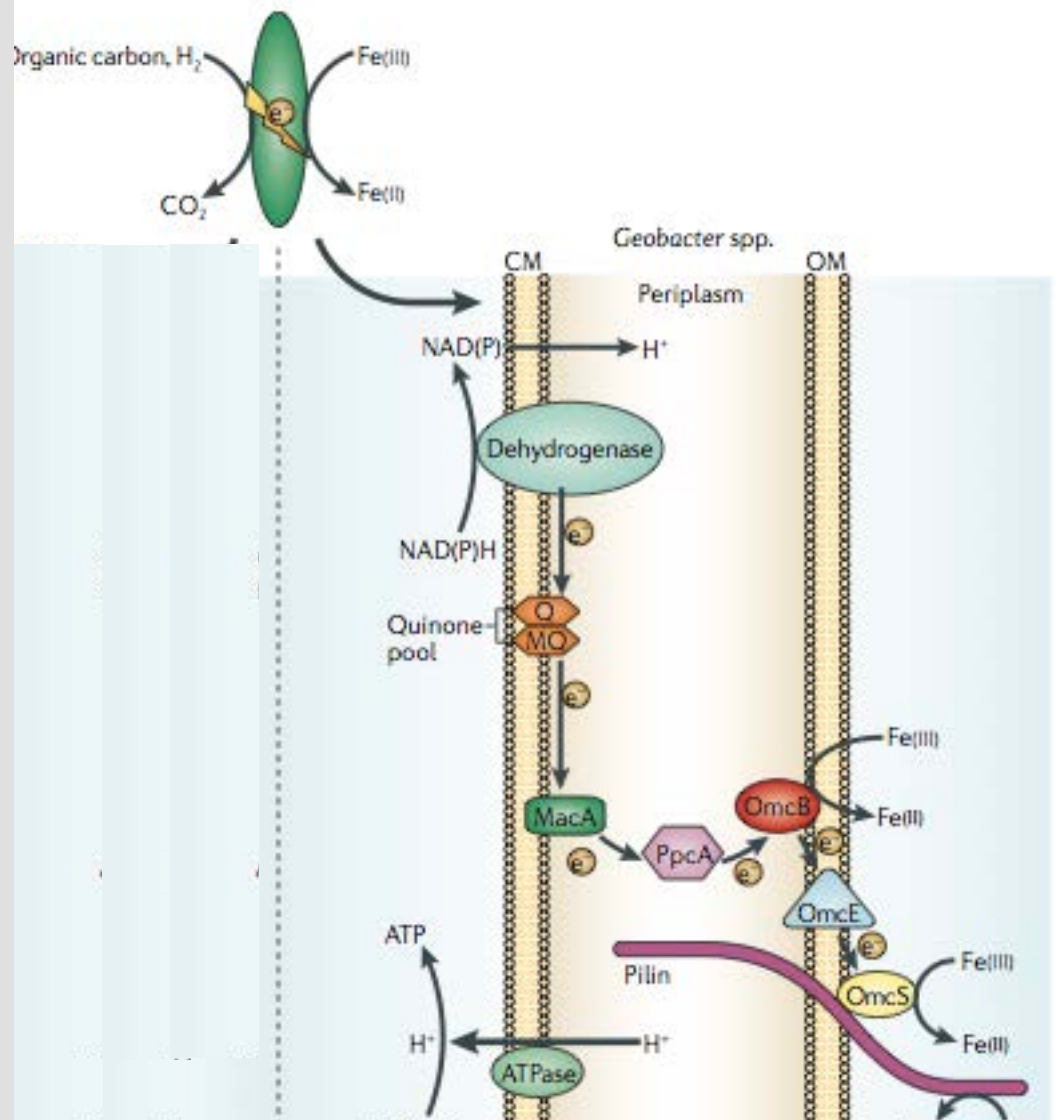


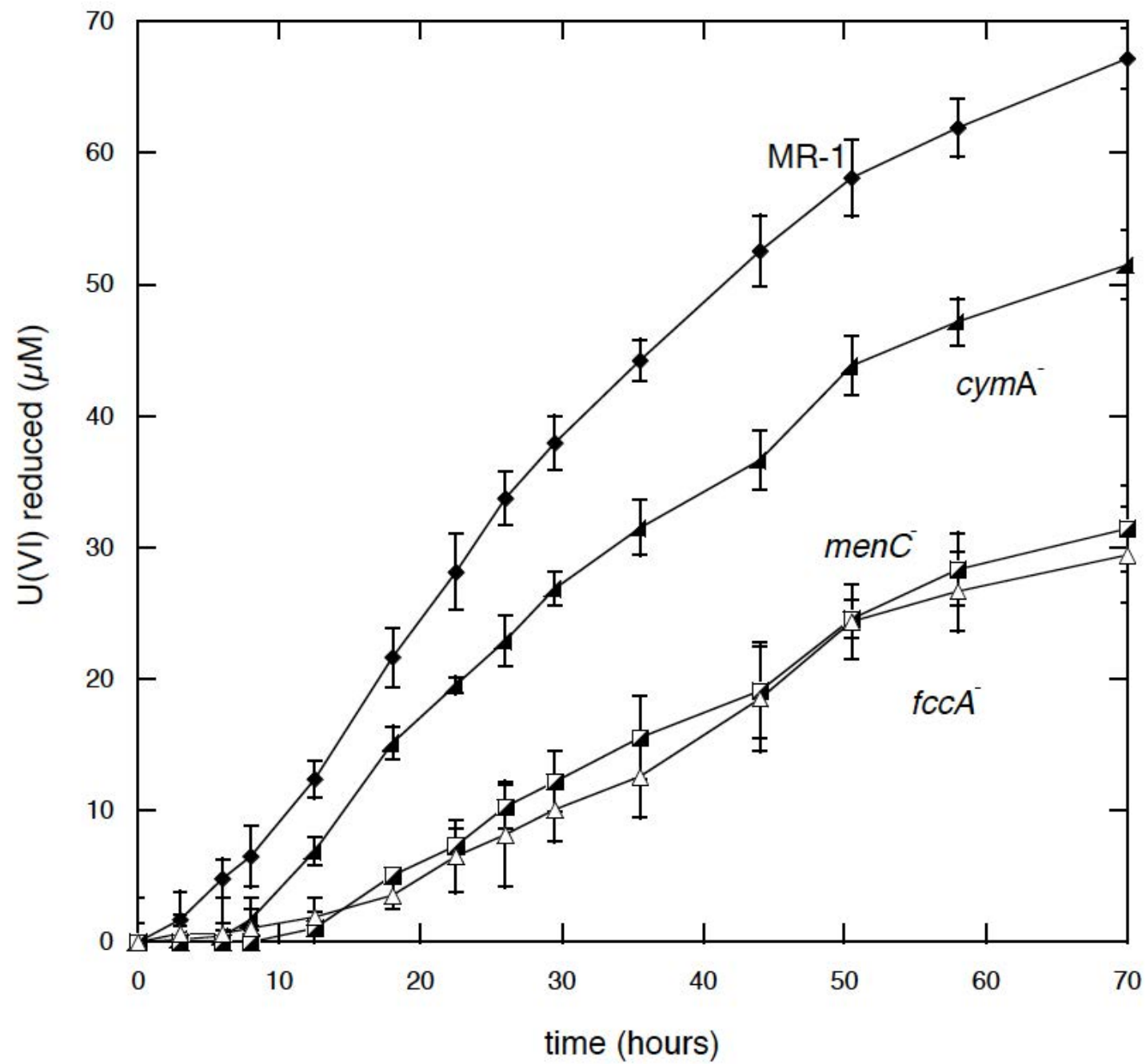


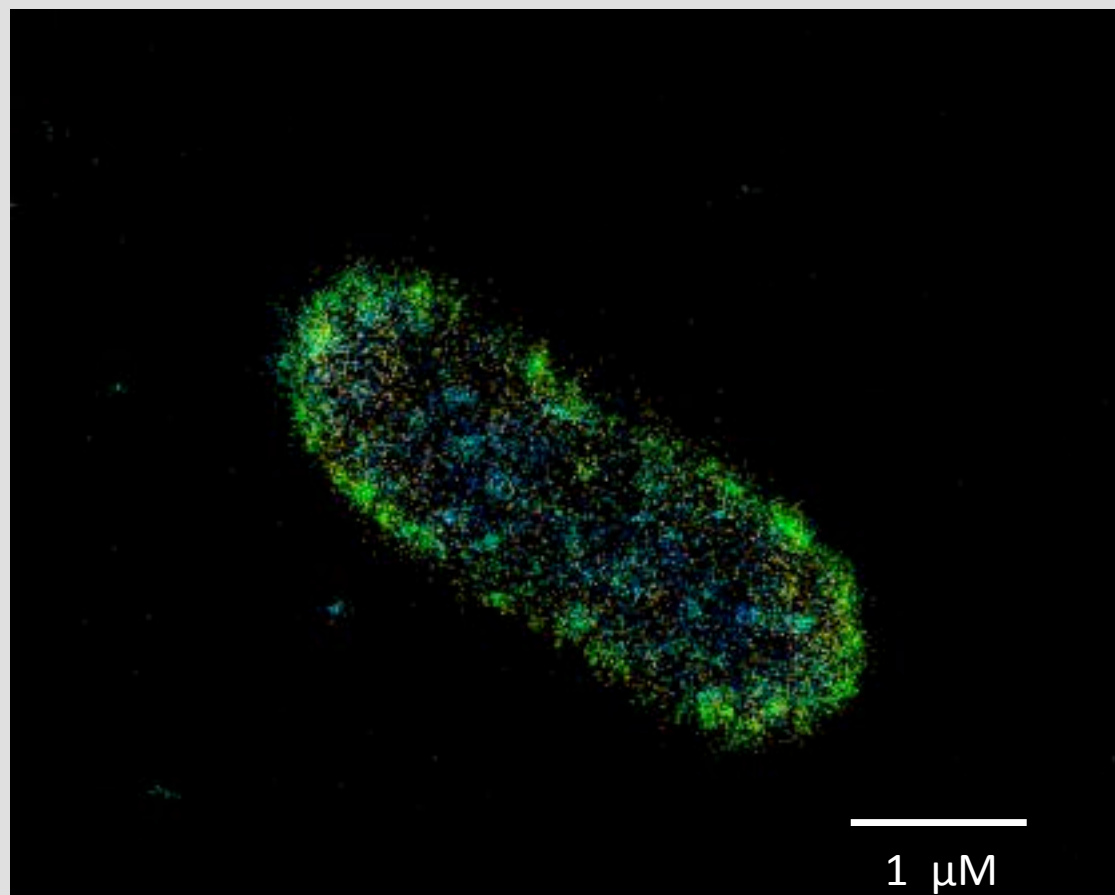
RESEARCH QUESTIONS

- How do microbes transform hexavalent chromium to trivalent chromium or hexavalent uranium to tetravalent uranium?
- What form of trivalent chromium or tetravalent uranium is produced?
- How stable is it in the subsurface?



