

**Faculty of Science Course Syllabus****Department of Biology**

BIOL 3326.03

**Vertebrate Design: Evolution and Function**

Fall 2019

**Instructor(s):** Dr. Jen Frail-Gauthier [jfrail@dal.ca](mailto:jfrail@dal.ca) LSC 5014**Lectures:** 08:35-09:25 MWF LSC 236**Office Hours:** Open door policy; I will be 95%-guaranteed to be in/around my office on MWF from 9:30-11:15. Always available over email.**Markers:** Kayla Hamelin and Anthony Cormier**Reviews:** There will be open review sessions scheduled TBA before tests and exams in LSC 2109 (across from the DAMS and DABS offices).

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*\*\*Please note that Jen is slowly modifying this course after decades of it being taught by Dr. Alan Pinder. This year's changes will be related to the evaluation scheme. Lecture schedule and content may vary from what is described and listed here, but follows Dr. Pinder's lecture design. Most of this 2019 syllabus is from Dr. Pinder's 2018 syllabus.\*\**

**Course Description**

Vertebrate Design explores 600 million years of vertebrate evolution, with particular attention to origins of major groups and the anatomical and functional innovations associated with their rise and diversification. Functional morphology of swimming, flying, and terrestrial locomotion is also briefly covered, along with the effect of body size on function (these are covered in much more detail in BIOL 3336: Vertebrate Functional Morphology with Dr. Margi Cooper in Winter 2020).

This class has a dual purpose: both to introduce you to vertebrate evolutionary history, which has resulted in the diversity of modern vertebrates that have arisen from a single common ancestor, and also to introduce you to the evidence and reasoning by which we infer evolutionary relationships and evolutionary events hundreds of millions of years ago.

While there are a lot of "facts" in this class (names, dates, anatomy of specific animals and groups), much of what is presented is **interpretation**. The cladograms, evolutionary relationships and trends, and possible evolutionary pressures discussed in class change as new evidence from fossils, geological history, genetics, and development is found. While the major outlines of vertebrate history are fairly stable, there will continue to be changes in the future. When you hear about changes of interpretation or alternative interpretations on TV, internet, or in print, you will be able to evaluate those new interpretations and the evidence for them. Your class assignments will go into this in more detail.

We will concentrate on morphology, seen in fossils and in modern vertebrates, as the main evidence **supporting our interpretations** of evolutionary relationships and history. In contrast to products of human design, which are often designed from scratch to serve a specific function, the morphology or "design" of organisms is through natural selection for function acting on existing structures, built of

biological materials – flesh and bone. Vertebrate morphology thus depends on evolutionary history, current function, and the physical properties of the building materials. We will review vertebrate evolutionary history, emphasizing evolutionary changes in basic body components - limbs, skulls, gills, lungs, etc. - shared by broad groups of vertebrates. Because these characteristics form the basis for classifying vertebrates, this will also serve as an overview of vertebrate systematics. Limbs, skulls, the axial skeleton, body shape etc. are also subject to natural selection for function and as we go through the evolutionary changes in morphology we will digress to talk about functional design, properties of materials, and effects of body size (allometry) - i.e. functional morphology and design constraints regardless of evolutionary history. For example, adaptation to fast swimming results in a typical body form that is seen in several evolutionary lineages, e.g. tunas, dolphins, ichthyosaurs, and lamnid sharks - so that they all look alike even though they come from teleost fish, chondrichthyan, mammalian, and "reptile" lineages.

### **Course Prerequisites**

BIOL 2003 (Animal Diversity), BIOL 2040 (Evolution), or permission of instructor

### **Course Objectives/Learning Outcomes**

Before taking this class, you are assumed to already know how to:

- 1) Identify living vertebrates to taxonomic class (BIOL 2003)
- 2) Interpret the information available in cladograms (BIOL 2003)
- 3) Describe the process of adaptation and requirements for evolution by natural selection (variation, heritability, differential reproduction) (BIOL 1000, 2040)
- 4) Describe basic anatomy and life history characteristics of living vertebrates (BIOL 2003)

At the end of this course, you will be able to:

