Microbial Ecology & Environmental Microbiology

ENV-412

Microbial Ecology?

Environmental Microbiology?

Environmental Microbiology:

The study of the microbial composition, physiology, and processes that are mediated by microorganisms in the environment (natural and engineered).

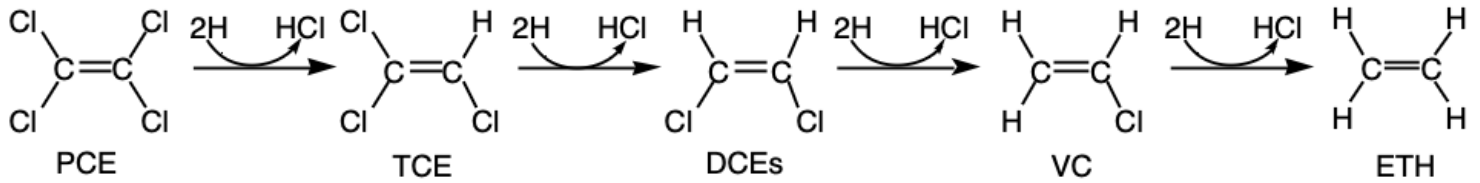
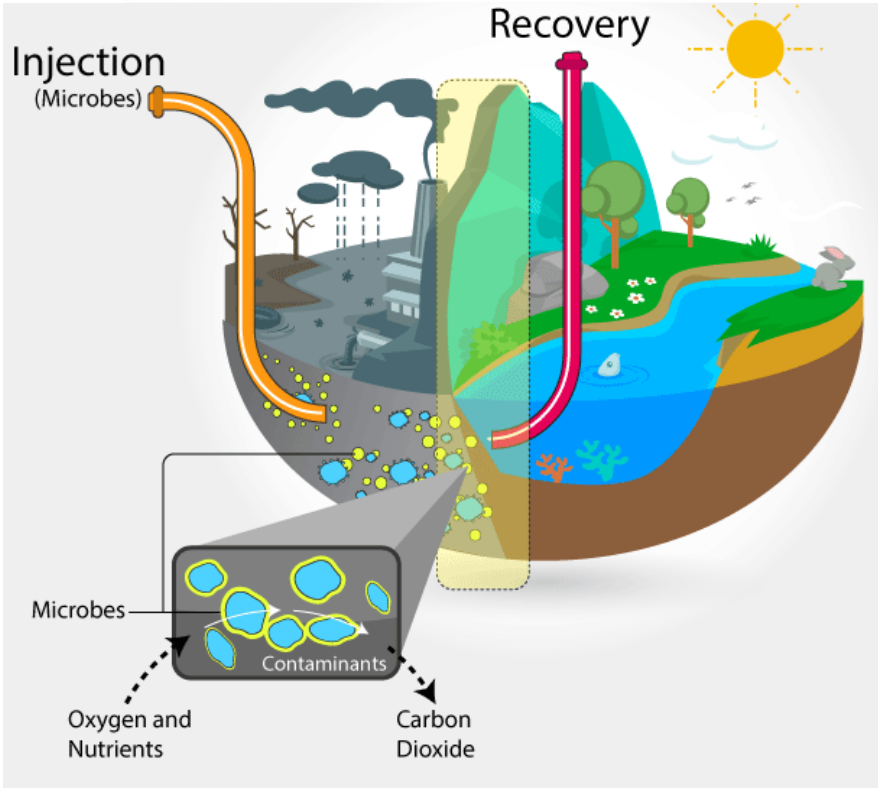
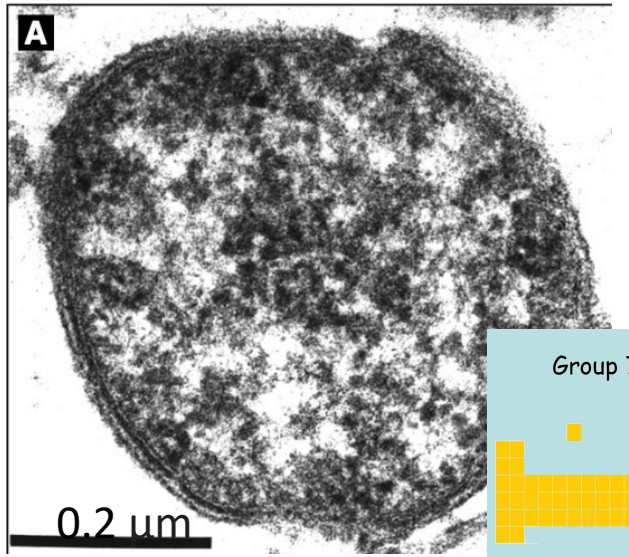
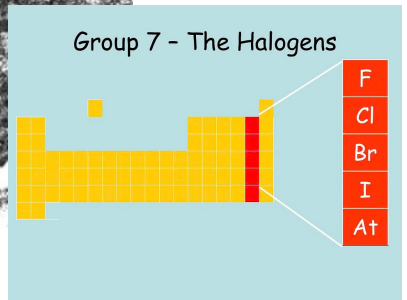


Fig. 1. Reductive dechlorination of chloroethenes. TCE, trichloroethene; DCEs, dichloroethene isomers (represented by *cis*-DCE); 2H, electron pair derived from the electron donor.

Dehalococcoides ethenogenes







Microbial Ecology?

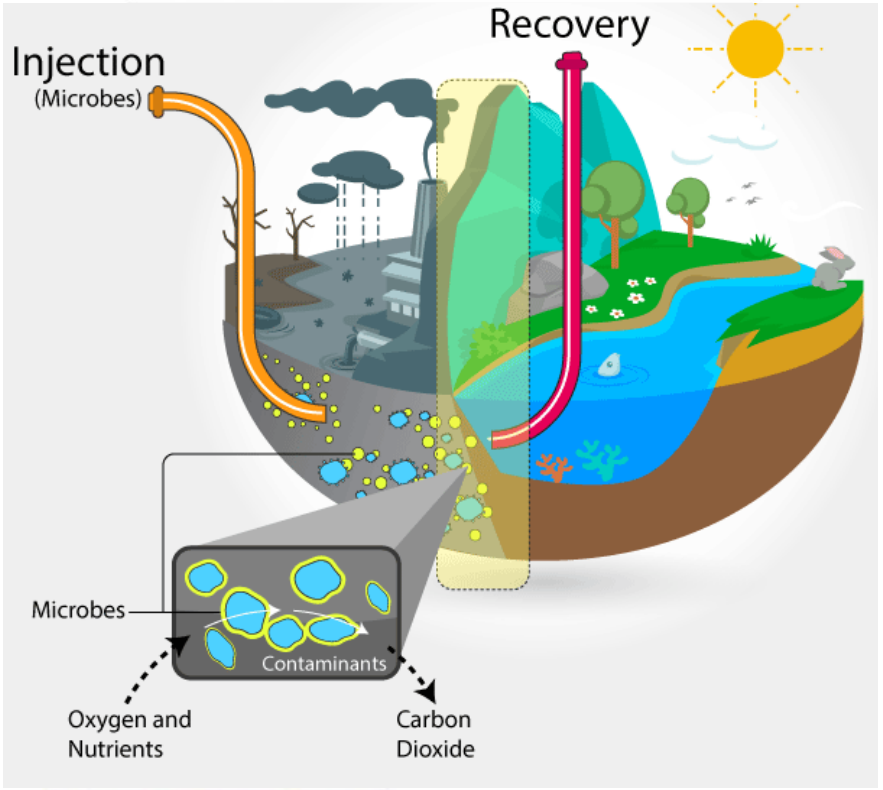
Environmental Microbiology?

