

Course Syllabus

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Evolutionary Developmental Biology

-The deep origins of the vertebrate body plan-

Course Syllabus (Spring 2022)

Course number: 01:447:470

Class location: RWH-208 Busch (in person) and Zoom (online). The zoom link is TBD.

Class meeting times: Monday and Thursday, 10:20AM-11:40AM

Canvas site: <https://Canvas.rutgers.edu/portal/site/75349788-bbec-4c05-8353-0fa4f9967224/page/5c90b8ab-7369-46f4-8950-16d2e9c03979?Canvas.state.reset=true>

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Phone: 848-445-7191

Email: nakamura@dls.rutgers.edu (email is the preferred method of contact)

Office Hours: Wednesday 9:30-11:30, **Arranging time before meeting is necessary.** Please

send an email to me first if you have any questions and want to discuss.

Course Description: Evolutionary origins of the vertebrate body plan are major problems in biology. While paleontology and comparative anatomy have revealed the evolutionary trajectories of organs, recent genetics, genomics and developmental biology are becoming powerful approaches to answer classical questions. The goals of this course are twofold; 1) obtain fundamental knowledge of anatomy, development, and the latest genomics and 2) learn how to integrate genetics, genomics and developmental biology to answer evolutionary questions through discussion during the course. The training to discover and answer scientific problems in animal diversity will be performed at the American Museum of Natural History (this is subject to change depending on the Covid-19 situation).

Course Goals: Students are expected to:

- Understand the concept of comparative anatomy and evolutionary history of vertebrate body.
- Understand the evolutionary mechanisms of vertebrate body in the light of genetics and genomics.
- Study state-of-the-art genomics to answer evolutionary questions.
- Learn how to integrate genomics, genetics, and developmental biology to reveal evolutionary mechanisms.
- Learn how to discover scientific problems from vertebrate morphology on sites.
- Learn how to approach scientific problems and how to discuss scientific ideas.

Departmental Learning Goal:

- Study basic concepts and terminology of comparative anatomy, developmental biology, and evolutionary genomics.
- Learn how to integrate genomics, genetics, and developmental biology to understand vertebrate evolution.
- Discuss methods to approach evolutionary problems based on published scientific papers.

Textbook

Required;

Vertebrates: Comparative Anatomy, Function, Evolution. 7th Edition.

by Kenneth Kardong ISBN-13: 978-0078023026

Recommended (but not required);

Developmental Biology 11th Edition by Scott F. Gilbert and Michael J.F. Barresi

ISBN-13: 978-0878939787.

The copy of this textbook will be uploaded on Canvas before lectures if necessary.

Other scientific articles that explain evolutionary genomics will be provided via Canvas.

Academic integrity policy

In accordance with Departmental and University Policies, violations of academic integrity will be reported to the dean. Violations include: cheating, fabrication, plagiarism, and facilitating violations of academic integrity. The use of another person's words, ideas, or results without giving that person appropriate credit or copying another student's work or answers on a quiz or examination are strictly prohibited. More information about violations of academic integrity is available on the following website: <http://academicintegrity.rutgers.edu/academic-integrity-policy/>. You are supposed to read all information and agree Departmental and University Policies.

Class Attendance (IMPORTANT-READ CAREFULLY)

Students are expected to attend and be punctual for all classes. **Attendance will be taken at the beginning of class using iClicker (see below).** Students will lose points for habitual lateness. If you expect to miss a class, you **MUST** use the University absence reporting website <https://sims.rutgers.edu/ssra/> to indicate the date and reason for your absence. If a student misses more than two classes prior to the withdrawal deadline, they will be asked to withdraw. If students have difficulties to attend classes, please contact an instructor before the course starts. **As the Covid-19 is still spreading in U.S., this course in Spring 2022 will be conducted as a “hybrid” of in person and online lectures. Students prefer to take this course via Zoom should contact the instructor at nakamura@dls.rutgers.edu BEFORE the course starts.**

Mini-quiz

At the first 5-10 minutes of the classroom is assigned for mini-quiz. You can check your textbooks/notes during mini-quiz if necessary. **However, if you do not pre-read textbooks, you do not have enough time to answer all of the mini- quiz.**

Required device for attendance and mini-quiz

iClicker Cloud will be used to check attendance and conduct mini-quiz. Students install an app to mobile device or use a device “iClicker”, which can be purchased at the Rutgers Bookstore. Find more info here; <https://canvas.rutgers.edu/external-apps/iclicker/>

Performance Expectations and Evaluation Methods

Grades will be based on attendance to lectures, performance of exams and quizzes, and presentations after a field trip. Percent contribution towards the final course grade will be as follows:

20% for pre-class reading – quizzes

20% Attendance

15% for a presentation of approaches to evodevo questions (group work)

15% for exam I

15% for exam II

15% for final exam

Grades will be calculated based on overall course performance. The following grading scale will be used:

85% A

80% B+

75% B

70% C+

60% C

I reserve the right to modify the grading scale downward (e.g., making the lowest A an 80%), but I will not adjust the grading scale upward. Grades below "C" will be determined based on the final score distribution at the end of the course.

