

Advanced Topics in Modern Biology: Biology of Regeneration

Professor Andrew Chisholm adchisholm@ucsd.edu

DRAFT syllabus (3/30/24). Subject to change – changes will be announced in class and on Canvas.

Class meetings will be in-person, Mondays 0930-1050 in York Hall 3010. As this is a discussion-based course, in-person participation is essential.

Office Hours: in-person, Wednesdays 0900-1000 in Bonner Hall 2402, or by appointment

Meeting Schedule

****students will be assigned to discussion groups in week 3. You can trade places with someone in another group (by mutual agreement) as long as you let me know the week before.**

<u>Date/Week</u>	<u>Format</u>	<u>Topic</u>
April 1/Week 1	Lecture 1	Logistics; kinds of regeneration
April 8/Week 2	Lecture 2	Analyzing regeneration
April 15/Week 3	All-class discussion	Presenting and critiquing a research article: heart regeneration
April 22/Week 4	Group Discussion 1	Appendage regeneration I
April 29/Week 5	Group Discussion 2	Whole body regeneration
May 6/Week 6	Group Discussion 3	Skin regeneration
May 13/ Week 7	Group Discussion 4	Neural regeneration I
May 20/Week 8	Group Discussion 5	Neural regeneration II
May 27/Week 9	<u>No meeting/ Memorial Day</u>	
June 3/Week 10	All-class discussion	Appendage regeneration II

Prerequisites: This course assumes knowledge of molecular biology, genetics, and cell biology. BICD100 (Genetics) is a prerequisite; BICD110 (Cell Biology) is strongly recommended.

Course Description

Student-led group discussions of primary research on regenerative biology.

Evaluation: Your grade will be based on (approximately):

50% group presentation

25% in-class participation

25% weekly questions and answers on canvas

Discussions will be on **primary research** article. Below are also listed some review articles for background reading

All papers can be found on PubMed, Google Scholar, using the PubMed or PubMed Central ID (PMID or PMCID). Presenters may also want to find the HTML versions, which sometimes have better images/movies. PubMed Central versions should have identical scientific content to the 'journal' versions but are not typeset or formatted. **For access to non-PMC content you may need to be on a UCSD IP address or VPN.**

Expect to spend 1-2 hours a week reading, more if presenting

RESOURCES

There is no suitable text specifically on regeneration, here are two general developmental biology textbooks that cover it among other dev bio topics:

Developmental Biology (Barresi and Gilbert 13th edition, OUP/Sinauer, 2023), is the leading textbook. The library has copies of earlier editions. Regeneration is covered in Chapter 24.

Essential Developmental Biology (Slack and Dale, 4th edition, Wiley-Blackwell, 2021) is shorter and cheaper. An earlier edition is on Ebook via UCSD library.

Much (not all) of regenerative biology concerns stem cells. You may want to check out **Stem Cell Core Concepts** from the International Society for Stem Cell Research:

<https://www.isscr.org/scientific-clinical-resources/education-resources>

iBiology talks <https://www.ibiology.org/> are aimed at non-experts. There are over 600 covering many areas of basic biology; most relevant are those by **Alejandro Sanchez Alvarado** (history of regeneration, planaria), **Peter Reddien** (planaria), and **Elly Tanaka** (axolotl limb regeneration). I recommend Reddien's talk here: <https://www.ibiology.org/development-and-stem-cells/drive-regeneration/>

The talk by **Susan McConnell** on giving a scientific presentation is recommended.

GROUP PRESENTATIONS

- **The primary goal of the group presentation is to stimulate an interactive class discussion** (meaning: do not lecture). The group presenters will be graded on how well they facilitate class discussion. Raise stimulating questions and leave time for discussion
- The presenting group should prepare **~10-12** slides on the discussion paper (~2 slides per member of the group) for ~ 40-60 minute presentation+discussion. The slides should be in a single powerpoint (or Google slides, etc) that I will upload to the Canvas site after the group discussion.
- The presenting group should meet with me **in person** the week before the class meeting and send me the final presentation after the class meeting. I will be available Thursday afternoons and all-day Fridays to meet with next week's group.
- Each member of the group should be prepared to answer questions and facilitate class discussion.
- The presenting group is responsible for controlling class time. The presentation should not go over 60 minutes!!
- Week 3 will be a 'trial run' of how to present a paper.

PRESENTATION CONTENT

- *Rationale*: What is the *biological problem*? What is the question or hypothesis that motivates the study? (this can be asked of the overall study and of individual sections)
- *Methods*: What are the tools and methodologies used? It is important to spend time on this so the results can be fully understood. Especially: what are the positive and negative

controls in the experimental design?

- *Results*: Each discussion group member should present one or two Figures/Tables. The discussion leaders are responsible for raising stimulating questions.
- **There is no need (or time) to go through every Figure or panel! Focus on the key points, or points that you think are worth discussing.** I will discuss with the presentation groups which aspects to focus on.
- We will not have time to discuss any supplemental information (SI) or extended data in class, but these should at least be skimmed.
- *Rigor and reproducibility*: presenters should stimulate discussion on how 'solid' the experimental design and results are. Sample sizes, controls, statistical tests, data transparency.
- *Conclusions*: How well do the results support the model or test the hypothesis? What are the remaining questions and next steps?
- *For an effective class discussion it is essential you read the paper **before** class. Grades are based on active participation in discussions.*

Questions + Answers on Canvas

- Prior to the group presentation, anyone NOT in the presenting group must submit a question about the paper on Canvas. (Deadline for these will be ~ 0800 on the day of the presentation)
- If needed, I will call on individuals to ask their questions in class.
- Questions must address the *specific scientific content of the paper*. Generic questions such as 'how does this apply to human regeneration' will receive low grades.
- AFTER the group presentation, anyone NOT in the presenting group must submit an answer to their question, based on what they took away from the discussion. Deadline for that will be ~0800 the day after the presentation.
- Questions and answers should not be more than 2-3 sentences.