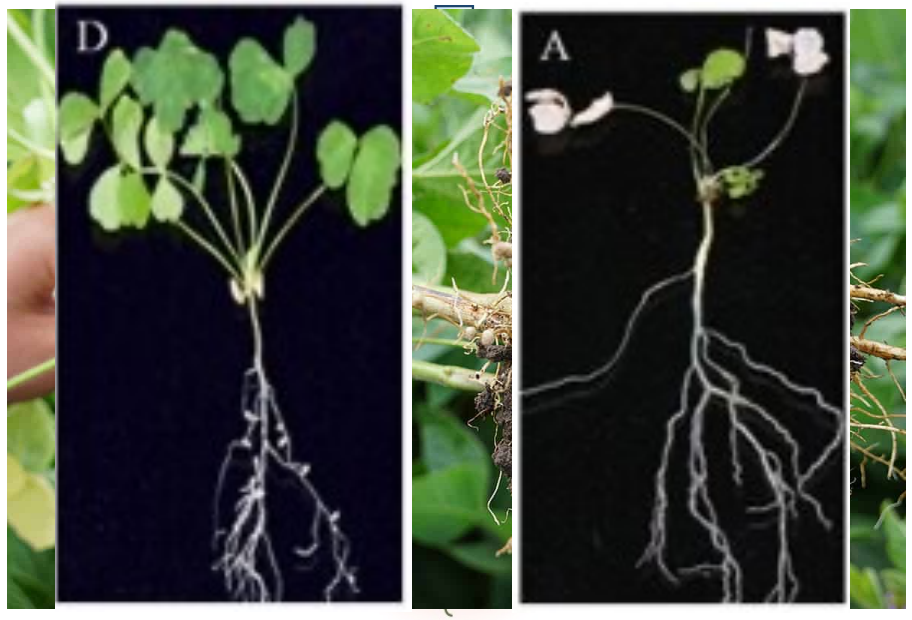
Environmental Microbiology:

The study of the microbial composition, physiology, and processes that are mediated by microorganisms in the environment (natural and engineered).

Microbial Ecology:

The study of the interactions between microorganisms, their environment, and higher life forms.



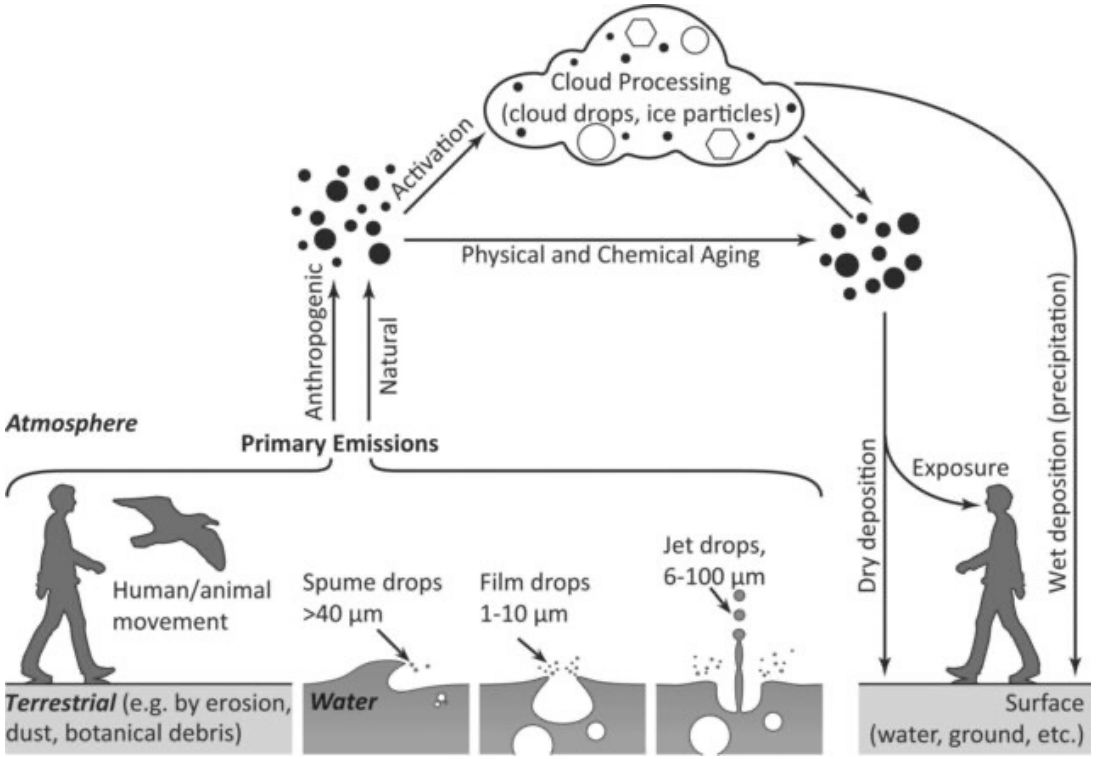


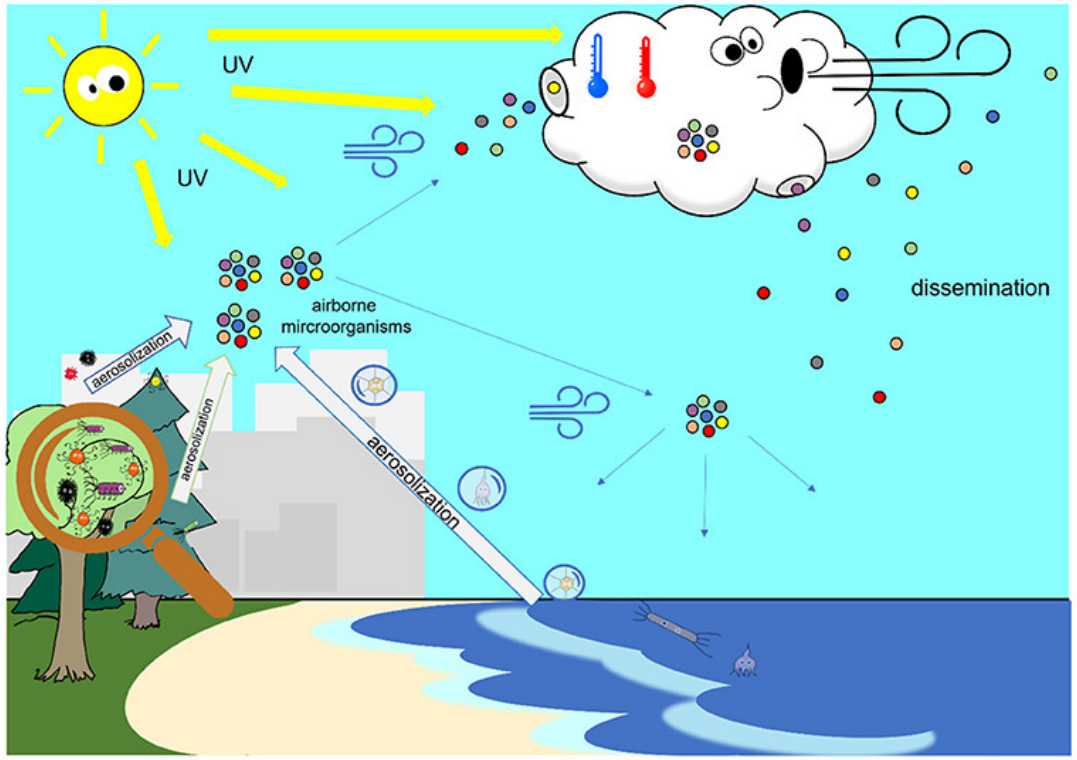
Rhizobia

What determines which microorganism are present in the environment?




