Genomics
EBIO 4460/5460

Professor	Nolan Kane	Nolan.Kane@Colorado.edu
	office hours:	Mondays, 2-3, Ramaley N395
TA	Silas Tittes	silas.tittes@Colorado.edu
		11:30-12:30 T, Th., Ramaley N395
LA	Pablo Mendieta	John.Mendieta@Colorado.edu
		Wed. 2-4, Fridays 11-1, Ramaley N395

All of us are available by appointment / drop in.

Course description
This course will provide an in-depth introduction to the use of modern, next-generation genomic sequence data to address ecological and evolutionary questions. The emphasis will be on working with real data from the beginning, starting, including working through whole genome assembly, SNP calling, transcriptome assembly, and annotation. I will teach the use of Unix commands, and the basics of programming in Perl, AWK and Sed, which are essential for processing large datasets in novel ways. The broad skills you will learn will be:
1. The basics of handling genomic sequence data -analyzing quality, cleaning and trimming to eliminate bad sequence.
2. Whole genome SNP and indel calling using reference-guided analysis.
3. "De novo" whole genome, genespace and transcriptome assembly and annotation.
4. Downstream analysis after alignment – assessing sequence abundance, SNP variation, heterozygosity, and other analysis
5. Basic resources for further study, and some key references

We will start the course by each putting together a few small genomes (chloroplast genomes) using freely available data that has not yet been assembled for this purpose. We will then annotate them and submit to Genbank, and by the end of the semester we will be comparing those genomes.
I am confident that the skills learned will be widely applicable to many purposes, both academic and applied.

Learning Goals
By the end of the course you will have developed several skills that will serve you well regardless of your career path. The skills include...

1) Understand verbal and graphical representations of genomes and comparisons of genomes
2) Graphically, verbally, or quantitatively representing genomic information.
3) Identifying, creating, and evaluating alternative hypotheses using genomic information
4) Collaborating with people of varying knowledge and skills to accomplish a common goal
5) Summarizing complex datasets efficiently and communicating that information effectively

Content
We will use a textbook and our notes as a source of content for the course. The textbook will be used as background and reference; as a ready source of information about particular topics. The textbook is very not perfect, but the best I have found so far. Gibson&Muse: A Primer of Genome Science.

Assessments and Evaluation
The main assessments are from your projects, as well as class discussion and assisting other students. If you fully complete all of your assignments, contribute to class discussions, and work well with us and with other students, you will get an A in the class. The main part of that is to fully assemble a chloroplast genome, annotate (identify and describe the function of) all of the genes, and submit it to genbank (NCBI). That is a huge project, but was fully completed by over half of the class last year.

More important and more valuable to you than the grade, though, will probably be the permanent boost to your record from having a very impressive genome you can put on your resume / CV. From that point forward, anyone, anywhere in the world with internet, can see that you are the first author on a small (but important) genome.

The "lecture" portion of the class
The "lecture" portion of the class will consist of various activities, including some lecture, group discussion and problem solving, and peer instruction.

Our expectations for you
We will do our best to make our expectations of your very clear. Here are a few of them:

1) Be prepared: read the material before class, do the assignments thoughtfully so you feel that you know the material, bring your clicker and paper and pencil or pen to class, etc. Bring your laptop to labs.
2) Be respectful: come to class on time; treat your peers, and us in a professional manner; refrain as much as possible from side conversations
3) Stay on task: an important factor that explains variation in learning gains among students is focus on the problem. Distractions compromise learning.
4) Be collaborative: work with your peers and try out your critical thinking and communication skills on your peers.
5) Be honest: cheating and plagiarism will not be tolerated and if detected may result in an F for the course (see the University's Honor Code policy below).
6) Be on time and present: late work will not be accepted and in-class activities require that you are engaged.

What you can expect from us
We will be here for you and will bring our knowledge of genetics and evolution, our enthusiasm for the subject and for learning, and our experience as an educator to the class every day. We are very committed to teaching and would love nothing more than to have all students earn the highest possible scores in this course.
More specifically, we will, as much as possible...

1) be fair
2) be transparent about our expectations of you and your work
3) be communicative and available to you to talk about the subject or anything you want to talk about
4) provide you with cognitive challenges that advance your critical thinking and science-as-a-way-of-knowing skills
5) be a resource for you about the study of evolution, and aid you in your professional development when possible

University Policies

Drop deadlines
Information on dropping the course can be found at
http://registrar.colorado.edu/students/registration/registration_packet/drop_add.html#dropadd

Being sick
When you are sick with an infectious disease (e.g. the flu), please do not come to class during the infectious period (usually when you have a fever). You can drop enough day-to-day activities that there should be no need to have "make up" work; however, we are happy to work with you to make sure you achieve the learning outcomes expected for the times you miss class. If you have to miss a lab, you can come to lab on a different day or work with us to get the lab assignments completed.

