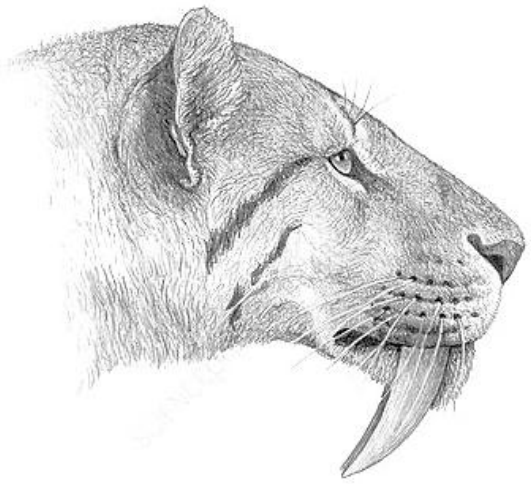
Department of Biology / College of Natural and Social Sciences

BIO4010/4010L – Vertebrate Biology

4 units



Syllabus Fall 2025

Meeting times:

- **Lecture –** MWF 1:30 pm – 2:30 pm
- **Lab** – M 2:45 pm – 6:15 pm; field trip days we flip lecture & lab times

Meeting location: Rohr Science 40 (in basement)

Final Exam: Friday December 15, 1:30 pm – 4:00 pm

Catalog Course Description **BIO 4010 – Vertebrate Biology / BIO 4010L (4 units)**

An exploration of the evolution of morphology, physiology, and behavior of the vertebrate lineage from hagfish to humans. Appropriate emphasis is given to the major evolutionary approaches of form and function, phylogenetic systematics, taxonomy, natural selection, evo-devo, and the study of fossils and molecular genetics. The course works its way from fish to tetrapods, surveying the distinguishing morphology, physiology, ecology, and lifestyle adaptations of each group. Conservation status and current threats from human impacts are covered. Students learn through readings, group activities and discussions, films, and a research project tracing the evolution of a currently threatened vertebrate species or group. Prerequisite: BIO 2011; Co-requisite: BIO 4010L.

Instructor: **Dr. Mike Mooring** Voice: 619-849-2719
Rohr Science 128 Email: mmooring@pointloma.edu

Open Office Hours – Please make an appointment to see me!

TAs: **Amar Massarani**, Lab TA Email: amassara0022@pointloma.edu
Anna Mason, Grader-TA Email: amason0022@pointloma.edu

Texts*: Vertebrate Life 10th edition, by Pough & Janis.; Oxford University Press, 2018.
ISBN: 9781605356075

Labs for Vertebrate Zoology 2nd edition, by Gergus & Schuett, 2000 (reprint).
ISBN: 9781884125782

Required: iClicker2 – bring to every class meeting; Dissection kit for all dissection labs

*This course is part of **LomaBooks**. The bookstore will provide each student with a convenient package containing all required physical materials; all digitally delivered materials will be integrated into Canvas. Click on this link for more information about LomaBooks.

Evolution as God's Creative Tool

Long ago God created the world. He created the sun, the moon, and the stars, as well as all the creatures which inhabit the earth. He created all of them out of nothing — not in a single instant of time, but over a vast period of time.

Genesis 1:1 (An interpretive translation by John Sailhamer, 'Genesis Unbound', 1996)

There is grandeur in this view of life, with its several powers, having been originally breathed by the Creator into a few forms or into one; and that, whilst this planet has gone cycling on according to the fixed law of gravity, from so simple a beginning endless forms most beautiful and most wonderful have been, and are being evolved.

Charles Darwin (from 'The Origin of Species', 1859)

It is wrong to hold creation and evolution as mutually exclusive alternatives. I am a creationist and an evolutionist. Evolution is God's method of Creation.

Theodosius Dobzhansky, 1973

Course Objectives

The goal of this course is to gain an intimate appreciation of God's design for life by analyzing and comparing the anatomy, physiology, ecology, and behavior of the vertebrates. We will examine how structure changes from one vertebrate group to another, and how structural changes are correlated with functional changes. Evolution, the mechanism of historical change and relatedness among groups of organisms, will be considered as God's creative tool. Such historical changes in the structure and function of vertebrates are not random, but reflect adaptations for solving different problems encountered in the environment. A unifying theme will be the role of evolutionary processes and the use of phylogenetic systematics (cladistics) to organize vertebrate diversity and to formulate hypotheses that seek to solve the 'mysteries' of vertebrate evolution. Current conservation efforts to save vertebrate species and retain biodiversity will be an underlying theme and a personal motivation.