"Everything is everywhere but the environment selects" - Lourens G. M. Baas Becking, 1934





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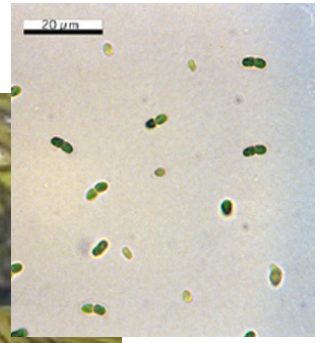
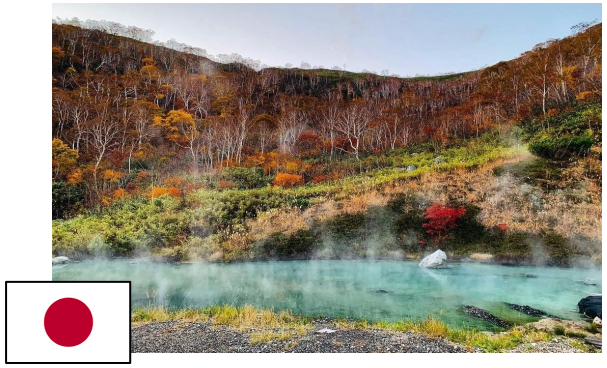
"Everything is everywhere but the environment selects" - Lourens G. M. Baas Becking, 1934

Is it?

