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**ERTH 3112: Vertebrate Evolution I – Fish and amphibian evolution**  
Course Syllabus

This course seeks to understand the origin and evolution of fish and amphibians, as evidenced by the fossil record, and discover the transformations that took place, leading to the success of these groups. Prerequisites: ERTH 1009 or BIOL 2001, or permission from the department.

Instructor: Dr. Jade Atkins  
Teaching Assistants: Dana Korneisel & Marissa Livius

Lecture: Fridays 2:35 to 5:25  
Lab: Thursdays 2:35 to 5:25

\*\*\*Please note that while I hope the labs and lectures will eventually shift to in-person learning, lectures will be held via Zoom and labs will be done independently with photo and video dissections up to and including the **January 28** lecture. The university will continue to monitor the situation and I will keep you updated as the situation evolves.

**Course objectives**

**Learn** details of the anatomy of fish and amphibians and comparative anatomy between groups.  
**Understand** currently accepted patterns of relationships between major fish and amphibian groups.  
**Describe** key evolutionary events in the origin and radiation of fish and amphibians.  
**Integrate** evolutionary mechanisms (e.g., developmental and functional) with patterns of diversity in fish and amphibians

**Learning outcomes**

By the end of this course, students will be able to:

**Recall** the anatomy of fish and amphibians.  
**Describe** and **evaluate** patterns of relationships between major fish and amphibian groups.  
**Describe** key evolutionary events in the origin and radiation of fish and amphibians.  
**Integrate** evolutionary mechanisms with patterns of diversity in fish and amphibians.

**Mark breakdown**

<b>Lectures</b>	<b>Labs</b>	<b>Term paper</b>
Mid-term 15%	Quizzes 31.5% (9 quizzes, each worth 3.5%)	Annotated bibliography 4.5%
		Peer review 4%
Final exam 20%		Presentation 10%
		Term paper 15%
Total: 35%	Total: 31.5%	Total: 33.5%

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### **Lecture schedule**

Lecture 1 (Jan 14) – Introduction & Vertebrate origins

Lecture 2 (Jan 21) – Agnatha

Lecture 3 (Jan 28) – Gnathostomata

Lecture 4 (Feb 4) – Actinopterygia

Lecture 5 (Feb 11) – Sarcopterygia

Lecture 6 (Feb 18) – Early tetrapods

### **Winter Break**

Lecture 7 (Mar 4) – **In class mid-term (lectures 1-6) 15%**

Lecture 8 (Mar 11) – Temnospondyls

Lecture 9 (Mar 18) – Anthracosaurs & Diadectomorphs

Lecture 10 (Mar 25) – Lepospondyls

Lecture 11 (Apr 1) – Lissamphibians

Lecture 12 (Apr 8) – Presentations

\*\* For the lab schedule & the term paper marking scheme please see below

### **Books**

Recommended text: Vertebrate Palaeontology, by M. J. Benton

Lab manual: The Dissection of Vertebrates, by De Iuliis and Pulera

### **Policies**

Missed midterm: Please send Dr. Atkins an email as soon as possible if you miss the lecture midterm. Reschedules may be possible.

Missed final exam: The University's exam services handles all requests for deferred final exams and missed final exams. That office should be contacted for anything to do with missing the formally scheduled final exam.

### **COVID-19**

All members of the Carleton community are required to follow COVID-19 prevention measures and all mandatory public health requirements (e.g. wearing a mask, physical distancing, hand hygiene, respiratory and cough etiquette) and [mandatory self-screening](#) prior to coming to campus daily.

If you feel ill or exhibit COVID-19 symptoms while on campus or in class, please leave campus immediately, self-isolate, and complete the mandatory [symptom reporting tool](#). For purposes of contact tracing, attendance will be taken in all classes and labs. Participants can check in using posted QR codes through the cuScreen platform where provided. Students who do not have a smartphone will be required to complete a paper process as indicated on the [COVID-19 website](#).

All members of the Carleton community are required to follow guidelines regarding safe movement and seating on campus (e.g. directional arrows, designated entrances and exits, designated seats that maintain physical distancing). In order to avoid congestion, allow all previous occupants to fully vacate a classroom before entering. No food or drinks are permitted in any classrooms or labs.

