

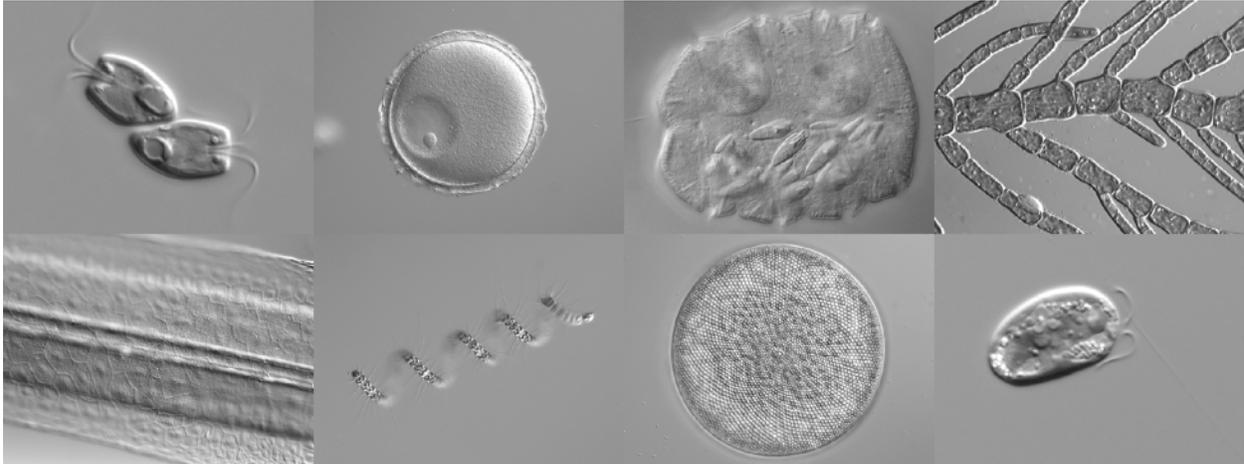
BI 322: Fall 2018

Cell Biology at OIMB: Cell Physiology in the Marine Realm

Instructor: George von Dassow

TA: Kara Robbins

Meeting Fridays 8:30–3:45: McConnaughey Lab for lectures; von Dassow research lab for labs and demos



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. These will be made available on Canvas one week before they are to be discussed in class. 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/>

Another very useful text is Dennis Bray's book "Cell Motility". Scanned selections will be on Canvas and there will be a hard copy for local reserve.

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. **You will not be in competition: I will be thrilled if everyone gets an A.**

Quizzes will be held each week. Most will consist of a fill-in-the-blanks text based on vocabulary study guides from the previous week.

Exercise worksheets will be handed out each week and turned in the next, along with the quiz. Worksheets will be assessed for depth and accuracy of observation. **I don't expect anyone to fill in the entire worksheet:** in general, you are obliged to choose about half the suggested exercises, but if you do a terrific, insightful study of a single question, I will give you full credit.

Course plan:

Paper discussion will take place at 8:30 AM in the Dining Hall. Why? Because they have couches. (Maybe we'll go to the library instead, we'll see.)

Most lectures will take place at 9:30 AM (after discussion) and 1 PM.

Week 1 (Sept. 28) – Fertilization, mitosis, and introduction to the cytoskeleton

Discussion: No discussion first week

Lectures:

- 1) 8:30 AM: Introduction to the course and a cellular view of animal development
- 2) 11 AM: Cell biology of fertilization; cortical reaction, pronuclear migration, and intracellular microtubules
- 3) 1 PM: Mitosis; stages, spindle function, checkpoints; introduction to cytokinesis
- 4) 3 PM: Microscope basics

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

Technical exercises: clay-feet preps; Köhler alignment; darkfield

Week 2 (Oct. 5) – Meiosis, mitosis, and cytokinesis in animal embryos

Discussion: the cytoskeleton and intracellular motion (Tilney's echinoderm acrosome; Hiramoto's pronuclear migration paper; Beroë fertilization; discovery of microtubule-based motors)

Lectures:

5) 9:30 AM: Meiosis and oocyte maturation; GVBD, meiotic spindle assembly, polar body formation, and centriole management

6) 1 PM: Cytokinesis and the embryonic cell cycle; cytokinetic patterning; asymmetric cell division; development of the blastula

Lab material: starfish oocytes and embryos

Technical exercises: Phase contrast, DIC; taking photos and videos.