Students with disabilities
Students with disabilities who qualify for academic accommodations must provide a letter from Disability Services (DS) and discuss specific needs with the professor, preferably during the first two weeks of class. DS determines accommodations based on documented disabilities (303-492-8671, Willard 322, www.colorado.edu/sacs/disabilityservices).

Sexual harassment
The University of Colorado at Boulder policy on Discrimination and Harassment (http://www.colorado.edu/policies/discrimination.html), the University of Colorado policy on Sexual Harassment and the University of Colorado policy on Amorous Relationships apply to all students, staff and faculty. Any student, staff or faculty member who believes s/he has been the subject of discrimination or harassment based upon race, color, national origin, sex, age, disability, religion, sexual orientation, or veteran status should contact the Office of Discrimination and Harassment (ODH) at 303-492-2127 or the Office of Judicial Affairs at 303-492-5550. Information about the ODH and the campus resources available to assist individuals regarding discrimination or harassment can be obtained at http://www.colorado.edu/odh.

Classroom behavior
Students and faculty each have responsibility for maintaining an appropriate learning environment. Students who fail to adhere to such behavioral standards may be subject to discipline. Faculty have the professional responsibility to treat all students with understanding, dignity and respect, to guide classroom discussion and to set reasonable limits on the manner in which they and their students express opinions. Professional courtesy and sensitivity are especially important with respect to individuals and topics dealing with differences of race, culture, religion, politics, sexual orientation, gender variance, and nationalities. Class rosters are provided to the instructor with the student's legal name. We will gladly honor your request to address you by an alternate name or gender pronoun. Please advise us of this preference early in the semester so that we may make appropriate changes to our records. See polices at
http://www.colorado.edu/policies/classbehavior.html and at
http://www.colorado.edu/studentaffairs/judicialaffairs/code.html#student_code

Cell phones and internet "cruising"
Research has demonstrated that the use of cell phones and internet cruising during class time significantly decreases your ability to learn with effects on your overall grade. Furthermore, phone use and internet cruising can be disruptive to other students. If you have to use a cell phone, please leave the room and restrict your internet activities to course-relevant material.

Honor code
All students of the University of Colorado at Boulder are responsible for knowing and adhering to the academic integrity policy of this institution. Violations of this policy may include: cheating, plagiarism, aid of academic dishonesty, fabrication, lying, bribery, and threatening behavior. All incidents of academic misconduct shall be reported to the Honor Code Council (honor@colorado.edu; 303-735-2273). Students who are found to be in violation of the academic integrity policy will be subject to both academic sanctions from the faculty member and non-academic sanctions (including but not limited to university probation, suspension, or expulsion). Other information on the

Honor Code can be found at http://www.colorado.edu/policies/honor.html
and at
http://www.colorado.edu/academics/honorcode/

Religious observances
Campus policy regarding religious observances requires that faculty make every effort to reasonably and fairly deal with all students who, because of religious obligations, have conflicts with scheduled exams, assignments or required attendance. In this class, students need to come talk with us about their particular conflicts as soon as those dates are known.
See full details at http://www.colorado.edu/policies/fac_relig.html

Course schedule:

Week	Dates	NOTES
Week 1: Intro to Genomics, Bioinformatics, and Unix	Aug. 24-28	No Monday rec.
Week 2: Reference-guided genome assembly	Sept. 1-4	
Week 3: Identification of sequence differences (SNPs)	Sept. 7-11	No Monday rec.
Week 4: Making a genome using a reference	Sept. 14-18	
Week 5: De Novo Assembly: concepts and intro	Sept. 21-25	
Week 6: Trimming and cleaning next-gen sequence reads	Sept. 28-Oct.1	
Week 7: De Novo assembly with SOAPdenovo	Oct. 5-9	
Week 8: Scaffolding and improving assembly with other data	Oct. 12-16	
Week 9: Error correction of draft genomes	Oct. 19-23	
Week 10: Annotation: gene finding	Oct. 26-30	
Week 11: Submitting data to genbank	Nov. 2-6	
Week 12: Comparing complete genomes: SNPs and indels	Nov. 9-13	
Week 13: Comparing complete genomes: synteny	Nov. 16-20	
(Thanksgiving break)		
Week 14: Copy number differences	Nov. 30-Dec.4	
Week 15: Phylogenetic analysis	Dec. 7-11	

Final project due: Dec. 15