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For the most recent information about Carleton's COVID-19 response and required measures, please see the [University's COVID-19 webpage](#) and review the [Frequently Asked Questions \(FAQs\)](#). Should you have additional questions after reviewing, please contact [covidinfo@carleton.ca](mailto:covidinfo@carleton.ca)

Please note that failure to comply with University policies and mandatory public health requirements, and endangering the safety of others are considered misconduct under the [Student Rights and Responsibilities Policy](#). Failure to comply with Carleton's COVID-19 procedures may lead to supplementary action involving Campus Safety and/or Student Affairs.

(note, these provisions apply to in-person activities primarily, but keep in mind that these measures may impact normal course operations in a number of ways)

### **Academic Integrity**

Academic integrity is taken very seriously in the Department of Earth Sciences, and Carleton University in general. Refer to the following document for policies and explanations of activities included with academic integrity.

<https://carleton.ca/registrar/academic-integrity/>

Some examples of violations that will not be tolerated include:

Plagiarism: submitting work written in part or whole by someone else, failing to acknowledge sources through proper use of citations.

Resubmission: resubmitting work from another or the same course (if repeated).

Test/exam behavior: attempting to read another student's paper, speaking to another student, using material not authorized by examiner.

Improper/unauthorized dissemination: providing access or receiving access to confidential materials (e.g. exam questions), and distribution of course materials.

Violations will be taken very seriously and may involve the Department Chair, and/or the Dean. Sanctions for such violations may include grade of zero, decreased course grade, remediation, withdrawal from the course, or more.

### **Requests for Academic Accommodation**

You may need special arrangements to meet your academic obligations during the term. For an accommodation request, the processes are as follows:

#### **Pregnancy obligation**

Please contact your instructor with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. For more details, visit the Equity Services website: [carleton.ca/equity/wp-content/uploads/Student-Guide-to-Academic-Accommodation.pdf](https://carleton.ca/equity/wp-content/uploads/Student-Guide-to-Academic-Accommodation.pdf)

#### **Religious obligation**

Please contact your instructor with any requests for academic accommodation during the first two

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weeks of class, or as soon as possible after the need for accommodation is known to exist. For more details, visit the Equity Services website: [carleton.ca/equity/wp-content/uploads/Student-Guide-to-Academic-Accommodation.pdf](https://carleton.ca/equity/wp-content/uploads/Student-Guide-to-Academic-Accommodation.pdf)

### **Academic Accommodations for Students with Disabilities**

If you have a documented disability requiring academic accommodations in this course, please contact the Paul Menton Centre for Students with Disabilities (PMC) at 613-520-6608 or [pmc@carleton.ca](mailto:pmc@carleton.ca) for a formal evaluation or contact your PMC coordinator to send your instructor your Letter of Accommodation at the beginning of the term. You must also contact the PMC no later than two weeks before the first in-class scheduled test or exam requiring accommodation (if applicable). After requesting accommodation from PMC, meet with your instructor as soon as possible to ensure accommodation arrangements are made. [carleton.ca/pmc](https://carleton.ca/pmc)

### **Survivors of Sexual Violence**

As a community, Carleton University is committed to maintaining a positive learning, working and living environment where sexual violence will not be tolerated, and its survivors are supported through academic accommodations as per Carleton's Sexual Violence Policy. For more information about the services available at the university and to obtain information about sexual violence and/or support, visit: [carleton.ca/sexual-violence-support](https://carleton.ca/sexual-violence-support)

### **Accommodation for Student Activities**

Carleton University recognizes the substantial benefits, both to the individual student and for the university, that result from a student participating in activities beyond the classroom experience. Reasonable accommodation must be provided to students who compete or perform at the national or international level. Please contact your instructor with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. <https://carleton.ca/senate/wp-content/uploads/Accommodation-for-Student-Activities-1.pdf>

For more information on academic accommodation, please contact the departmental administrator or visit: [students.carleton.ca/course-outline](https://students.carleton.ca/course-outline)

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## **ERTH 3112: Vertebrate Evolution I – Fish and amphibian evolution**

### Lab Syllabus

In this lab, you will gain first-hand experience analyzing slides, dissections and casts of real fossil material. As you work through the material, place your observations in a broader context of early vertebrate evolution, compare structures across taxa and to the fossil record.