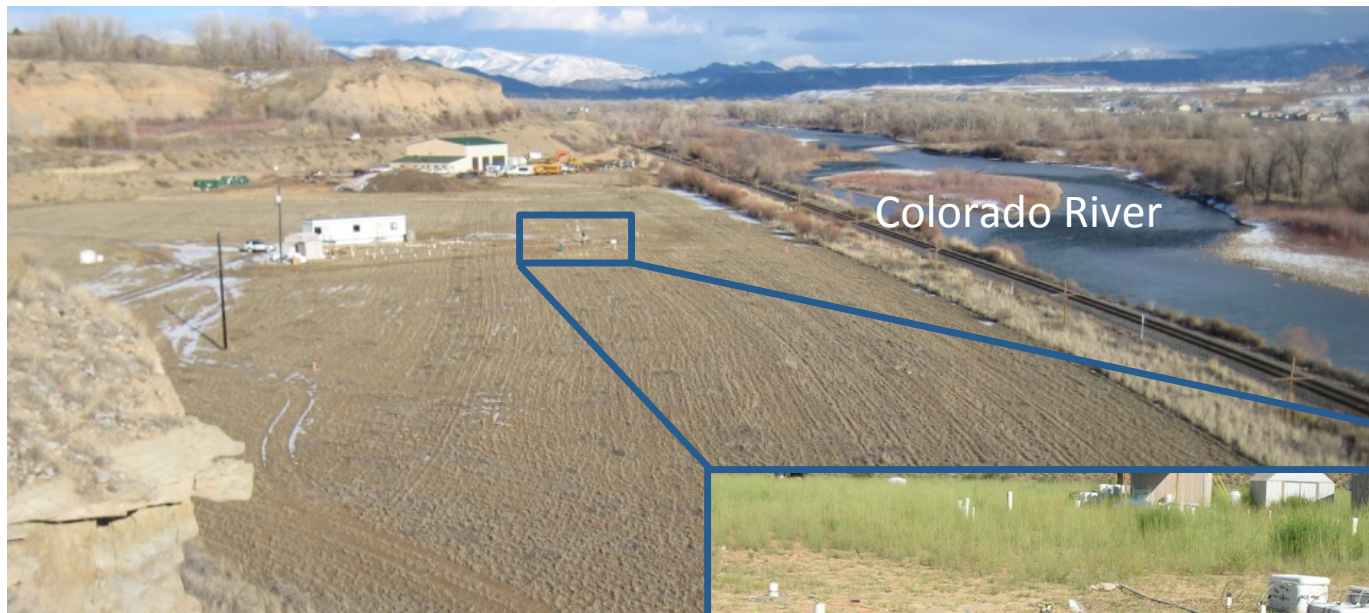


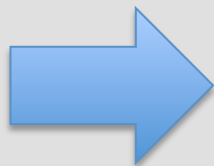




Old Rifle, CO site

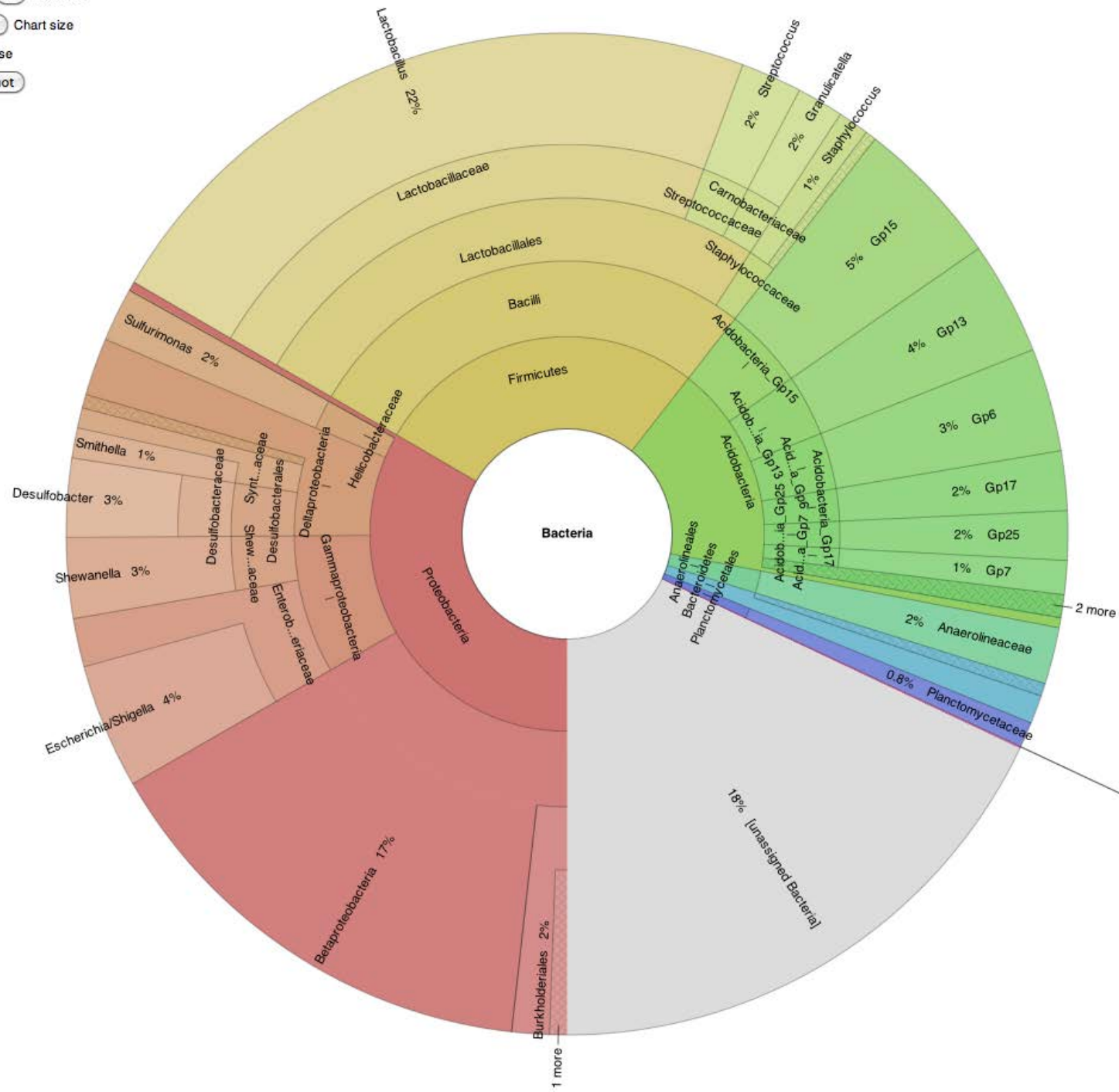
- Former U, V mill (shut down 1957)
- Large persistent U(VI) plume (up to $1.5 \mu\text{mol/L}$)
- DOE's Integrated Field-Scale Research Challenge Site
- Several years of bioremediation experiments