Important: points will be taken off for not following instructions or not meeting deadlines!

Rules of conduct

Cell phone use is not allowed in class except for mini-quiz and attendance. If a student is found to use a cell phone in class, she/he will lose a point of attendance in that lecture. Laptop computers are necessary to attend classes, but not for surfing the internet or playing games. Such behavior is distracting to other students in the class. **Students who are found to have violated this policy will lose a point of attendance.** Recording of lectures or classmate presentations by students is not permitted; however, **recordings of online lectures will be available for all students who registered for this course.**

What is the class like?

This is a course to help students understand how we approach evolutionary problems by integrating comparative anatomy, genetics, genomics, and developmental biology. To follow the course, pre-reading the provided materials or text books are necessary. The course will proceed with a significant amount of small group discussion including the instructor and presentation of own idea. **Presenting your idea and discussing**

scientific problems in a classroom are significantly encouraged. The types of lectures can be categorized into three components and a group presentation:

-Comparative Anatomy

The Instructor will explain the basic anatomy of the vertebrate body and the ways to compare morphologies among different species. Pre-reading of text books is necessary, and the knowledge will be tested by a mini quiz at the beginning of lectures. You do not need to remember all of the anatomical vocabulary.

-Development

The molecular mechanisms of vertebrate development and current problems will be explained by an instructor. Pre-reading of text books is necessary, and the knowledge will be tested by mini quiz at the beginning of lectures. Usually, lectures will proceed with active group discussions with an instructor.

-Genomics and genetics

The instructor will provide recent articles that deploy state-of-the-art genomics to answer evolutionary questions. The instructor will do a mini quiz at the beginning of lectures. The lectures of genomics and genetics would be more practical than that of anatomy and development. Through discussion in lectures, students will learn how to combine anatomy, genomics, genetics, and developmental biology to answer evolutionary questions.

-A field trip to AMNH and presentations

During one-day field trip to the American Museum of Natural History, students will be assigned into small groups (3-4 students/group) and will explore evodevo questions regarding to animal diversity. In the previous years, seminars and a backyard tour provided by professors at AMNH were a part of this trip. However, these activities could be conducted as online lectures during the course to meet the safety guideline of Covid-19 in Spring 2022. After coming back to the campus, two lectures will be off for summarizing scientific questions and preparing presentations that will show how to approach the questions. Each presentation length is 10-15 minutes followed by 5 minutes Q&A session. The details of presentation style and score criteria will be provided in classes. **As the field trip takes place on Saturday (4/2/2022), the attendance to the AMNH trip is not counted for a grade. Students who can not attend explore scientific questions using online resource and conduct group presentations. Given the Covid-19 situation, students may also prefer this online option.** The details of the AMNH trip is subject to change.

Information for Student-Wellness Services:

Just In Case Web App (<http://codu.co/cee05e>)

Access helpful mental health information and resources for yourself or a friend in a mental health crisis on your smartphone or tablet and easily contact CAPS or RUPD.

Counseling, ADAP & Psychiatric Services (CAPS)

(848) 932-7884 / 17 Senior Street, New Brunswick, NJ 08901/ rhscaps.rutgers.edu/

CAPS is a University mental health support service that includes counseling, alcohol and other drug assistance, and psychiatric services staffed by a team of professional within Rutgers Health services to support students' efforts to succeed at Rutgers University. CAPS offers a variety of services that include: individual therapy, group therapy and workshops, crisis intervention, referral to specialists in the community and consultation and collaboration with campus partners.

Violence Prevention & Victim Assistance (VPVA)

(848) 932-1181 / 3 Bartlett Street, New Brunswick, NJ 08901 / vpva.rutgers.edu/

The Office for Violence Prevention and Victim Assistance provides confidential crisis intervention, counseling and advocacy for victims of sexual and relationship violence and stalking to students, staff and faculty. To reach staff during office hours when the university is open or to reach an advocate after hours, call 848-932-1181.