Teaching Assistants: Dana Korneisel & Marissa Livius  
Emails: DanaKorneisel@cmail.carleton.ca & MarissaLivius@cmail.carleton.ca

Lab period: Thursdays 2:35 to 5:25

\*\*\*Please note that while we hope the labs and lectures will eventually shift to in-person learning, labs will be done independently with photo and video dissections up to and including the January 28 lecture. The university will continue to monitor the situation and we will keep you updated as the situation evolves.

Required lab manual: The dissection of Vertebrates; De luliis & Pulerà.  
Required tools: dissection kit, lab coat, lab notebook (notes and drawing), pencils.

#### **Lab schedule**

Lab 1 (Jan 27, **online**) – Vertebrate origins: Amphioxus dissection and slides  
Lab 2 (Feb 3) – Skeletons: Connective tissue & scale slides, skeletal systems  
Lab 3 (Feb 10) – External morphology: Lamprey, shark, perch, frog  
Lab 4 (Feb 17) – Muscles: Lamprey, shark, perch, frog  
Lab 5 (Mar 3) – Fossil fish: Agnathan and gnathostome fossils  
Lab 6 (Mar 10) – Nervous system: Lamprey, shark, perch, frog  
Lab 7 (Mar 17) – Circulation & organs: Lamprey, shark, perch, frog  
Lab 8 (Mar 24) – Fossil tetrapods: Basal tetrapods and temnospondyls  
Lab 9 (Mar 31) – Fossil tetrapods: Lepospondyls & stem amniotes

#### **Lab quizzes**

To allow for maximum flexibility, you will be tested weekly on lab material. Each lab quiz is worth 3.5% of your mark and will consist of 5 questions. Lab quizzes will open following the lab period (Thursdays at 5:35) and close prior to the start of the next lab period (Thursdays at 2:35).

#### **Policies**

You must read and accept Lab Safety requirements prior to the first lab (see below). Also, read the lab exercise and manual before coming to lab. Bring all tools to each lab period.

In-person, missed labs are not repeatable. If you miss a lab, you are responsible for making up missed material in the following lab. Your TA will not provide a make-up period.

## Laboratory Safety

As a student in a laboratory, you have certain rights and responsibilities according to the Occupational Health and Safety Act of Ontario. It is your right to work in a safe environment. You are responsible for:

1. Knowing and following all applicable safety rules and practices as outlined in this manual and by the supervisor. **This includes reading experimental instructions prior to performing the experimental work so that you are aware of any hazards or safety requirements pertaining to each experiment.**
2. Using and wearing personal protective equipment according to instructions.
3. Reporting any incidents or unsafe conditions to the laboratory supervisor.

In addition, there are specific rules and regulations for this laboratory. These are:

- I. Notify your instructor if you have any medical condition that may require special precautionary measures in the laboratory.
  - II. Emergency equipment (first aid kit, fire extinguisher, emergency shower and eye wash station) is located in the laboratory. Know where these items are located, should they be required.
  - III. In case of fire, evacuate the room and assemble outside the building. The evacuation route for room 114 is out the door and turn left or right. You must remain outside until the 'all-clear' is signalled.
  - IV. Bench space is limited and must not be cluttered with nonessential items (*e.g.*, coats, backpacks and other bulky articles). Place these articles at the sides of the lab or under the bench; **do not leave articles in the aisles that someone may trip over.**
  - V. Beverages and food are not permitted in the laboratory.
  - VI. No electronic devices, with exception of cameras, laptops, social acquaintances, or pets are allowed in or to be used the lab.
  - VII. Cell phones should be turned off when working in the laboratory.
  - VIII. Confine loose hair, clothing, and jewellery.
  - IX. Contact lenses are not safety eyewear and may actually add to the severity of an eye injury. If you must wear contact lenses, safety glasses are required when working with corrosive chemicals.
  - X. Use laboratory equipment only for its designed purpose.
  - XI. Avoid disturbing or distracting others while they are working in the laboratory.
  - XII. Never pipette by mouth; always use a mechanical pipetting device.
  - XIII. Use an open flame only as long as necessary and extinguish it when done.
  - XIV. Keep containers of alcohol (*i.e.*, slide jars) and other flammable liquids away from flames and closed when not being used.
  - XV. Follow proper waste disposal procedures.
  - XVI. No lab material (for example, pieces of preserved animals) may be removed from the laboratory.
- ALWAYS WASH YOUR HANDS BEFORE LEAVING THE LABORATORY, PARTICULARLY AFTER HANDLING CHEMICALS, MICROORGANISMS OR ANIMALS (PRESERVED OR ALIVE).**