Course Learning Outcomes

Upon completion of the course, you will be able to:

- Explain how vertebrate form is a product of both function and evolutionary history.
- Assess the role of natural selection and evo-devo in the emergence of novel traits and body plans.
- Summarize the principles of the cladistic approach to evolutionary history and relatedness.
- Compare the major groups of vertebrates in terms of structural, physiological, and behavioral traits.
- Be familiar with taxonomic nomenclature and the phylogenetic tree of major vertebrate taxa.
- Research and describe the importance of protecting and conserving vertebrate biodiversity.
- Research, synthesize, and analyze data from the literature for an original research project.

COURSE DESIGN –

(1) Lecture and Lab: The lecture and lab components will cover most of the same topics, although they will not always be synchronized. Lab partners will complete exercises in phylogenetic systematics, comparative anatomy dissections, examination of mounted specimens, and field trips to the Birch Aquarium and the San Diego Zoo. For the comparative anatomy labs, you will need the Gergus & Schuett lab manual, a dissecting kit with sharp scalpel blades, and clothing that can get dirty.

(2) Textbook Readings and Questions: I have prepared a set of guided questions for each topic reading in the Pough & Janis textbook that is available on the Canvas Module for that week. The guided questions are designed to: (1) help you focus on the information that is most relevant to this course, (2) prepare you for iClicker quizzes and exams, and (3) give you the foundational knowledge for the in-class activities.

(3) Exams: The exams will include multiple choice, short answer, and a cladogram that will allow you to demonstrate your grasp of whole concepts and ability to synthesize different material. Each exam will count equally; the midterms will be non-comprehensive and the final will be semi-comprehensive. Study guides will specify the material you need to know. I will not cover all the material in lecture, but you should be reading the assigned chapters in the textbook to prepare for exams.

(4) Great Transitions Review Paper: Towards the semester's end, you will conduct independent research and write a paper about a major transition in vertebrate evolution – i.e., evolution of a novel character seen in the transformation from an ancestral to a derived form, with a focus on the transitional stage ("missing link"). Your paper will be 4-5 pages with a minimum of 6 journal article references properly cited. A rubric will be available. The goal is to craft an engaging but scientifically accurate account the proposed evolutionary transition in the best tradition of science journalism. Note that you may use AI only to generate ideas for your topic, but all research and writing must be YOU.

(5) Canvas: All the class material will be available to you on the course Canvas site. Assignments will be submitted via Canvas Modules and graded online. Bring your laptops to class and lab, as the in-class assignments will be submitted online. Canvas does not support 'Pages', so submit Word or PDF files.

(6) iClickers: Class will involve a combination of lecture and small group activities. Classroom quizzes based on readings and assignments will be administered using **iClicker2**, so please always bring your clicker to class so that your participation is recorded. Clickers will be used to assess participation (engagement) and performance (getting the right answer). Total iClicker points will be adjusted to compensate for excused absences. I will also be experimenting with the ***Poll Everywhere*** app this semester.

(7) Course Attendance Policy: You are required to sign the attendance roster at each and every class meeting. You are permitted 5 absences without penalty. Every absence in excess of 5 will incur a penalty to be deducted from your attendance participation points and will impact your final grade.

(8) Late Assignments: All assignments should be submitted before the due date and time indicated on Canvas. Late penalties will apply for all assignments submitted after the due date. For labs (15-20 pts) and readings (5 pts), 2 points and 1 point will be deducted for each day late, respectively; no points will be awarded after 10 days under normal circumstances. The intent of late penalties is to encourage you to turn in your work on time, and to be fair to those who do. If you have a legitimate reason for not submitting an assignment on time, please email both the grader and professor in a timely fashion (as soon as possible).

(9) Academic Honesty: The PLNU policy on academic honesty is listed under the institutional policies. My experience is that many students are not aware that some of their regular practices are considered plagiarism. For example, while you are free to discuss readings and lecture material among yourselves, I expect that you will each do your own work on individual assignments. In this case, teaming up with other students to write joint answers that are then turned in as if they were individual efforts is considered plagiarism. Do not share electronic files of your answers to an assignment with another student; if they subsequently use your answers in their assignment, you are also guilty of plagiarism.

