Biomedical Transport Phenomena

BME4632 Section 1854
Class Periods: M,W,F – Period 5 – 11:45a-12:35p
Location: Larsen Hall, Rm 0330
Academic Term: Fall 2024

Instructor:
Chris Geiger
cgeiger@bme.ufl.edu
Office Phone: (352) 273-9338
Office Hours: M,W 1:30p-3p, T,R 11a-12p or by appointment, BMS J293

If you would prefer to meet with me virtually during office hours via Zoom or Microsoft Teams, scheduling is **required, please email me with the date and time you would like to meet so I can ensure that time is available.** In addition to my open office hours, you can schedule a meeting with me through Calendly for times you would like to meet with me outside of my scheduled office hours:

https://calendly.com/rcgeiger/

If none of those times work with your schedule, please email me and we'll try to figure something out.

Outside of class and office hours, I prefer to be contacted via email and will make every effort to respond as quickly as possible (more quickly during the work week than on the weekend). As the instructor, I will do my best to follow the proposed course schedule as closely as possible. However, I also reserve the right to make necessary changes if the need arises.

Teaching Assistant/Peer Mentor/Supervised Teaching Student:
Please contact through the Canvas website
- Wesley Hargrove, wesleyhargrove@ufl.edu, TBD
- Audry Singletary, singletarya@ufl.edu, TBD

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
BME 3060 with a minimum grade of C.

Course Objectives
Upon the completion of this course, students will:
1. Understand the relationship between blood flow and physiological function and dysfunction in the surrounding tissues and organs.
2. Be able to solve transport equations using methods from advanced mathematics.
3. Become comfortable applying fundamental biotransport fundamentals to the design and interpretation of experiments.
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5. Be able to apply dimensional analysis to the equations for the problems in fluid transport.
6. Learn about receptor-ligand kinetics and how to apply the kinetic models to study cell adhesion and intracellular signaling.

Professional Component (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.

Relation to Program Outcomes (ABET):

Outcome	Coverage*	Teaching Level**
1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics	High	Emphasized
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
- Title: Transport Phenomena in Biological Systems
- Authors: Truskey, Yuan, and Katz
- 2nd Edition, 2009
- ISBN number: 0-13-156988-8

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

Course Topics (see Canvas for specific class dates, assignments, presentations and exams)
- 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/#fall24text

Attendance Policy, Class Expectations, and Make-Up Policy
Attendance Policy - Regular participation in classes is expected of all students. Unavoidable absences do not excuse students from the course material covered on that day. Activities and subsequent grades cannot be made up by the student.

Participation will affect the final course grade according to the following schedule.

Up to 2 activities missed…	No effect on final grade.
3 activities missed…	50% reduction in participation grade for the semester.
4 activities missed…	100% reduction in participation grade for the semester.
5 or more activities…	Final grade of 0 assigned (Official withdrawal recommended).

Participation will be monitored through the submission of in-class materials after class. All materials will be available via Canvas prior to the start of class. Participation submission dropboxes will not accept late work, be sure to check the due date for your materials! Please let me know in advance if you will be missing (or have missed) more than 2 consecutive classes, as I am here to help you if you experience illness or an event that makes it challenging to keep up with course materials.

Communication - Canvas will act as our primary repository of documents. It will contain a synopsis of upcoming classes, including reading assignments, lesson objectives, and any "handouts" that should be brought to class. Additionally, all pre-quizzes or other materials that require completion prior to the current lesson will be provided no later than 24 hours prior to that class.

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, courteous, and professional manner.

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 2 primary resources: 1) your peers and 2) 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 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 that 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 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***.

Make-Up Policy – 5 exams will be held throughout the semester, please consult Canvas for the most recent schedule. **No makeup exams will be given.** If a single exam is missed due to a university approved absence, the exam grade will be based entirely on the results of the other exams. If multiple exams are missed, please contact the instructor for additional considerations.

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.

Evaluation of Grades

Assignment	**Percentage of Final Grade**
Homework and Out of Class Assignments	25%
Quizzes and In-Class Participation	15%
Exams (5 at 12% per exam)	60%
TOTAL	100%

Grading Policy

Letter grade conversion plan:

A	A-	B+	B	B-	C+	C	C-	D+	D	D-	E
≥92	90-91	87-89	83-86	80-82	77-79	73-76	70-72	67-69	63-66	60-62	< 60

Late submission policy - Late submissions for all out of class assignments are penalized **40% per day late,** up to 2 days (80%), after which time no late submissions will be accepted. For example, if a project is worth 300 points, turning in that project 1 day late will result in the project being graded out of a maximum possible 180 points.

Exams - All exams, quizzes and the final are closed book.

Additional exam policies:

- The only materials allowed on the desktop during the exam are writing instruments, calculators (see below), straightedges such as a ruler, scale, triangle, or protractor, and any materials provided by the instructor. Scratch paper, if needed, will be provided by the instructor. All other materials (books, notebooks, etc.) must be placed under the desk for the duration of the exam. All cell phones MUST be placed face down on the top of your desk. Failure to comply with this will result in receiving a zero for the exam.
- To help protect exam integrity, only NCEES approved calculators can be used during exams. A list of approved calculators can be found at: http://ncees.org/exams/calculator-policy/
- Once the exam begins, students may not leave the room (i.e., bathroom breaks, answering a cell phone, etc.) unless it is part of an accommodation approved by the instructor prior to the administration of the exam. All students must turn in their exam and reference materials prior to departure.

To maximize your partial credit in grading:

1. Write legibly and do not crowd your work.
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

Although solutions to the homework and other out of class materials are readily available, they are one of the best ways to prepare for an exam and **it is in your best interest to complete them prior to looking at the solutions to the problems**.

In order to graduate, students must have an overall GPA and an upper-division GPA of 2.0 or better (C or better). Note: a C- average is equivalent to a GPA of 1.67, and therefore, it does not satisfy this graduation

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

Technology Policy
Use of cell phones, laptops and tablets are acceptable for class related work and activities only. The purpose of coming to class is to learn, and real, meaningful learning is hard work. Cognitive and behavioral scientists have found that electronic devices can erode a person's ability to concentrate[1], and focus has been highly correlated with educational and occupational success[2]. When using such devices, please make sure all sounds/alerts/etc. are turned off/muted so as not to disrupt those around you.

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

[1] https://www.theguardian.com/lifeandstyle/2018/oct/14/the-lost-art-of-concentration-being-distracted-in-a-digital-world
[2] https://www.kqed.org/mindshift/32826/age-of-distraction-why-its-crucial-for-students-to-learn-to-focus

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 Undergraduate Coordinator
- HWCOE Human Resources, 352-392-0904, student-support-hr@eng.ufl.edu
- Pam Dickrell, Associate Dean of Student Affairs, 352-392-2177, pld@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://elearning.ufl.edu/.

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*.