- 1) Identify and compare homologous anatomical features between vertebrates
- 2) Describe in general terms which vertebrates lived at what time
- 3) Relate vertebrate history to geological history
- 4) Relate vertebrate history to history of other organisms
- 5) Describe important fossils close to major divergences in lineages
- 6) Synthesize a phylogeny showing relationships of arbitrarily chosen lineages of vertebrates
- 7) Diagram major anatomical structures (skull, limbs/fins, axial skeleton etc.)
- 8) Assess new paleontological evidence (fossils) and their implications for interpretations of vertebrate history
- 9) Evaluate media accounts of vertebrate history and evolution (scientific literacy)
- 10) Use cladistic analysis of morphology to evaluate phylogenetic hypotheses
- 11) Distinguish between mass extinctions and background extinctions and their implications for adaptation (extinction, evolutionary constraint) (3)
- 12) Relate morphology to function and selection pressures (form and function, adaptation) (3)
- 13) Argue for or against interpretations of major events in vertebrate history (e.g. dinosaur endothermy, origin of flight, relationships between legs and fin types etc.)
- 14) Use principles of allometry to predict differences in structure and function between large and small animals (more in BIOL 3336)
- 15) Trace the ancestry and evolutionary changes in morphology from modern vertebrates back to early Paleozoic animals

## Course Materials

**Text:** The recommended (not required) text that covers vertebrate history and general biology well is *Vertebrate Life*, by F.H. Pough, C.M. Janis, and J.B. Heiser (Prentice-Hall; any of the recent editions is fine; it is now up to the 10<sup>th</sup> edition). For those particularly interested in comparative anatomy, I recommend *Vertebrates: comparative anatomy, function, evolution* by Kenneth Kardong, now up to its seventh edition. This text has much more anatomical detail, but less ecology and behavior than *Vertebrate Life*. Both *Vertebrate Life* and *Vertebrates* have been used previously in this class, so there should be used copies around (earlier editions are fine; I do not assign specific pages to read, and I generally cover important new material in class). I use both texts (and other sources) as sources of figures in my powerpoint presentations; you can find relevant sections of the text either by using the index to look up key words, or find the figure I used in the powerpoint presentation in the body of the text. There are copies of both recommended texts on reserve in the library. I did not order texts for the bookstore; they are available on reserve, used, or through online or storefront bookstores.

**Brightspace:** There are extensive lecture notes in sections titled “Vertebrate History I” (origin of chordates to teleost fish) and “Vertebrate History II” (the transition to land and tetrapod radiation). These are lecture NOTES – they are what Dr. Pinder used to prepare for class, but are written in note form, and I do not follow my own notes exactly as I present lectures. The Powerpoint presentations I use in class are a better guide to what I cover in a given year; copies of the presentations are available on Brightspace. I also post exams from previous years, but keep in mind that the class has been recently reorganized, and changes somewhat each year anyway, so that not all the questions from previous years will be appropriate this year, and the timing of some questions may be different (e.g. on the first midterm instead of the second etc.). My lecture notes and the Powerpoint presentations should serve as **backups** (and spelling checks!) **to your own notes**; your own notes should serve as your primary source for studying. The act of writing and organizing notes is an excellent aid to memory.

I also post recent reviews of topics we cover in class, along with new and interesting scientific and popular literature articles and sometimes videos on Brightspace. If you are interested in the material presented in class, these supplemental materials will also be of interest. They are supplements, usually giving more detail on specific topics than I have time for in class, and are not necessary for exams. Browse them when you have time, open up those that seem most interesting, take a look at the abstract or intro and see if you get sucked into reading more. **Most of these articles are best opened when you are at Dal on the Dal network**; most are links to journals or other sources to which Dalhousie has a license but journals will ask for big bucks if you try to link to them from off campus. Many of them come from journals like *Science* and *Nature*, and you can access them off campus, but you will have to sign in through the library to get free access.

**In-class response system:** I will ask questions in class; these will often be presented with multiple choice answers for response with the Top Hat response system, which most of you will need for other Biology or Dalhousie classes. This is a new system to Biology, so if you do not wish to purchase the licence for this class, please let me know.