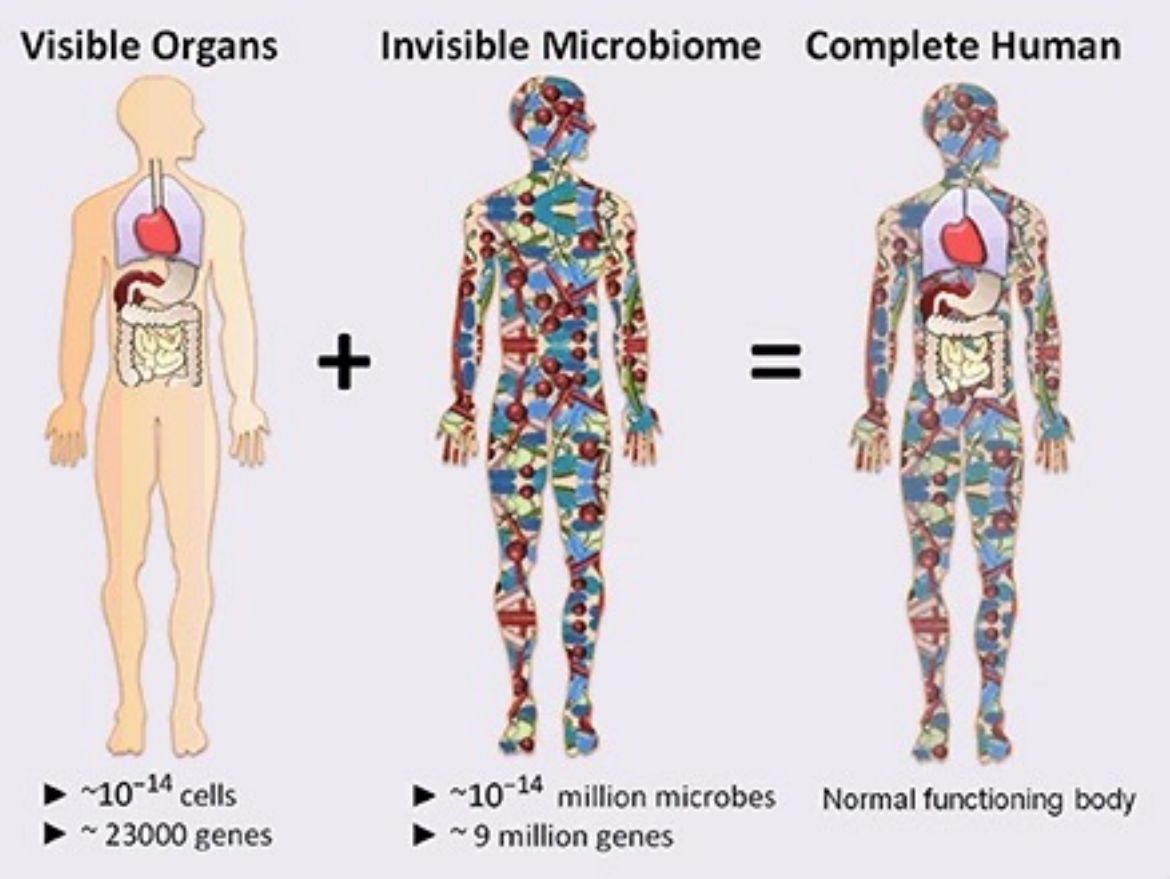


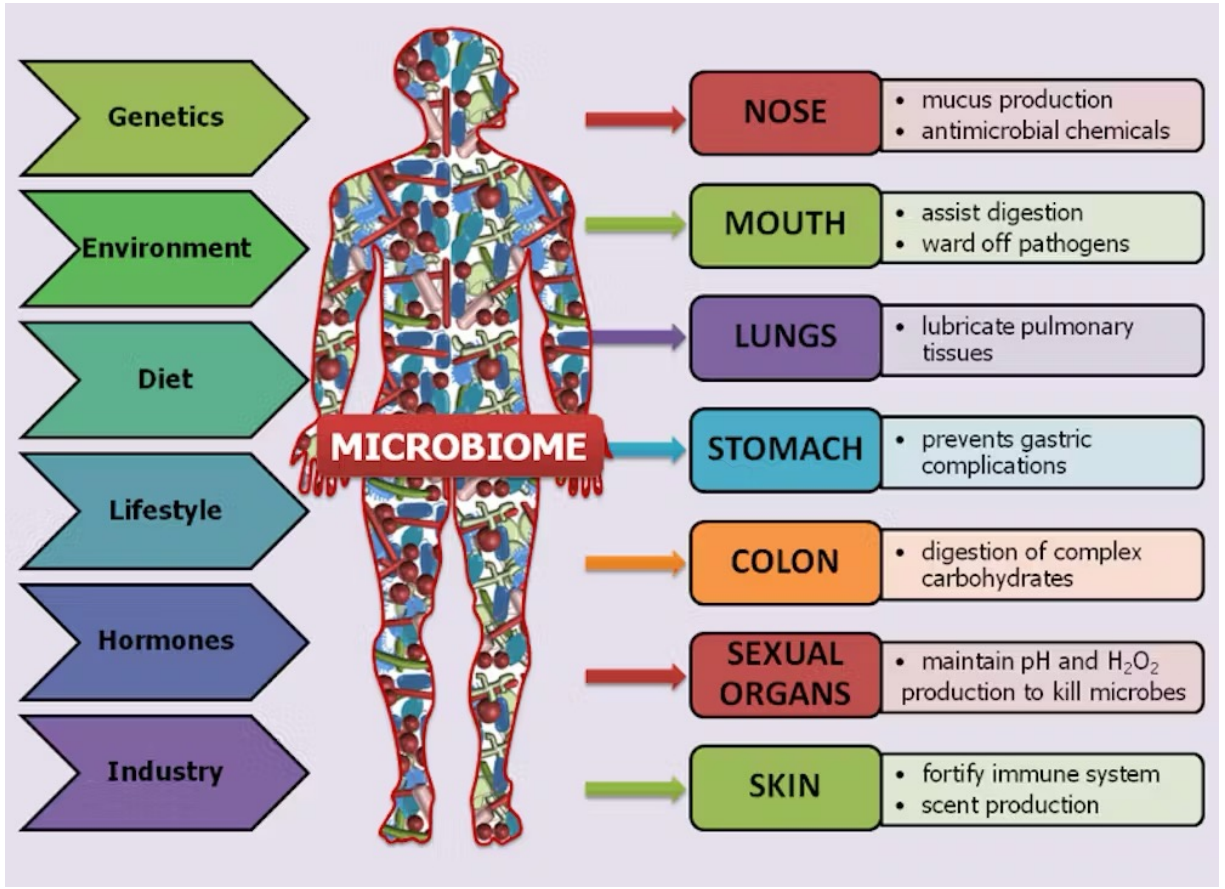
Synechococcus

temperature limit of 72°C

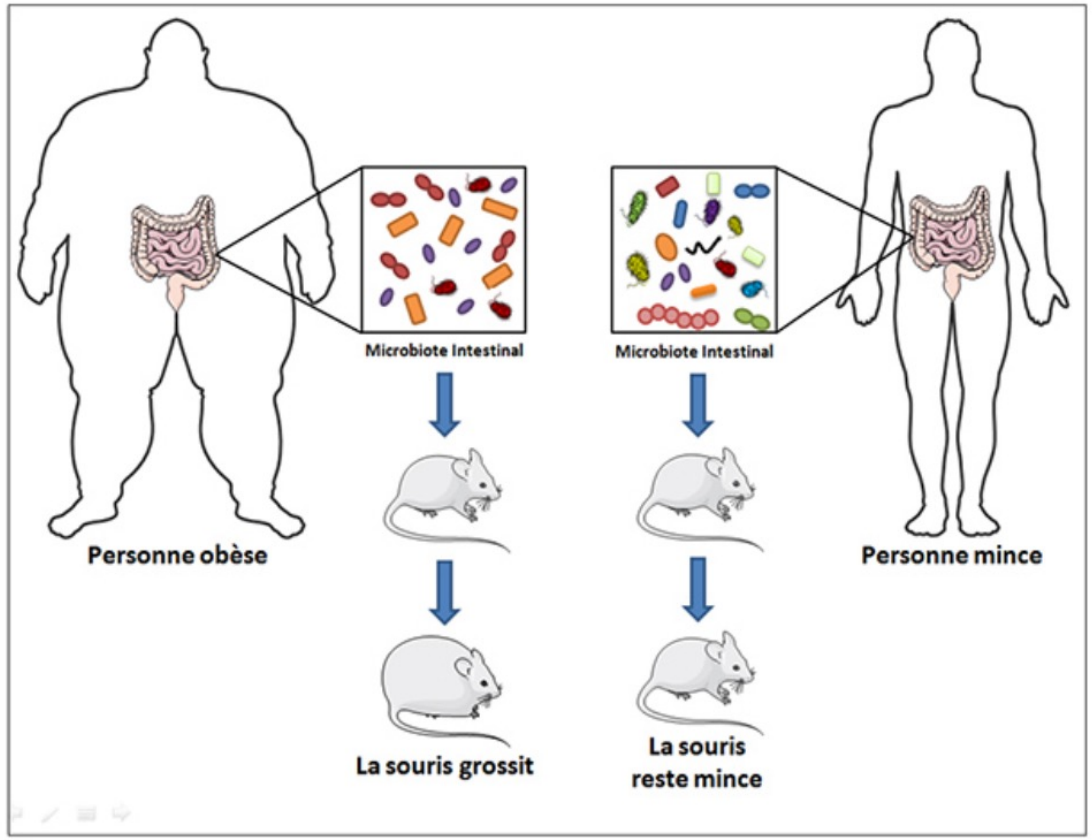


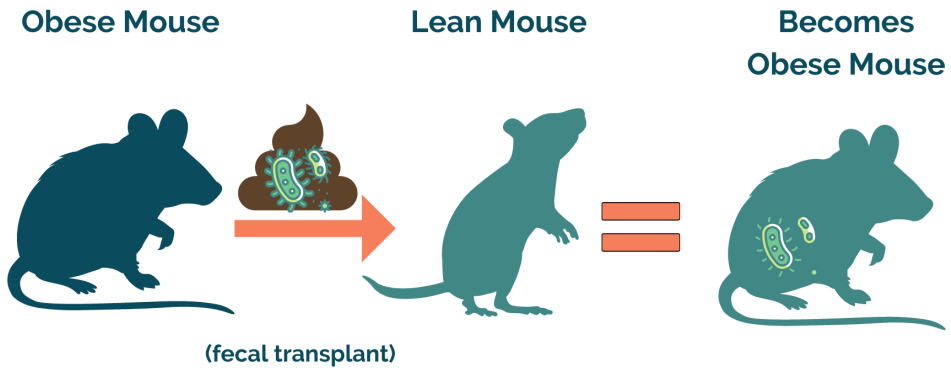
Humans are environments for microbial communities



