

Faculty of Science Course Syllabus Fall 2020 (revised June 2020)

Department of Biology

BIOL 3326 (online)

Vertebrate Design: Evolution and Function

Fall 2020

**DRAFT SYLLABUS as of August 17, 2020 --- specifics subject to change  
(please fill in the Google Forms that was emailed to registered students on August 17, 2020).  
(details subject to change in red)**

**Instructor(s):** Dr. Jen Frail-Gauthier (she/her) jfrail@dal.ca Weekly or twice-weekly Check-In office hours (with quizzes); Use email for personal questions; use Slack workspace for class-specific questions

**Lectures:** Asynchronous lecture content on BrightSpace.

**Markers/Demonstrators:** TBA

*The times and deadlines for the class are all listed in ATLANTIC (Halifax) TIME. If you are in another time zone, please make sure you adjust accordingly.*

*Dalhousie University is located in Mi'kma'ki, the ancestral and unceded territory of the Mi'kmaq. We are all Treaty people.*

*We support an open, respectful, and safe learning environment, for all students. We value kindness, compassion, diversity, equality, and inclusion.*

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## 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.

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 **Opinion Blog piece assignment** 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)

### **Learning Objectives/Course 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 (also part of your **Fossil Species Account** project)
- 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 (also part of **Fossil Species Account, Opinion Piece**)
- 9) Evaluate media accounts of vertebrate history and evolution (scientific literacy; part of **Opinion Piece** assignment)
- 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)

- 12) Relate morphology to function and selection pressures (form and function, adaptation)
- 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
- 16) Visually represent scientific information to the general public (**fossil species account brochure and video presentation**)
- 17) Practice peer-review and evaluation

### Course Materials

**NOTE:** there is nothing required for you to purchase. All course information will be available on BrightSpace, including links to software you can use for the course assignments (e.g., Slack, Canva, OpenShot, Panopto, Zoom, Kahoot).

**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.

**Brightspace:** There will be extensive lecture notes posted on BrightSpace. 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 video lectures 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. Additionally, due to the take-home nature of the exams, **questions will reflect critical thinking (analysis, synthesis, evaluation) and not memorizing.** 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. 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.**

## Course Assessment

Component	Weight (% of final grade)	Date
<b>Assignments</b>	Opinion-blog piece (10%) Fossil Species account (40% total)	October 16 <sup>th</sup> (11:59 PM) Throughout term; see schedule (all times 11:59 PM Atlantic)
<b>Tests/quizzes</b>	Midterm test (take-home; 1 hour); 10% Kahoot “trivia” quizzes in check-ins <b>Best 7 of 9; 20% total</b>	<b>Wed. Oct 7<sup>th</sup></b> <b>Weekly; preferably Monday or Friday</b>
<b>Final exam</b>	20%; cumulative; take-home (3 hours)	<i>(Scheduled exam period)</i>

The details for the Fossil Species Account term assignment (including a literature review, written species account, museum brochure, peer-review, and 2-min final video presentation”(media) – 40%) and details for the opinion piece (10%) will be uploaded on BrightSpace. Details about quizzes and take-home tests will also be posted separately.

### 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)		

## Course Policies

No sick notes are required for missed or late academic requirements, however, it is your responsibility to contact me as soon as possible, preferably before the deadlines, if there is a conflict, to arrange an alternate assessment/hand-in date. Deadlines are set in place to help keep you on track **with independent, online learning**. However, deadlines can be flexible on a case-by-case basis. If you are missing multiple deadlines, I encourage you to (and may myself) reach out to Patricia Laws, Assistant Dean of Student Affairs.

If you cannot attend the **final exam**, which is scheduled by the registrar and will be a “take-home” style written essay test, there are multiple options to complete course assessments and outcomes. These include (1) a make-up exam offered at an alternate date (**preferred option**), (2) an alternate assessment (only on a case-by-case basis).

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.

I 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. I also understand that this online delivery of your undergraduate curriculum is challenging. I will be working with you to assure all learning outcomes are met, and that you have the resources you need to be successful in this course! Please never hesitate to reach out.

