

Biomedical Engineering Department

BMD ENG 347 Foundations of Regenerative Engineering

Instructor: Shu Q. Liu
E327, Tech
847 491 5745
sliu@northwestern.edu

Grader: To be named

Time: Fall quarter
TuTh 11:00AM - 12:20PM

Prerequisites BIOL_SCI 215 Genetics and Molecular Biology
or
BIOL_SCI 219 Cell Biology

Course Description: Foundations, principles, and technologies of molecular, cellular, and tissue regenerative engineering.

Course Objectives:

1. Understand the concepts of regenerative medicine and engineering.
2. Understand the principles of developmental biology, stem cell biology, and somatic regeneration.
3. Integrate engineering principles and technologies into regenerative medicine.

Course Outcomes:

Enable students to:

1. Assess the mechanisms of naturally occurring developmental and regenerative processes (assessed by quizzes, midterm/final exams, and homework assignments)
2. Acquire knowledge about the principles and technologies of molecular, cellular, and tissue regenerative engineering (assessed by quizzes, midterm/final exams, and homework assignments).
3. Establish hypotheses for regenerative engineering research (assessed by homework assignments and final design project).
4. Design engineering strategies for regenerative medicine (assessed by homework assignments and final design project).

References

1. Shu Q. Liu, *Bioregenerative Engineering: Principles and Applications*. Wiley Interscience, New York, 2007*.
2. Shu Q. Liu. *Cardiovascular Engineering: A Protective Approach*. McGraw-Hill, New York, 2020.

Assessments

1. Quizzes (weekly): 20%
2. Homework assignments (weekly): 20%
3. Midterm: 20%
4. Final: 30%
5. Design project: 10%

Lectures:

- I. Introduction to regenerative engineering
 - Basic concepts
 - Rationale for regenerative engineering
 - Molecular regenerative engineering
 - Cellular regenerative engineering
 - Tissue regenerative engineering
- II. Biological basis of regenerative engineering
 - Regenerative machineries
 - Molecules
 - Cells
 - Systems
 - Cell generation during embryonic development
 - Embryonic processes
 - Mechanisms of cell generation
 - Embryonic stem cells
 - Stem cell identification
 - Stem cell characterization
 - Stem cell function
 - Somatic resident stem cells
 - Bone marrow stem cells
 - Other resident stem cells
 - Somatic organ regeneration
 - Liver regeneration
 - Regeneration of other organs
 - Cytokines in regeneration
 - Growth factors in regeneration
 - Extracellular matrix in regeneration

III. Principles and technologies of regenerative engineering

Gene-based regenerative engineering

Identification of pathogenic and regenerative genes

Gene recombination and manipulations

Biological mediations of gene transfer

Chemical and physical mediations of gene transfer

Small interfering RNAs for mRNA modulations

Epigenetic modulations

MicroRNA modulations

Gene editing

Cell-level regenerative engineering

Tissue-level regenerative engineering

IV. Research design