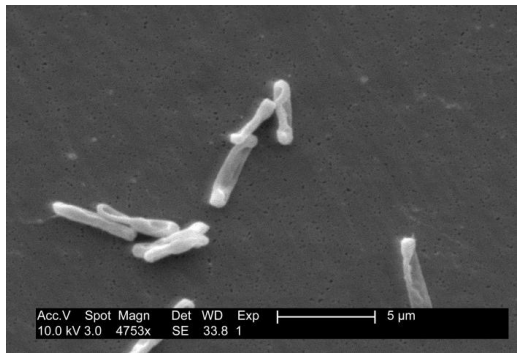


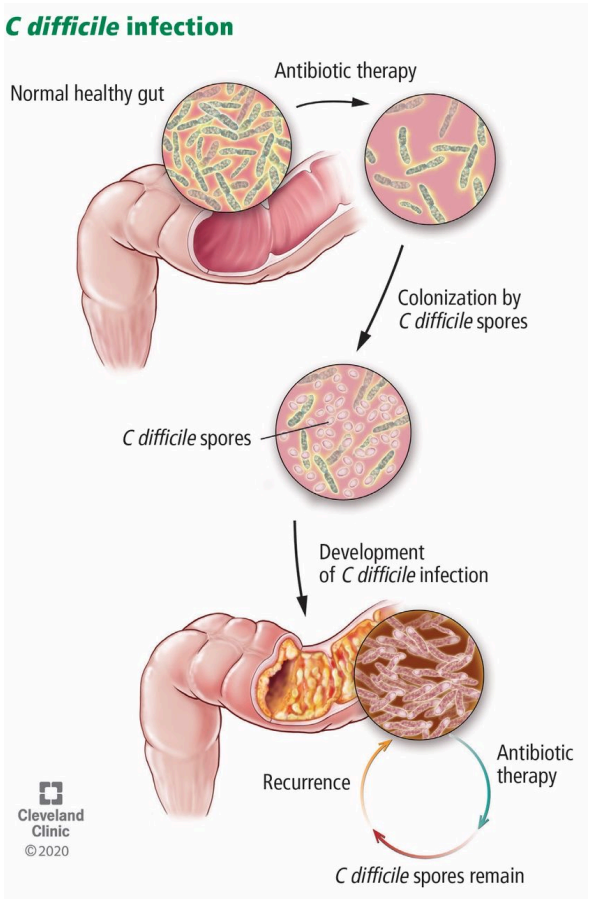
Host-Microbe interactions

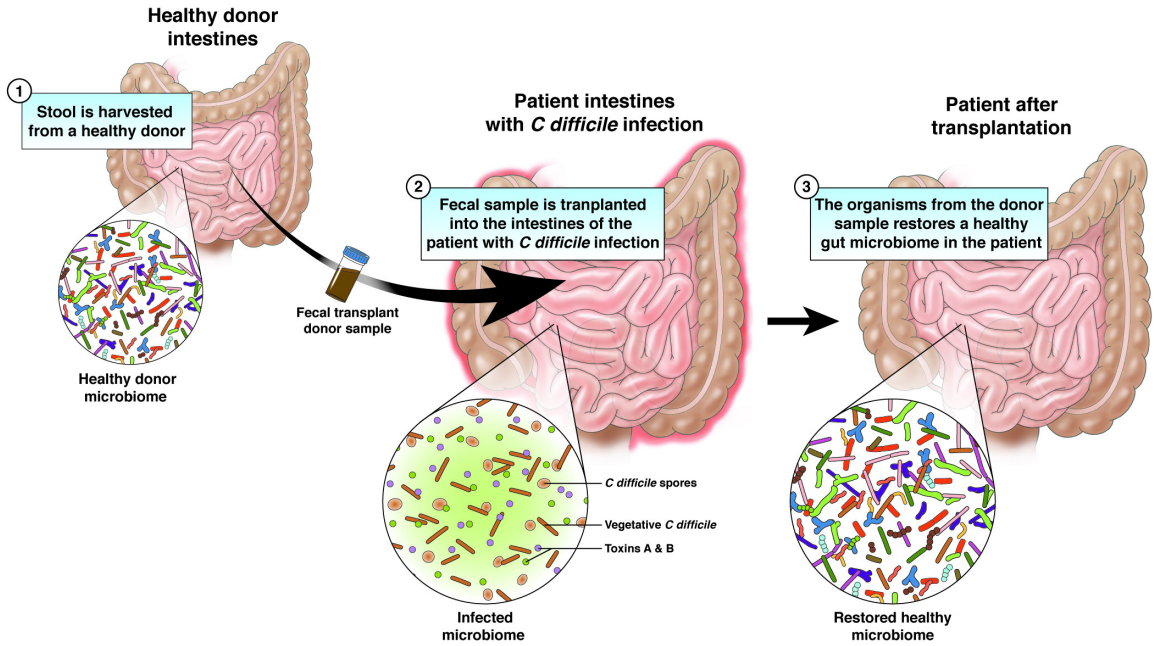




Host-Microbe interactions –Dysbiosis







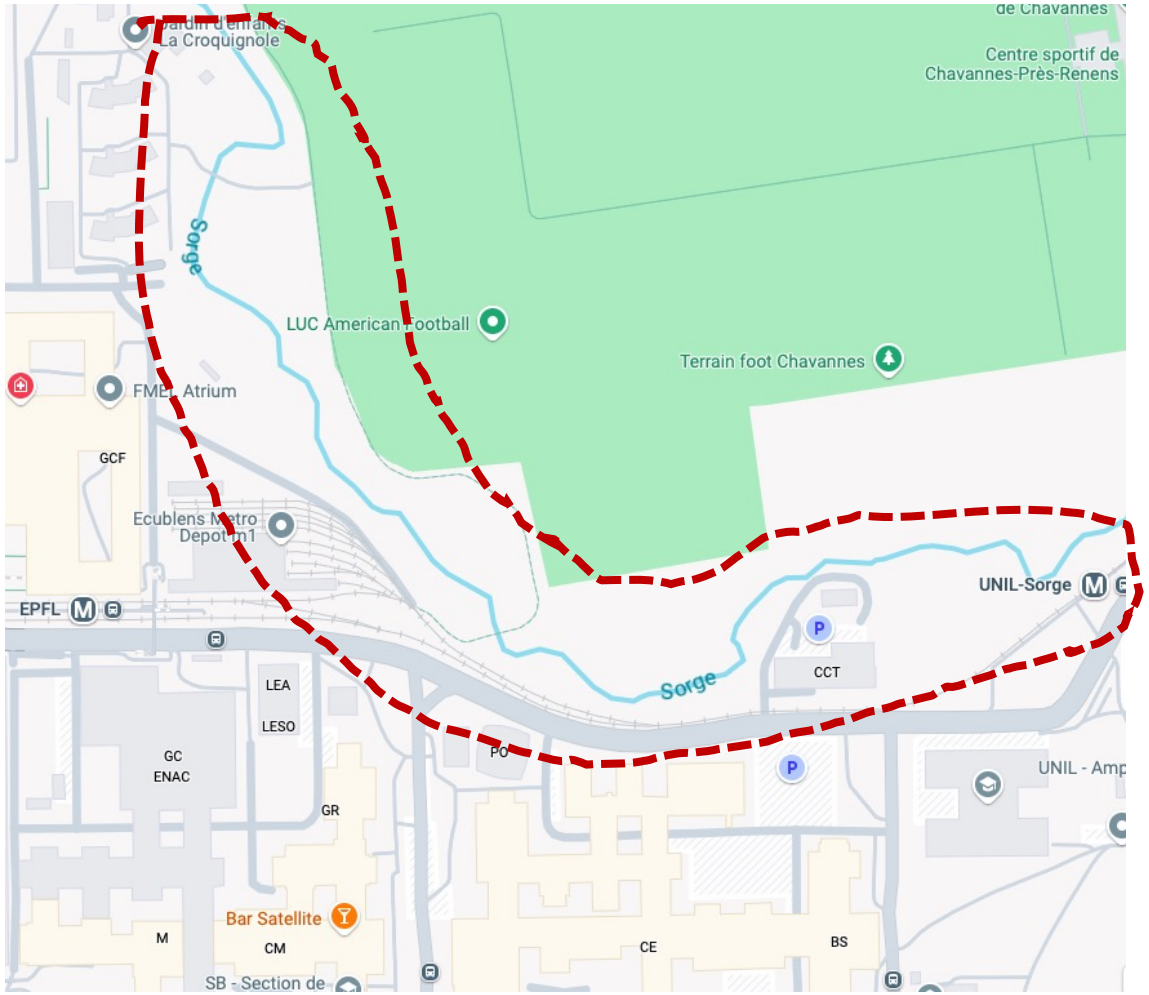
ENV-412: What will we do?

