Biology 41: Cells into Organs: Assembly, Function and Disease
Fall 2021
LSC Room 105

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Office Hours: Tue 10 AM – 11 AM, Thurs 2 PM – 3 PM
Meeting times: MWF, 11:30 am – 12:35 pm; (X-hour: Tue, 12:15 pm – 1:05 pm)

Course Description:
How do cells organize into the myriad forms of tissues, and how do they work together to perform specific physiological functions? In this course, we will use epithelial tissues as an example to explore these fundamental questions. Epithelia are among the most common types of tissue organization in animals. They line the cavities, ducts and surfaces of all the major organ systems and provide a variety of functions such as secretion, protection and sensing. During development, epithelial tissues also function in morphogenetic processes that guide the formation of body patterns. Defects in epithelial growth control and function play a major role in human diseases such as cystic fibrosis and cancer. The goal of this course is to understand the form, dynamics and function of epithelial tissues, and how dysregulation of epithelia can lead to various human diseases.

Pre-Requisites: Biol 012 or permission of instructor

Learning Objectives:
1. Gain a working knowledge of the general principles of tissue organization and function.
2. Understand the mechanisms underlying epithelial reorganization in morphogenesis.
3. Learn about how dysregulation of epithelia leads to human diseases.
4. Become familiar with the experimental methods used to study tissue organization, function and morphogenesis.
5. Become comfortable reading research papers from the primary literature that investigate fundamental aspects of epithelial organization and function.

Teaching Approach:
Class period will be a combination of lectures, discussions of the assigned reading (see below), and question-based exercises completed in small groups. Some lecture materials will be delivered as Pre-Lecture recordings accessible on the Canvas page. The in-class group exercises are designed to help reinforce the lecture material and master skills for data interpretation and problem solving. All class sessions will be recorded and posted on Canvas.

Reading Materials:
– There is no required textbook for this course. Instead, I will post selected review articles to supplement the lecture material. These readings are intended to reinforce and contextualize material covered in class. Reading these review articles is optional.
– This syllabus, power point presentations, additional readings, and in-class assignments will be posted to Dartmouth's Canvas site (http://canvas.dartmouth.edu).
– Optional textbook readings for further independent study (will not be covered on the exams):
Epithelial Organization and Development. Edited by Tom P. Fleming
Epithelial Morphogenesis in Development and Disease. Edited by Walter Birchmeier and Carmen Birchmeier

TOPICS AND SCHEDULE:

Part 1 (week 1-3): Epithelial organization, cell polarity and tumorigenesis

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Week 1: Basic principles of epithelial organization

(9/13 M) L1. From cell in solitary to cell aggregates – Self-organization of tissue architecture

(9/15 W) L2. How do cells glue together? – The nuts and bolts of cell-cell adhesions

(9/17 F) L3. Epithelial polarity and tumorigenesis – Lessons from model organisms

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Week 2: Epithelial integrity, cell communication and epithelial-mesenchymal transition

(9/20 M) L4. Epithelial-mesenchymal transition in development and metastasis

(9/22 W) Paper discussion 1:

Cooperative regulation of cell polarity and growth by Drosophila tumor suppressors. Bilder et al. Science. 2000

(9/24 F) L5. How do cells talk to each other? – Chemical communication between cells

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Week 3: Epithelial integrity, cell communication and epithelial-mesenchymal transition (cont.)

(9/27 M) Paper discussion 2:

The transcription factor Snail controls epithelial-mesenchymal transitions by repressing E-cadherin expression. Cano et al. Nat Cell Biol. 2000

(9/29 W) Review session 1

(10/1 F) Midterm Exam 1

Part 2 (week 4-6): Regulation of tissue size and shape

Week 4: Cell proliferation and organ size control

(10/4 M) L6. Coordination of cell proliferation and cell death in organ size control

(10/6 W) L7. Control of cell growth by ECM and integrin signaling

(10/8 F) Paper discussion 3:

Role of YAP/TAZ in mechanotransduction. Dupont et al Nature 2011.

Week 5: Epithelial morphogenesis

(10/11 M) L8. From 2D to 3D: epithelial folding and the role of actin–myosin contractility

(10/13 W) L9. Planar cell polarity: from hair orientation to body axis elongation

(10/15 F) Paper discussion 4:

Pulsed contractions of an actin–myosin network drive apical constriction. Martin et al., Nature. 2009.

Week 6: Epithelial morphogenesis (cont.)

