

# How Cells Sense Mechanical Forces: An Engineer's Guide to Mechanobiology

ECH 6937, sections 27539 + 27838

**Class Periods:** MWF, Period 6, and 12:50-1:40 pm

**Location:** ZOOM/CANVAS

**Academic Term:** Fall 2020

## **Instructor:**

Dr. Whitney Stoppel

[Whitney.Stoppel@ufl.edu](mailto:Whitney.Stoppel@ufl.edu)

Wertheim 466, 352.392.6205

**Office Hours:** Mondays 2-3:30pm via Zoom

## **Course Description**

The cross-talk between cells and their microenvironment has a direct impact on the cell's behavior and functions, including proliferation, migration, and differentiation. Cells' ability to sense mechanical signals and elicit selected biological functions are what cause observable changes to cell, tissue, and organ structure and composition. As engineers, we aim to utilize biomaterials or in vitro culture platforms to understand these processes, with the ultimate goal being the ability to engineer artificial environments to leverage these processes. Through an exploration of primary literature published starting in the early 2000's, we will follow the journey of the biomaterials community through understanding and leveraging these mechanisms. We will start with an introduction to mechanobiology and basic stem cell biology. We will then proceed with a chronological reading and discussion of the relevant primary literature to enable an understanding of the effects mechanical forces have on development, pathology, and regenerative medicine. Students will be encouraged to think about the role mechanical forces have in their cell, tissue, or organ of choice and devise an experimental plan to investigate their hypotheses through an end of semester project.

## **Course Pre-Requisites / Co-Requisites**

Graduate standing, all MS and PhD students in HWCOE are welcome; ChE undergraduates interested should request instructor approval should space be available. Knowledge of basic biology required.

## **Course Objectives**

- Ability to design experiments and interpret data
- Ability to function on multidisciplinary teams
- Ability to communicate effectively in written work
- Recognition of the need for and an ability to engage in lifelong learning and continued exploration
- Knowledge of contemporary issues in the field of biomaterials and mechanobiology

## **Required Textbooks and Software**

Course content is developed by Dr. Stoppel and will include a combination of pre-recorded videos, live lectures and discussions, primary literature, review papers, and existing resources (e.g., KhanAcademy) to aid in development of necessary background information and assist with vocabulary building. *You must be able to use your video camera for some discussions.*

## **Syllabus Notation:**

**Synchronous Lecture (SL)**- live lecture and journal club-like discussion over Zoom; students are required to show up to the zoom meeting during class time. 90% attendance = all points in participation portion of the course grade (20 SL so for all the points you must be present and active at 18 sessions). Email to notify Dr. Stoppel for excused absences (e.g., attending BMES or AIChE). Video cameras will be needed during some of the SL.

**Asynchronous Learning (AL)**- recorded lecture videos, reading, and other activities for the week exist on CANVAS. Use your class time to watch these videos, read the material and post to the discussion board. Can be

done at own pace; discussion board participation will have deadlines leading up to live, zoom, discussions. CANVAS will contain specific instructions.

### Course Schedule

Week	Date		Type of Lecture	Notes	
Week 1	31-Aug	Monday	SL	Discussion of topics and course trajectory + syllabus	Module 1: Introduction to Biology and Mechanotransduction
	2-Sep	Wednesday	AL		
	4-Sep	Friday	AL		
Week 2	7-Sep	Monday	SL		Module 2: History of Mechanotransduction and Substrate Properties
	9-Sep	Wednesday	SL		
	11-Sep	Friday	AL		
Week 3	14-Sep	Monday	SL		Module 3: MSC Story
	16-Sep	Wednesday	SL		
	18-Sep	Friday	AL		
Week 4	21-Sep	Monday	SL	Writing Assignment 1 Due	
	23-Sep	Wednesday	AL	CAREER SHOWCASE	
	25-Sep	Friday	AL	NOBCCHE 9/24-9/25	
Week 5	28-Sep	Monday	SL		
	30-Sep	Wednesday	SL		
	2-Oct	Friday	AL	Technically no longer a holiday	
Week 6	5-Oct	Monday	SL		
	7-Oct	Wednesday	SL		
	9-Oct	Friday	AL		
Week 7	12-Oct	Monday	SL	Writing Assignment 2 Due	Module 4: More MSCs, but a shift in perspectives
	14-Oct	Wednesday	AL	BMES	
	16-Oct	Friday	AL	BMES	
Week 8	19-Oct	Monday	SL	SACNAS	
	21-Oct	Wednesday	AL	SACNAS	
	23-Oct	Friday	AL	SACNAS	
Week 9	26-Oct	Monday	SL	Writing Assignment 3 Due	
	28-Oct	Wednesday	SL		
	30-Oct	Friday	AL	Group Project Discussion Time (group meetings with Dr. Stoppel)	
Week 10	2-Nov	Monday	SL	**don't forget to vote!	
	4-Nov	Wednesday	AL	Group Project Discussion Time (group meetings with Dr. Stoppel)	
	6-Nov	Friday	AL	Group Project Discussion Time (group meetings with Dr. Stoppel)	
Week 11	9-Nov	Monday	SL		

