Biology 4ED3 - Evolutionary Developmental Biology
Biology Department, McMaster University - Winter Term, 2016

Instructor: Dr. Ian Dworkin (dworkin@mcmaster.ca)

Class Schedule:
Tuesday 12:30 - 2:20 PM
Friday 2:30 - 4:20 PM

Class Location: MCCL 1115

Office Hours: TBA (By appointment) LSB428

Website: https://avenue.cllmcmaster.ca/d2l/home/144582 (I think)

Changes to this outline:
The instructor reserves the right to change the means by which our course objectives are to be achieved, but this will not occur either precipitously or without reasonable notice to the students enrolled in the course. Such changes could result, for example, from new ideas emerging as the course develops and/or from particular arrangements discussed between instructor and students.

Course Description:
This course will examine the role that developmental mechanism plays in shaping evolutionary trajectories of traits (including gene expression, morphology and behaviour), and how evolution in turns influences development. Material in this course will integrate subject matter from evolutionary biology, genetics, developmental biology and genomics. Furthermore we will introduce concepts and tools in the biological analysis of shape (geometric morphometrics), an important tool in the study of the evolution of development. Other than the first two or three weeks, this course will be primarily student directed in the form of discussions (and short paper write ups), presentations and a final paper.

Course objectives:
By the end of this course students should be able to,

- Demonstrate critical reading skills of the scientific literature, in particular with respect to subjects in Evolutionary Developmental Biology.
- Communicate how an integrative approach combining development, genetics, genomics and evolution can be used to enable an understanding of biodiversity.
- Demonstrate basic facility and comprehension of the methods and basic analyses appropriate for the biological analysis of shape (geometric morphometrics).
- Demonstrate verbal communication skills through regular discussions.
- Demonstrate writing skills through regular paper analysis and written work.

- Discuss the biological literature and the ability to both express and defend your perspective using biological terminology.

Prerequisites: Bio 3FF3; One of Mol Bio 3II3 or Mol Biol 3M03 is strongly recommended.

Readings for the course:
Most of the readings for this course will be papers from the primary literature, selected by both the instructor and the students of the class. However, I have also provided two ***recommended*** texts that may provide useful background readings for the students.

1. Endless Forms Most Beautiful - Sean B. Carroll (WW Norton).
2. How the snake lost its legs: Curious Tales from the frontiers of Evo-Devo - Lewis I. Held (Cambridge University Press).

Course Assessment:
Not only will much of the subject matter be student driven, but the exact breakdown for the course assessments can also be modified by each student (for themselves) as described below, and with permission of the instructor.

Here are the default breakdowns for assessment

Class participation (in class and online discussions):	20%
Paper Summaries/reviews:	20%
Mid Term Examination (Take Home):	15%
Final paper / project:	25%
Term Presentation (groups):	20%

Flexible assessment: If an individual student prefers, they may during the first week of instruction work with the instructor to modify the default grading scheme. The constraints that apply are 1) The same five assessments will be used (Class Participation, Paper Summaries/reviews, Mid Term Examination, Final paper/Project & Term Presentation) and 2) That each of the five assessments needs to be valued between 10%-30% of your final grade (in 5% increments). We will discuss this further during the first class. It should be noted that the same expectations for projects are required regardless of how you choose to modify your individual marking scheme. All that will change is what percentage of your final grade it counts toward. Once the grading scheme has been mutually agreed upon by each student and the instructor (we will jointly sign this), it can not be changed.

Details on Course Assessment:

Class participation: This is a small 400 level class, and as such you will be expected to participate and discuss the material in the classroom at a fairly

sophisticated level. Among the activities that you will be assessed on is your participation in group discussions about papers and problems posed in the class. This includes both asking and answering questions. It is important to be an active and vocal participant in both small group and whole class activities. However, be aware that dominating class time to the exclusion of other participants could have a negative influence on your participation grade (the instructor will speak with the individual first in case they are unaware of their effect on the rest of the class). While critical and skeptical discussion is an essential part of the process, it is expected that you will keep all discourse polite, even when expressing your disagreement with your peers or the instructor.