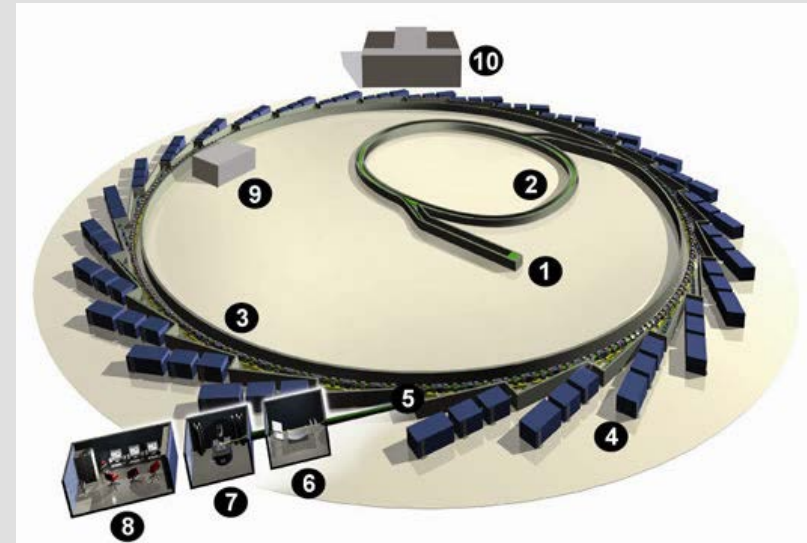


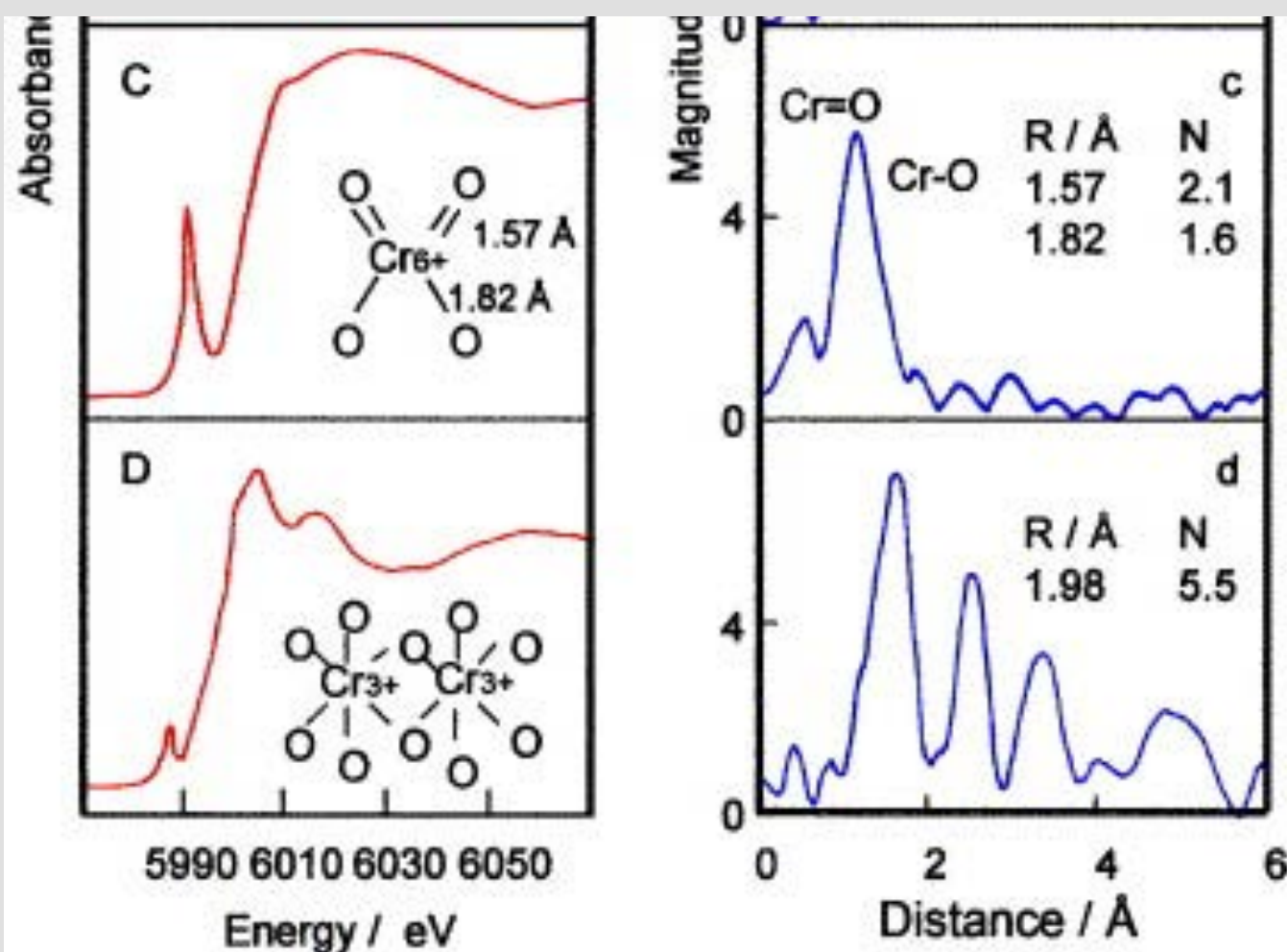




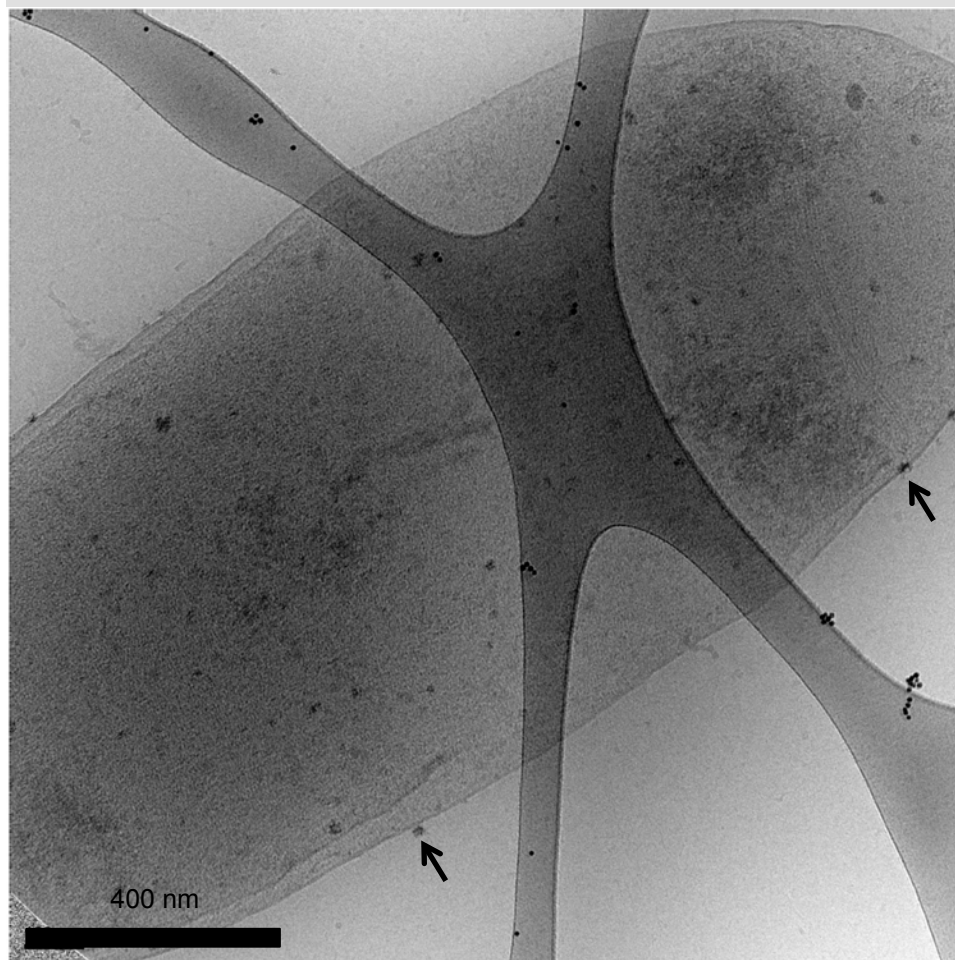
