

BME 4632: Biomedical Transport Phenomenon (3 credits)

Meeting Information:

3pm-4:55pm Tue (Periods 8-9) MCCA G186, 4:05pm-4:55pm Thur (Period 9) RNK 0110

Final Exam Time: Monday May 1 from 3pm-5pm

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.

Prerequisites: BME 3060 with a minimum grade of C.

Course Specific Aims:

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.

Instructor:

Chris Geiger

Office: BMS J293

Email: cgeiger@bme.ufl.edu

Learning Assistant:

Wes Hargrove

wesleyhargrove@ufl.edu

Office Hours: TBD

Although my office hours are open, I would prefer that you schedule a meeting with me to ensure I can give you my undivided attention. If you would prefer to meet with me virtually for office hours via Zoom or Microsoft Teams, scheduling is **required**. You can schedule a meeting with me through Calendly (additional times outside of scheduled office hours are also available via Calendly):

<https://calendly.com/rcgeiger/1>

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.

Textbook:

Transport Phenomena in Biological Systems, by Truskey, Yuan and Katz. Second Edition, Pearson Prentice Hall, 2009.
ISBN-13: 0-13-156988-8.

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 fundamentals 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 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 judgement 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.

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

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 - 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.

Evaluation of Grades and Grading Polices

The following is the breakdown of graded requirements and overall grade criteria¹.

Assignment	Percentage of Final Grade
Homework and Out of Class Assignments	25%
Quizzes and In-Class Participation	10%
Exams (3 at 20% per exam)	60%
TOTAL	100%

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.

¹ subject to change

Exams - 3 exams will be held throughout the semester, please consult Canvas for the most recent schedule. **No makeup exams will be given.** If an exam is missed due to a valid medical or family emergency, the exam grade will be based entirely on the results of the other 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 concentrate², and focus has been highly correlated with educational and occupational success³. When using such devices, please make sure all sounds/alerts/etc. are turned off/muted so as not to disrupt those around you. If you are expecting an emergency call (life happens), please let me know prior to the start of class and feel free to step out of the classroom to take it.

Students Requiring Accommodations

Students with disabilities requesting accommodations should first register with the Disability Resource Center (352-392-8565, <https://disability.ufl.edu/students/get-started/>) by providing appropriate documentation. Once registered, students will receive an accommodation letter which must be presented to the instructor when requesting accommodation. Students with disabilities should follow this procedure 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/>.

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/policies/student-honor-code-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 broad diversity within our community and is committed to individual and group empowerment, inclusion, and the elimination of discrimination. It is expected that every person in this class will treat one another with dignity and respect regardless of gender, sexuality, disability, age, socioeconomic status, ethnicity, race, and culture.

² <https://www.theguardian.com/lifeandstyle/2018/oct/14/the-lost-art-of-concentration-being-distracted-in-a-digital-world>

³ <https://www.kqed.org/mindshift/32826/age-of-distraction-why-its-crucial-for-students-to-learn-to-focus>

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
- Robin Bielling, Director of Human Resources, 352-392-0903, rbielling@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: <http://www.counseling.ufl.edu/cwc>, 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 support, 352-392-4357 (select option 2) or e-mail to Learning-support@ufl.edu. <https://lss.at.ufl.edu/help.shtml>.

Career Resource Center, Reitz Union, 392-1601. Career assistance and counseling. <https://www.crc.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://care.dso.ufl.edu>.

On-Line Students Complaints: <http://www.distance.ufl.edu/student-complaint-process>.

Important University Dates:

<https://catalog.ufl.edu/UGRD/dates-deadlines/2023-2024/#spring24text>