(10/18 M) L10. Human neural tube defects

(10/20 W) Review session 2

(10/22 F) Midterm exam 2

Part 3 (week 7-9): Tissue malfunction, repair and regeneration

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Week 7: Defects in molecule transport

(10/25 M) L11. Molecule transport across the epithelium – What causes Cystic Fibrosis?

(10/27 W) L12. Polarized protein targeting in epithelial cells

(10/29 F) Paper discussion 5:

Misfolding diverts CFTR from recycling to degradation: quality control at early endosomes. Sharma et al., JCB.2004

Week 8: Defects in signal sensing and transduction

(11/1 M) L13. Autosomal Dominant Polycystic Kidney Disease (ADPKD) – Part I (primary cilium and signal sensing)

(11/3 W) L14. Autosomal Dominant Polycystic Kidney Disease (ADPKD) – Part II (what drives cyst formation?)

(11/5 F) Paper discussion 6 (Part 1 of 2: ADPKD, in-class literature search)

Week 9: Tissue repair and regeneration

(11/8 M) L15. How do injured tissues heal themselves? – Mechanisms of wound repair

(11/10 W) L16. Tissue engineering and regenerative medicine

(11/12 F) Paper discussion 6 (Part 2 of 2: ADPKD, in-class group presentation)

Week 10: Review

(11/15 M) Review session 3

Final Exam (Exam 3) Time TBD

ASSESSMENT:

Midterm exams (15% each)
Final exam (20%)
Paper evaluations (5% for each of the 5 papers, plus 5% for Discussion 6; 30% in total)
Class participation (20%)

(1) Exams:

– Exams will focus on material covered in lecture, emphasizing data interpretation and problem-solving. Material from the readings that are not discussed in lecture will not be tested. Students taking the exams are expected to abide by the Dartmouth Honor principle. The midterm and final exams are open book, but they must be completed independently. The answers that you provide must be entirely your own work.
– Graded exams will be returned to the students approximately one week after they are taken. Exams are graded not only for content but also for clarity and conciseness.
– The exam key will be posted on the course Canvas site. If, after reading the key, you feel there was an error in the scoring of your exam, you may submit an error correction request. Include a typewritten explanation stapled to your exam detailing the mistake made in the grading. Do not write or alter the exam prior to handing it in for error correction. The error correction request must be submitted within one week of the distribution of the graded exam.

(2) Paper Evaluations:

– We will read and discuss 5 research papers from the primary literature.
– For each paper, you will complete an assignment addressing a short list of questions related to the background, hypotheses, results and conclusions of the paper.
– The assignments should be submitted electronically (Canvas) **before** the beginning of class on the day we discuss the paper.
– On the day of paper discussion, each group will present a pre-assigned part of the paper.

(3) Class Participation:

– Your active participation in this course is essential and will be evaluated through your attendance at the lectures (10%) and active engagement during the in-class exercises and paper discussions (10%) throughout the term.
– I recognize that we are facing challenging circumstances due to the pandemic. If you are aware of circumstances that will affect your ability to participate in the course regularly or occasionally, please arrange a meeting with me so we can plan ahead. I will be more than happy to work with you to find an avenue for participation that works for your situation if you reach out.

ACADEMIC HONOR:
The Dartmouth College Student Handbook (page iii) states “Fundamental to the principle of independent learning are the requirements of honesty and integrity in the performance of academic assignments, both in the classroom and outside. Dartmouth operates on the principle of academic honor, without proctoring of examinations. Students who submit work which is not their own or who commit other acts of academic dishonesty forfeit the opportunity to continue at Dartmouth.” The complete text of the Dartmouth Academic Honor Principle is given in the Dartmouth College Student Handbook.

There are a number of situations in which a student in Biology 41 might be tempted to violate the Academic Honor Principle. These situations include (but are not limited to) the following:
a) Examinations must be completed without reference to written materials other than those provided with the exam paper and must be completed without communication with anyone else (the only permissible exception is that students may request clarification of any exam question from the course faculty and staff who are present expressly for that purpose). The answers that you provide must be entirely your own work.
b) Class policy permits the re-submission of exams for potential re-evaluation by the professor. Any alteration of the answers between the time when the graded papers were returned to the student and the time when the paper was submitted for re-grading constitutes a breach of the Academic Honor Principle.

Honesty is the foundation of the academic pursuit of knowledge. In recognition of this, the faculty of Biology 41 will not overlook any violations of the Academic Honor Principle. Indeed, the Faculty Handbook of Dartmouth College states explicitly that College Faculty members are obligated to report potential violations of the Academic Honor Principle to the Dartmouth College Committee on Standards. Should the Committee on Standards find the student to be in violation of the Academic Honor Principle, punishments usually involve suspension for multiple terms or separation of the student from the College.

