Share and Learn Discussion Notes: May 25th, 2022 1-2pm EST

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Teaching Biotransport to Biomedical Engineering Students

Presentation Notes:

- What is Biotransport
  - The role of fluid, heat, and mass transfer in biological systems and in biomedical engineering devices/applications
- Prerequisites
  - Thermodynamics
  - Differential Equations
  - Anatomy and Physiology
- Undergraduates vs. Graduates
  - Both, 4 credit course
- Textbooks Used
  - Fundamentals of Momentum, Heat, and Mass Transfer, James Welty, Gregory L. Rorrer, David G. Foster. 7th Edition, Wiley 2019
    - Better for undergraduate students to understand
  - Biological and Bioenvironmental Heat and Mass Transfer, Ashim K. Datta, Marcel Dekker, 2002.
    - Only covers heat and mass transfer, requires knowledge of fluids first
  - Biotransport: Principles and Applications, Robert. J. Roselli, and Kenneth R. Diller, Springer; 2011th Edition
    - Hard for undergraduate students to understand, more for graduate level
- Projects
  - Design project (mainly paper design done) – e.g. design heat exchanger for cooling of blood to reduce temperature of blood during surgical operation, measurement of chicken property heat conductivity in longitudinal or transverse direction and design device to measure this using CAD
  - Experimental project?
  - Tests?
  - Other topics?
- Syllabus Sharing
  - 2 main parts: 1) fluids (6 weeks), 2) heat transfer (6 weeks), 3) mass transfer (1 week)
  - Difficult to cover too much in 1 course
- Other notes:
  - Two programs have been run, and noticed students have very low interest in biotransport because they are not interested in fluids and heat transfer
  - Drug delivery, hemodialysis, or other areas may be of better interest to get students excited about the topic, but these are more research related topics
  - May be great course as a tech elective, but harder to teach as a required course

Open Discussion and Resources:

- Does BME undergraduate need biotransport?
    - Ruth – looks at value of it and what they can do with it moving forward to show how it's important and useful
    - Adam – same issue with not having fluids background, so teaches fluid and mass transfer only
        - Agrees that cramming it all into only 1 semester/course makes it too difficult for students, and it's hard to focus down and identify only important pieces – e.g. break down to calculate flow rates through tubes and fundamental questions
    - Maribel – can't find a good book that makes undergraduates happy because most are more for the graduate level, uses own slides/power points to make own mini book chapter and focuses on problem solving techniques in class and uses YouTube videos to describe fundamentals of fluids
        - Navier Stokes – flow through tube via glaucoma in the retina where pressure increases through small cylinder tube, and if add heat via laser, etc. what happens
        - Difficulty is they are juniors and it's 3 separate classes on top of each other where they have to combine everything together
    - Zhongping – uses problem solving of blood cells but connects to industry skill and identify pumping system, so choose pump for patient, and how to use that to create appropriate pressure gradients
- What is the best way to teach biotransport, lecture + labs
    - Zhongping's curriculum has labs lumped together so the biotransport topics aren't taught in a lab right after, rather integrated with other topics
        - Two labs associated with his research: see how blood cells transport between inside and outside, so they measure hematcrit levels and concentration of blood levels using saline or other biological fluids, show students that water will penetrate red blood cells membranes and why they don't use water to change concentrations of blood cells, uses hemodialysis as topic and spectrometer to measure
        - Wants to use temperature measuring device for next year's course
    - Ruth – also doesn't have a lab associated with their biotransport class
    - Adam – doesn't have lab, so does paper-based design project on choose technology or device and analyze it from fluid mechanics and mass transport
- More focus on devices or biological system
    - Adam – does a blend of both devices and biological systems, pulls specific biofluid aspects of biofluid mechanics course into biotransport using blood flow
- Applications
    - Zhongping – you need to focus on principles and fundamentals first, and need to prepare them well for themselves

    - Adam – thinking about teaching diffusion and convection (heat vs mass) side by side to see if he can cover both to focus on fundamentals and be able to get both heat and mass covered in the class – uses dialyzer for mass transport application
    - Zhongping – feels heat exchange design and how to apply this is more important, and gave up convection vs conduction relationship
- No Credits?
    - Maribel and Adam – 3 credits
    - Zhongping – 4 credits
    - Ruth – you need to focus on what do you need to know when you walk out door to break it down and scale it down
- How much of the course do you dedicate to teaching tools for mass transport?
    - Zhongping – does not teach CFD in the course, is more for other majors
        - We need to develop and write a biotransport textbook because everyone has same problem that there is no good book like there is for mechanical or chemical engineering majors
    - Maribel – there is no common syllabus and noticed that 3 colleagues in the department that teach things completely differently for the biotransport class, one uses matlab, one does not, and one does not cover same or depth of certain topics
    - Adam – has different instructors for other courses (same for biotransport) and they use a required course objectives (e.g. solve problems with software), other method is to split the course and teach only half of same course across sections