ERTH 3112: Vertebrate Evolution I – Fish and amphibian evolution  
Term paper and presentation information

You will complete a term paper of approximately 10 pages in length (double spaced, excluding references and figures) on a topic or challenge in fish and amphibian evolution. You will also give a short, complementary presentation summarizing your term paper in the last class or last lab of the term (5% of final grade).

### Paper topic

Choose a topic to write your paper on. The topic can be any aspect pertaining to the evolution of fish and amphibians. Approve your topic with your TA as soon as possible as we will not allow more than one student to write on the same topic.

E.g.    The origin of teeth and/or jaws                  Evolution of sensory systems  
          Fin to limb transition                                Lissamphibian origins

### Paper guidelines

You will write your paper making sure you cover:

- A detailed **introduction** to the concept or problem in fish and amphibian evolution, introducing the problem/topic/question/idea and ongoing challenges
- A review of **current** ideas in the literature
- A **critical discussion** of literature, pointing out strengths and weaknesses of observations in the literature
- **Suggestions** for next steps, what would be needed to provide more definitive conclusions, or clarify remaining uncertainty

Figure: Figures are encouraged but must be cited and formatted accordingly. This includes a descriptive figure caption below the image, as well as the original citation of the paper it was sourced from.

References: Your paper will thoroughly cite the primary literature (minimum of 10 journal articles), original journal articles and textbooks, only. In-text citations may follow any style as long as it is consistent

All literature cited will be listed at the end of the paper under a “**References**” heading. You may use any style for your references, but please be consistent.

### Grading

The mark for your term paper is broken down into four components:

- Annotated bibliography (due February 11, 2022) – 4.5%
- Peer review (due March 18 & April 1, 2022) – 4%
- Term paper presentation (April 8, 2022, in class) – 10%
- Term paper document (due April 12, 2022) – 15%

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### **Annotated bibliography**

The annotated bibliography will help you to organize your sources for your term paper early in the semester. You will read at least **5** peer-reviewed manuscripts from the literature on your topic and write, at minimum, 200-word summaries of these manuscripts that include why they are important for your topic.

### **Peer review**

Peer review is an important part of scientific writing. You will hand in a rough draft of your paper to your TA on March 18. Your TA will then send you a colleague's paper for you to read and critique (both good aspects of the paper and aspects that require work). Your edits and thoughts on your colleague's work is due on April 1. You will be asked to incorporate comments and edits into your final draft

### **Presentation guidelines**

See below for the presentation's marking scheme. You will create a PowerPoint (or similar) presentation to give the class on the last day of the course. These will be short, conference style presentations (~10mins).

Tips:

- Roughly estimate 1 slide per minute
- Minimize text on the slides and maximize imagery
- Practice your talk – sometimes writing out what you want to say and practicing it will create a smoother presentation.

### **Term paper**

See below for the term paper's marking rubric.

### **Policies**

The paper is due on **April 12, 2022**. If you need to miss the presentation date, please email Dr. Atkins as soon as possible.

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Student name: \_\_\_\_\_ ID: \_\_\_\_\_

Seminar title/topic: \_\_\_\_\_

Marking rubric for **term paper:** \_\_\_\_\_ /100

Section	Percentage & notes from your TA
Introduction and explanation of the early history of the topic and any ongoing challenges in the field (25%)	____/25
Accurately review current literature on the topic by describing examples from the literature that lead to advances in our understanding of the topic (25%)	____/25
Critically evaluate the current literature on your topic (i.e., what is missing from the literature? How would you resolve outstanding issues?) and propose further steps to be taken in resolving the challenge or remaining questions (30%)	____/30
Is the format (i.e., text, figures, references) consistent and easy to read? (10%)	____/10
Is the paper edited and easy to read? (10%)	____/10

**Presentation:** \_\_\_\_\_ /100

Ability to clearly present term paper contents	/50
Logical flow and clarity	/20
Visual presentation	/20
Oral delivery	/10