Week 3 (Oct. 12) – Cell cycle and cilia

Discussion: adaptations of cell division in early animal development (oocyte centriole inheritance; meiotic spindle assembly; cytokinetic timing; checkpoints? what checkpoints?)

Lectures:

7) 9:30 AM: 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) 1 PM: Structure and motility of cilia; ciliary assembly and intraciliary transport; primary cilia

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

Technical exercise: microinjection

Week 4 (Oct. 19) – Alternative lifestyles: meet the diatoms!

Discussion: classics on ciliary motility (*Chlamydomonas* ciliary reversal; ctenophore ciliary reversal; intraflagellar transport; ciliary length control)

Lectures:

9) 9:30 AM: Biology of diatoms

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

Technical exercise: Hoechst staining, fluorescence microscopy

Week 5 (Oct. 26) – Ciliary motility in context

Discussion: cell biology of diatoms (cytokinesis; cell cycle; sexuality; motility)

Lectures:

10) 9:30 AM: Feeding by ciliated invertebrate larvae

11) 1 PM: Survey of phytoflagellates

Lab material: phytoflagellates, ciliated larvae; examine various phytoflagellates; look for wild phytoflagellates in water samples

Technical exercise: high-speed video

Week 6 (Nov. 2) – Actin-based cytoskeleton and cell crawling

Discussion: phytoflagellates as compound cells (Maruyama and Kim phagotrophy; cryptophyte genome; *Emiliana virus*; dinoflagellate eyes)

Lectures:

12) 9:30 AM: Actin: actin dynamics; *Listeria* and the Brownian ratchet; protrusions and cell crawling; muscle and myosin, and non-muscle contractility

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.

Technical exercise: confocal microscope demo

Week 7 (Nov. 9) – Living together as multicellular organisms

Discussion: dynamic behaviors of the actin cytoskeleton (wound healing; ascidian tail resorption; keratocyte lamellipodia; in vitro actomyosin contraction)

Lectures:

13) 9:30 AM: Multicellularity: Animal epithelia, tissue polarity, and cell shape change
14) 1 PM: Multicellularity: survey of multicellularity in the rest of the eukaryotic world

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

Technical exercise: more with the confocal, focusing on macrophytes

Week 8 (Nov. 16) – Making things with cilia

Discussion: morphogenesis in animals (ciliary band in urchins; epithelium of larvaceans; pilidium growth; anemone tentacles)

Lectures:

15,16) 9:30 AM and 1 PM: Back to cilia: compound cilia; macrociliary development in ctenophores; ciliary sense organs; ciliation constraint

Lab material: ctenophores, ciliated larvae, ciliates; work on video projects

Technical exercise: high-speed video

Week 9 (Nov. 23) – Thanksgiving holiday

Week 10 (Nov. 30) – Making things outside of cells

Discussion: papers on eukaryotic symbiosis (green hydra; termite flagellates; *Mesodinium*-cryptophyte relationship; *Dinophysis*-*Mesodinium* kleptoplasty)

Lab material: work on video projects

Lectures:

17, 18) 9:30 AM and 1 PM: Secretion: compartments and membrane cycling; protein traffic to the outside; building extracellular structures; biomineralization

Finals week:

- We will conduct a group final in the morning of regular class hours (Dec. 7)
- Video presentations accompanied by write-ups are due on the day of the final.
- The final is followed by lab clean-up. All students must participate in lab clean-up.