POINT 1902 LOMA
NAZARENE UNIVERSITY

Department of Biology

Bio4000 Developmental Biology (course + lab)

4 units total (3 unit lecture + 1 unit lab)
Fall 2026

Meeting days/times: MWF 12:10 – 1:15 (lecture)
Thursdays 2:30 – 5:30 (lab)

Meeting location; Latter 02 (lecture)
Sator 120 (lab)

Final Exam: Monday, Dec. 14th 10:30 – 1:00

INFORMATION	SPECIFICS FOR THE COURSE
Instructor title and name:	Dr. Mike Dorrell
Phone:	619-849-2962
Email:	mdorrell@pointloma.edu
Office location and hours:	Rohr Science 158

Office Hours: M,W 10:30 – 11:30, Mondays from 3:00 – 5:00, and Fridays 8:30 – 10:00. I love to meet with (and help) students. If the "office hour" times don't work for you, please contact me and I am more than happy to find a time that will work. I have an open door policy so if I am in my office, feel free to stop in.

PLNU Mission✪

To Teach ~ To Shape ~ To Send

Point Loma Nazarene University exists to provide higher education in a vital Christian community where minds are engaged and challenged, character is modeled and formed, and service is an expression of faith. Being of Wesleyan heritage, we strive to be a learning community where grace is foundational, truth is pursued, and holiness is a way of life.

Course Description✪

Catalog description: An analysis of mechanisms of early development of invertebrates and vertebrates. Includes a study of the cellular, molecular, and genetic factors that influence cell differentiation and the determination of the body plan, as well as a study of the morphogenesis of selected organ systems. The laboratory uses a variety of model organisms to study normal and abnormal development. Lecture and lab. Offered every year.

Full Description: Developmental Biology is a course about how living organisms in all of their complexity come into being from two single cells. Developmental biology has also emerged as the key factor in determining the mechanism of evolution (Evo-Devo). Studying the emergence of life and coming to know it at quite a sophisticated level is awe-inspiring. The remarkable events that must occur in perfect sequence so that we become functional human beings are extremely complex. It is no less than a miracle that we each began as a single fertilized cell. That is the primary objective in this course. As we study the process of development, we are studying that which has been put in place by our Creator, so perhaps the highest objective of all is that we are drawn into worship, not only because of what God has done, but because of who the Creator is. The same Creator whose work we are studying is also our Father who looks at each of our lives with love and, at times, a sense of pride in us, his greatest creation. So being the finest of the fine, studying the majesty of development reminds us of our very significant place in the universe. It reminds us to not take it lightly.

Program and Course Learning Outcomes✪

- Prepare lab reports demonstrating in-depth observations and analysis of the process of development after performing experiments using various model organisms.
- Understand and describe the specifics of fertilization, gene expression, cell signaling, and tissue differentiation, and how these events relate to our development from a single fertilized cell into a fully developed organism. [PLO #1]
- Summarize the events that occur during development of higher level organs, including neuronal development, cardiovascular systems, and limb development. [PLO #1]
- Design and conduct an independent investigation testing the effects of a teratogen on development using a model organism. [PLO #1]
- Critically evaluate and present primary research literature identifying the research purpose, the important methodology, results and conclusions to an audience relatively knowledgeable in biology.
- Articulate and defend a position on how 'endless forms most beautiful' have evolved from a basis of understanding of the importance of development, developmental switches, and genetic mutations (Evo/Devo). [PLO #3]

Required Texts and Recommended Study Resources*

1. **Lab Manual; Provided through canvas**
2. **Related text (<u>required</u>);** *Endless Forms Most Beautiful.* Sean B. Carroll. Norton Pub.
3. **Text (recommended)**: *Developmental Biology*. 13th Edition. Michael J. Barresi and Scott F. Gilbert. Oxford University Press, 2024. **(the course follows this text closely so this is a great resource for learning and studying. I recommend renting or ebook unless you want to go into Developmental Biology in which case this is a great resource to own and keep)**

Assessment and Grading✪

Exams: Exam II, III, and IV will be cumulative, and thereby will include questions from the previous section of the course. Exam II and III will consist of approximately 15% from the previous section(s), and the final exam (Exam IV) will be about 65% cumulative.