Paper Summaries/reviews: For the majority of the semester we will have class discussions about scientific papers from the primary literature. At the beginning of the class (prior to the initiation of class discussion, lecture or other activity) you will hand in a short summary (less than a page) regarding the paper for discussion. This will include a brief description of the central question of the paper (and why it is an important topic in the field - if it is in your judgment important), how they tested the question, and the conclusions and implications of the study. If in your judgment you feel the study was inadequate in testing the central question, or had other flaws (including clarity), feel free to express this.

Mid Term examination: This will be a take home examination that will cover all of the material discussed in the class prior to the mid term break. This will be in the form of short essay questions and evaluations of papers from the scientific literature.

Final Paper/Project: This will be the primary independent project of the course. You will have the opportunity to either do independent new research utilizing available data as provided by the instructor (using geometric morphometrics), or to write a synthetic review of a topic of your choosing (but approved by the instructor).

Term Presentation: Students will present individually on in pairs on a particular subject from a list of subjects provided by the instructor. The presentation will be in the form of a 30-40 minute “lecture” followed by the students leading a discussion or other group activity. The topic chosen can not be the same ones that the presenters use for their final paper/project.

Academic Accommodation of Students with Disabilities:
Students who require academic accommodation must contact Student Accessibility Services (SAS) to make arrangements with a Program Coordinator. Academic accommodations must be arranged for each term of study. Student Accessibility Services can be contacted by phone 905-525-9140, ext. 2865 or e-mail sas@mcmaster.ca. For further information, consult McMaster University’s Policy for Academic Accommodation of Students with Disabilities.

Policy on Academic Integrity:
You are expected to exhibit honesty and use ethical behaviour in all aspects of the learning process. Academic credentials you earn are rooted in principles of honesty and academic integrity.
Academic dishonesty is to knowingly act or fail to act in a way that results or could result in unearned academic credit or advantage. This behaviour can result in serious consequences, e.g. the grade of zero on an assignment, loss of credit with a notation on the transcript (notation reads: "Grade of F assigned for academic dishonesty"), and/or suspension or expulsion from the university.

It is your responsibility to understand what constitutes academic dishonesty. For information on the various types of academic dishonesty please refer to the Academic Integrity Policy, located at http://www.mcmaster.ca/academicintegrity

The following illustrates only three forms of academic dishonesty:

1. Plagiarism, e.g. the submission of work that is not one's own or for which other credit has been obtained.
2. Improper collaboration in group work.
3. Copying or using unauthorized aids in tests and examinations.

Policy on Absence/Missed Academic work:
We follow the McMaster University Senate Policies on Absence/Missed Academic work. To avoid penalty, student who miss a published due data for any assignment or any examination are required to provide acceptable documentation to their Dean of Studies as to why the assignment or exam was missed. Once such documentation has been provided, the University will inform the Instructor. The Instructor and the student then can reach an agreement as to how to handle any required revision to grading. An exam or assignment completely missed without reason will be recorded as a grade of 0%, Late assignments will be penalized. In most cases we cannot offer makeup exams. Please visit the URL http://www.mcmaster.ca/academicintegrity for details about the academic integrity policy for McMaster University.

The use of TURNITIN.COM:
In this course we will be using a web-based service (Turnitin.com) to reveal plagiarism. Students will be expected to submit their work electronically to Turnitin.com and in hard copy so that it can be checked for academic dishonesty. Students who do not wish to submit their work to Turnitin.com must still submit a copy to the instructor. No penalty will be assigned to a student who does not submit work to Turnitin.com. All submitted work is subject to normal verification that standards of academic integrity have been upheld (e.g., on-line search, etc.). To see the Turnitin.com Policy, please go to www.mcmaster.ca/academicintegrity.