(10) Electronic Etiquette: Recent studies have indicated that we are currently experienced an epidemic of 'digital distraction' caused by multi-tasking – moving quickly between tasks on electronic devices in which only partial attention is given to each task. In the classroom setting, studies reveal that the use of laptops and smartphones for non-course related tasks (checking emails, texts, social media) distracts attention from learning and results in reduced academic performance and lowered grades. The reality is that you cannot fully learn new information or master new concepts when distracted by multi-tasking. Evidence indicates that even classmates who see your screen are distracted and their performance reduced. To ensure the best learning environment possible, please plan to do the following:

- **During lecture use your laptop ONLY for taking notes, nothing else.**
- **During class, power off and put away all other electronic devices.**
- **Take some notes by hand because handwriting improves learning.**

Recent research on the effect of multitasking on learning

- **The impact of Smartphone use on course comprehension**
- **Digital distractions from point of view of higher education students**
- **Dividing attention in the classroom reduces exam performance**
- **The influence of technology on academic distraction**

(11) Artificial Intelligence (AI) Policy: The university has provided free access to **NotebookLM**, which is a type of generative AI that functions as a sort of personalized AI assistant to help organize information from lecture slides and readings, produce summaries and learning aids such as mock questions, podcasts, and video overviews of the material covered. These tools can be helpful when combined with traditional study methods (i.e., you will still have to memorize strange terms!). This tool should only be used with the lecture slides and other resources provided to you. Everyone also has access to other **generative AI systems** (e.g., ChatGPT, Gemini, Perplexity), which are LLM (Large Language Models) that generate text. These models are trained on massive datasets, and none of them are foolproof – they can make mistakes. The trick is to learn how to use these tools wisely to help you now without hurting you later. You may use these tools to organize information but not to write your assignments for you. All use of AI for assignments must be acknowledged and cited using APA citation format for AI attribution.

Assignment	Approximate Points
Exams: 3 @ 100 pts	300
Text questions: 21@ 5 pts	105
Clicker quiz points	75
Great Transitions paper	50
Classroom activities	50
Attendance participation	50
Lab reports: 13@ 20 pts	260
TOTAL	**840**

Letter	Percent	Letter	Percent
A	90	C	70
A-	88	C-	68
B+	86	D+	66
B	80	D	60
B-	78	D-	58
C+	76	F	<58

Vertebrate Biology Class Schedule - Fall 2025

Readings are for Pough et al. 10th edition

DATE	TOPIC	CHAPTER	SECTION	PAGES
Sept 1	**LABOR DAY**			
Sept 3	Evolution	1	1.2-1.3	5-9
Sept 5	Evo-Devo	1	1.4	11-14
	Duplication of Hox genes	2	2.4	27-28
Sept 8	*Summary of Vertebrate Diversity*	1	1.1	1-4
	Basic Vertebrate Attributes	2	2.1-2.6	19-36
Sept 10	Earliest Fish	3	3.1-3.3	41-50
Sept 12	Arrival of Jaws	3	3.4-3.7	51-61
Sept 15	Living in Water	4	4.1-4.2	65-72
Sept 17	Radiation of Cartilaginous Fish	6	6.1-6.2	95-101
	Optional - Extant Sharks and Rays	*7*	*7.1-7.5*	*103-114*
Sept 19	Radiation of Bony Fish 1	8	8.1-8.3	121-130
Sept 22	Radiation of Bony Fish 2	8	8.1-8.3	121-130
	Optional - Extant Bony Fish	*9*	*9.1-9.8*	*133-56*
Sept 24	Life on Land: Arrival of Tetrapods	10	10.1-10.4	161-175
Sept 26	**NO CLASS MEETING – *Au Sable Academic Advisory Council***			
Sept 29	Life on Land: Arrival of Tetrapods	10	10.1-10.4	161-175
Oct 1	♦**Exam 1** (Wed)			
Oct 3	Amphibians	11	11.1-11.6	181-206
Oct 6	Amphibians	11	11.1-11.6	181-206
Oct 8	Ectothermy	15	15.1-15.5	269-279
Oct 10	World of Turtles	16	16.1-16.6	283-295
Oct 13-15	Snakes and Lizards	17	17.1-17.10	301-323
Oct 17	Crocodylians	18	18.1-18.6	239-337
Oct 20-22	Dinosaurs and Mesozoic Diapsids	19	19.1-19.11	343-366
Oct 24	**FALL BREAK**			
Oct 27	Endothermy	20	20.1-20.4	371-383
Oct 29	♦**Exam 2** (Wed)			
Oct 31	Origin of Flight	21	21.1-21.4	387-394
Nov 3	Origin of Flight	21	21.1-21.4	387-394
Nov 5-7	Avian Specializations	22	22.1-22.12	399-429
Nov 10	Avian Specializations	22	22.1-22.12	399-429
Nov 12-14	Evolution of Mammals	24	24.1-24.5	451-474
Nov 17	Common Features of Mammals	25	25.1-25.8	481-515
Nov 19	Specializations of Mammals	25	25.1-25.8	481-515
Nov 21	Ecology and Sociality of Mammals	25	25.1-25.8	481-515
No 24	Neotropical Mammalogy Special Topics			
Nov 26-28	**THANKSGIVING RECESS**			
Dec 1-5	Primate Evolution	26	26.1-26.7	519-549
Dec 8-12	Human Evolution	26	26.1-26.7	519-549