Disability Services

(848) 445-6800 / Lucy Stone Hall, Suite A145, Livingston Campus, 54 Joyce Kilmer Avenue, Piscataway, NJ 08854 (<https://ods.rutgers.edu/>)

The Office of Disability Services works with students with a documented disability to determine the eligibility of reasonable accommodations, facilitates and coordinates those accommodations when applicable, and lastly engages with the Rutgers community at large to provide and connect students to appropriate resources.

Scarlet Listeners

(732) 247-5555 / <http://www.scarletlisteners.com/>

Free and confidential peer counseling and referral hotline, providing a comforting and supportive safe space.

Schedule

Schedules are subject to changes due to school closings, class progress, etc. Any updated syllabus will be posted on Canvas.

#	Date	Day	Time	Topic/Activities	Assignments BEFORE CLASS
1	Jan. 20	Thursday	10:20-11:40AM	Opening - 400 million years of vertebrate evolution	
2	Jan. 24	Monday	10:20-11:40AM	Craniofacial: the origin and basic anatomy of the skull in early vertebrates (Anatomy)	<i>Pre-reading: Chapter7 of Vertebrates (p240-253)</i>
3	Jan. 27	Thursday	10:20-11:40AM	Craniofacial: the general trends of cranial evolution in vertebrates (Anatomy)	<i>Pre-reading: Chapter7 of Vertebrates (p254-265)</i>
4	Jan. 31	Monday	10:20-11:40AM	Craniofacial: the enigma of the cell origins (EvoDevo)	<i>Pre-reading: p464-480 of Developmental Biology</i>

5	Feb. 3	Thursday	10:20-11:40AM	Craniofacial: the genetic mechanisms of skull diversity – fish, chimp, and human (Genomics)	<i>Pre-reading: scientific articles and some copy of textbooks will be uploaded Canvas</i>
6	Feb. 7	Monday	10:20-11:40AM	Appendage: hands of fish, whale, and bat (Anatomy)	<i>Pre-reading: Chapter9 of Vertebrates (p325-346, but skip from “Pectoral girdle” of p336 to “Pelvic girdle” of p339 and also Fig.9.19-9.2)</i>
7	Feb. 10	Thursday	10:20-11:40AM	Appendage: development of fins and limbs (EvoDevo)	<i>Pre-reading: Chapter19, Developmental Biology (p613-627)</i>
8	Feb. 14	Monday	10:20-11:40AM	Appendage: genetic basis for striking adaptations (Genomics)	<i>Pre-reading: Chapter19, Developmental Biology (p635-646), scientific articles will be uploaded in Canvas</i>
9	Feb. 17	Thursday	10:20-11:40AM	Exam 1 (Craniofacial & Appendage)	
10	Feb. 21	Monday	10:20-11:40AM	Musculature: from simple to complex - how can birds fly? (Anatomy)	<i>Pre-reading: Chapter10 of Vertebrates (Fig.10.18&10.20 and p39-410, Skip all TABLES and BOX essay)</i>

#	Date	Day	Time	Topic/Activities	Assignment Due?
11	Feb. 24	Thursday	10:20-11:40AM	Musculature: canonical theory and contradiction (Development)	<i>Pre-reading: Chapter 17 of Developmental Biology (Fig. 17.1, fig. 17.2, and p560-570)</i>
12	Feb. 28	Monday	10:20-11:40AM	Musculature: secrets of electronic rays and turtles (Genomics and evodevo)	<i>Pre-reading: p575-578 of Developmental Biology, scientific articles will be uploaded in Canvas</i>
13	Mar. 3	Thursday	10:20-11:40AM	Integument: scales, feathers, and antlers (Anatomy)	<i>Pre-reading: Chapter 6 of Vertebrates (p212-224)</i>
14	Mar. 7	Monday	10:20-11:40AM	Integument: developmental mechanisms of integumentary systems (Development)	<i>Pre-reading: p528-537 of Developmental Biology and scientific articles will be uploaded in Canvas</i>
15	Mar. 10	Thursday	10:20-11:40AM	Integument: are scales and feathers homologous? (Evodevo & genomics)	<i>Pre-reading: scientific articles will be uploaded in Canvas</i>
16	Mar. 14	Monday		No lecture	Spring recess
17	Mar. 17	Thursday	10:20-11:40AM	No lecture	Spring recess