On-Line activities in the course:

In this course we will be using avenue/desire to learn and possibly Piazza. Students should be aware that, when they access the electronic components of this course, private information such as first and last names, user names for the McMaster e-mail accounts, and program affiliation may become apparent to all other students in the same course. The available information is dependent on the technology used. Continuation in this course will be deemed consent to this disclosure. If you have any questions or concerns about such disclosure please discuss this with the course instructor.

Topics:

Note: I am leaving a number of class times empty with respect to subject material as I tend to be optimistic about how much can be covered and discussed, so I want to leave plenty of flexibility.
At certain points in the course it may make good sense to modify the schedule outlined below. The instructor reserves the right to modify elements of the course and will notify students accordingly (in class and post any changes to the course website).

Week 1 (Week beginning Jan 4th 2016):

- Class Introduction and Overview.
- What is Evolutionary Developmental Biology?
- The Genotype-Phenotype Map. Some concepts of phenotypic variation.
- Introduction to Geometric Morphometrics I: The analysis of biological shape.
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Week 2 (Jan 11th):

- How do you make an organism? The Developmental Toolkit
- Overview of critical reading of a scientific paper.
- Approaches to the study of Evolutionary Biology
- Introduction to Geometric Morphometrics II: Landmarks, curves and data acquisition (and a little bit of linear algebra)

Week 3 (Jan 18th):

- Techniques in Evolutionary Developmental Biology
- Which way is up? Body Plan Evolution
- Introduction to Geometric Morphometrics III: Simple size and shape, ideas about superimposition (and a bit more linear algebra).

Week 4 (Jan 25th):

- It's all eyes: Concepts of Homology and parallelism
- Comparative Genomics and the evolution of development
- How important is regulatory variation in the evolution of development?
- Introduction to Geometric Morphometrics IV: Superimposition and the theory of biological shape.

Week 5 (Feb 1st):

- Regulatory variation and Evolution part I:
- The same thing, over and over: Co-option of genetic networks.
- Analyzing variation for shape I: Ordination methods (Principal Components Analysis, Discriminant Function) using MorphoJ.

Week 6 (Feb 8th):

- Cryptic Genetic Variation, Canalization and asymmetry.

- There is more to the environment than just selection: Phenotypic Plasticity, reaction norms Canalization and genetic accomodation
- Introduction to Geometric Morphometrics V: Thin Plate Spline and beyond.

Week 7 (Feb 22nd):
- mid-term take home exam due.
- The evolution of Novelty: Is anything really novel in evolution?
- Didn't I see that yesterday: Heterochrony & heterotopy
- Can Evolution be constrained: Developmental Constraints
- Analyzing variation for shape II: Regression, ANOVA and the linear model using MorphoJ.

Week 8 (Feb 29th):
- Where does this bit go? Modularity and Integration
- The Evolutionary Developmental Biology of sex determination mechanisms.
- Introduction to Geometric Morphometrics: The analysis of co-variation and modularity (partial least squares).

Week 9 (March 7th):
- Student Presentations
- Pardon me, but aren't you missing your tadpole? How Evolution shapes Development: Direct VS indirect Development
- In class work on morphometrics project.

Week 10 (March 14th):
- Student Presentations
- Geometric Morphometrics: project discussion and class work.

Week 11 (March 21st):
- Student Presentations
- When things get really big and really small: The Evolutionary Developmental Biology of size
- Geometric Morphometrics: Project Discussions/Statistics continued (general linear model, resampling techniques).

Week 12 (March 28th):
- Student Presentations
- How big is that? The Evolutionary Developmental Biology of allometry.
- Geometric Morphometrics: Project Discussion/ analysis of allometry and related effects
- The Evolution and Evolutionary Developmental Biology of sexual size and shape dimorphism.

Week 13 (April 4th 2016)

- Synthesis: Is evolutionary Developmental biology its own discipline or should it be completely integrated into evolutionary biology.
- Final work on morphometrics project
- Class evaluation

Other Notable dates:
Mid-term recess Monday February 15th - February 20th 2016
Mid-term exam due: Tuesday February 23rd.
Final Project/Paper Due: April 8th, beginning of class.