Dec 19 (FRIDAY) ♦**Final Exam** (1:30 - 4:00 PM)

Vertebrate Biology TEXT READING SCHEDULE – 2025

- Readings are for Pough et al. 10th edition. Assignments are due by 12:00 noon of the date indicated.
- These are estimated due dates; check the Canvas Modules assignments for current due dates.

DATE DUE	TOPIC	READING	SECTION	PAGES
Sept 3	Evolution – Phylogenetic Systematics	1	1.2-1.3	5-9
Sept 5	Evo-Devo	2	1.4 2.4	11-14 27-28
Sept 8	Basic Vertebrate Attributes	3	2.1-2.6	19-36
Sept 10	Earliest Fish	4	3.1-3.3	41-50
Sept 12	Arrival of Jaws	5	3.4-3.7	51-61
Sept 17	Radiation of Cartilaginous Fish	6	6.1-6.2	95-101
Sept 19	Radiation of Bony Fish	7	8.1-8.3	121-130
Sept 24	Life on Land: Arrival of Tetrapods	8	10.1-10.4	161-175
Oct 1	**Exam 1**			
Oct 3	Amphibians	9	11.1-11.6	181-206
Oct 10	World of Turtles	10	16.1-16.6	283-295
Oct 13	Snakes and Lizards	11	17.1-17.10	301-323
Oct 17	Crocodylians	12	18.1-18.6	239-337
Oct 20	Dinosaurs and Mesozoic Diapsids	12	19.1-19.11	343-366
Oct 29	**Exam 2**			
Oct 31	Origin of Flight	13	21.1-21.4	387-394
Nov 5	Avian Specializations	14	22.1-22.12	399-429
Nov 12	Evolution of Mammals	15	24.1-24.5	451-474
Nov 19	Specializations of Mammals	16	25.1-25.8	481-515
Nov 21	Ecology and Sociality of Mammals	17	Variety of readings	
Dec 1	Primate Evolution	18	24.1-24.6	581-611
Dec 8	Human Evolution	19	26.1-26.7	519-549
CONSERVATION READINGS	Declining Shark Populations	7	7.4	114
	Pollution, overfishing, and fish farming	9	9.8	155-156
	Why are amphibians disappearing?	11	11.6	205-206
	Fateful characteristics of turtles	16	16.6	295
	Lepidosaurs and climate change	17	17.10	323
	Crocodylians and the skin trade	18	18.6	337
	Birds and urbanization	22	22.12	428-429
	Mammals and trophy hunting	25	25.8	513-515
	Humans and other vertebrates	26	26.7	547-549

Vertebrate Biology Lab Schedule - Fall 2025

All on-campus labs (e.g., dissection labs) are MONDAY from 2:45-6:15 pm in RS 40. On field trip days we will flip our lecture-lab schedule and do the field trip first followed by the lecture class after returning to campus. We will meet at 1:30 for the field trip, return to campus by 5:00, and meet for class at 5:20 in Rohr Science 40. All labs are due before the next lab.