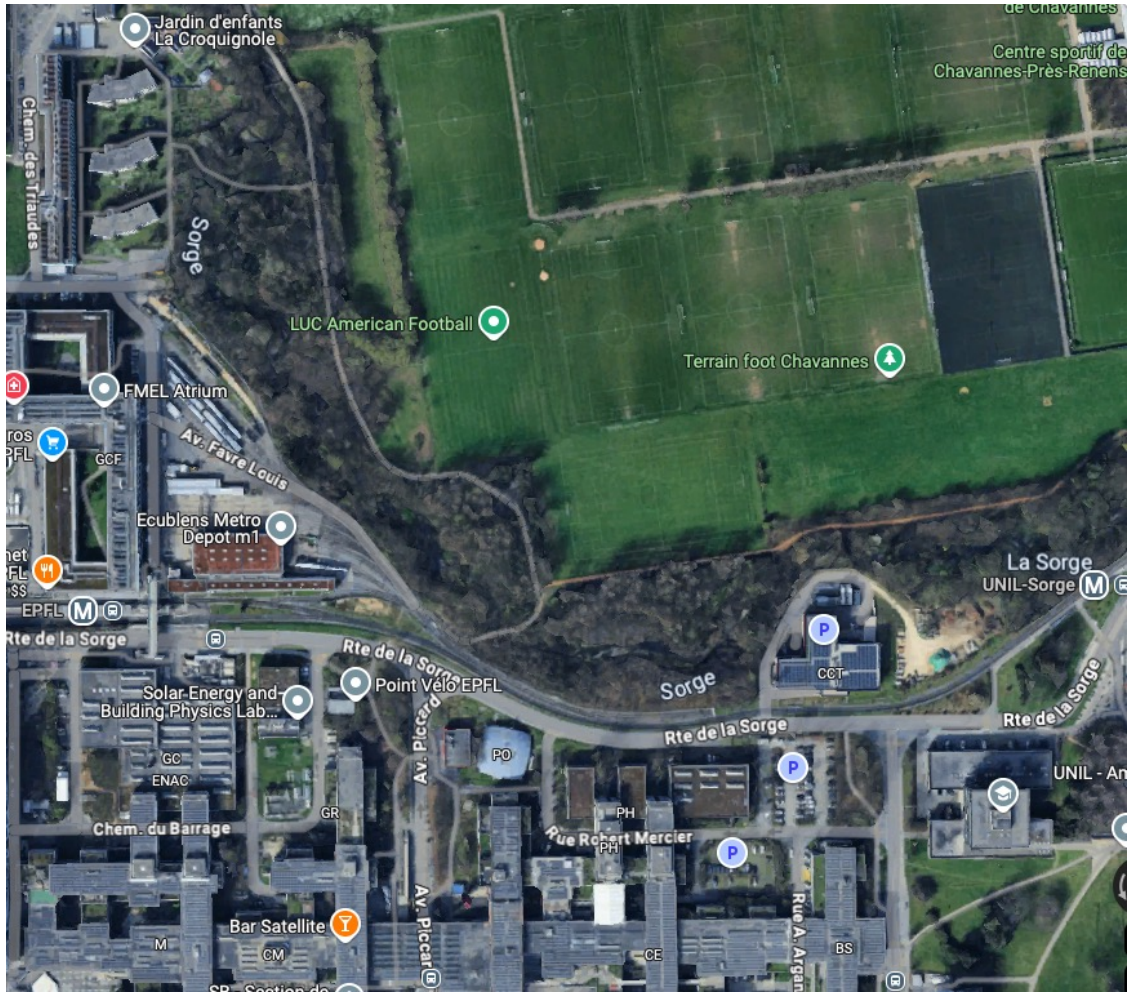
- **Lectures:**
  - Intro to Microbial Ecology & Environmental Microbiology
  - Microbial Ecosystem Functions
  - Microorganisms in Different Environments
  - Microbial Interactions & Communities
  - Applied Microbial Ecology
  - Methods in Microbial Ecology
- **Research Project**
  - Field work
  - Physicochemical analysis of soil and water samples
  - Building a diverse microbial community
  - Microbial cultivation
  - Characterization of microbial isolates and communities
  - Nucleic acid extractions and sequencing
  - Bioinformatics -intro

Project: The Sorge river microbial ecosystem

Aquatic and terrestrial system

Project: The Sorge river microbial ecosystem

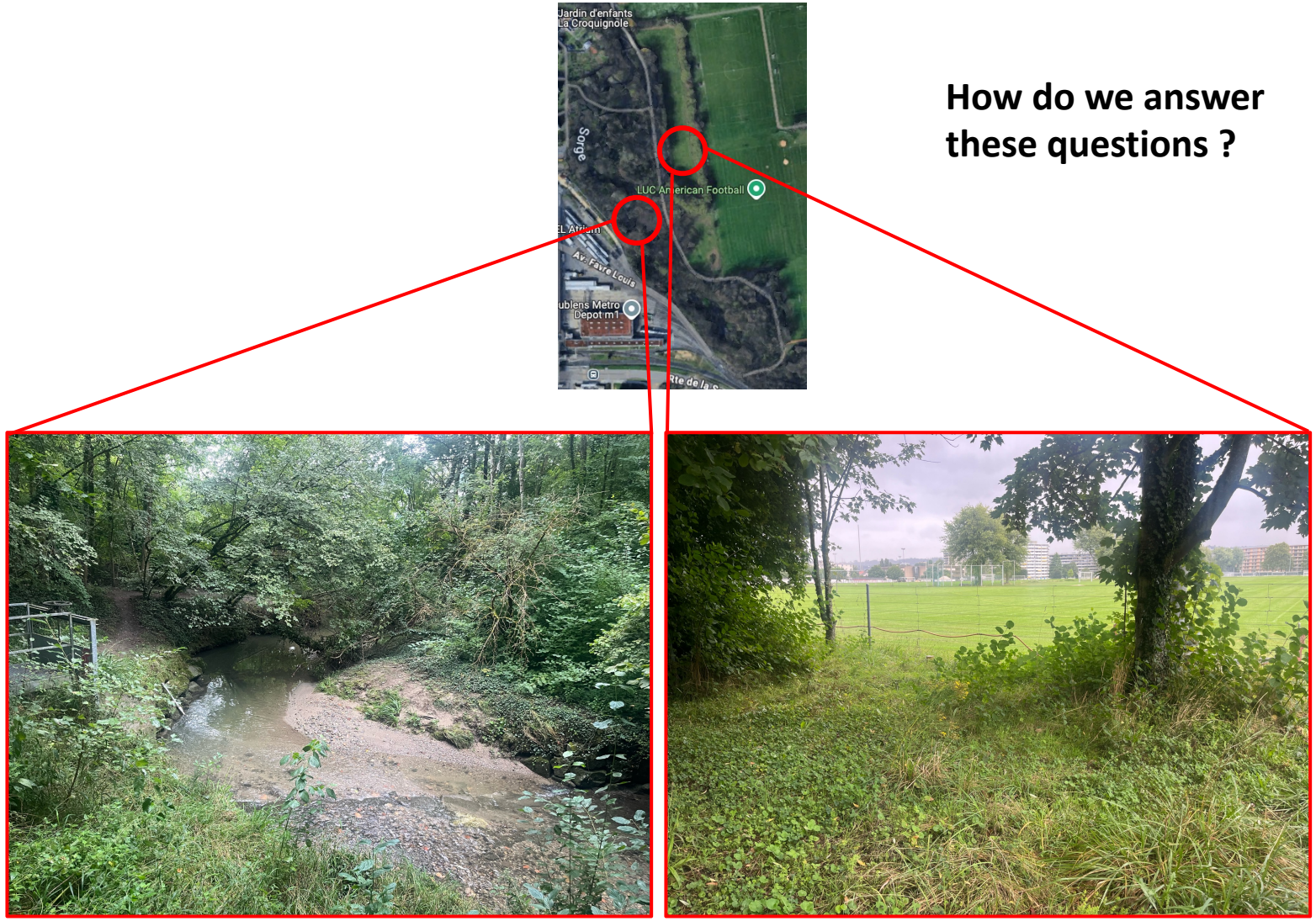




Project: The Sorge river microbial ecosystem

Aquatic and terrestrial system

- What kinds of microorganisms live in the the different niches of the Sorge river ecosystem ?
- How do the different niches contribute to GHG fluxes ?
  - CO_2, CH_4, N_2O
- How do they contribute to biogeochemical cycles ?
- What are the interactions between microorganism and other lifeforms ?



How do we answer these questions ?

