Biomedical Transport Phenomena

BME 4632 Section: 24BC
Class Periods: T, Tr; period 8; 3:00 – 4:55 PM, 4:05 – 4:55 PM
Location: Room 103 Fine Arts B (FAB)
Academic Term: Spring 2025

Instructor: Prof. Jamal Lewis
Email: jlewis@bme.ufl.edu
Office Phone Number: (352)392-1598
Office Hours: Mondays, 4 – 5PM, 490 Wertheim Engineering Bldg.

Teaching Assistant/Peer Mentor/Supervised Teaching Student/ Learning Assistant:
Please contact through the Canvas website

- **STS**, Office hours and location: TBD; Virtual (Zoom); Review sessions – please see course schedule.
- **Mr. Javier Quiros Sanchez**, jquirossanchez@ufl.edu, Office hours and location: TBD, Review sessions – please see course schedule.
- **Mr. Jason Bonasera,** jasonbonasera@ufl.edu, Office hours and location: TBD, Review sessions – please see course schedule.

Course Description
Introduction to and application of the concepts of momentum, mass, and thermal energy transport in the context of problems of interest in biomedical sciences and engineering. Macroscopic and microscopic analysis of momentum, mass, and thermal energy transport problems in biomedical systems. (3 credits)

Course Pre-Requisites / Co-Requisites
Pre-Req: BME 3060 (Biomedical Fundamentals) with minimum grade of C.

Course Objectives
1. Students will understand the relationship between blood flow and physiological function and dysfunction in the surrounding tissues and organs.
2. Students will be able to solve transport equations using methods from advanced mathematics.
3. Students will become comfortable applying fundamental biotransport fundamentals to the design and interpretation of experiments.
4. Students will develop an intermediate/advanced understanding of transendothelial transport and oxygen delivery to tissues and organs.
5. Students will be able to apply dimensional analysis to the equations for the problems in fluid transport.
6. Students will learn about receptor-ligand kinetics and how to apply the kinetic models to study cell adhesion and intracellular signaling.

Materials and Supply Fees
N/A

Relation to Program Outcomes (ABET):
This course will prepare students to apply advanced mathematics to solve problems at the interface of engineering and physiology. Specific to the UF BME program educational outcomes, students will gain experience applying a knowledge of biotransport fundaments to solving open ended biomedical engineering challenges related to therapeutic design and basic science discovery.

The following ABET learning outcomes are emphasized in this course.

Outcome	Coverage*	Teaching Level**
1. An ability to identify, formulate, and solve complex engineering problems by applying principles of	High	Emphasized

engineering, science, and mathematics		
2. An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors		
3. An ability to communicate effectively with a range of audiences		
4. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts		
5. An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives		
6. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions	Medium	Reinforced
7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies	Low	Reinforced

* Coverage is given as high, medium, or low. **Teaching Level corresponds to the sequential fit in the curriculum and is given as introduced, reinforced, or emphasized.

Required Textbooks and Software

G.A. Truskey, F. Yuan, D.F. Katz, Transport Phenomena in Biological Systems, 2nd Edition. Pearson Prentice Hall, 2009. ISBN: 0-13-156988-8.

Software: A means for solving systems of equations is required for completion of certain assignments (e.g., Matlab, graphing calculator, or Wolfram Alpha website).

Required Computer

UF student computing requirement: *https://news.it.ufl.edu/education/student-computing-requirements-for-uf/*

Topics and Anticipated Sequence of Materials Covered in this Course

- Approaching problems from an engineering perspective
- Introduction to biotransport problems
- Introduction to diffusion and convection
- Review of forces and fluid statics

- Newtonian fluids and shear/stain relationships
- Fluid transport: kinematics, conservation equations
- Fluidic applications: parallel-plate, rectangular and cylindrical channels
- Differential forms of the conservation of mass and momentum: Navier Stokes
- Integral forms of the conservation of mass and momentum
- Blood rheology
- Physiological and pathological blood flow and the cardiovascular system
- Dimensional analysis and scaling
- Mass transport: steady diffusion and boundary conditions
- Steady state diffusion from variable geometries
- Unsteady diffusion
- Transport in porous media

