

BIOLOGICAL PROCESSES

ENV 304

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Course Objectives

This course covers the theory and application of biological processes that are relevant for wastewater treatment engineering applications, with an emphasis on municipal/industrial wastewaters and biosolids. The initial lectures provides fundamental concepts of biological processes including stoichiometry, kinetics of biochemical reactions and microbial energetics. The remainder of the course involves the application of these foundational principles to treatment processes and bioreactor design considerations. The course also gives information on biological nutrient removal, anaerobic treatment of wastewater and treatment sludge.

Course Content

Introduction to biological processes, characterization of wastewaters and sludge, Microbial metabolism and growth, enzymes and inhibition, Stoichiometry of microbial growth and bacteria energy, Reactors and mass balance, Reactor kinetics of biological processes, Design parameters in biological processes, Suspended aerobic systems, Design of activated sludge systems for carbon removal, Design of activated sludge systems for nutrient removal, Biofilm systems, Biological nutrient removal, Anaerobic treatment systems, Aerobic and anaerobic sludge treatment

Course Learning Outcomes

- 1) Explain key principles of biological processes including stoichiometry, kinetics and microbial pathways.
- 2) Identify the range of conventional and advanced biological treatment processes for the treatment of organics and nutrients.
- 3) Define design principles of biological treatment processes.
- 4) Explain activated sludge principles, design parameters and operation.
- 5) Design activated sludge systems for both carbon and nutrient removal.
- 6) Explain anaerobic digestion principles, design and operation.
- 7) Explain biological nutrient removal including Anamox and alternative nutrient removal processes.

Course Plan

1. Week Introduction to biological processes, characterization of wastewaters and sludge
2. Week Role of microorganisms in biological wastewater treatment, microbial metabolism and growth
3. Week Kinetics of bacterial growth
4. Week Activated sludge processes
5. Week Activated sludge processes
6. Week Design of activated sludge systems for carbon removal
7. Week Nitrification and design of activated sludge systems for both carbon removal and nitrification
8. Week Mid-term
9. Week Biological nutrient removal -Nitrification
10. Week Biological nutrient removal - Denitrification
11. Week Biological nutrient removal -Nitrification and Denitrification Systems
12. Week Biological nutrient removal-Phosphorus removal
13. Week Biofilm systems
14. Week Other Biological Processes: Ponds and lagoons, Anaerobic processes, Sludge treatment processes (aerobic and anaerobic stabilization)

Textbooks

- Tchobanoglous, G., Burton, F.L., Stensel, H.D., (2003) Wastewater Engineering Treatment and Reuse, Metcalf&Eddy, McGraw-Hill, 4th edition
- Wang, L.K., Pereira N.C., Hung, Y-T, (2009) Biological Treatment Processes, Handbook of Environmental Engineers, Volume 8, Humana Press, USA.

Evaluation

Midterm	20%
Homework	20%
Final	60%

Attendance: Students are encouraged to attend classes to be able to pass this course. If they fail to do so, they may not be allowed to take the final.