Project: The Sorge river microbial ecosystem

Research Project Work:

1) Field work

- Measurements of *in-situ* physicochemical properties
  - pH, temperature, chemical properties

- Sampling of water and soil

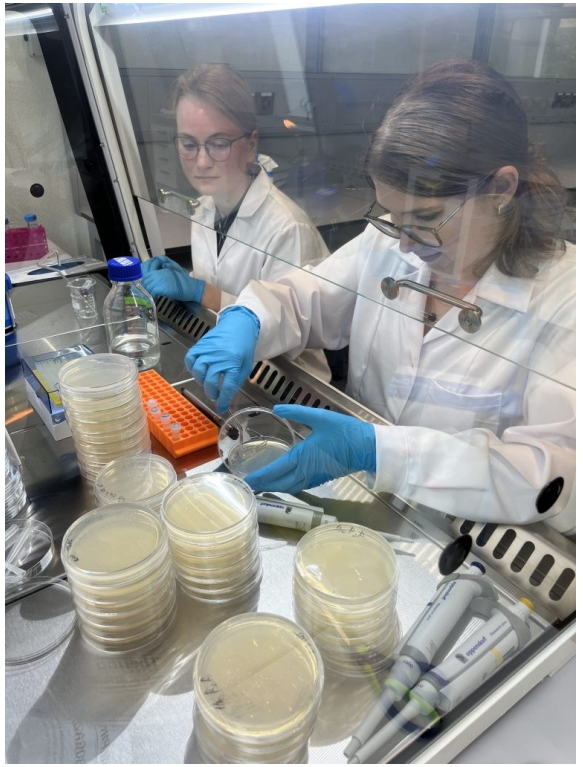
- Greenhouse gas fluxes

Project: The Sorge river microbial ecosystem

Research Project Work:

2) Microbial cultivation

- Soil and water
- Heterotrophic plate counts
  - CFU- colony forming units
- Isolation of individual microorganisms
  - Bacteria and fungi



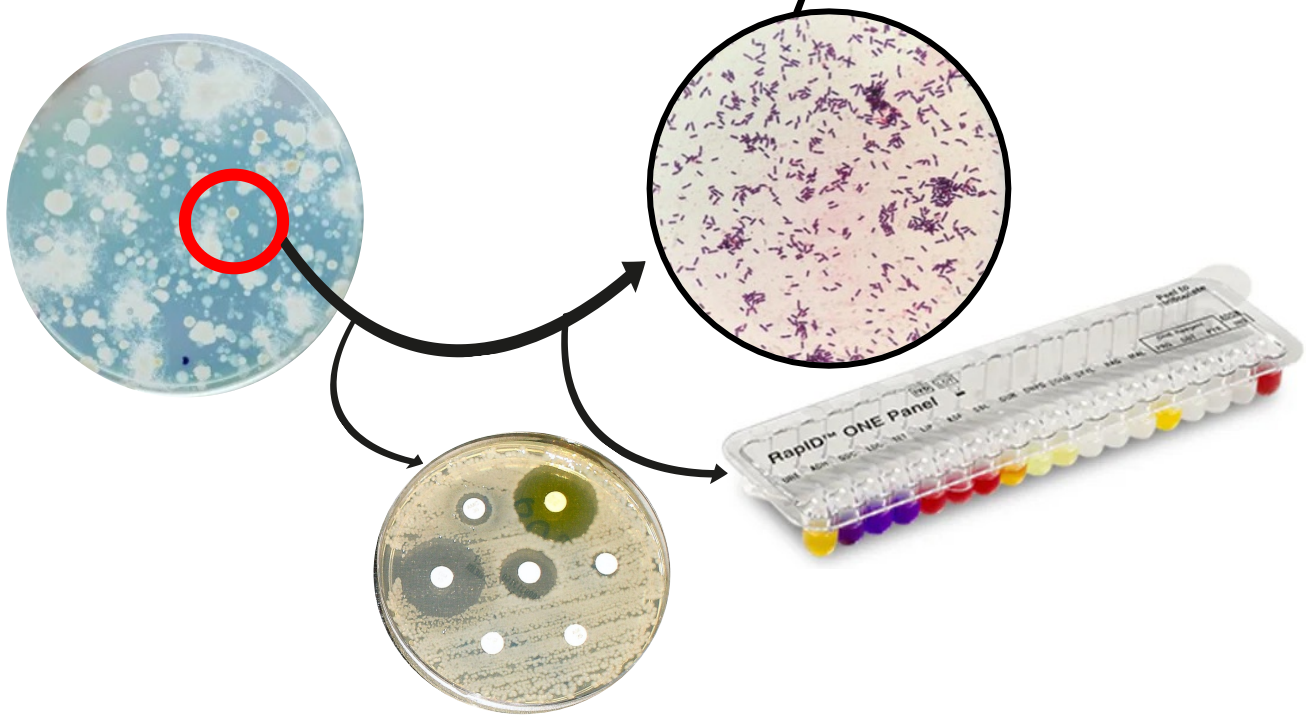
Project: The Sorge river microbial ecosystem

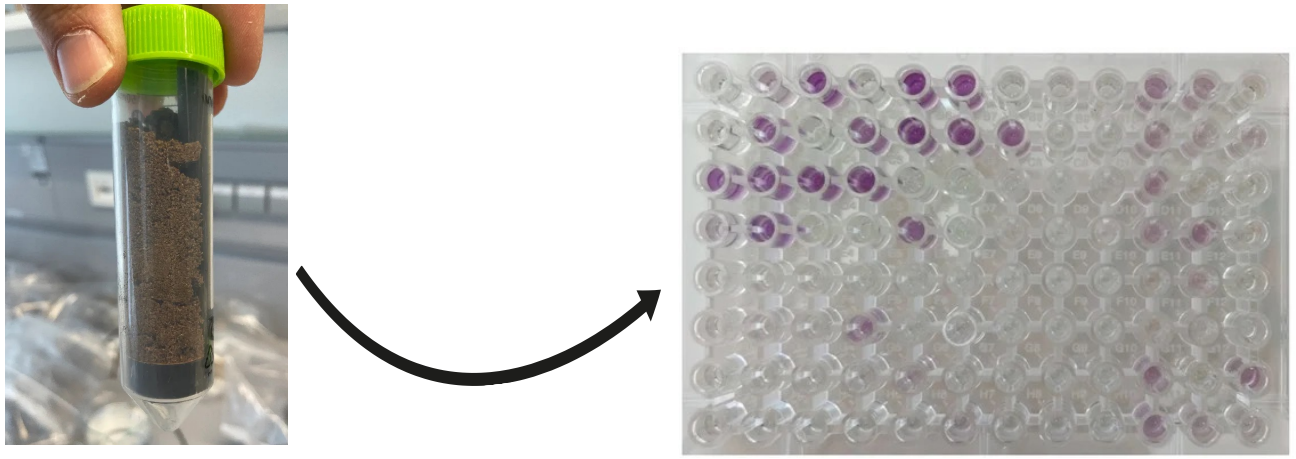
Research Project Work:

3) Microbial characterization

- Individual isolates
  - Gram stain
  - Enzymatic assays
  - Antibiotic resistance

- Community C substrate utilization
  - EcoPlates plates



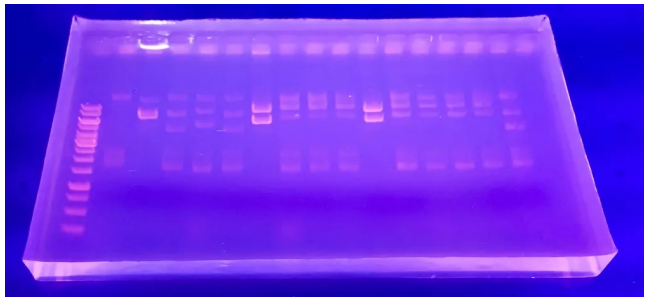


Project: The Sorge river microbial ecosystem

Research Project Work:

