

**Biology 41: Cells into Organs: Assembly, Function and Disease**  
**Fall 2023**  
**LSC Room 205**

**Instructor:** Bing He  
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**Office Phone:** 603-646-2649  
**Office Hours:** Mon 4 PM – 5 PM, 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:** BIOL12/BIOL19 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:

### Module 1: Epithelial organization, cell polarity and tumorigenesis

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#### **Topic 1: Basic principles of epithelial organization**

- (9/11 M) L1. From cell in solitary to cell aggregates – Self-organization of tissue architecture  
(9/13 W) L2. How do cells glue together? – The nuts and bolts of cell-cell adhesions  
(9/15 F) L3. Epithelial polarity and tumorigenesis – Lessons from model organisms  
(9/18 M) In-class activities  
(9/20 W) Paper discussion 1:

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

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#### **Topic 2: Epithelial integrity, cell communication and epithelial-mesenchymal transition**

- (9/22 F) L4. Epithelial-mesenchymal transition in development and metastasis  
(9/25 M) L5. How do cells talk to each other? – Chemical communication between cells  
(9/27 W) Paper discussion 2:

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

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- (9/29 F) Review session 1

(10/2 M) 7:00-9:00 PM, Midterm Exam 1 (no meeting during regular class time today)

### Module 2: Regulation of tissue size and shape

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#### **Topic 3: Cell proliferation and organ size control**

- (10/4 W) L6. Coordination of cell proliferation and cell death in organ size control  
(10/6 F) L7. Control of cell growth by ECM and integrin signaling  
(10/9 M) Paper discussion 3:

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

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#### **Topic 4: Epithelial morphogenesis**

- (10/11 W) L8. From 2D to 3D: epithelial folding and the role of actin–myosin contractility  
(10/13 F) L9. Planar cell polarity: from hair orientation to body axis elongation  
(10/16 M) Paper discussion 4:

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

- (10/18 W) L10. Human neural tube defects
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(10/20 F) Review session 2

(10/23 M) 7:00-9:00 PM, Midterm Exam 2 (no meeting during regular class time today)

Module 3: Tissue malfunction, repair and regeneration

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**Topic 5: Defects in molecule transport**

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

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

(10/30 M) Paper discussion 5:

*Misfolding diverts CFTR from recycling to degradation: quality control at early endosomes. Sharma et al., Journal of Cell Biology. 2004*

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**Topic 6: Defects in signal sensing and transduction**

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

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

(11/6 M) Paper discussion 6 – *Part 1 of 2: ADPKD, in-class literature search*

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**Topic 7: Tissue repair and regeneration**

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

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

(11/13 M) Paper discussion 6 – *Part 2 of 2: ADPKD, in-class group presentation*

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(11/14 T) Review session 3 (X-hour)

**Final Exam (Exam 3) 11/19 Sunday: 3 – 5 PM**

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## ASSESSMENT:

Midterm exams (17% each)

Final exam (20%)

Paper evaluations (5% for each of the 5 papers, plus 5% for Discussion 6; 30% in total)

Class participation (16%)

### (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. The error correction request must be submitted within one week of the distribution of the graded exam.

### (2) Paper Assignments:

- 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 must be completed independently and 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 and active engagement during the in-class exercises and paper discussions throughout the term.
- 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 happy to work with you to find an avenue for participation that works for your situation if you reach out.

**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 requesting disability-related accommodations and services for this course are required to register with Student Accessibility Services (SAS; Apply for Services webpage; [student.accessibility.services@dartmouth.edu](mailto: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 may play in accommodation implementation. This process works best for everyone when completed as early in the quarter as possible. If you have questions about whether you are eligible for accommodations or have concerns about the implementation of your accommodations, please contact the SAS office directly. All inquiries and 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 the course, please meet with me as soon as possible, or before the end of the second week of the term—at the latest, to discuss appropriate adjustments. Dartmouth has a deep commitment to support students' religious observances and diverse faith practices.

**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.L.Clemens@Dartmouth.edu](mailto:Kristi.L.Clemens@Dartmouth.edu)) (and deputies if appropriate).

**ACADEMIC HONOR:**

The Dartmouth College Student Handbook 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.”

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 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) The assignments must be completed independently and represent the student’s own work. While students are encouraged to discuss the questions in the assignments with their classmates, all assignments must be written individually by each student.

Honesty is the foundation of the academic pursuit of knowledge. In recognition of this, the faculty will not overlook any violations of the Academic Honor Principle. Indeed, the Faculty Handbook of Dartmouth College states explicitly that College faculty are obligated to report potential violations of the Academic Honor Principle to the Dartmouth College Committee on Standards.

For more information, see <https://students.dartmouth.edu/community-standards/policy/academic-honor-principle>

**COVID-19 INFORMATION:**

If you feel sick or have COVID-19 symptoms, please follow Dartmouth’s COVID-19 guidelines: <https://covid.dartmouth.edu/testing-health#symptoms-and-exposure>