BIOL 649 COMPARATIVE GENOMICS SPRING 2016

INSTRUCTOR: Andy Shedlock TA: Alexis "Lexi" Temkin

LECTURE TIME: 10:50AM - 12:05 PM, TUESDAYS & THURSDAYS

LOCATIONS: TUESDAY H-206 Hollings Marine Laboratory (HML)
THURSDAY 100 School of Science & Math Bldg (SSMB)

PROVISIONAL COURSE OUTLINE & SYLLABUS:

PART I.

Jan 7 - Introductions, policies, goals, course overview

Week 1 – Jan 12 & 14
- The emergence of the era of genomics
- Building genome assemblies
- High throughput genome analysis platforms

Week 2 – Jan 19 & 21
- Anatomy and origins of genome architecture
- The construction of genome theory
- Neutralist versus selectionist arguments
- Major components of genomes
- Coding vs. non-coding compartments

Week 3 – Jan 26 & 28
- Jan 26: Lexi Temkin (MUSC) Guest Lec on her Comp Gen project and her PhD dissertation research.
- Jan 28: Paul Anderson (Comp Sci) Guest Lec on Computational Approaches I

Week 4 – Feb 2 & Feb 4
- The Transcriptome
- Protein coding genes
- Single copy DNA vs. multigene families
- MicroRNAs: trash or treasure?
- Functionality and Clustering
- The frontier of gene regulatory networks
- Translational genome biology

Week 5 – Feb 9 & 11
- Mobile DNA and genomic repeats
- The genomic molecular "fossil" record
- Genome evolutionary dynamics
- Repeats as genetic markers

PART II.

Week 6 – Feb 16 & 18
- Comparative Vertebrate Biology and Phylogenetics
- Reconstructing ancestral states
- Testing hypotheses with genome scale information
- Paleogenomics and the importance of fossils

Week 7 – Feb 23 & 25
- Genome assemblies in the vertebrate tree of life
- Living in water
- Jawless fishes
  - Lamprey and hagfish genomes
- Cartilaginous fishes
  - The chimera assembly
- Bony fishes
  - Teleost assemblies and genomic diversity
  - The coelacanth and lungfish genomes

Week 9 – Mar 1 & 3
- Mar 1: Paul Anderson (Comp Sci) Guest Lec on Computational Approaches II
- **Mar 3: EXAM 1** (300 POINTS) COVERING MATERIAL WEEKS 1-7

Mar 8 & 10 SPRING BREAK NO CLASS

Week 10 & 11 – Mar 15, 17, 22, 24
- Living on land
- Amphibian genomes
  - The Xenopus assembly
  - Salamander genomes
- Amniote origins and reptilian genomic diversity
  - The Anolis assembly
  - The painted and softshell turtle assemblies
  - The alligator assembly
  - The python assembly and garter snake genome
  - The tuatara genome

Week 12 – Mar 29 & 31
- Endothermy and taking flight
  - Dinosaur genomes
  - The chicken and turkey assemblies
  - The zebrafinch assembly and cryptic neoavian genomic diversity
  - The emu genome

Week 13 – Apr 5 & 7

Mammalian adaptation and diversification

The platypus assembly

The opossum assembly

The diversity of Eutherian assemblies

Week 14 – April 12 & 14

Primate comparative genomics

Placing the human genome in perspective

Human population genomics and public health

Personalized genomics and individual health

Forensics and the law

Who sees the data and why?

April 14: ANNOTATED BIBLIOGRAPHY ASSIGNEMENT DUE

Week 15 – April 19

EXAM 2 (300 POINTS) COVERING MATERIAL AFTER SPRING BREAK

Grading based on 1000 points:

Midterm Exams (600)
Bibliography Assignment (300)
Participation (100)

Overview of Annotated Bibliography Assignment (Due Tuesday April 15 in class)

In the laboratory section of Vertebrate Genome Biology you will be developing a fundable proposal based on a pilot study that analyzes genome-scale information. In order to accomplish this in a rigorous and properly researched manner you will need to explore the genome biology primary literature in detail and appropriately cite studies that introduce your ideas and explain your proposed research activities and expected results.

Your proposal will thus need to consider (more on this assignment separately in lab):

- An introduction including why the genomics of this group is important (such as evolutionarily or medically or ecologically or economically, etc.).
- A review of the current state of the genetic and genomic knowledge surrounding this taxon using correct reference citations from printed or electronic sources of the peer-reviewed scientific literature.
- What important questions remain about the taxon and what data would you need to generate to answer these questions.

• A hypothesis and the nature of results that would either confirm or reject that hypothesis, including what results would support the hypothesis and what results would force you to reject your hypothesis.
• A summary of your argument and concluding statement.
• A proper, accurate and consistently formatted bibliography in the style of the scientific journal *Genome Research*.

ASSIGNMENT (300 Points): Provide an annotated bibliography that comprehensively addresses all aspects of the development and presentation of your research proposal. For each citation in this document, you will need to provide a one-page or less written summary of the reference and explicitly describe how it does relate or does not directly relate to your proposal synthesis. Do not just copy the abstract and major bullets but rather summarize what you are/are not taking away from carefully reading and comprehending and thinking critically about the entire reference as is relates to your project ideas. YOUR ANNOTATED BIBLIOGRAPHY SHOULD INCLUDE AT LEAST 30 REFERENCES. Most (at least around 70%) but not necessarily all of these should also be included in your final written proposal (lab section assignment) but regardless, you must summarize all the papers you explored as part of your proposal literature background, development and synthesis.