18	Mar. 21	Monday	10:20-11:40AM	Exam2 (Musculature and Integument)	
19	Mar. 24	Thursday	10:20-11:40AM	The nervous system: cranial nerves of sharks, snakes, and you (Anatomy)	<i>Pre-reading: Chapter16 of Vertebrates (p628-641)</i>
20	Mar. 28	Monday	10:20-11:40AM	The nervous system: Body trunk or appendages? (Development)	<i>Pre-reading: Figure16.2 of Vertebrate Kardong and p488-497 of Developmental Biology</i>
21	Mar. 31	Thursday	10:20-11:40AM	The nervous system: dissecting evolutionary mechanisms of innervation (genomics)	<i>Pre-reading: p465-466 of Developmental Biology, and other scientific articles will uploaded in Canvas</i>
22	Apr. 2	<u>Saturday</u>	10am-5:30 am at AMNH	Lectures by AMNH professors, a backyard tour, exploration of evodevo questions.	
23	Apr. 4	Monday	10:20-11:40AM	A lecture off in-lieu	

24	<i>Apr. 7</i>	Thursday	10:20-11:40AM	A lecture off in-lieu	
25	<i>Apr. 11</i>	Monday	10:20-11:40AM	Presentation preparations with group members in a classroom:	
26	<i>Apr. 14</i>	Thursday	10:20-11:40AM	No lecture (prep for presentation, NO need for coming to a class room). The instructor is available on Zoom and Canvas to answer any questions.	
27	<i>Apr. 18</i>	Monday	10:20-11:40AM	No lecture (prep for presentation, NO need for coming to a class room). The instructor is available on Zoom and Canvas to answer any questions.	
28	<i>Apr. 21</i>	Thursday	10:20-11:40AM	Group presentation and discussion (1)	<i>Pre-reading: p635-645 of Developmental Biology (again!), and scientific articles will be uploaded in Canvas</i>
29	<i>Apr. 25</i>	Monday	10:20-11:40AM	Group presentation and discussion (2)	<i>Pre-reading: scientific articles will be uploaded in Canvas</i>

30	Apr. 28	Thursday	10:20-11:40AM	<p>Deep conservation: human hands, cuttlefish arms, and drosophila wing (EvoDevo)</p>	<p><i>Pre-reading: scientific articles will be uploaded in Canvas</i></p>
31	May. 2	Monday	10:20-11:40AM	<p>Deep conservation: Eyes of human, squid, and insects (Genomics)</p>	
32	TBD			<p>Final Exam (Nervous systems and deep conservation)</p>	

Contents by topics

Craniofacial, Jan. 24 –

In class: Instructor will explain the general trends of craniofacial evolution and its underlying genetic mechanisms. The first and second weeks are for comparative anatomy of skulls, third week is for explaining developmental mechanisms of cranial bones, and the fourth week will be used for explaining genomics and genetics to understand craniofacial evolution. Particularly, the fourth week is used for discussing ways to integrate comparative anatomy, developmental biology, and genomics to answer evolutionary questions. Each class begins with a small quiz to confirm whether everyone is on board.

Appendage, Feb. 7 -

In class: Instructor will explain the origin and diversity of appendage and its underlying genetic mechanisms. These lectures contain multiple topics – fish fin-to-limb evolution and diversity of tetrapod limb such as the number of digits. The first week is for comparative anatomy of appendages (fish, amphibian, tetrapods etc.), second week is for explaining developmental mechanisms of appendages, and the third week will be used for explaining current understanding of appendage diversity by genomics and genetics. Each class begins with a small quiz to confirm whether everyone is on board.

Musculature, Feb. 21 -

In class: Instructor will explain the structures of vertebrate musculature system and their evolutionary diversity. The first week is for comparative anatomy of muscles (eye, appendages, body trunk etc.), second week is for explaining developmental mechanisms of musculature systems, and the third week will be used for explaining current understanding of muscular evolution by genomics and genetics. Each class begins with a small quiz to confirm whether everyone is on board.

Integument, Mar. 3 -

In class: Instructor will explain the structures of vertebrate integument system and their evolutionary diversity. The first week is for comparative anatomy of integument systems (scales, feathers etc.), second week is for explaining developmental mechanisms of integument systems, and the third week will be used for explaining current understanding of evolution of integument systems by genomics and genetics. Each class begins with small quiz to confirm whether everyone is on board.

The nervous system, Mar 24-

In class: Instructor will explain the structures of vertebrate nervous systems and their evolutionary diversity. The first week is for comparative anatomy of cranial nervous systems, second week is for brain, third week is for explaining developmental mechanisms of nervous systems, and the fourth week will be used for explaining current understanding of evolution of nervous systems by genomics and genetics. Each class begins with a small quiz to confirm whether everyone is on board.

Deep conservation, Apr 28-

In class: Instructor will explain the deep origins of vertebrate body structures. Convergent evolution of bones, eyes, and appendages are particularly focused. The lectures will contain significant amount of discussion. Instructor and students will discuss how deep conservations have been tested and what should be done to test new hypothesis.