4) Genome characterization

- Nucleic acid extractions from isolates
- PCR – 16S & ITS
- Gel electrophoresis
- Sequencing
  - Library preparation
  - Long read sequencing



Project: The Sorge river microbial ecosystem

Research Project Work:

5) Community Analysis

- Nucleic acid extractions from environmental samples

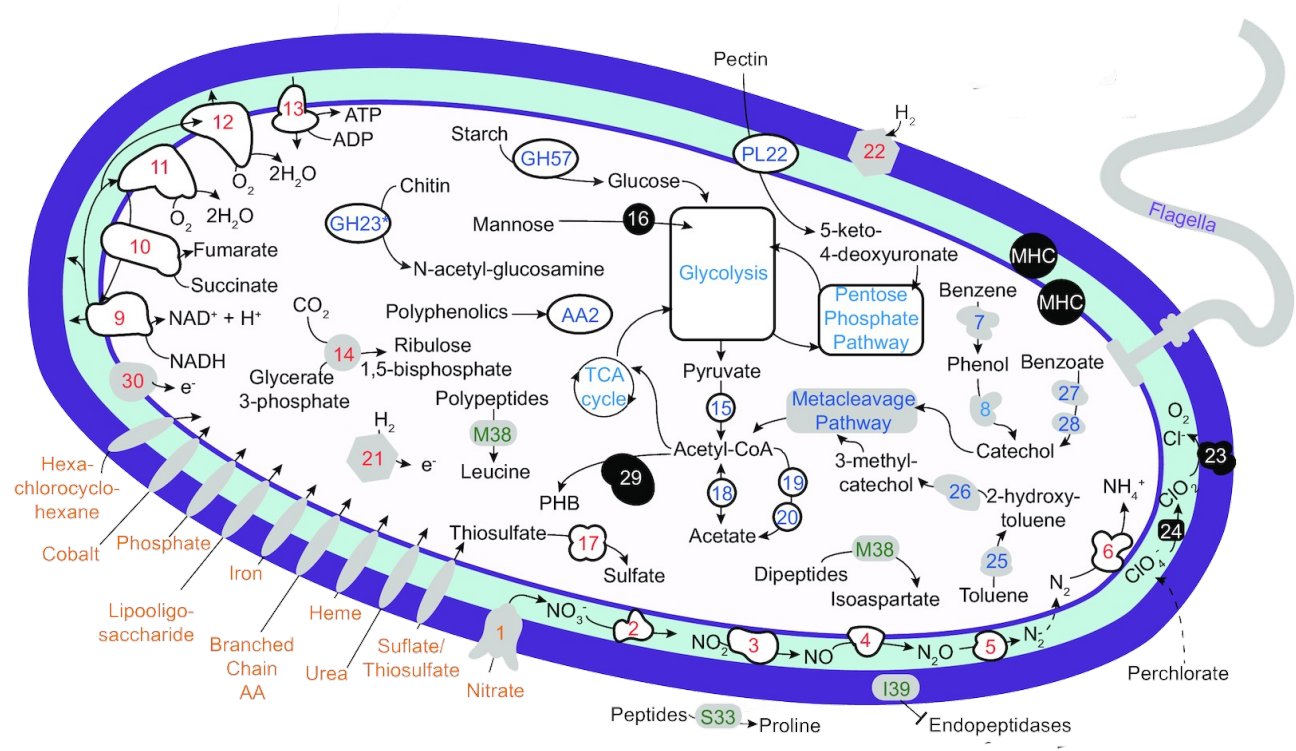
- Sequencing
  - Library preparation
  - Long read sequencing

Project: The Sorge river microbial ecosystem

Research Project Work:

6) Bioinformatics

- Genome annotation of isolated microorganisms
- Community analysis of the environmental microbiomes



Assessment

- Project report

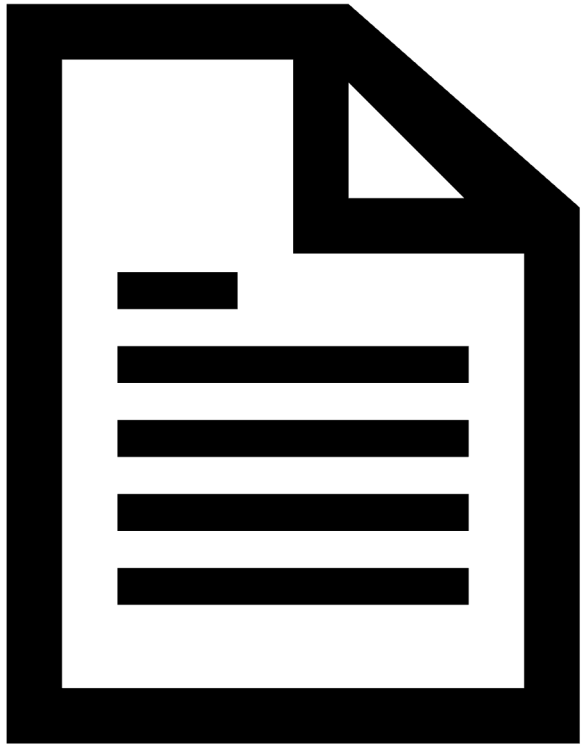
- Project presentation

- Exam

Project report

- 25 % of the grade
- In groups or individual

- Research paper
  - Based on data collected during the course
  - Intro, Methods, Results, Discussion, Conclusion, References



- Focus on your isolated microorganism
  - What is its taxonomy?
  - What kind of metabolism does it have?
  - How does it acquire Nitrogen and Carbon?
  - Can it produce greenhouse gases? Which?
  - What kind of metabolites does it make/excrete?
  - Can it detoxify metal contamination?
  - Does it have antibiotic resistance genes?
  - How can it potentially interact with other organisms?

- Discuss your isolate in the context of the entire microbiome

Project presentation

- 25 % of the grade
- In groups

- Present your isolated microorganism

- "How does it work?" methods section.
  - Winogradsky columns
  - Gram stain
  - Water probes
  - RapIDTM ONE System (enzymatic reactions)
  - Ecolog Plates
  - PCR/gel electrophoresis
  - Nanopore sequencing
  - Gas flux analysis
  - Other?

Exam 

- 50 % of the grade

Timeline

Sep 12 –	Today / Field Day: scout
Sep 19 –	Intro to Microbial Ecology / Filed day: site selection & samples for Winogradsky columns
Sep 26 –	Sergei Winogradsky / Winogradsky columns
Oct 03 –	Field day: sample collection, *in-situ* measurements
Oct 10 –	Microbial Ecology in Diverse Env/ Lab work: Spread plates & Chem analysis on samples
Oct 17 –	Microbial Ecosystem Functions / Lab work: Plate counts & colony isolation
Oct 31 –	Microbial Interactions and Communities / Lab work: Microscopy, Gram stain
Nov 07 –	Applied Microbial Ecology / Lab work: Ecolog plates & enzyme panel
Nov 14 –	Lab work: DNA Extraction, PCR
Nov 21 –	Methods in Microbial Ecology / Lab work: Gel electrophoresis, Library prep, Sequencing
Nov 28 –	Analysis of data
Dec 05 –	Analysis of data
Dec 12 & 19 –	Presentations
January –	Report due & Exam