Online References:

Original articles for published genome assemblies available via the Entrez-NCBI searchable database for Genome Project Resources: http://www.ncbi.nlm.nih.gov/genomes/leuks.cgi

Texts Placed on Reserve at Addlestone and Marine Resources Libraries:

Brown, T. A. 2006. *Genomes 3*. Garland Science, New York, NY.
Caetano-Anollés, G. (Ed.) 2010. *Evolutionary Genomics and Systems Biology*. Wiley-Blackwell, Hoboken, NJ.
Dittmar, L. and D. Liberlies (Eds.) 2010. *Evolution After Gene Duplication*. Wiley-Blackwell, Hoboken, NJ.
Gibson G. and S. Muse 2009. A Primer of Genome Science, 3rd ed., Sinauer Associates, Inc., Sunderland, MA.
Murphy, W. (Ed.) 2007. *Phylogenomics*. Methods in Molecular Biology Series, Humana Press, Totowa, NJ.
Lynch, M. 2007. *The Origins of Genome Architecture*. Sinauer Associates, Inc., Sunderland, MA.
Pough, F.H., Janis C.M., and J.B. Heiser. 2008. *Vertebrate Life*, 9th ed., Prentice Hall, NJ.
Van Straalen, N. M. and D. Roelofs. 2012. Ecological Genomics, 2nd ed., Oxford University Press, New York, NY.

BIOL 649 LABORATORY IN COMPARATIVE GENOMICS
SPRING 2016
INSTRUCTORS: SHEDLOCK (Biology)
TECHNICAL SUPPORT: ANDERSON (Computer Science)
TA: TEMKIN (Pathology)
TIME: 5:30-7:30 PM THURSDAYS
LOCATION: ROOM 250 School of Science and Mathematics Building (SSMB)

PROVISIONAL COURSE OUTLINE & SYLLABUS:

Weeks 1-3
Module 1: Individual Project Formation
- Identify testable hypotheses
- Develop rationale and justification for proposed research
- Select taxonomic scope
- Design genomic sampling

Weeks 4-8
Module 2: Project Implementation
- Compile data from online or proprietary resources
- Select and test relevant computational tools
- Construct primary data set
- Analyze primary data set

Weeks 9-11
Module 3: Project Synthesis
- Prioritization of pilot results
- Interpretation of statistical significance and trends
- Graphical summary of most relevant comparisons
- Interpretation and discussion of evidence
- Synthesis of arguments for proposed funding
- **Submit proposal outline and justification (Due March 17th; 200 points)**

Weeks 12-14
Module 4: Written and Oral Communication
- Selection of final bibliographic resources
- Written construction of graded pilot proposal
- Preparation of oral presentation of research
- **Oral presentation at student-run symposium (Thursday April 17; 300 points)**
- **Submit full written proposal (Due by 5 p.m. Monday April 25th; 400 points)**

Grading based on 1000 points:
Proposal outline and justification (200)
Full Proposal with pilot results and bibliography (400)
Oral Presentation (300)
Participation (100)

Learning Outcomes, Assessment and Grading Scale:
1. Understand fundamental and advanced concepts and the hierarchical scales of biological organization inherent to the investigation of eukaryotic genome content, structure, variation and dynamics.

The instructor will assess learning outcome 1 based on student performance on tests covering materials presented in lecture over the course of the semester. Two exams (one mid-term and one final) will be given that require in-depth review of genome structure and creating graphical representations of data and relating experimental results to the genome science concepts discussed in lecture.

Grade A = Student correctly represents concepts and data provided by lecture material and case studies and relates the experimental results to genomic concepts for at least 90% of each exam.
Grade B = As above for 80-90% of each exam.
Grade C = As above for 60-80% of each exam.
Grade F = As above for less than 60% of each

2. Understand in-depth the primary structure of genomic data and the standard tools and newly emerging technologies and strategies used to interrogate genomes.

The instructor will assess learning outcome 2 by evaluating students based on oral in-class summaries and written outlines of their project development strategies and aims for testing hypotheses established for individual class projects. In-depth understanding will also be evaluated based on performance on tests covering materials presented in lecture and laboratory over the course of the semester. Two exams (one mid-term and one final) will be given that require review of fundamental aspects of genome structure and creating graphical representations of data and relating experimental results to the genome science concepts discussed in lecture and investigated in lab.

Grade A = Student correctly represents concepts and data provided by lecture material, case studies and lab assignments and relates the experimental results to genomic concepts for at least 90% of each assignment or exam.
Grade B = As above for 80-90% of each assignment or exam.
Grade C = As above for 60-80% of each assignment or exam.
Grade F = As above for less than 60% of each assignment or exam.

3. Become familiar with the historical developments, new advances, and future directions of genome science based on review and discussion of the primary literature in genome biology.

The instructor will assess learning outcome 3 through written and oral presentation assignments and active participation in student discussion relating pilot study results to the genome biology concepts discussed in lecture and investigated in lab.

Grade A = Student correctly relates genome data analysis results collected from investigations in lab to genome biology concepts for at least 90% of each assignment.
Grade B = As above for 80-90% of each assignment.
Grade C = As above for 60-80% of each assignment.
Grade F = As above for less than 60% of each assignment.

4. Gain hands-on experience designing an hypothesis-driven genomic investigation, analyzing large-scale genomic data, interpreting results of genomic investigations, and communicating a proposal for funding future work based on pilot results both in writing and orally.

The instructor will assess learning outcome 4 through written and oral presentation assignments and active participation in student discussion relating pilot study results to the genome biology concepts discussed in lecture and investigated in lab.

Grade A = Student correctly relates genome data analysis results collected from investigations in lab to genome biology concepts for at least 90% of each assignment.
Grade B = As above for 80-90% of each assignment.
Grade C = As above for 60-80% of each assignment.
Grade F = As above for less than 60% of each assignment.