Labs that are starred (*) will involve dissection of preserved specimens; bring dissecting kit and wear appropriate clothing.

G&S = Gergus & Schuett lab manual.

DATE	LAB #	ACTIVITY	READING
Sept 1		**LABOR DAY (no lab)**	
Sept 8	1	Systematics: phylogenetic & taxonomic analysis	G&S Lab 1
Sept 15	2*	Hemichordata, Urochordata, & Cephalochordata	G&S Lab 2
	3*	Jawless Craniates: Myxinoidea & Petromyzontoidea	G&S Lab 3
Sept 22	4*	Gnathostomata: Chondrichthyes	G&S Lab 4
Sept 29	5	▲ **Field trip to Birch Aquarium**	Handout
Oct 6	6*	Osteichthyes: Actinopterygii, Latimeria & Dipnoi	G&S Lab 5
Oct 13	7*	Tetrapoda: Amphibia	G&S Lab 6
Oct 20	8*	Amniota: Reptilia (turtles, snakes, and lizards)	G&S Lab 7 – part 1
Oct 27	9	▲ **Field trip to San Diego Zoo: *Amphibians & Reptiles***	Handout
Nov 3	10*	Amniota: Reptilia (birds)	G&S Lab 7 – part 2
Nov 10	11	▲ **Field trip to San Diego Zoo: *Birds***	Handout
Nov 17	12*	Amniota: Mammalia	G&S Lab 8
Nov 24	13	▲ **Field trip to San Diego Zoo: *Mammals***	Handout
Dec 1	14	Mammalia: Mounts, skins, skulls, and teeth	Handout
Dec 8	15	Research Project Presentations	

PLNU INSTITUTIONAL POLICIES

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 becomes an expression of faith. Being of Wesleyan heritage, we aspire to be a learning community where grace is foundational, truth is pursued, and holiness is a way of life.

ARTIFICAL INTELLIGENCE (AI) POLICY

You are allowed to use Artificial Intelligence (AI) tools to generate ideas and organize information, but you are NOT allowed to use AI tools to generate final content that will end up in any work submitted to be graded for this course. AI tools (e.g., ChatGPT, Gemini, Perplexity) are based on predictive machine learning and not true 'intelligence', thus the information it gives you may be inaccurate and must be fact-checked! Use of AI for assignments must be acknowledged and cited using APA citation format for AI attribution. If you have any doubts about using AI, please ask the instructor.

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.

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 619-849-2533). 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 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 drop date or, after that date, receive an "F" grade.

STATE AUTHORIZATION

State authorization is a formal determination by a state that PLNU is approved to conduct activities regulated by that state. PLNU is not authorized to enroll online (distance education) students in certain states. Thus, if a student moves to another state after admission to the program and/or enrollment in an online course, 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.

CONTENT WARNING

I acknowledge that each of you comes to PLNU with your own unique life experiences which contribute to the way you perceive various types of information. In BIO4010/4010L (Vertebrate Biology) all of the class content, including that which may be intellectually or emotionally challenging, has been intentionally designed to achieve the learning goals for this course. The decision to include such material is not taken lightly. **These topics include evolutionary changes in organisms, global environmental shifts, and lab dissections of representative vertebrates**. If you encounter a topic that is intellectually challenging for you, it can manifest in feelings of discomfort and upset. If this occurs, I encourage you to come talk to me or your friends or family about it. Class topics are addressed for the sole purpose of expanding your intellectual engagement in the area of vertebrate biology and I will support you throughout your learning in this course.

TRIGGER WARNING

In BIO4010/4010L (Vertebrate Biology) we will be exploring the theme of **evolutionary changes in the form and function of vertebrate organisms, as well as global environmental shifts and lab dissections.** It is possible that these topics and activities may be a trigger for you. 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 vertebrate biology and I will support you throughout your learning in this course.

LANGUAGE AND BELONGING

Point Loma Nazarene University faculty are committed to helping create a safe and hospitable learning environment for all students. As such, it is important that our language be equitable, inclusive, and prejudice free. 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. If you (or someone you know) have experienced other forms of discrimination, you can find more information on reporting and resources at Nondiscrimination and Anti-harassment Policy.

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 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.

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 students 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.

FINAL EXAMINATION POLICY

Successful completion of this class requires taking the final examination on its scheduled day. 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.

Diversity of the Vertebrates