**Review sessions:** Review sessions will be scheduled in the week to 10 days before an exam. They are opportunities to see specimens of some of the animals and structures discussed in class, see casts of important fossils, review powerpoint presentations and to ask questions. Review sessions are not mandatory; in fact if everyone showed up to one there would not be enough room. Reviews will be in LSC 2109, opposite the DABS and DAMS offices, at times arranged in class and announced on BrightSpace.

## Course Assessment

*New to 2019, course assessment will not be 100% based on testing and examination, as this is not always the best way to evaluate student success (and is in accordance with developing an Inclusive Classroom). Testing will now only total 60%, and assignments/participation will total 40%. Please see assignment guidelines on BrightSpace for details of these assignments.*

All exams are written, closed book exams with a combination of short answer, diagram, problem, and short essay questions. A numerical mark will be given on each exam, which will be converted to a letter grade at the end of the class according to the university-wide grade scale. If you feel that the mark given on the exam is not fair (apart from errors in addition, which I will correct immediately), I will regrade the entire exam; I will not argue about partial marks on individual questions. See also the Faculty of Science policy on grade appeals (below).

There will be makeup exams for students who miss any test or assignment for a medical reason; notify me (email) as soon as you realize you will have a problem and complete the **Student Declaration of Absence form on BrightSpace** in order to do the makeup. Makeup exams/extensions for assignments will be held at a mutually convenient time outside class in the week after the exam/due date. In exceptional circumstances I may allow a makeup exam/extension on compassionate grounds - make sure you contact me BEFORE missing the exam to find out if your circumstance will be accepted. Not being prepared for an exam, or forgetting about an exam, are not accepted as "exceptional circumstances". I also understand that some weeks are exceptionally busy for students. Please use good time management skills in the weeks leading up to those busy weeks; however, exceptions may be made on a case-by-case basis.

Component	Weight (% of final grade)	Date
<b>Tests/quizzes</b>	Quiz 1 – 12.5%	October 4 <sup>th</sup>
	Quiz 2 – 12.5%	November 6 <sup>th</sup>
<b>Final exam</b>	35%	(Scheduled by Registrar)
<b>Assignments</b>	Fossil Species Account 30% total	(in parts, see schedule)
	Topic opinion/literature review – 5%	October 25 <sup>th</sup>
	Participation (Top Hat/attendance/discussions) 5%	throughout course

## Other course requirements

The details for the Fossil Species Account term assignment (including a literature review, written species account, and 2-min final “presentation” (media) – 30%) and details for the opinion piece (5%) will be uploaded on BrightSpace and discussed in class. In lieu of purchasing a text book, there will be a link to register for Top Hat, which will be used to monitor participation and encourage active learning in the (early) morning classroom.

## Conversion of numerical grades to Final Letter Grades follows the Dalhousie Common Grade Scale

A+ (90-100)	B+ (77-79)	C+ (65-69)	D	(50-54)
A (85-89)	B (73-76)	C (60-64)	F	(<50)
A- (80-84)	B- (70-72)	C- (55-59)		



