

Developmental Biology

BIOL UN3022

Fairchild 601

TR 1:10 - 2:25pm

Fall 2023

Alice Hecklen



Course Description:

Come discover how the union of egg and sperm triggers the complex cellular interactions that specify the diverse variety of cell types present in multicellular organisms. The cellular and molecular aspects of sex determination, gametogenesis, genomic imprinting, X inactivation, telomeres, stem cells, cloning, the pill and cell interactions will be explored, with an emphasis on humans.

After this class, you should be able to:

- Explain how a grid of paracrine gradients, which is read by transcription factors, assigns organ identity to cells
- Understand how transcription factors, histone modifications and DNA methylation regulate cell fate
- Formulate ways to use stem cells or artificial reprogramming to treat disease
- Comprehend the level of reprogramming per treatment
- Critically evaluate, considering the degree of reprogramming involved, which treatments to approve
- Apply developmental biology principles to understand popular science newspaper articles

Instructor & TA Information

Instructor: Alice Hecklen

Office Hour: T 4-5pm 744B Mudd

e-mail: ah2289@columbia.edu

TAs:

Jaime Jacob

jgj2116

Rahul Mullick

rm3814

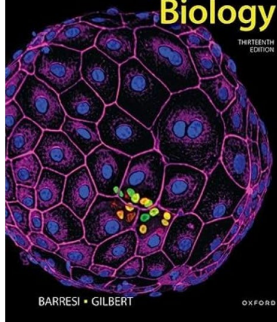
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Prerequisite:

BIOL UN2005/2006 or a comparable year of molecular based intro biology

Developmental Biology



Recommended Textbook:

Barresi & Gilbert, Developmental Biology, 13th Edition, 2024 Oxford

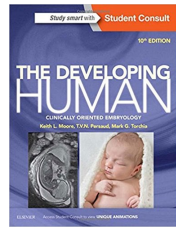
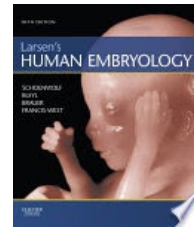
ISBN: 9780197574591

Slides are frequently from (not required):

Schoenwolff et al. 2009 Larson's Human Embryology, 4th Edition, Elsevier.

Moore & Persaud 2008 The developing human:

Clinically oriented embryology 8th Edition, Saunders.



Point Distribution

Exam I & II:	200 (100 points each)
Article Assignments:	40 (10 points each x4)
Article Discussion:	40 (10 points each x4)
Re/Deprogramming Assignment:	10
Heart Case Study:	10
Final Exam:	<u>125</u>
	425

Class Median = B+

348pts (82%) or more = A range & 347 - 297pts (70%) = B range

Graduate student are required to submit Main Points – ask Dr H!

Research Articles:

The primary purpose of the articles is to expose you to current research so you can see how the concepts taught in class are derived.

Use the internet as much as possible for anything you don't know or fully understand.

Annotate your article. If you really want to understand an article (& be able to discuss it),

you need to label the figure specifics, define words, write implications in margins, etc.

For each article, there will be: (1) an individual assignment worth 10 points that requires you to answer questions based on the article and relevant class material (due before we discuss each article in class) & (2) in class questions worth 10 points. Half of these 10 points will be for answering the question regardless of the validity of the answer, to promote participation. **Attendance on article discussion & case study days is required.**

Heart Case Study:

Answers to the questions & the worksheet must be submitted at the end of class

Required Articles:

1. Takahashi et al. 2007 Induction of pluripotent stem cells from adult human fibroblasts by defined factors, *Cell* **131**: 861-872
2. Tachibana et al 2013 Human embryonic stem cells derived by somatic cell nuclear transfer *Cell* **153**: 1-11
Background: Cibelli 2014 *Cell Stem Cell* **14**: 699-701
3. Murakami et al. 2023 Generation of functional oocytes from male mice in vitro *Nature* **605**: 900-906 + extended data figure 2C
4. Liu et al. 2018 Human embryonic stem cell-derived cardiomyocytes restore function in infarcted hearts of non-human primates, *Nature Biotechnology* **36**: 597-605

Newspaper Re/deprogramming Articles

Submit 2 articles from the last 5 years that describes an advancement in re/deprogramming from a major US or British newspaper stating the following:

- Re/deprogramming from stage X to stage Y
- Potency of each of those stages
- State if programming is also occurring & from stage Y to stage Z
- Potency of each of those stages
- State the new advancement in 1 sentence, i.e. why was this news worthy?

Canvas

PowerPoints (posted just before the lecture) and handouts will be posted under “Files” within sequentially numbered lecture folders. Qsets and article Qs will be posted under files in separate folders.

Exam answer keys will also be posted in files. Ask the TAs if you have trouble locating one of the articles that will be discussed in class. These articles are intentionally not posted to be sure you know how to access articles.