Important Dates

Please consult Canvas for the most up to date schedule regarding class assignments, exams, etc.
Important university dates/deadlines: https://catalog.ufl.edu/UGRD/dates-deadlines/2024-2025/#spring25text

Attendance Policy, Class Expectations, and Make-Up Policy

Attendance: Attendance is not monitored but is essential for success in this course. It is your responsibility to keep up to date on the materials/assignments when you have missed class. Please notify me in advance if you will be missing (or have missed) more than 2 consecutive classes, as I am here to help if you experience illness or an event that makes it challenging to keep up with course material.

Communication: Class announcements will be posted to Canvas and all students are responsible for ensuring awareness of these postings. Failure to review the course website is not an excuse for missing assignments, class time changes, etc. All students are expected to communicate in a professional manner. Contact me via Canvas only, as this ensures a prompt reply (I have an email filter that flags the emails differently so they stand out from the hundreds of emails I receive each day).

Conduct: All students are expected to conduct themselves in a professional manner when participating in this course. A student participating in conduct that is not supportive of the educational experience will be requested to terminate this activity or leave the classroom. Discussions should be conducted in a respectful and courteous manner, to encourage a dynamic interaction from all in attendance.

Make-Up Policy: Make up exams and/or quizzes will only be permitted for university approved absences. Please review your student handbook to ensure that you understand the requirements for a university approved absence. Excused absences are consistent with university policies in the undergraduate catalog (https://catalog.ufl.edu/ugrad/current/regulations/info/attendance.aspx) and require appropriate documentation.

Assistance with Course Material: You should expect this course to challenge you and require time, effort, and thoughtful analysis for success. When a concept or problem presents a challenge, spend the time to really think about how to approach the problem, as this thoughtful analysis will train you for success in exams (and future classes). If you are struggling with a concept or problem, you have 3 primary resources: 1) your peers, 2) your STS and 3) your professor. Before you reach out to any of these resources, you are expected to have spent considerable time on your own attempting to understand or complete the problem.

Peers: Establishing a strong and fruitful peer network is an important resource in your major and will help serve you well as you progress in BME, so seek out colleagues that can serve as a strong peer network. Brainstorming on problems with your peer group (after you have attempted to solve them independently) is permitted; however, this dynamic interaction should be one that leads to improved conceptual understanding on how to approach problems – not one used as a crutch to copy solutions. Assignments are used to train you for exams, so copying

solutions from friends will inevitably result in a poor exam performance. In the end, individual assignments must be your own work, not a copied solution. ***If copying of work on an individual assignment is evident, the problem will earn 0 credits.***

Requirements for class attendance and make-up exams, assignments, and other work in this course are consistent with university policies. Click here to read the university attendance policies: https://catalog.ufl.edu/UGRD/academic-regulations/attendance-policies/

Evaluation of Grades

Assignment	Percentage of Final Grade
HomeWorks (8, escalating in weight as semester progresses)	40%
Exam I	20%
Exam II	20%
Exam III	20%
	100%

To maximize your partial credit in grading:

1. Write legibly and do not crowd your work.
2. Show complete rationale and logic
2. Construct a clear diagram, if appropriate.
3. Write the equations you are using in symbols before substituting in numbers.
4. Label all numerical quantities/values with units.
5. Box your final answer.

Bonus Points: During the semester, bonus points can be earned during class periods via designated in- class assignments or discussions. Points are accrued between exam periods and are added to the final grade of each exam during that period. These points are offered to all students (never individually) and may be offered in-class only or off-line. Opportunities vary throughout the semester and advanced notice will not be provided.