Summary: The activities described above will contribute to your total course grade based on the following percentages (these are subject to change slightly):

Exams I, II, III, IV(Final)	~55%
Lab	~13%
Journal club	~8%
EFMB evo / devo (quizzes, discussions, and reflection)	~8%
Scientific American and Nautilus article summaries (homework)	~6 %
Asynchronous work and class participation	~10 %
Total	**100%**

Letter grades will be assigned at the end of the course based on your percentage of total possible points, according to the following scale:

A	93 – 100%	A-	90 – 93%	B+	87 - 90%	B-	83 - 87%
C+	77 – 80%C	C	73 – 77%	C-	70 – 73%	D	60 – 70%
	NC/F < 60%						

Plusses and minuses (*e.g.*, B+/A-) will be determined partially at the instructor's discretion. A major factor in this decision will be *class participation and general effort*.

Final Examination Policy✪

Successful completion of this class requires taking the final examination on its scheduled day. The final examination schedule is posted on theTraditional Undergraduate Records: Final Exam Schedules site. If you find yourself scheduled for three (3) or more final examinations on the same day, you are authorized to contact each professor to arrange a different time for one of those exams. However, unless you have three (3) or more exams on the same day, no requests for alternative final examinations will be granted.

Major projects and assignments:

JOURNAL CLUB:

A major aspect of keeping up to date with current scientific findings entails reading current primary literature and discussing the findings with colleagues. During 4 labs over the course of the semester, you will be given an article to read. We will be discussing these articles together in lab. Each person will be responsible for reading the article and completing an associated worksheet designed to help guide you through the reading. In lab we will be discussing the articles together and dividing into groups to prepare and present a small portion of the article. In this way, everyone should have a chance to discuss, fully understand, and present portions of the article each week. I will be evaluating everyone on their submitted worksheets, and then a significant portion of this evaluation will be based on participation in the discussion, questions asked, etc., and your group work for the small presentation portions.

REFLECTION ON EVOLUTION AND DEVELOPMENT

Over the course of the semester, we will be relating development to the mechanisms of evolution. During this time, we will also discuss the theological implications of these topics. As part of this section, we will be reading the book "Endless Forms Most Beautiful" ('*EFMB*'), by Sean Carroll. This is an excellent book which I feel ties together the concepts of developmental biology and does a great job of relating them to our current understanding of evolution. As part of this section, you will be expected to write a ~1500 word reflection of development and evolution that incorporates aspects of your learned knowledge of developmental biology, our reading of EFMB, and our discussions throughout the course. These discussions are designed to present the evidence from developmental biology in support of evolution, and to discuss how science and religion can tie together rather than conflict, they are not designed to force any particular stance on this topic. Your stance can shine through in this reflection, regardless of what your viewpoint may be (in fact, I encourage that), as long as your ideas are clearly stated and supported, and a clear understanding of what we've learned in developmental biology is apparent.

BRIEF SUMMARIES OF SCIENTIFIC AMERICAN AND NAUTILUS ARTICLES

Periodically throughout the semester, I will be distributing some relatively simple overviews that relate to particular topics (6 total are planned). These are designed give you an overview of what we are discussing, even while we are diving into some of the more intimate details. They are also designed to give you some extra historical background information, or make you think about the context of the information we are learning as it applies to human life and our beliefs. You will be expected to write and turn in a short summary of each of these (~500 words) that summarizes the article, its main points, and how it fits into our topics.

LAB

See the accompanying lab syllabus and lab schedule for information on the various lab projects, grading, and due dates.