**Course Content – Quiz Details (live check ins) TBD (based on Google Forms- may be Mondays OR Fridays- i.e., you can select)**

Date	Lecture Topics for the Week (Important Dates/Tests in BOLD)
Sept 8 - 11	Introduction: mechanics and philosophy of course – including phylogeny, geologic time scale and classification and taxonomy <b>Syllabus/Intro Kahoot Quiz 1 Friday Sept 11<sup>th</sup></b>
Sept 14 - 18	Chordate origins, living fossils – Cambrian explosion, hagfish and lampreys <b>Fossil species account assignment– selections made by 11:59 PM Sept 18 – Google Docs</b>
Sept 21 - 25	Vertebrate body plan, material properties of flesh and bone <b>Kahoot Quiz 2 – Based on previous week’s material – Monday Sept 21</b> <b>Fossil species account assignment – initial literature review/annotation due Friday Sept 25 (5%)</b>
Sept 28 - Oct 2	Paleozoic armoured fish: heterostracans, osteostracans et al. <b>Kahoot Quiz 3 – Based on previous week’s material – Monday Sept 28<sup>th</sup></b>
Oct 5 - 9	Origin of gnathostomes: placoderms, acanthodians, chondrichthyes, teleosts <b>Midterm Test on October 7<sup>th</sup> (1 hour; 10%)</b>
Oct 14- 16	<b>No class material for October 12<sup>th</sup> – Thanksgiving Day</b> Radiation of teleosts: variations on aquatic feeding and locomotion <b>Opinion Piece/Review due Friday Oct 16<sup>th</sup> (11:59 PM) – 10%</b>
Oct 19 - 23	Transition to land: sarcopterygia, Tiktaalik, Acanthostega, Ichthyostega: <i>transformations in limbs, girdles, axial skeleton, respiration &amp; senses</i> <b>Kahoot Quiz 4 – Based on post-midterm material – Monday Oct 19<sup>th</sup></b>
Oct 26 - 30	Paleozoic anamniotic tetrapods and origin of modern amphibians <b>Kahoot Quiz 5 – Based on previous week’s material – Monday Oct 26<sup>th</sup></b> <b>Fossil species infographic/museum brochure Friday October 30<sup>th</sup> 11:59 PM (5%)</b>
Nov 2 - 6	Origin of the amniotes; amniote egg, sauropsids and synapsids <b>Kahoot Quiz 6 – Based on previous week’s material – Monday Nov 2<sup>nd</sup></b> <b>Written portion of fossil species account due Friday Nov 6<sup>th</sup> (11:59 PM) – 15%</b>
Nov 9 - 13	<b>STUDY BREAK – no classes</b>
Nov 16 - 20	Origin of amniotes continued Non-dinosaur archosaurs <b>Fossil species media presentation due Friday Nov 20<sup>th</sup> (11:59 PM) – 10%</b>
Nov 23 - 27	Archosaurs: dinosaurs and birds; allometry (size matters!), morphology of flight <b>Kahoot Quiz 7 – Based on week before and after study break – Monday Nov 23<sup>rd</sup></b>
Nov 30 - Dec 4	Birds continued Synapsids and the fabulous furballs (aka Mammals) <b>Fossil species – peer evaluation due Friday Dec 4<sup>th</sup> 11:59 PM (5%)</b> <b>Kahoot Quiz 8 – Based on previous week’s material – Monday Nov 30<sup>th</sup></b>
Dec 7 Dec 8 Dec 10- 20	End Mammals (Hopefully!!) <b>Kahoot Quiz 9 – Final Review! Tuesday Dec 8<sup>th</sup></b> <b>FINAL EXAM – Cumulative – Scheduled by Registrar</b>

Faculty of Science Course Syllabus (Section B) (revised June-2020)

Fall 2020 – online delivery

## **BIOL 3326 – Vertebrate Design: Evolution and Function**

### **University Policies and Statements**

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

#### **Missed or Late Academic Requirements due to Student Absence**

As per Senate decision instructors may not require medical notes of students who must miss an academic requirement, **including the final exam**, for courses offered during fall or winter 2020-21 (until April 30, 2021). Information on regular policy, including the use of the Student Declaration of Absence can be found here: [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).

#### **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)

## **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>