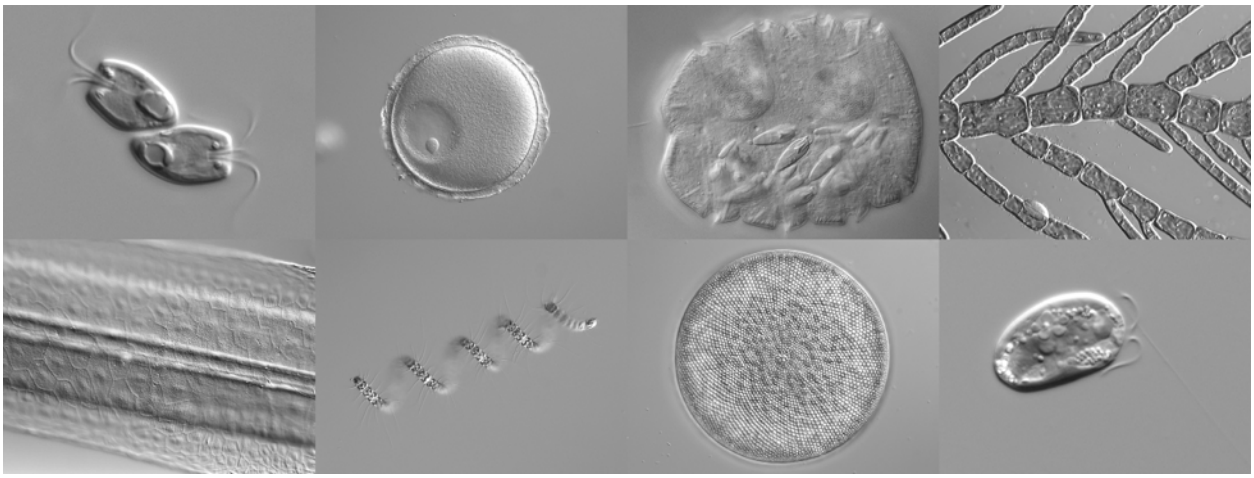
BI 322: Spring 2016
Cell Biology at OIMB: Cell Physiology in the Marine Realm
Instructor: George von Dassow
Meeting Thursdays 9–5 in the McConnaughey Lab



This course covers fundamental topics of cell biology with a focus on marine organisms in relation to their lifestyle in the natural environment. Specific topics will include cell division (mitosis, meiosis, and cytokinesis) and the cell cycle, organization and dynamics of the cytoskeleton, cell motility and related behaviors, intracellular transport, cell shape change, and multicellularity. This course will *not* directly cover gene expression, signal transduction, or prokaryotes.

Text:

Required readings will be limited to papers for weekly discussions. Optional readings (selections from texts, papers, as appropriate) will be available on reserve or through Canvas.

A standard text of cell biology (e.g., Alberts et al., Molecular Biology of the Cell) in any edition published after 2000 will provide a valuable reference but is not explicitly required. Please note that the entire 4th edition of Alberts is available free (requires search; cannot be browsed) through the National Library of Medicine: http://www.ncbi.nlm.nih.gov/books/NBK21054/

Learning goals:

1) Acquire fluency in the basic vocabulary of mainstream cell biology, including competence at reading the primary literature from classical to current works;
2) Master the standard techniques of transmitted light microscopy to observe and document cell shape, structure, and behavior;
3) Become able to develop testable hypotheses, based on the standard repertoire of cell structures and behaviors, to explain kinematic observations of living cells

Grading:

- Class participation (25%) includes attendance for labs, lectures and demos, not falling asleep too much in lectures, and final lab clean-up.

- Discussion (25%) is eight weekly sessions in which groups of students read, analyze, and explain papers from the primary literature of cell biology.
- Weekly quizzes and exercises (25%) will focus on vocabulary and observation.
- Final exam (25%) will be a group final in which everyone is obliged to contribute to answering a mixture of practical and conceptual questions. Every participant will earn the same shared score.
- Video, presentation, and essay (25%): each student is assigned to document on video a cell biological phenomenon, present the video, and turn in a written account.

These add up to more than 100%. The grading approach in this course is based on two principles: first, if your instructor doesn't try to teach you more than you can learn, you're not getting your money's worth (a mathematical proof of this will be provided); second, your instructor doesn't pretend to know everything and can't expect you to either. Therefore, some not-quite-perfect score (100/125, in this case) should be "good enough" for an A.