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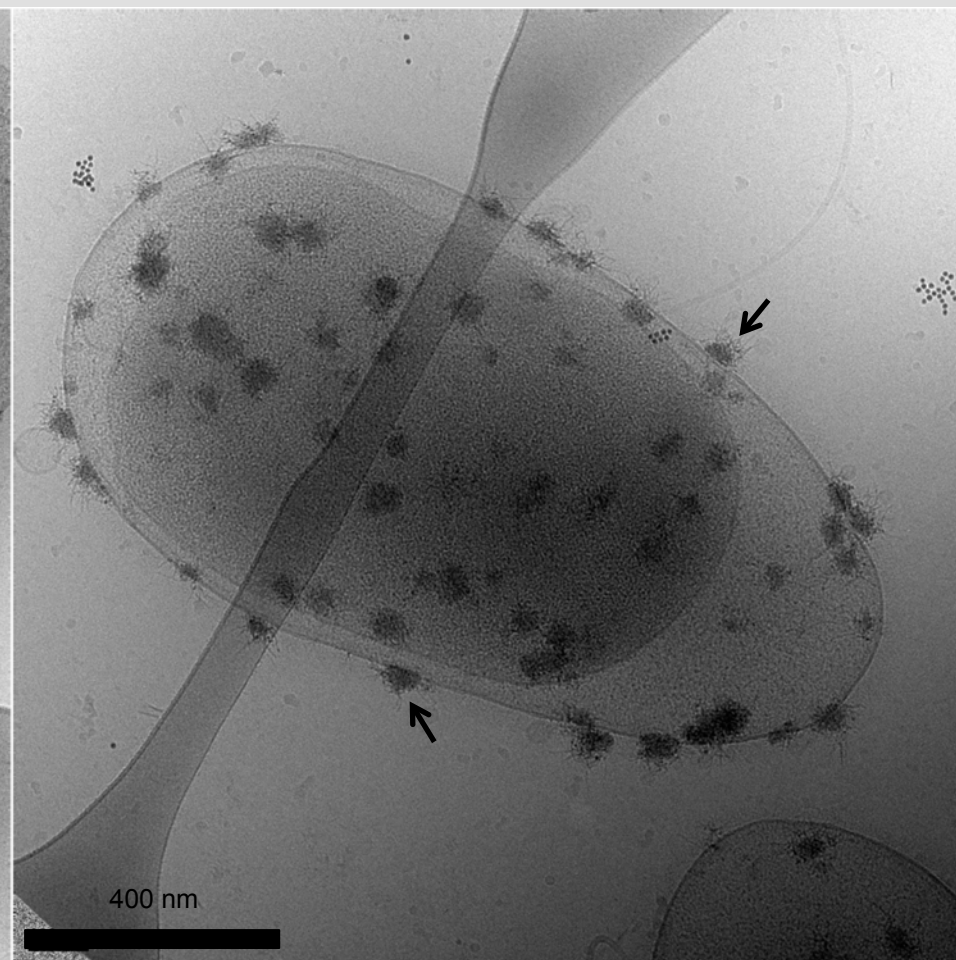


PRODUCTS OF URANIUM REDUCTION



Uraninite

- A stable mineral
- Nanoparticles
- Desirable product



Monomeric U(IV)

- Unstable
- Hair-like structure
- Undesirable product