Tentative lecture schedule:

	Date	Topic	Textbook Ref.
Week 1	**8-31**	Intro to Dev Bio; Questions of Dev. Bio	Chapter 1.1 – 1.6 (up to tree of life)
	9-2	History of Developmental Biology, Stages of Development, and Fate Mapping	Chapter 1.1 – 1.6 (up to tree of life)
	9-4	***Asynchronous:*** Paradigm of differential gene expression ***Be reading Primary Lit Article #1: wksht due 9-10***	Chapter 3.1 – 3.3, 3.5 (49–59, 64–72)
Week 2	**9-7**	No Class; Labor Day	
	9-9	Paradigm of differential gene expression ***(Be reading Scientific American article; "Developmental Switches")***	Ch.3.4 (59–63)
	9-11	***No Class (1st Friday off)***	
Week 3	**9-14**	Paradigm of differential gene expression ***Due: "Developmental Switches" by Sunday night***	Chapter 3.6 – 3..7 (75 – 84)
	9-16	Specification	Chapter 2.1 – 2.4
	9-18	***Asynchronous:*** Cell-cell communication - cell adhesion, juxtacrine signals, and paracrine signals ***(Be reading Nautilus Article #1)*** ***Be reading Primary Lit Article #2; wksht due 9-24***	Chapter 4.1 – 4.4 (Pgs 87-98) and 4.7 (106-118)
Week 4	**9-21**	Cell-cell communication in development	Ch. 4.5-4.6
	9-23	Cell – cell communication cont. ***DUE: Nautilus Article #1 due Tuesday night*** ***(make sure you are finishing EFMB intro – Ch. 3)***	Chapter 4.9 (Pgs 128 – 131)
	9-25	***No class (2nd Friday off)***	
Exam #1		**10-1 Lab Period; Exam I (covers Ch. 1 - 4)**	
Week 5	**9-28**	***Asynchronous -- I am gone today at a conference*** Independent study: "The Stem Cell Concept" ***Complete worksheet***	Chapter 5
	9-30	Cell – Cell communication *cont.* Catch up day for Chapters 3 and 4 / Review ***(make sure you are finishing EFMB intro – Ch. 3)***	Chapter 4 (catch up)
	10-2	***Asynchronous:*** *Fertilization part 1 – egg and sperm, and species specificity*	Chapter 7.1 – 7.2 (Pgs. 211 – 223)
Week 6	**10-5**	Fertilization (prevention of polyspermy)	Ch 7.3 (223 - 240)
	10-7	**EFMB discussion (Intro and chapters 1 – 3).** *Quiz on these sections at the beginning of class*	EFMB; Intro – Chapter 3
	10-9	**No Class (3rd Friday off)**	
Week 7	**10-12**	Early development; autonomous specification. Snails, C-elegans, and tunicates	Ch 8.1 – 8.2 Ch. 9.1 , Ch. 11.5
	10-14	Drosophila ***(Be reading Nautilus article #2)***	Chapter 10
	10-16	***Asynchronous:*** Early development; Sea Urchins	Ch. 11 (335-350)

