SCK•CEN
STUDIECENTRUM VOOR KERNENERGIE
CENTRE D'ETUDE DE L'ENERGIE NUCLEAIRE

Microbiology

Context

Bacteria are single-cell organisms and play a key role in our daily live and the environment. Bacteria are amazingly abundant (ca. 10^{29} cells on Earth) and are extraordinarily diverse. They are key actors in diverse processes, including the good digestion of food in our body, the biogeochemical cycle in soils and the oxygen production in the oceans. They also play a role in food production as fermenters, industrial applications as catalysts, or can be a hazard in conservation protocols as spoilage or deteriorating agents, and in health care as cause of infectious diseases.

Objectives

The research unit Microbiology studies the behaviour of bacteria in 'extreme' environments, i.e. environments where they are exposed to toxic (radioactive) metals or ionising radiation, such as heavily polluted soils, nuclear installations and waste disposal sites or outer space. With the acquired knowledge, we want to better prevent bacterial activity when harmful, or use bacteria for our benefit via biotechnology, on Earth and in space. We study the bacterial behaviour at the multi-cellular, cellular and molecular level, using a diversity of modern high quality cellular and molecular analysis tools and data analysis through bioinformatics.

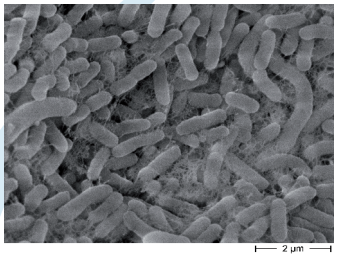
Main activities

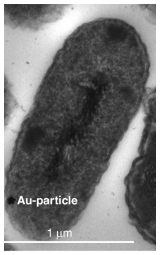
We provide research, services and training on:

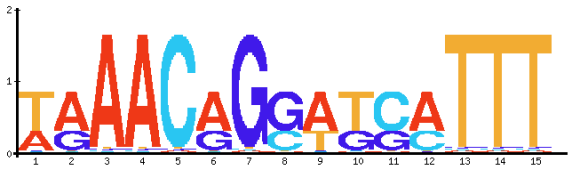
Bacterial interaction with (radioactive) metals and bacterial radiation resistance

Molecular analysis of microbes for a better understanding of:

- Bacterial detoxification systems for (radioactive) metals:
  - To determine the fate of metals in the environment.
    e.g. detection of toxic metals via biosensors/ biomarkers.
    e.g. biodetoxification and/or -extraction of toxic pollutants.
    e.g. gold bioprecipitation from mine tailings.
  - To enable better or novel (re)use of metals.
    e.g. use of silver as biocide in drinking water.
    e.g. production of biogenic metal nanoparticles.
- Molecular mechanisms providing radioresistance in bacteria, to facilitate radioprotection or health beneficial applications.





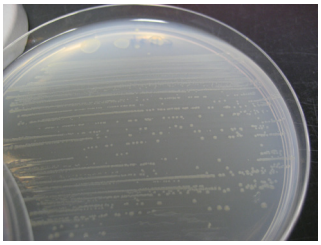


Investigation of metal-resistant bacterium* Cupriavidus metallidurans *CH34.
Left: Microscopy image of bacterial biofilm.
Right: Bacterial cell containing a gold particle in cell envelope.
Below: Motif in DNA sequence regulating gene expression upon exposure to metals, detected with bioinformatics.

Microbial activity in nuclear installations and nuclear waste disposal facilities

Determination of microbial presence and activity in deep geological nuclear waste repositories (e.g in clay):

- To reveal the unique microbial diversity hidden deep underground in ancient rocks and clay.
- To prevent disturbance or damage of instrumentation by microbes.
  e.g. inhibition of methane bioproduction or biofouling.
- To assess the impact of microbes on waste storage safety.
  e.g. biocorrosion by sulphate reducing microbes.
  e.g. gas production by nitrate reducing and methane producing microbes.



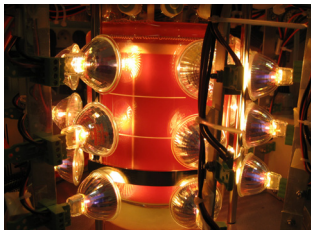
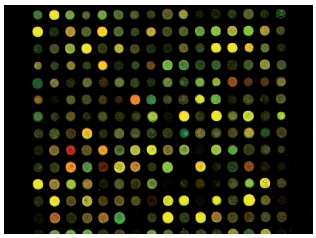
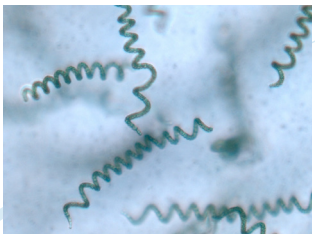
Investigating microbial activity in the HADES underground research laboratory at -225 m below the SCK•CEN site.
Left: Drilling for clay samples.
Above right: Cultivation of boom clay bacteria.
Below right: Characterization and identification of bacteria.

Oxygen, water and food production by bacteria in space for human space exploration

Microbial analysis for the development of a miniaturized and fully controllable artificial ecosystem called 'MELiSSA' enabling water and waste recycling and oxygen and food production with bacteria in space.

- Investigating the effects of space conditions on bacteria, including cosmic radiation and gravity.
- Selection, cultivation and characterization of photosynthetic bacteria.
- Deciphering of the DNA code and properties of edible bacteria for oxygen and food production.
- Assessment of genetic and physiological changes of bacteria over long-term cultivation in bioreactors and in space.

Research performed in collaboration with the European Space Agency ESA and a team of highly qualified European scientists.

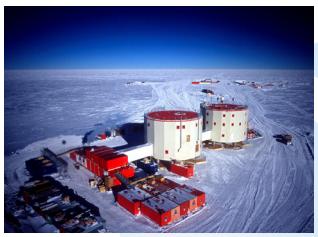
Investigating the effects of space flight related environmental conditions on photosynthetic bacteria evolution.
Above left: Cultivation of bacteria in the International Space Station.
Above right: Cultivation of bacteria in photobioreactors.
Below left: Analysis of gene expression and regulation of bacteria grown in space.
Below right: Characterization of edible microalgea (cyanobacterium Arthrospira*) on the cellular and molecular level.*

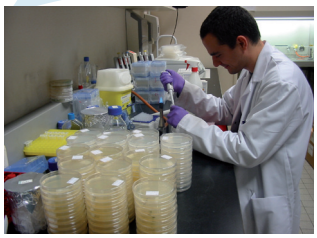
Microbial contamination in confined space capsules and possible impact on astronaut health and spacecraft integrity

Microbial analysis for the development of biocontamination prevention, detection and mitigation protocols, to guarantee the crew biosafety during long-duration space missions in confined spacecraft.

- Characterization of bacterial contaminants found in air, water and on surfaces from spacecraft (e.g. the International Space Station) and analogues on Earth (e.g. Concordia station on Antarctica).
- Characterization of microbial dispersion and survival in ultraclean man-made (space)habitats.
- Characterization of microbial genetic rearrangements and gene transfer, on Earth and in space (e.g. with cosmic radiation).

Research performed in collaboration with the European Space Agency ESA and international space agencies.



Investigating the microbial community during the closed period.
Above left: Hibernation and isolation in the Concordia station.
Above right: Sampling the air inside the Concordia station.
Below left: Storage of samples on Antarctica in an ice cave at -50 °C.
Below right: Analysis of the samples at SCK•CEN in Belgium.

Contact
Natalie Leys
natalie.leys@sckcen.be
Tel. + 32 14 33 27 26

© 2010 - SCK•CEN