Advanced Developmental Biology and Human Health
Fall 2015

A course offered jointly by:
The Department of Biological Sciences, Carnegie Mellon University
The Department of Biological Sciences, University of Pittsburgh

Time: Tuesday, 6:00 – 8:00 p.m.

Place: 355 Mellon Institute

Pre-requisites (CMU): 03-240 (Cell Biology) and 03-330 (Genetics), or consent of instructor.

Course web sites to access syllabus and pdfs: http://www.cmu.edu/blackboard

Faculty contact information:

Name	Address	Phone	Email
Debbie Chapman	University of Pittsburgh Dept. of Biological Sciences 101 Life Sciences Annex	624-0774	dlc7@pitt.edu
Chuck Ettensohn	Carnegie Mellon University Dept. of Biological Sciences 609-611 Mellon Institute	268-5849	ettensohn@cmu.edu
Jeffrey Hildebrand	University of Pittsburgh Dept. of Biological Sciences 103 Life Sciences Annex	624-6987	jeffh@pitt.edu
Brooke McCartney	Carnegie Mellon University Dept. of Biological Sciences 600D Mellon Institute	268-5195	brookem@andrew.cmu.edu

General course description:
This course examines current research in developmental biology, focusing on areas that have important biomedical implications, such as stem cell biology, cellular reprogramming, cell signaling pathways, tissue morphogenesis, and genetic/developmental mechanisms of birth defects and human diseases. Emphasis is placed on the critical reading of recent, original research papers and classroom discussion, with supporting lectures by faculty.

Learning objectives:
The course is intended to help students accomplish the following goals:
1) To gain expertise in reading and critically analyzing primary scientific literature
2) To gain experience in designing and analyzing original scientific experiments
3) To gain expertise in oral presentation and writing
4) To gain specific knowledge in current areas of research in developmental biology with important implications for human health.

Course structure:
Each module of the course will focus on a specific topic in developmental biology and will be led by one of the course instructors. An introductory lecture by an instructor will launch each module and will be

followed by two class sessions during which papers chosen by the instructor will be discussed. The instructor will lead these discussions but all students should come to class prepared to discuss the papers in detail and to answer questions about the papers. At the conclusion of each module, individual students will present a paper that they have chosen and which is related to the topic of the module.

For Carnegie Mellon students, this course can be taken for 9 units (03-451) or 12 units (03-751). These versions of the course are identical except that students in 03-750 write a grant proposal based on one of the topic areas, due at the end of the semester.

Grading:
Participation in class discussion- 45%
Homework- 30%
Main paper presentation- 20%
Paper introduction presentation- 5%

For students in 03-751, the written grant proposal will constitute 25% of the final grade and the remaining course material (above) will constitute 75% of the final grade.

A note on class participation:
Active participation in class is required of **all** students!! It is expected that each student will have read **all** assigned papers carefully before each class session. Students may wish to read or review a textbook chapter or other material to provide them with the background necessary to understand the reading. All students should come prepared to discuss the overall rationale, design, findings, and significance of the experiments in the assigned papers. Students should think about: the hypotheses behind the experiments, the methodology used, and whether the data support the authors' conclusions.

Missed classes:
As 45% of your grade is based on in-class discussion, missing class is strongly discouraged. If, however, you do miss class because of sickness or religious obligations, you are expected to make up missed material by writing a summary of the papers that were discussed. For each paper, you should turn in a 1-page summary that includes a discussion of why this work was carried out, the methods used, the conclusions drawn by the authors, and why it was important. You should also include your own opinion of the work and whether you feel the data support the conclusions drawn. Make-up papers should be handed in within one week of the missed class.

Main paper presentations:
You will present one paper during the semester. Choose a paper related to one of the topic areas and, as early as possible, e-mail the relevant faculty member to have the paper approved. Paper approvals are on a first-come, first-served basis.

Timing: Plan a 25-30 minute presentation (not including discussion).

During the paper presentation, you should cover the following:

1) Explain why you chose the paper.
2) Provide enough background information to place the paper in the larger context of the field as a whole.
3) You will not have time to go through all of the figures of the paper! Therefore choose the most important/significant figures (or panels from figures) that support the important conclusions of the paper.
4) Identify any major weaknesses in the paper.

5) Identify the broader significance of the work (i.e. how did this work extend our knowledge in this field?).
6) Future studies. What questions were left unanswered? What would you do next?

Your **grade** for your presentation will be based on your:
1) Organization and clarity of presentation
2) Understanding of experiments
3) Identification of important conclusions
4) Ability to answer questions

Presenting students: Be prepared to answer thoughtful, probing questions.
Non-presenting students: For any student not presenting on a particular day, you will be expected to have read the paper and have insightful questions for the presenter. You will be graded on your preparation for this question period as well!

Paper introductions:
Each faculty-selected paper (but **not** the student selected/presented papers) will be introduced briefly by a student. Most students will have only one such introduction during the semester, worth 5% of the course grade. Limit your introduction to 5 minutes and 5 Powerpoint slides MAXIMUM! In your introduction, try to "set the stage" for the paper. You should include:

1) Basic information: What is the title of the paper? How many authors contributed and what institutions were they from? In what journal was the paper published?
2) What was the overarching goal of the work? What were the main gaps in our knowledge that it was trying to fill?
3) What experimental organism/cell type was used in the study?
4) What were the major experimental methods used in the study? Highlight/briefly explain any that you think are especially important or complicated.