Week 8	**10-19**	Drosophila (cont.) ***Nautilus article #2: sex and gender***	Chapter 10
	10-21	Drosophila (cont.) ***(Be reading EFMB and Nautilus article #3)***	Chapter 10
	10-23	***No class; Fall break and 4th Friday off***	
Exam #2		**10-29 Lab Period; Exam 2 (covers Ch. 5, 7 - 12)**	
Week 9	**10-26**	Drosophila (cont.) ***Nautilus article #3: Spemann's Organizer***	Chapter 10
	10-28	***EFMB discussion. Chapters 4 – 7*** ***Quiz at beginning of class:*** Catch-up day / review	EFMB Ch. 4 - 7
	10-30	***Asynchronous:*** Early development in birds and early mammalian development	Ch. 13.1 – 13.3 Ch 14.3 – 14.5
Week 10	**11-2**	Early development in mammals ***Watch 1st 44 minutes of "What Darwin Never Knew" prior to lab this week***	Ch. 13.4 – 13.5 (418 - 432)
	11-4	Early development in mammals ***Be reading primary lit article #4; wksht due 11-12***	Chapter 13 cont.
	11-6	**No Class (5th Friday off)**	
Week 11	**11-9**	Ectoderm; Neurulation and brain growth	Ch. 15.1 – 15.2 (481-495)
	11-11	Ectoderm; Neural tube development **Be reading Sci. Am. article; *"What makes us human"***	Ch. 15.2 – 15.3 Ch. 16.1 – 16.2
	11-13	***Asynchronous*:** Creativity and cooperation: roles in human evolution ***Evo/Devo reflections due coming up; 11-24)*** ***(Be reading EFMB Ch. 8 – 11)***	
Week 12	**11-16**	Ectoderm; CNS dev. cont.: The human brain ***Due: Sci. Am. Article "What Makes Us Human"***	Ch. 16.3 (518-524)
	11-18	**Catch up day and EFMB discussion (Chapters 8 – 11) and quiz**	
	11-20	Neural Crest ***(Evo/Devo reflections due by end of Mon. 11-23)***	Ch 17.1, 17.3 (525-531, 536-542)
Week 13	**11-23**	**No Class (6th Friday off); Monday of Thanksgiving week in place of Friday last week**	
	11-25	No Class – Thanksgiving Break	
	11-27	No Class – Thanksgiving Break	
Exam #3		**12-3 Lab Period; Exam 3 (covers Ch. 13 - 17)**	
Week 14	**11-30**	Neural Crest	Ch. 17.4 – 17.5
	12-2	Neural Crest	Ch. 17.6 – 17.8
	12-4	***Asynchronous:*** Heart & blood vessel development	Ch. 20..2 – 20.4
Week 15	**12-7**	Tetrapod limbs ***(Due: Self-designed teratogen write-up)***	Ch. 21.1 – 21.3 (663-675)
	12-9	Making tetrapod limbs ***(Be reading "How limbs develop"; extra credit)***	Ch. 21.4 – 21.6 (676-692)
	12-11	***Asynchronous (short; if needed):* limbs** ***(Due; Sci. Am. Article: "How Limbs Develop")***	Ch. 21.7 – 21.9 (693-699)
Final Exam; Monday, Dec. 14th 10:30 – 1:00			

Tentative lab schedule:

Date	Topic	Text
9-3	**Lab 1: Chick development observation** **Lecture on Lab techniques**	**(Lab 1) Chick embryonic development**
9-10	**Lab 2 (intro): Lab introduction and practice dejellying embryos** **- *Intro teratogen exp.***	**(Lab 2) Axolotls and Teratogens** **- Continue chick observations**
	Journal club #1. Science article… DNA methylation in honeybee epigenetics (first part of lab)	
9-17	**Lab 2b (perform retinoic acid and cyclopamine mutagenesis). (lab manual Pg. 7-11)**	**Continue chick observations (euthanize remaining chick embryos)**
	Finalize teratogen partner and teratogen – Phys. Relevant conc. / solubility	
9-24	**Lab 2c analysis of teratogenic effects on axolotls (manual pgs. 7-11)**	***Lab 1 write-up (Intro and results) due*** **Lab 4; (self-designed exp.) – planning stages (*read pgs 29 – 35 in manual*)**
	***Journal club #2.* iPS cells & modeling Spinal Muscular Atrophy (SMA)**	
10-1	**Exam 1 (Chapters 1 – 4).**	
10-8	**Fertilization lab and start of Self-designed teratogen experiment…**	***Lab 2 write-up: results and discussion*** **Lab 3: Sea Urchin fertilization**
	Come prepared to work on creating physiological concentrations for your teratogen experiment. – zebrafish asynchronous work	
10-15	**Lab 4; Self-designed teratogen experiment**	***Have zebrafish embryos delivered (Dorrell)***
	Journal club #3. Nature article…Generation of a novel wing pattern by wingless morphogen	
10-22	**No lab --- Fall break (Lab 3, methods write-up due)**	
10-29	**Exam II (Chapters 5, 7-12)**	
11-5	**Self-designed teratogen work**	***Have zebrafish embryos delivered (Dorrell)***
	***Journal club #4.* Nature article… Control of ground state pluripotency by allelic regulation of Nanog.**	
11-12	**Evo - Devo video / human skulls /**	**continue to work on teratogen experiment.**
11-19	**Self-designed teratogen work analyses and follow-up -- (analyzing data)**	***Draft of introduction and methods for Self-designed teratogen experiment due***
11-26	**No lab – Thanksgiving break**	
12-3	**Exam III (chapters 11-15)**	
12-7 (Mon)	***Self-designed teratogen experiment write-up due***	
12-10	**Presentations**	**Teratogen presentations (by group)**

Attendance: Attendance at lab sessions is required. Absence from a lab results in a zero for any work done on that day.