NOTE TO STUDENTS WITH PHYSICAL OR LEARNING DISABILITIES:
I encourage students who may need disability-related academic adjustments to see me privately as early as possible in the term, preferably before the end of the first week. Students requiring disability-related academic adjustments or services must consult the Student Accessibility Services (SAS) office (Carson Suite 125, student.accessibility.services@dartmouth.edu). Once SAS has authorized adjustments or services, I will need to view the originally signed SAS Services and Consent form and/or a letter on SAS letterhead. If you have questions about whether you qualify to receive academic adjustments or services, please contact the SAS office directly. All discussions will remain confidential.

RELIGIOUS OBSERVANCES:
Some students may wish to take part in religious observances that occur during this academic term. If you have a religious observance that conflicts with your participation in this course, please speak with me as soon as possible to discuss appropriate accommodations.

MENTAL HEALTH:
I recognize that the academic environment at Dartmouth is challenging, that our terms are intensive, and that classes are not the only demanding part of your life. There are a number of resources available to you on campus to support your wellness, including:
your undergraduate dean (http://www.dartmouth.edu/~upperde/),
Counseling and Human Development (http://www.dartmouth.edu/~chd/),
and the Student Wellness Center (http://www.dartmouth.edu/~healthed/).
I want you to be aware of these resources and encourage you to use them as needed.

TITLE IX:
At Dartmouth, we value integrity, responsibility, and respect for the rights and interests of others, all central to our Principles of Community. We are dedicated to establishing and maintaining a safe and inclusive campus where all have equal access to the educational and employment opportunities Dartmouth offers. We strive to promote an environment of sexual respect, safety, and well-being. In its policies and standards, Dartmouth demonstrates unequivocally that sexual assault, gender-based harassment, domestic violence, dating violence, and stalking are not tolerated in our community.

The Sexual Respect Website (https://sexual-respect.dartmouth.edu) at Dartmouth provides a wealth of information on your rights with regard to sexual respect and resources that are available to all in our community. Please note that, as a faculty member, I am obligated to share disclosures regarding conduct under Title IX with Dartmouth's Title IX Coordinator. Confidential resources are also available, and include licensed medical or counseling professionals (e.g., a licensed psychologist), staff members of organizations recognized as rape crisis centers under state law (such as WISE), and ordained clergy (see https://sexual-respect.dartmouth.edu/reporting-support/all-resources/confidential-resources). Should you have any questions, please feel free to contact Dartmouth's Title IX Coordinator (Kristi.Clemens@Dartmouth.edu) (and deputies if appropriate).

COVID-19 INFORMATION

ATTENDANCE:

You are expected to attend class in person unless you have made alternative arrangements due to illness, medical reasons, or the need to isolate due to COVID-19. For the health and safety of our class community, please: **do not attend class when you are sick**, nor when you have been instructed by Student Health Services to stay home. Please arrange with me how to catch up on any course material that you miss.

SAFETY:

In accordance with current College policy (https://covid.dartmouth.edu/face-mask-policy), all members of the Dartmouth community are required to wear a suitable face covering when indoors, regardless of vaccination status. This includes our classroom and other course-related locations, such as labs, studios, and office hours. If you need to take a quick drink during class, please dip your mask briefly for each sip. Eating is never permitted in the classroom. (The only exception to the mask requirement is for students with an approved disability-related accommodation; see below.) If you do not have an accommodation and refuse to comply with masking or other safety protocols, I am obligated to assure that the Covid health and safety standards are followed, and you will be asked to leave the classroom. You remain subject to course attendance policies, and dismissal from class will result in an unexcused absence. Additional COVID-19 protocols may emerge. Pay attention to emails from the senior administrators at the College.

ACCOMMODATIONS:

Students requesting disability-related accommodations and services for this course are required to register with Student Accessibility Services (SAS; https://students.dartmouth.edu/student-accessibility/students/working-sas/getting-started-sas; student.accessibility.services@dartmouth.edu; 1-603-646-9900) and to request that an accommodation email be sent to me in advance of the need for an accommodation. Then, students should schedule a follow-up meeting with me to determine relevant details such as what role SAS or its Testing Center (https://students.dartmouth.edu/student-accessibility/services/testing-center) may play in accommodation implementation. This process works best for everyone when completed as early in the quarter as possible. If students have questions about whether they are eligible for accommodations or have concerns about the implementation of their accommodations, they should contact the SAS office. All inquiries and discussions will remain confidential.