# BME 427 - BioTransport

3 Credits, 3 Contact hours
Instructor: Yusuf Oni, Ph.D.

## Textbook(s)/Materials Required:

Transport Phenomena in Biological Systems, G.A Truskey, F. Yuan, and D.F. Katz, Prentice Hall; 2nd edition, **ISBN-10:** 0131569880

## Description:

The transport of energy, mass, and momentum is essential to the function of living systems. There must be efficient delivery of nutrients and regulators of growth and other processes. Indeed, organisms control the concentrations of molecules in their tissues and organs through specialized mechanisms that regulate the movement of these molecules in cells. This course is an introduction to Transport Phenomena in Biological Systems. It is designed to help students understand these mechanisms at the biological level as well as from an engineering perspective (math models & concepts). The objective of the course, therefore, is to gain knowledge of the basic principles of transport phenomena and its application to biological systems.

The course will attempt to integrate the development of fundamental principles of transport processes, the mathematical expression of these principles and the solution of transport equations, along with the characterization of composition, structure and function of living systems to which they are applied.

Students will be introduced to the basic concepts of transport phenomena by developing mass and momentum balance relations from first principles. Fundamental mathematical concepts such as calculus (differentials, integrals, ODEs), error functions, power series etc. will be reviewed to enable their understanding of balance relations. These relations will then be applied to some biomedical contexts that will demonstrate the effects of geometry and boundary conditions. Students will be introduced to conservation and constitutive relations in three dimensions for mass and momentum and how to apply them to more complex problems. Diffusion, convection, and biochemical interactions are introduced to highlight their importance in biological systems with multiple real world engineering problems and applications through device, implant, or drug delivery in the human body. Students will learn how to approach and critically analyze biotransport problems and the application of appropriate equations/solutions. Problems and

examples will include analytical as well as numerical solutions. Analytical solutions will be emphasized as they provide physical insights that are important for introductory material.

## Prerequisites by topic:

MATH 222 and BME303
This is a required course for the Biomaterials and Tissue Engineering Track.

## Course Learning Outcomes (CLOs):

1. Be able to understand the fundamental principles of cell biology, molecular biology, and engineering towards understanding transport processes in the body and the design of medical devices
2. Be able to able to identify elements of biological systems that are impacted by transport phenomena
3. Be able to describe the major transport mechanisms and the conditions under which they can be applied with the body
4. Be able to apply knowledge of math, engineering and science to identify, formulate, and solve biomedical problems involving mass and momentum transfer
5. Be able to formulate differential equations that represent the physical situation of biomedical problems involving mass and/or momentum and/or heat transfer and determine appropriate boundary conditions
    a. Be able to mathematically define and describe general biotransport problems including derivation of the governing equation and defining the appropriate boundary/initial conditions
    b. Be able to apply mass transport models and approaches to biomedical problems and to interpret the solutions/results

## Student Outcomes:

**Student outcome 1** - an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
**Related CLO - 1,2,3,4,5**

## Program Specific Criteria:

A- an understanding of biology and physiology
**Related CLO – 1,2**

B- the capability to apply advanced mathematics (including differential equations and statistics) to solve the problems at the interface of engineering and biology
**Related CLO – 3,4,5**

C - the capability to apply advanced science and engineering to solve the problems at the interface of engineering and biology
**Related CLO – 1,2,3,4,5**

E - address problems associated with the interaction between living and non-living materials and systems

**Related CLO – 1,2,3,4,5**

## Course Topics:

Mass Transport, Diffusion with Convection, Transport in Porous Media, Transvascular Transport, Mass Transport with Biochemical Interactions, Cell Surface Ligand-Receptor Kinetics, Cell Adhesion, Transport of Gases between Blood and Tissues, Drug Transport