ENV-550 **Biological resource recovery**

Gu Wenyu

| Cursus | Sem. | Type |
|---|---|---|
| Environmental Sciences and Engineering | MA2, MA4 | Opt. |

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|---|---|
| Language of teaching | English |
| Credits | 3 |
| Session | Summer |
| Semester | Spring |
| Exam | Oral |
| Workload | 90h |
| Weeks | 14 |
| **Hours** | **3 weekly** |
| Courses | 2 weekly |
| Exercises | 1 weekly |
| **Number of positions** | |

## Summary

Principles and technologies of biological resource recovery from waste streams into valuable resources. Emphasis is placed on the microbial processes underlying these technologies, their engineering applications, and their role in advancing sustainable and circular environmental systems.

## Content

**Course Content**

1. **Introduction to Biological Resource Recovery**

• Circular economy and sustainable resource management
• Wastewater as a source of water, energy, and materials
• Fundamentals of environmental microbiology for resource recovery

2. **Microbial Processes in Resource Recovery**

• Microbial metabolism and biogeochemical cycles
• Microbial communities in engineered systems
• Process monitoring and microbial ecology tools

3. **Water Reuse**

• Water reclamation and reuse applications
• Biological treatment processes
• Water quality, pathogens, and emerging contaminants

4. **Energy Recovery by Anaerobic Digestion**

• Principles of anaerobic digestion
• Microbiology of hydrolysis, acidogenesis, acetogenesis, and methanogenesis
• Biogas production, upgrading, and utilization
• Process optimization and operational challenges

5. **Nutrient Recovery**

• Nitrogen transformation and recovery technologies
• Phosphorus recovery (e.g., struvite precipitation and biological phosphorus removal)
• Integration of nutrient recovery into wastewater treatment

6. **Metal Recovery**

- Microbial interactions with metals
- Bioleaching and biosorption
- Recovery of critical metals from wastewater and waste streams

7. **Integrated Resource Recovery Systems**

- Resource recovery in wastewater treatment plants
- Process integration and system design
- Environmental, economic, and life-cycle considerations

8. **Emerging Technologies and Future Perspectives**

- Resource recovery from novel waste streams
- Biotechnology and synthetic biology for resource recovery
- Case studies and current research trends

## Keywords

Biological resource recovery; Environmental microbiology; Circular economy; Water reuse; Wastewater treatment; Anaerobic digestion; Biogas production; Nitrogen recovery; Phosphorus recovery; Metal recovery; Microbial processes; Sustainable environmental engineering; Resource recovery technologies.

## Learning Prerequisites

### Required courses

Environmental microbiology. Wastewater treatment.

### Important concepts to start the course

- Resource recovery
- Circular economy
- Sustainability
- Renewable energy
- Microbial processes

## Learning Outcomes

- Explain principles of biological resource recovery from wastewater and other waste streams
- Compare resource recovery technologies based on technical, environmental, and economic criteria.
- Assess / Evaluate relevant literature.
- Propose strategies for environmental engineering applications.

## Transversal skills

- Demonstrate the capacity for critical thinking
- Communicate effectively, being understood, including across different languages and cultures.
- Access and evaluate appropriate sources of information.

- Make an oral presentation.
- Summarize an article or a technical report.
- Assess one's own level of skill acquisition, and plan their on-going learning goals.
- Plan and carry out activities in a way which makes optimal use of available time and other resources.
- Set objectives and design an action plan to reach those objectives.

## Teaching methods

- Lectures
- Guided literature review and discussion of recent research
- Project on a biological resource recovery technology

## Assessment methods

- Homework and literature review: 5 x 6% = 30 %
- Midterm exam/quiz: 20%
- Final project report and oral presentation: 25+25 %

## Supervision

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|---|---|
| Office hours | Yes |
| Assistant.e.s | Yes |
| Forum | Yes |

## Resources

### Virtual desktop infrastructure (VDI)

No

### Moodle Link

- https://go.epfl.ch/ENV-550