ACADEMIC INTEGRITY

Group presentations are designed to be collaborative efforts and each member of the group will receive the same points for the presentation. Academic misconduct includes using any prohibited or dishonest means to receive course credit, a higher grade, or avoid a lower grade. Use of Generative AI (GenAI) tools in this class is not permitted. Evidence of GenAI use will be reported to the [Academic Integrity Office](#).

ACCOMMODATIONS

Students requesting accommodations and services due to a disability for this course need to provide a current Authorization for Accommodation (AFA) letter issued by the [Office for Students with Disabilities \(OSD\)](#), prior to eligibility for requests. Receipt of AFAs in advance is necessary for appropriate planning for the provision of reasonable accommodations. Instructors are unable to provide accommodations without authorization by OSD. For more information, contact the OSD at (858) 534-4382.

ATTENDANCE/PARTICIPATION

'Participation' counts for 50% of your grade. Sessions will allow ample time for everyone to participate. Presenters will be graded in part on how they facilitate participation and discussion.

UCSD Principles of Community

Class meetings should be a safe environment for all students and instructors. Class discussions should be conducted in a respectful and collegial manner, in accord with UCSD's [Principles of Community](#). Disruptive behavior may be referred to the [Center for Student Accountability, Growth and Education](#).

READING LIST (Subject to change)

To find these articles, look up in PubMed (<https://pubmed.ncbi.nlm.nih.gov>) using the PMCID or PMID number (or find on Google Scholar). All should be freely available online—anything that is not will be posted on Canvas.

Week 1: Course logistics, examples of biological regeneration and towards a definition

Week 2: Key questions and how to study regeneration

--Key questions in biological understanding regenerative phenomena

--Review the 'conceptual tool kit' of developmental and stem cell biology

Background reviews for lectures 1 and 2:

Reddien and Tanaka 2011. The cellular basis for animal regeneration. PMCID: PMC3139400

Slack 2017. Animal regeneration: ancestral character or evolutionary novelty? PMCID: PMC5579372.

Maden 2018. The evolution of regeneration – where does that leave mammals? PMID: 29938749.

Mokalled and Poss. 2018. A regeneration toolkit. PMCID: PMC6373444

Week 3: Presenting a research article

Presenters: everyone.

Discussion paper: Kikuchi et al 2010. Primary contribution to zebrafish heart regeneration by *gata4*(+) cardiomyocytes. PMCID: PMC3040215.

Background reading: Tzahor and Poss 2017. Cardiac regeneration strategies: staying young at heart. PMCID: PMC5614484

Week 4: Presentation group 1. Appendage regeneration I

Presenters: TBD

Discussion paper: Sugiura et al. 2016. MARCKS-like protein is an initiating molecule in axolotl appendage regeneration. PMCID: PMC4795554

Background reading: Cox, Yun and Poss. 2019. Can laboratory systems instruct human limb regeneration? PMCID: PMC6917474

Week 5: Presentation group 2. Whole body regeneration

Presenters: TBD

Discussion paper: Wagner, Wang and Reddien 2011. Clonogenic Neoblasts Are Pluripotent Adult Stem Cells That Underlie Planarian Regeneration. PMCID: PMC3338249

Background reading: Reddien 2018. The cellular and molecular basis for planarian regeneration. PMID: PMC7706840

Week 6: Presentation group 3. Skin regeneration

Presenters: TBD

Discussion paper: Seifert et al 2012. Skin shedding and tissue regeneration in African spiny mice (*Acomys*). PMID: PMC3480082

Background reading: Erickson and Echeverri 2018. Learning from regeneration research organisms: the circuitous road to scar free wound healing. PMID: PMC5914521

Week 7: Presentation group 4. Neural regeneration I

Presenters: TBD

Discussion paper: Squair et al 2023. Recovery of walking after paralysis by regenerating characterized neurons to their natural target region. PMID: 37733871

Background reading: Zheng and Tuszynski 2023. Regulation of axonal regeneration after mammalian spinal cord injury. PMID: 36604586

Week 8: Presentation group 5. Neural regeneration II

Presenters: TBD

Discussion paper: Enamorado et al 2023. Immunity to the microbiota promotes sensory neuron regeneration. PMID: 36640762

Background reading: preview by Iliev et al. 'When IL-17 gets on your nerves'. PMC10967262

Week 9: No meeting / Memorial Day

Week 10: All class discussion: Appendage regeneration II

Presenters: everyone

Discussion of Abrams et al 2021 A conserved strategy for inducing appendage regeneration in moon jellyfish, *Drosophila*, and mice. PMID8782573, plus: the comment by Sustar and Tuthill 2023 PMC10287152, and the response by Li et al 2023 PMC10287153.