**Tentative Lecture Schedule based on 2018; with added Due Dates and Test Dates for 2019**

<b>Date</b>	<b>Lecture Topics for the Week (Important Dates/Tests in BOLD)</b>
Sept 4 - 6	Introduction: mechanics and philosophy of course – including phylogeny, geologic time scale and classification and taxonomy
Sept 9 - 13	Chordate origins, living fossils – Cambrian explosion, hagfish and lampreys
Sept 16 - 20	Vertebrate body plan, material properties of flesh and bone <b>Fossil species account assignment– selections made by end of day Sept 18 – Google Docs</b>
Sept 23 - 27	Paleozoic armoured fish: heterostracans, osteostracans et al. <b>Fossil species account assignment – initial literature review/annotation due Friday Sept 27 (5%)</b>
Sept 30 Oct 2 <b>Oct 4</b>	Origin of gnathostomes: placoderms, acanthodians, chondrichthyes, teleosts <b>Midterm Quiz 1 on October 4<sup>th</sup> (last 25 mins of class – i.e., 9AM)</b>
Oct 7-11	Radiation of teleosts: variations on aquatic feeding and locomotion
Oct 16 - 18	<b>No class October 14<sup>th</sup> – Thanksgiving Day</b> Transition to land: sarcopterygia, Tiktaalik, Acanthostega, Ichthyostega: <i>transformations in limbs, girdles, axial skeleton, respiration &amp; senses</i>
Oct 21 - 25	Paleozoic anamniotic tetrapods and origin of modern amphibians <b>Topic opinion/review due Oct. 25<sup>th</sup> (5%)</b>
Oct 28 - Nov 1	Origin of the amniotes; amniote egg, sauropsids and synapsids
Nov 4 <b>Nov 6</b> Nov 8	Origin of amniotes continued <b>Midterm Quiz 2 on Nov 6<sup>th</sup> (last 25 mins of class; 9 AM)</b> Non-dinosaur archosaurs
Nov 11 - 15	<b>STUDY BREAK – no classes</b>
Nov 18 - 22	Archosaurs: dinosaurs and birds; allometry (size matters!), morphology of flight <b>Fossil species account – written assignment due Nov 20<sup>th</sup> (15%)</b>
Nov 25 - Nov 29	Birds continued Synapsids and the fabulous furballs (aka Mammals) <b>Fossil species account ‘media’ due by end-of-day Nov 29<sup>th</sup> (10%) – will be shared with class as a final exam study tool of all the species we have examined this term!</b>
Dec 2 Dec 3 Dec 5-15	End Mammals (Hopefully!!) Last thoughts & review – class spill over (Tuesday Dec 3 follows a Monday schedule) <b>FINAL EXAM – Cumulative – Scheduled by Registrar</b>

**Course Policies**

**In addition to** contacting Jen before a missed test, you must use the Student Declaration of Absence form (BrightSpace) for missed tests in this course (except for the final exam). Additional information is in the supplemental syllabus (section B below).

If you miss an **assignment deadline, please notify Jen ASAP**. Extensions/excuses may be granted on case-by-case bases. If you do not contact Jen or do not have a valid reason, expect late deductions of 10% (of individual assignment grade) per day.

The fossil species account term “project” is an individual assignment. Please follow all academic integrity guidelines from the University (see Syllabus section B below).

All official communication (e.g., class extensions, cancelled classes) will occur on BrightSpace. Announcements will also be made in class as needed, but will always be followed by official announcements on BrightSpace. Make sure you check your Dal Email regularly, or forward your Dal email to an email address you DO check frequently.

**Faculty of Science Course Syllabus (Section B)  
BIOL 3326 Fall 2019**

**University Policies and Statements**

**This course is governed by the academic rules and regulations set forth in the University Calendar and by Senate**

**Academic Integrity**

At Dalhousie University, we are guided in all of our work by the values of academic integrity: honesty, trust, fairness, responsibility and respect (The Center for Academic Integrity, Duke University, 1999). As a student, you are required to demonstrate these values in all of the work you do. The University provides policies and procedures that every member of the university community is required to follow to ensure academic integrity.

**Information:** [https://www.dal.ca/dept/university\\_secretariat/academic-integrity.html](https://www.dal.ca/dept/university_secretariat/academic-integrity.html)

**Accessibility**

The Advising and Access Services Centre is Dalhousie's centre of expertise for student accessibility and accommodation. The advising team works with students who request accommodation as a result of a disability, religious obligation, or any barrier related to any other characteristic protected under Human Rights legislation (Canada and Nova Scotia).

**Information:** [https://www.dal.ca/campus\\_life/academic-support/accessibility.html](https://www.dal.ca/campus_life/academic-support/accessibility.html)

**Student Code of Conduct**

Everyone at Dalhousie is expected to treat others with dignity and respect. The Code of Student Conduct allows Dalhousie to take disciplinary action if students don't follow this community expectation. When appropriate, violations of the code can be resolved in a reasonable and informal manner—perhaps through a restorative justice process. If an informal resolution can't be reached, or would be inappropriate, procedures exist for formal dispute resolution.