Content Warning*

I acknowledge that each of you comes to PLNU with your own unique life experiences. This contributes to the way you perceive various types of information. In [class name], all of the class content, including that which may be intellectually or emotionally challenging, has been intentionally curated to achieve the learning goals for this course. The decision to include such material is not taken lightly. These topics include [list topics]. If you encounter a topic that is intellectually challenging for you, it can manifest in feelings of discomfort and upset. In response, I encourage you to come talk to me or your friends or family about it. Class topics are discussed for the sole purpose of expanding your intellectual engagement in the area of [subject/major], and I will support you throughout your learning in this course.

Trigger Warning*

I acknowledge that each of you comes to PLNU with your own unique life experiences. This contributes to the way you perceive several types of information. In [class name], we will cover a variety of topics, some of which you may find triggering. These topics include [list topics]. Each time this topic appears in a reading or unit, it is marked on the syllabus. The experience of being triggered versus intellectually challenged are different. The main difference is that an individual must have experienced trauma to experience being triggered, whereas an intellectual challenge has nothing to do with trauma. If you are a trauma survivor and encounter a topic in this class that is triggering for you, you may feel overwhelmed or panicked and find it difficult to concentrate. In response, I encourage you to take the necessary steps for your emotional safety. This may include leaving class while the topic is discussed or talking to a therapist at the Counseling Center. Should you choose to sit out on discussion of a certain topic, know that you are still responsible for the material; but we can discuss if there are other methods for accessing that material, and for assessing your learning on that material. Class topics are discussed for the sole purpose of expanding your intellectual engagement in the area of [subject/major], and I will support you throughout your learning in this course.

Incompletes and Late Assignments

All assignments are to be submitted/turned in by the beginning of the class session when they are due—including assignments posted in Canvas. Late assignments will be deducted points based on the amount of time past the due date that they are submitted. In general, there will be a 10% reduction for each day late.

Spiritual Care*

Please be aware PLNU strives to be a place where you grow as whole persons. To this end, we provide resources for our students to encounter God and grow in their Christian faith.

If you have questions, a desire to meet with the chaplain or have prayer requests you can contact your professor or the Office of Spiritual Life and Formation.

State Authorization✪

State authorization is a formal determination by a state that Point Loma Nazarene University is approved to conduct activities regulated by that state. In certain states outside California, Point Loma Nazarene University is not authorized to enroll online (distance education) students. If a student moves to another state after admission to the program and/or enrollment in an online course, continuation within the program and/or course will depend on whether Point Loma Nazarene University is authorized to offer distance education courses in that state. It is the student's responsibility to notify the institution of any change in his or her physical location. Refer to the map on State Authorization to view which states allow online (distance education) outside of California.

PLNU Copyright Policy✪

Point Loma Nazarene University, as a non-profit educational institution, is entitled by law to use materials protected by the US Copyright Act for classroom education. Any use of those materials outside the class may violate the law.

PLNU Academic Honesty Policy✪

Students should demonstrate academic honesty by doing original work and by giving appropriate credit to the ideas of others. Academic dishonesty is the act of presenting information, ideas, and/or concepts as one's own when in reality they are the results of another person's creativity and effort. A faculty member who believes a situation involving academic dishonesty has been detected may assign a failing grade for that assignment or examination, or, depending on the seriousness of the offense, for the course. Faculty should follow and students may appeal using the procedure in the university Catalog. See Academic Policies for definitions of kinds of academic dishonesty and for further policy information.

Artificial Intelligence (AI) Policy*

You are allowed to use Artificial Intelligence (AI) tools (e.g, ChatGPT, iA Writer, Marmot, Botowski) to generate ideas, but you are not allowed to use AI tools to generate content (text, video, audio, images) that will end up in any work submitted to be graded for this course. If you have any doubts about using AI, please gain permission from the instructor.