Course plan:

Week 1 (March 31) – Fertilization, mitosis, and introduction to microtubule cytoskeleton

Lab material: echinoid eggs and embryos, blastulas and early larval stages

Lectures:
1) Introduction to the course and a cellular view of animal development
2) Cell biology of fertilization: cortical reaction, pronuclear migration, and intracellular microtubules
3) Mitosis: stages, spindle function, checkpoints; introduction to cytokinesis
4) Microscope basics

Technical exercises: Köhler alignment; clay-feet preps

Discussion: No discussion first week, microscope tutorial instead

Week 2 (April 7) – Meiosis, mitosis, and cytokinesis in animal embryos

Lab material: starfish oocytes and embryos

Lectures:
5) Meiosis and oocyte maturation: GVBD, meiotic spindle assembly, polar body formation, and centriole management
6) Cytokinesis and the embryonic cell cycle: cytokinetic patterning; asymmetric cell division; development of the blastula

Technical exercises: Phase contrast, DIC; handling individual eggs.

Discussion: fundamental challenges of eggs (Hiramoto's pronuclear migration paper; Rappaport's torus; Schroeder's contractile ring)

Week 3 (April 14) – Cell cycle and cilia

Lab material: more echinoderms, including larvae; observe simple ciliary behavior, organization, and development

Lectures:
7) Cell cycle continued: complete somatic cell cycle; growth control; endoreplication, cell size, etc.; comparative sketch of the cell cycle in relation to eukaryotic life cycles
8) Cilia: ciliary assembly and intraciliary transport; mechanism of motility; primary cilia

Technical exercise: taking photos and videos; microinjection demo

Discussion: adaptations of cell division in animal development (oocyte centriole inheritance; meiotic spindle assembly; asymmetric cleavage)

Week 4 (April 21) – Alternative lifestyles: meet the diatoms!

Lab material: diatoms, cultured and wild-collected; examine and identify various diatoms from plankton and other habitats

Lectures:
9) Biology of diatoms

Technical exercise: Hoechst staining, fluorescence microscopy; more microinjection

Discussion: three classics about ciliary motility

Week 5 (April 28) – Ciliary motility in context

Lab material: phytoflagellates, ciliated larvae; examine various phytoflagellates; look for wild phytoflagellates in water samples; learn to use a haemocytometer

Lectures:
10) Feeding by ciliated invertebrate larvae
11) Survey of phytoflagellates

Discussion: three on the cell biology of diatoms (cytokinesis; frustule formation; motility)

Week 6 (May 5) – Actin-based cytoskeleton and cell crawling

Lab material: most of this lab will be taken up by confocal microscopy; we will try to do some quick-and-simple staining and also use live-labeled embryos to demonstrate actin based motility.

Lectures:
12) Actin: actin dynamics; *Listeria* and the Brownian ratchet; protrusions and cell crawling; muscle and myosin, and non-muscle contractility
13) Confocal microscopy and fluorescent proteins

Technical exercise: confocal microscope demo

Discussion: three phytoflagellate genomes

Week 7 (May 12) – Living together as multicellular organisms

Lab material: cultured and collected macrophytes; examine tissue organization, reproductive structures, growth patterns

Lectures:
14) Multicellularity: Animal epithelia, tissue polarity, and cell shape change
15) Multicellularity: survey of multicellularity in the rest of the eukaryotic world

Technical exercise: more with the confocal, focusing on macrophytes

Discussion: dynamic behaviors of the actin cytokseleton (wound healing; *Thyone* acrosome; ascidian tail resorbtion)

Week 8 (May 19) – Making things with cilia

Lab material: ctenophores, ciliated larvae, ciliates

Lectures:
16,17) Cilia continued: compound cilia; macrociliary development in ctenophores; ciliary sense organs; ciliation constraint

Technical exercise: high-speed video

Discussion: papers on morphogenesis in animals (tubulogenesis in ascidian notochord; ctenophore lithocytes; pilidium growth)

Week 9 (May 26) – Making things outside of cells

Lab material: various examples of extracellular products (skeletons, plates, cuticles, etc.)

Lectures:
18, 19) Secretion: compartments and membrane cycling; protein traffic to the outside; building extracellular structures; biomineralization

Discussion: papers on eukaryotic symbiosis (dinoflagellate eyes; phagotrophy connection in phytoflagellates; cryptophyte origins)

Week 10 (June 2) – Synthesis: organismal biology as the synergy of cell functions

Lab material: Larvaceans; we will try to examine muscles, notochord, ciliary behavior, epithelia, and test/house formation, gonad development, embryogenesis.

Lectures:
20) Biology of larvaceans from the point of view of the cells that compose them

Discussion: no paper discussion, video presentations instead

Finals week:

- We will conduct a group final in the morning of regular class hours (June 9)
- Videos accompanied by write-ups are due on the day of the final.

- The final is followed by lab clean-up. All students must participate fully in lab clean-up.