**Code:** [https://www.dal.ca/dept/university\\_secretariat/policies/student-life/code-of-student-conduct.html](https://www.dal.ca/dept/university_secretariat/policies/student-life/code-of-student-conduct.html)

**Diversity and Inclusion – Culture of Respect**

Every person at Dalhousie has a right to be respected and safe. We believe inclusiveness is fundamental to education. We stand for equality. Dalhousie is strengthened in our diversity. We are a respectful and inclusive community. We are committed to being a place where everyone feels welcome and supported, which is why our Strategic Direction prioritizes fostering a culture of diversity and inclusiveness

**Statement:** <http://www.dal.ca/cultureofrespect.html>

**Recognition of Mi'kmaq Territory**

Dalhousie University would like to acknowledge that the University is on Traditional Mi'kmaq Territory. The Elders in Residence program provides students with access to First Nations elders for guidance, counsel and support. Visit or e-mail the Indigenous Student Centre (1321 Edward St) ([elders@dal.ca](mailto:elders@dal.ca)).

**Information:** [https://www.dal.ca/campus\\_life/communities/indigenous.html](https://www.dal.ca/campus_life/communities/indigenous.html)

**Important Dates** in the Academic Year (including add/drop dates)

[https://www.dal.ca/academics/important\\_dates.html](https://www.dal.ca/academics/important_dates.html)

**University Grading Practices**

[https://www.dal.ca/dept/university\\_secretariat/policies/academic/grading-practices-policy.html](https://www.dal.ca/dept/university_secretariat/policies/academic/grading-practices-policy.html)

**Missed or Late Academic Requirements due to Student Absence (policy)**

[https://www.dal.ca/dept/university\\_secretariat/policies/academic/missed-or-late-academic-requirements-due-to-student-absence.html](https://www.dal.ca/dept/university_secretariat/policies/academic/missed-or-late-academic-requirements-due-to-student-absence.html)

**Student Resources and Support****Advising**

**General Advising** [https://www.dal.ca/campus\\_life/academic-support/advising.html](https://www.dal.ca/campus_life/academic-support/advising.html)

**Science Program Advisors:** <https://www.dal.ca/faculty/science/current-students/academic-advising.html>

**Indigenous Student Centre:** [https://www.dal.ca/campus\\_life/communities/indigenous.html](https://www.dal.ca/campus_life/communities/indigenous.html)

**Black Students Advising Centre:** [https://www.dal.ca/campus\\_life/communities/black-student-advising.html](https://www.dal.ca/campus_life/communities/black-student-advising.html)

**International Centre:** [https://www.dal.ca/campus\\_life/international-centre/current-students.html](https://www.dal.ca/campus_life/international-centre/current-students.html)

**Academic supports**

**Library:** <https://libraries.dal.ca/>

**Writing Centre:** [https://www.dal.ca/campus\\_life/academic-support/writing-and-study-skills.html](https://www.dal.ca/campus_life/academic-support/writing-and-study-skills.html)

**Studying for Success:** [https://www.dal.ca/campus\\_life/academic-support/study-skills-and-tutoring.html](https://www.dal.ca/campus_life/academic-support/study-skills-and-tutoring.html)

**Copyright Office:** <https://libraries.dal.ca/services/copyright-office.html>

**Fair Dealing Guidelines** <https://libraries.dal.ca/services/copyright-office/fair-dealing.html>

**Other supports and services**

**Student Health & Wellness Centre:** [https://www.dal.ca/campus\\_life/health-and-wellness/services-support/student-health-and-wellness.html](https://www.dal.ca/campus_life/health-and-wellness/services-support/student-health-and-wellness.html)

**Student Advocacy:** <https://dsu.ca/dsas>

**Ombudsperson:** [https://www.dal.ca/campus\\_life/safety-respect/student-rights-and-responsibilities/where-to-get-help/ombudsperson.html](https://www.dal.ca/campus_life/safety-respect/student-rights-and-responsibilities/where-to-get-help/ombudsperson.html)

**Safety**

**Biosafety:** <https://www.dal.ca/dept/safety/programs-services/biosafety.html>

**Chemical Safety:** <https://www.dal.ca/dept/safety/programs-services/chemical-safety.html>

**Radiation Safety:** <https://www.dal.ca/dept/safety/programs-services/radiation-safety.html>

**Scent-Free Program:** <https://www.dal.ca/dept/safety/programs-services/occupational-safety/scent-free.html>