PLNU Academic Accommodations Policy✪

PLNU is committed to providing equal opportunity for participation in all its programs, services, and activities. Students with disabilities may request course-related accommodations by contacting the Educational Access Center (EAC), located in the Bond Academic Center (EAC@pointloma.edu or 619-849-2486). Once a student's eligibility for an accommodation has been determined, the EAC will issue an academic accommodation plan ("AP") to all faculty who teach courses in which the student is enrolled each semester.

PLNU highly recommends that students speak with their professors during the first two weeks of each semester/term about the implementation of their AP in that particular course and/or if they do not wish to utilize some or all of the elements of their AP in that course.

Students who need accommodations for a disability should contact the EAC as early as possible (i.e., ideally before the beginning of the semester) to assure appropriate accommodations can be provided. It is the student's responsibility to make the first contact with the EAC.

PLNU Recording Notification⊛

In order to enhance the learning experience, please be advised that this course may be recorded by the professor for educational purposes, and access to these recordings will be limited to enrolled students and authorized personnel.

Note that all recordings are subject to copyright protection. Any unauthorized distribution or publication of these recordings without written approval from the University (refer to the Dean) is strictly prohibited.

Language and Belonging*

Point Loma Nazarene University faculty are committed to helping create a safe and hospitable learning environment for all students. As Christian scholars we are keenly aware of the power of language and believe in treating others with dignity. As such, it is important that our language be equitable, inclusive, and prejudice free. Inclusive/Bias-free language is the standard outlined by all major academic style guides, including MLA, APA, and Chicago, and it is the expected norm in university-level work. Good writing and speaking do not use unsubstantiated or irrelevant generalizations about personal qualities such as age, disability, economic class, ethnicity, marital status, parentage, political or religious beliefs, race, gender, sex, or sexual orientation. Inclusive language also avoids using stereotypes or terminology that demeans persons or groups based on age, disability, class, ethnicity, gender, race, language, or national origin. Respectful use of language is particularly important when referring to those outside of the religious and lifestyle commitments of those in the PLNU community. By working toward precision and clarity of language, we mark ourselves as serious and respectful scholars, and we model the Christ-like quality of hospitality.

You may report an incident(s) using the Bias Incident Reporting Form.

Sexual Misconduct and Discrimination*

In support of a safe learning environment, if you (or someone you know) have experienced any form of sexual discrimination or misconduct, including sexual assault, dating or domestic violence, or stalking, know that accommodations and resources are available through the Title IX Office at pointloma.edu/Title-IX. Please be aware that under Title IX of the Education Amendments of 1972, faculty and staff are required to disclose information about such misconduct to the Title IX Office.

If you wish to speak to a confidential employee who does not have this reporting responsibility, you can contact Counseling Services at counselingservices@pointloma.edu or find a list of campus pastors at pointloma.edu/title-ix.

PLNU Attendance and Participation Policy✪

Regular and punctual attendance at all class sessions is considered essential to optimum academic achievement. If the student is absent for more than 10 percent of class sessions, the faculty member will issue a written warning of de-enrollment. If the absences exceed 20 percent, the student may be de-enrolled without notice until the university withdrawal date or, after that date, receive an "F" grade.

In some courses, a portion of the credit hour content will be delivered asynchronously and attendance will be determined by submitting the assignments by the posted due dates. See Academic Policies in the Undergraduate Academic Catalog.

Asynchronous Attendance/Participation Definition

A day of attendance in asynchronous content is determined as contributing a substantive note, assignment, discussion, or submission by the posted due date. Failure to meet these standards will result in an absence for that day. Instructors will determine how many asynchronous attendance days are required each week.

Loma Writing Center

The Loma Writing Center exists to help all members of the PLNU community cultivate transferable writing skills to engage their academic, professional, personal, and spiritual communities. We work toward this goal by conducting one-on-one consultation sessions, supporting writing education across the PLNU community, and participating in ongoing writing center research.

Getting feedback from the Loma Writing Center while you're in the process of working on an assignment is a great way to improve the quality of your writing and develop as a writer. You are encouraged to talk with a trained writing consultant about getting started on an assignment, organizing your ideas, finding and citing sources, revising, editing for grammar and polishing final drafts, and more. For information about how to make in-person or online appointments, see Loma Writing Center webpage or visit the Loma Writer Center on the first floor of the Ryan Library, room 221.