Course Policies

Make-up exams. In case of serious illness or personal crisis, rescheduling of the exam will require support documentation (doctor’s note, hospital admission documentation, etc.). Should an emergency arise, please contact Dr. H as soon as possible to arrange a make-up.

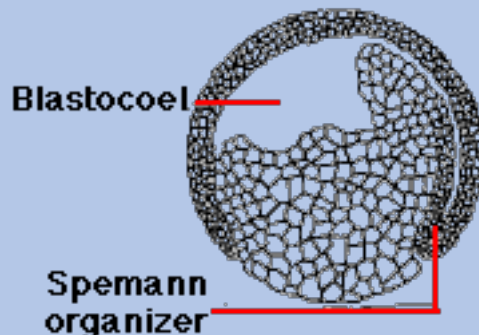
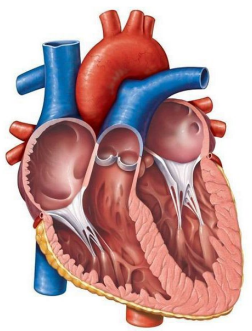
Late Assignment Policy. As this pertains primarily to the individual research article assignments, the purpose of which is to prepare you for the article discussion, no late assignments (i.e., after class has begun for each article) will be accepted.

Regrade Policy. Regrades are permitted up to 1 week after exams are returned in class.

Technology Policy. Laptops and tablets are welcome to facilitate note taking. In addition, every student needs to bring a device to connect to the internet on each of the article days to participate in Poll Everywhere (response system) questions.

AI tools may not be used to complete assignments.

Academic Integrity: as outlined below, is required. <http://www.college.columbia.edu/academics/academicintegrity>



Help & Resources

1. Participate

Questions will be asked throughout the semester. These questions, the case studies and the article discussion are designed to be done in groups. Teamwork has been shown to improve student learning and employers value the ability of employees to work in teams. Participation in these activities will benefit you and your classmates.

2. Instructor Office Hours

T, 4-5pm 744B Mudd

If you can not attend at this time, Please email me to make an appointment.

3. TA Sessions

TAs hold office hours every other week, unless it is a week with an article or an exam. TAs hold review sessions before each article and before each exam. These sessions are a valuable source of advice and information.

4. Instructor Reviews

Dr H holds a review session before each exam

5. Disability Services

Once registered with disability services, students are not required to have accommodation letters signed by the faculty, but students must fill out the student section of the form and submit it to disability services

Course Schedule

Date	Gilbert e12	Topic
1. September 5	Ch 1: 1-5, 17-20	Fate Mapping
2. September 7	Ch 2: 35-43; Ch3 Ch 5: 133-143	Fate Determination Stem cells
3. September 12		TFs & Histone Modifications
4. September 14		DNA Methylation & Imprinting
5. September 19		X Inactivation & Telomeres
6. September 21	Ch 5: 162-173	Artificial Reprogramming, iPS & SCNT
7. September 26	Ch 6: 175-187, 193-203	Lineage Conversion, Organoids & Sex Determination
8. September 28	Ch 7: 211-217; 231-240 Ch 14:441-446	Gametogenesis & Female Cycle
9. October 3	Article 1	Takahashi et al. 2007 Cell 131 : 861-872
10. October 5	Exam 1	
11. October 10		Fertilization + Re/Deprogramming assignment due
12. October 12		Infertility & Embryo Testing
13. October 17	Ch 4: 87-106; 113-116 Ch 8: 247-260	Early Development, Inductions & Fertility Case Study
14. October 19	Article 2	Tachibana et al. 2013 153 : 1-11
15. October 24	Ch 1: 7-12; 14-17 Ch 12: 357-386	Frog Development
16. October 26		Frog Development
17. October 31	Ch 13:418-424 Ch 15:481-483 Ch 14: 435-441, 447-480 Ch 18: 581-587	Neurulation, Lens & Early Human Development
18. November 2	Article 3	Murakami et al 2023 605: 900-906 + Suppl. F2C
19. November 7	Holiday - Elections	
20. November 9	Exam 2	
21. November 14		Placenta, Twins & Human gastrulation
22. November 16	Ch 10:325-328 Ch 13:424-429	Hox Genes
23. November 21	Ch 20: 643-652	Heart
24. November 23	Thanksgiving Holiday	
25. November 28		Heart & Aging
26. November 30	Fig.5.16	Balancing Aging & Regeneration & Cancer
27. December 5		Heart Case Study
28. December 7	Article 4	Liu et al. 2018 Nature Biotechnology 36 : 597-605
Tentative T 12/19	FINAL 1:10—3:10pm	

Red & Green days = required attendance

Readings & topics may not perfectly correspond to the day stated as lectures vary from year to year