Grading Policy (per UF)

Percent	Grade	Grade Points
93.4 - 100	A	4.00
90.0 - 93.3	A-	3.67
86.7 - 89.9	B+	3.33
83.4 - 86.6	B	3.00
80.0 - 83.3	B-	2.67
76.7 - 79.9	C+	2.33
73.4 - 76.6	C	2.00
70.0 - 73.3	C-	1.67
66.7 - 69.9	D+	1.33
63.4 - 66.6	D	1.00
60.0 - 63.3	D-	0.67
0 - 59.9	E	0.00

Final cumulative numerical grades will be rounded to the nearest tenth of a point. Curving of assignments is exceptionally rare and typically only due to the entire class missing a question. No extra assignments for additional credit are given in this course. There is no curving of final grades.

Note: To graduate, students must have an overall GPA and an upper-division GPA of 2.0 or better (C or better). A grade of "C minus" is equivalent to a GPA of 1.67.

Grade challenges: We do our best to grade evenly and fairly, but mistakes in grading can happen. Requests to modify points on assignments, quiz, or exams must be submitted in writing to Dr. Lewis within 1 week from when the graded assignment was made available. The request should identify the question and provide clear justification/reasoning for the requested change. The instructor will then review the request and modify the grade, as necessary. For grade challenge requests, the instructor reserves the right regrade the entire assignment, not just the points in question. The instructor also reserves the right to turn down unreasonable or frivolous grade challenge requests.

More information on UF grading policy may be found at:
https://catalog.ufl.edu/ugrad/current/regulations/info/grades.aspx

Students Requiring Accommodations
Students with disabilities who experience learning barriers and would like to request academic accommodations should connect with the disability Resource Center by visiting https://disability.ufl.edu/students/get-started/. It is important for students to share their accommodation letter with their instructor and discuss their access needs, as early as possible in the semester.

Course Evaluation
Students are expected to provide professional and respectful feedback on the quality of instruction in this course by completing course evaluations online via GatorEvals. Guidance on how to give feedback in a professional and respectful manner is available at https://gatorevals.aa.ufl.edu/students/. Students will be notified when the evaluation period opens, and can complete evaluations through the email they receive from GatorEvals, in their Canvas course menu under GatorEvals, or via https://ufl.bluera.com/ufl/. Summaries of course evaluation results are available to students at https://gatorevals.aa.ufl.edu/public-results/.

In-Class Recording
Students are allowed to record video or audio of class lectures. However, the purposes for which these recordings may be used are strictly controlled. The only allowable purposes are (1) for personal educational use, (2) in connection with a complaint to the university, or (3) as evidence in, or in preparation for, a criminal or civil proceeding. All other purposes are prohibited. Specifically, students may not publish recorded lectures without the written consent of the instructor.

A "class lecture" is an educational presentation intended to inform or teach enrolled students about a particular subject, including any instructor-led discussions that form part of the presentation, and delivered by any instructor hired or appointed by the University, or by a guest instructor, as part of a University of Florida course. A class lecture does not include lab sessions, student presentations, clinical presentations such as patient history, academic exercises involving solely student participation, assessments (quizzes, tests, exams), field trips, private conversations between students in the class or between a student and the faculty or lecturer during a class session.

Publication without permission of the instructor is prohibited. To "publish" means to share, transmit, circulate, distribute, or provide access to a recording, regardless of format or medium, to another person (or persons), including but not limited to another student within the same class section. Additionally, a recording, or transcript of a recording, is considered published if it is posted on or uploaded to, in whole or in part, any media platform, including but not limited to social media, book, magazine, newspaper, leaflet, or third party note/tutoring services. A student who publishes a recording without written consent may be subject to a civil cause of action instituted by a person injured by the publication and/or discipline under UF Regulation 4.040 Student Honor Code and Student Conduct Code.

University Honesty Policy
UF students are bound by The Honor Pledge which states, "We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honor and integrity by abiding by the Honor Code. On all work submitted for credit by students at the University of Florida, the following pledge is either required or implied: "On my honor, I have neither given nor received unauthorized aid in doing this assignment." The Honor

Code (https://sccr.dso.ufl.edu/process/student-conduct-code/) specifies a number of behaviors that are in violation of this code and the possible sanctions. Furthermore, you are obligated to report any condition that facilitates academic misconduct to appropriate personnel. If you have any questions or concerns, please consult with the instructor or TAs in this class.

