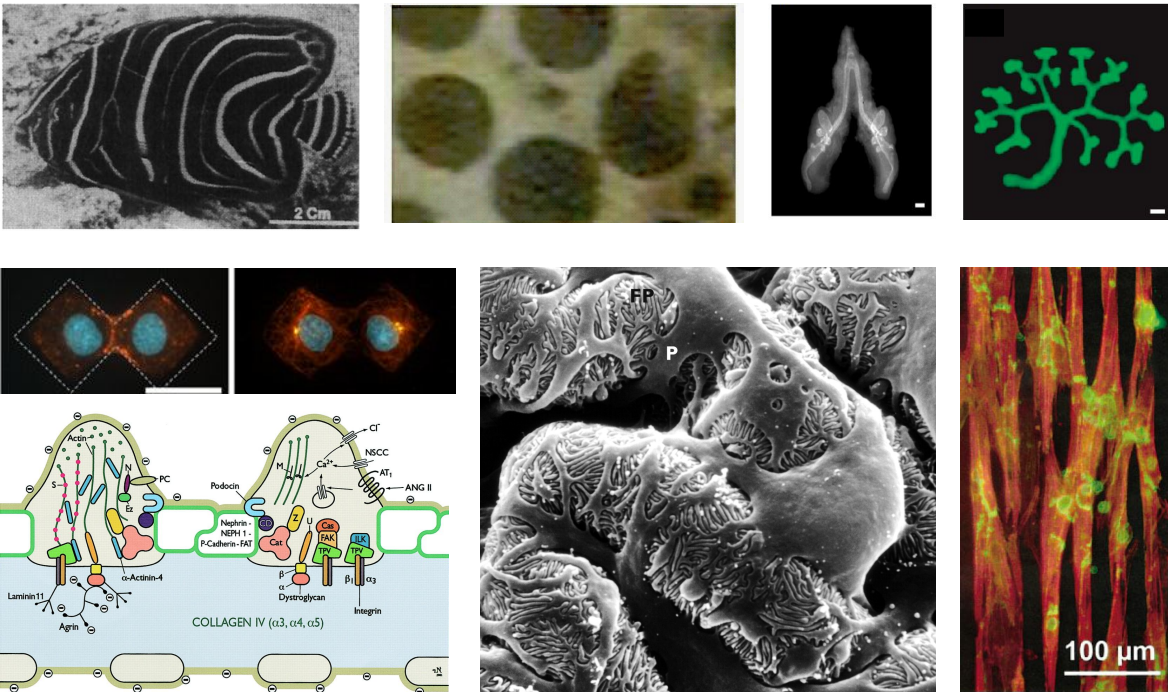


BE159: Signal Transduction and Biomechanics in Eukaryotic Cell Morphogenesis



Syllabus

This course examines the mechanical and biochemical pathways that govern eukaryotic cell morphogenesis. Topics include embryonic pattern formation, cell polarization and migration in tissue development and regeneration. Biomechanics will be treated at the molecular, cellular and multi-cellular levels of organization. In addition to providing background material on cytoskeletal biomechanics and intra/intercellular signaling in cell-matrix and cell-cell interactions, the course will emphasize the interplay between mechanical and biochemical pathways in tissue morphogenesis and homeostasis. Current understanding of malignant transformation will be briefly described as well. The course will briefly introduce appropriate modeling techniques and tools such as fabrication and optical approaches to the quantitative study of morphogenesis.

Course Instructor

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Class Tues/Thurs 2:30 to 4:00 pm Keck 142

TA: Jihun Kim (jhkim@caltech.edu)
 6 units (3-0-6); third term.
 Prerequisite: Bi 8, Bi 9, ACM 95abc.

Evaluation

There will be no exams. The evaluation will be done by the following way.

- a) Form small teams with other people.
- b) Each team chooses one of the following topics (or create one, after discussion with lecturer and TA) and presents a report in mid-term or final weeks. Contribution to the presentation from each team member should be listed and given to the TA.
- c) Those teams not presenting the reports needs to write a critique for the presentation.
- d) The presentations, reports, and critiques will be used for the evaluation.
- e) Alternatively, you can submit a proposal for the report. (Critiques are still required).

Topics for presentation:

Cell migration, chemotaxis, apicobasal polarity, planar cell polarity, crosstalk between integrin and receptor tyrosine kinase, epithelial morphogenesis, epithelial-mesenchymal interaction, epithelial-mesenchymal transition, pattern formation, cell polarity in development and cancer, wound healing, branching morphogenesis

Recommended textbooks:

- a) **“Molecular Cell Biology.”** by Lodish et al., W.H. Freeman and Company, 2007.
- b) **“Biological Physics of Developing Embryo.”** by Gabor Forgacs and Stuart A Newman, Cambridge University Express, 2005.
- c) **“Mechanisms of Morphogenesis: the creation of biological form.”** by James A. Davies, Elsevier Academic Press, 2005.
- d) **“Mathematical Biology.”** by James D Murray, Springer.

Tentative topics for lecture

Topic	Readings or researcher groups
Intracellular biomechanics: actin filaments and myosin	“Molecular Cell Biology.” Ch 17-18
Extracellular Biomechanics: extracellular matrix and surface receptors	“Molecular Cell Biology.” Ch 19
Signal transduction: receptor activation and downstream signaling	“Molecular Cell Biology.” Ch 15-16
Cell migration Cell-matrix and cell-cell adhesion Chemotaxis	Peter Devreotes, Elaine Fuchs, James Nelson
Epithelial morphogenesis Planar cell polarity Apicobasal polarity Epithelial-mesenchymal transition	“Biological Physics of Developing Embryo.” Ch 4-5. Keith E Mostov,

Lumen formation	Elaine Fuchs, Mina Bissel
Cell Shape and cell fates Epithelial morphology and metabolism Cell polarity in development and cancer	Christopher Chan, Donald Ingber, Elaine Fuchs
Mesenchymal morphogenesis and condensation, Epithelial-mesenchymal interaction	Biological Physics of Developing Embryo.” Ch 6. Donald Ingber, Cheng-Ming, Chuong
Pattern formation of skin appendages	Biological Physics of Developing Embryo.” Ch 7. Cheng-Ming, Chuong
Branching Morphogenesis	Biological Physics of Developing Embryo.” Ch 8.

Independent Proposals

Title

Something short and informative

Summary and Specific Aims

One paragraph summary of your research proposal and the specific aims (likely the 2-3 aims of your project in bullet form).

Background and Significance

Include information that will help the reader understand the area of research and what your proposal aims to solve in this research are and why it is significant. What is the general technical area in which you will be working? What is the problem that you are trying to solve, and how did the problem arise? Why is its solution interesting or worthwhile? (2-4 paragraphs)

Research Design and Methods

What do you aim to accomplish in your task? What will you measure, and under what conditions; or, what will you calculate, model, or simulate? What are your starting assumptions or conditions, and what will be the result or product of a successful research project? What are the criteria for success? Specifically, how will you

accomplish your objective? What will you do? What are the principal steps or milestones along the path? How long will each take? What steps promise to be the most difficult, and how will you overcome the difficulties? What equipment or other resources will you need? (3-5 paragraphs)

Conclusion and Feasibility

Summarize your proposal and/or proposed findings. What future studies could be attempted based on your findings or the devices that you are making? What is the feasibility of your proposal? (1-2 paragraphs)

Figures and/or tables (if necessary)

References

List all pertinent papers or reports that you have consulted to prepare your proposal.