2015 Module Topics

1- Vertebrate limb regeneration (Dr. Ettensohn)
2- Cilia in development and disease (Dr. Hildebrand)
3- Intermediate mesoderm (kidney) specification and development (Dr. Chapman)
4- Immune system development (Dr. McCartney)

Course Schedule:

Sept

1 Introduction to course, Module 1 lecture (Ettensohn)
8 Module 1 papers (x2)
15 Module 1 papers (x2)
22 Student presentations (x1), Module 2 lecture (Hildebrand)
29 Module 2 papers (x2)

Oct

6 Module 2 paper (x1), Student presentations (x1)
13 Student presentations (x1), Module 3 lecture (Chapman)
20 No class
27 Module 3 papers (x2)

Nov

3 Module 3 paper (x1), Student presentations (x1)
10 Student presentations (x1), Module 4 lecture (McCartney)
17 Module 4 papers (x1)
24 Module 4 paper (x1), Student presentations (x1)

Dec

1 Student presentations (x2)

Module 1- Vertebrate Limb Regeneration
Charles Ettensohn

Sept 8

Reviews:

1) Brockes JP, Gates PB. Mechanisms underlying vertebrate limb regeneration: lessons from the salamander. Biochem Soc Trans. 2014 Jun; 42(3):625-30.

Discussion papers:

2) Kumar A, Godwin JW, Gates PB, Garza-Garcia AA, Brockes JP. Molecular basis for the nerve dependence of limb regeneration in an adult vertebrate. Science. 2007 Nov 2;318(5851):772-7.

3) Makanae A, Mitogawa K, Satoh A. Co-operative Bmp- and Fgf-signaling inputs convert skin wound healing to limb formation in urodele amphibians. Dev Biol. 2014 Dec 1;396(1):57-66.

Sept 15

Reviews:

1) Rinkevich Y, Maan ZN, Walmsley GG, Sen SK. Injuries to appendage extremities and digit tips: A clinical and cellular update. Dev Dyn. 2015 May;244(5):641-50.

Discussion papers:

2) Sandoval-Guzmán T, Wang H, Khattak S, Schuez M, Roensch K, Nacu E, Tazaki A, Joven A, Tanaka EM, Simon A. Fundamental differences in dedifferentiation and stem cell recruitment during skeletal muscle regeneration in two salamander species. Cell Stem Cell. 2014 Feb 6;14(2):174-87.

3) Takeo M, Chou WC, Sun Q, Lee W, Rabbani P, Loomis C, Taketo MM, Ito M. Wnt activation in nail epithelium couples nail growth to digit regeneration. Nature. 2013 Jul 11;499(7457):228-32.

Cilia in development and disease
Jeffrey Hildebrand

Background

Gray RS, Roszko I, Solnica-Krezel L. (2011) Planar cell polarity: coordinating morphogenetic cell behaviors with embryonic polarity. Dev Cell 21:120-33

Eggenschwiler JT, Anderson KV. (2007) Cilia and developmental signaling. *Annu Rev Cell Dev Biol*. 23:345-73

Pedersen LB, Veland IR, Schrøder JM, Christensen ST. (2008) Assembly of primary cilia. *Dev Dyn*. 237(8):1993-2006

Hirokawa N, Tanaka Y, Okada Y. (2012) Cilia, KIF3 molecular motor and nodal flow. *Curr Opin Cell Biol.* 24(1):31-9.

Paper that will be discussed in class:

September 29

Park TJ, Mitchell BJ, Abitua PB, Kintner C, Wallingford JB. (2008) Dishevelled controls apical docking and planar polarization of basal bodies in ciliated epithelial cells. Nat Genet. 40(7):871-9.

Weatherbee SD, Niswander LA, Anderson KV. (2009) A mouse model for Meckel syndrome reveals Mks1 is required for ciliogenesis and Hedgehog signaling. *Hum Mol Genet.* 18(23):4565-75.

October 6

Yoshiba S, Shiratori H, Kuo IY, Kawasumi A, Shinohara K, Nonaka S, Asai Y, Sasaki G, Belo JA, Sasaki H, Nakai J, Dworniczak B, Ehrlich BE, Pennekamp P, Hamada H. (2012) Cilia at the node of mouse embryos sense fluid flow for left-right determination via Pkd2. *Science.* 338(6104):226-31

Intermediate mesoderm specification and development
Debbie Chapman

Module Lecture: October 13th

Review articles: *Either of these review articles is fine for background information if needed.*

Dressler GR. (2006) The cellular basis of kidney development. *Annu Rev Cell Dev Biol.* 22:509-29.

Dressler GR. (2009) Advances in early kidney specification, development and patterning. *Development* 136(23):3863-74.

Papers for discussions:

October 25th

1) Mauch TJ, Yang G, Wright M, Smith D, Schoenwolf GC. (2000) Signals from trunk paraxial mesoderm induce pronephros formation in chick intermediate mesoderm. *Dev Biol.* 220(1):62-75.

2) James RG, Schultheiss TM. (2003) Patterning of the avian intermediate mesoderm by lateral plate and axial tissues. *Dev Biol.* 253(1):109-24.

November 3rd

3) Chi X, Michos O, Shakya R, Riccio P, Enomoto H, Licht JD, Asai N, Takahashi M, Ohgami N, Kato M, Mendelsohn C, Costantini F (2009) Ret-dependent cell rearrangements in the Wolffian duct epithelium initiate ureteric bud morphogenesis. *Dev Cell* 17(2):199-209.

1 Student selected paper

November 10th

1 Student selected papers