Commitment to a Safe and Inclusive Learning Environment

The Herbert Wertheim College of Engineering values varied perspectives and lived experiences within our community and is committed to supporting the University's core values, including the elimination of discrimination. It is expected that every person in this class will treat one another with dignity and respect regardless of race, creed, color, religion, age, disability, sex, sexual orientation, gender identity and expression, marital status, national origin, political opinions or affiliations, genetic information, and veteran status.

If you feel like your performance in class is being impacted by discrimination or harassment of any kind, please contact your instructor or any of the following:

- Your academic advisor or Graduate Program Coordinator
- HWCOE Human Resources, 352-392-0904, student-support-hr@eng.ufl.edu
- Curtis Taylor, Associate Dean of Student Affairs, 352-392-2177, taylor@eng.ufl.edu
- Toshikazu Nishida, Associate Dean of Academic Affairs, 352-392-0943, nishida@eng.ufl.edu

Software Use

All faculty, staff, and students of the University are required and expected to obey the laws and legal agreements governing software use. Failure to do so can lead to monetary damages and/or criminal penalties for the individual violator. Because such violations are also against University policies and rules, disciplinary action will be taken as appropriate. We, the members of the University of Florida community, pledge to uphold ourselves and our peers to the highest standards of honesty and integrity.

Student Privacy

There are federal laws protecting your privacy with regards to grades earned in courses and on individual assignments. For more information, please see: https://registrar.ufl.edu/ferpa.html

Campus Resources:

Health and Wellness

U Matter, We Care:

Your well-being is important to the University of Florida. The U Matter, We Care initiative is committed to creating a culture of care on our campus by encouraging members of our community to look out for one another and to reach out for help if a member of our community is in need. If you or a friend is in distress, please contact umatter@ufl.edu so that the U Matter, We Care Team can reach out to the student in distress. A nighttime and weekend crisis counselor is available by phone at 352-392-1575. The U Matter, We Care Team can help connect students to the many other helping resources available including, but not limited to, Victim Advocates, Housing staff, and the Counseling and Wellness Center. Please remember that asking for help is a sign of strength. In case of emergency, call 9-1-1.

Counseling and Wellness Center: https://counseling.ufl.edu, and 392-1575; and the University Police Department: 392-1111 or 9-1-1 for emergencies.

Sexual Discrimination, Harassment, Assault, or Violence

If you or a friend has been subjected to sexual discrimination, sexual harassment, sexual assault, or violence contact the **Office of Title IX Compliance**, located at Yon Hall Room 427, 1908 Stadium Road, (352) 273-1094, title-ix@ufl.edu

Sexual Assault Recovery Services (SARS)

Student Health Care Center, 392-1161.

University Police Department at 392-1111 (or 9-1-1 for emergencies), or http://www.police.ufl.edu/.

Academic Resources

E-learning technical suppor*t*, 352-392-4357 (select option 2) or e-mail to Learning-support@ufl.edu. https://lss.at.ufl.edu/help.shtml.

Career Connections Center, Reitz Union, 392-1601. Career assistance and counseling; https://career.ufl.edu.

Library Support, http://cms.uflib.ufl.edu/ask. Various ways to receive assistance with respect to using the libraries or finding resources.

Teaching Center, Broward Hall, 392-2010 or 392-6420. General study skills and tutoring. https://teachingcenter.ufl.edu/.

Writing Studio, 302 Tigert Hall*,* 846-1138. Help brainstorming, formatting, and writing papers. https://writing.ufl.edu/writing-studio/.

Student Complaints Campus*:* https://sccr.dso.ufl.edu/policies/student-honor-code-student-conduct-code/;https://care.dso.ufl.edu.

On-Line Students Complaints*:* https://distance.ufl.edu/getting-help/; *https://distance.ufl.edu/state-authorization-status/#student-complaint*.