	11-Nov	Wednesday	HOLIDAY		
	13-Nov	Friday	AL		
Week 12	16-Nov	Monday	AL	AICHe	Module 5: The role of degradation
	18-Nov	Wednesday	AL	AICHe	
	20-Nov	Friday	SL	note this is the only Friday SL	
Week 13	23-Nov	Monday	SL	Writing Assignment 4 Due	
	25-Nov	Wednesday	HOLIDAY		
	27-Nov	Friday	HOLIDAY		
Week 14	30-Nov	Monday	SL		
	2-Dec	Wednesday	AL		
	4-Dec	Friday	AL		
Week 15	7-Dec	Monday	SL		Module 6: Special Topics or more discussion
	9-Dec	Wednesday	AL	Last Day of Class	
Final Project	16-Dec	Wednesday		Project Due via CANVAS submission by 9:30 AM (end of final block)	

### **Online Course Recording**

Our class sessions over zoom may be audio visually recorded for students in the class to refer back and for enrolled students who are unable to attend live. Students who participate with their camera engaged or utilize a profile image are agreeing to have their video or image recorded. If you are unwilling to consent to have your profile or video image recorded, be sure to keep your camera off and do not use a profile image. Likewise, students who un-mute during class and participate orally are agreeing to have their voices recorded. If you are not willing to consent to have your voice recorded during class, you will need to keep your mute button activated and communicate exclusively using the "chat" feature, which allows students to type questions and comments live. The chat will not be recorded or shared. As in all courses, unauthorized recording and unauthorized sharing of recorded materials is prohibited.

### **Attendance Policy, Class Expectations, and Make-Up Policy**

Attendance during SL will be monitored by me taking a screen shot of the participants list during the zoom meeting. Excused absences should be communicated. SL will be recorded when deemed necessary. The class will decide how they want to handle discussions on the first day of class.

### **Evaluation of Grades**

Assignment	Total Points	Percentage of Final Grade
Writing Assignments (50 pts each)	200	36.5%
Final Project	100	18%
Participation in SL	100	18%
Discussion Board Participation	150	27.5%
	550	100%

### **Grading Policy**

Percent	Grade	Grade Points
90.0 - 100.0	A	4.00
87.0 - 89.9	A-	3.67
84.0 - 86.9	B+	3.33

81.0 – 83.9	B	3.00
78.0 - 80.9	B-	2.67
75.0 - 79.9	C+	2.33
72.0 – 74.9	C	2.00
69.0 - 71.9	C-	1.67
66.0 - 68.9	D+	1.33
63.0 - 65.9	D	1.00
60.0 - 62.9	D-	0.67
0 - 59.9	E	0.00

More information on UF grading policy may be found at:

<http://gradcatalog.ufl.edu/content.php?catoid=10&navoid=2020#grades>

### ***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/>.

### ***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.

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](mailto:rbielling@eng.ufl.edu)
- Curtis Taylor, Associate Dean of Student Affairs, 352-392-2177, [taylor@eng.ufl.edu](mailto:taylor@eng.ufl.edu)
- Toshikazu Nishida, Associate Dean of Academic Affairs, 352-392-0943, [nishida@eng.ufl.edu](mailto: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](mailto: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](mailto: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](mailto: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>.