General Education Course Information Sheet

Please submit this sheet for each proposed course

Department & Course Number Bioinformatics 98T

Course Title The Computer is the New Microscope: Bioinformatics and the Interpretation of DNA Sequence Data

1 Check the recommended GE foundation area(s) and subgroups(s) for this course

Foundations of the Arts and Humanities

- Literary and Cultural Analysis _____
- Philosophic and Linguistic Analysis _____
- Visual and Performance Arts Analysis and Practice _____

Foundations of Society and Culture

- Historical Analysis _____
- Social Analysis _____

Foundations of Scientific Inquiry

- Physical Science _____
  With Laboratory or Demonstration Component must be 5 units (or more) _____
- Life Science x
  With Laboratory or Demonstration Component must be 5 units (or more) _____

2. Briefly describe the rationale for assignment to foundation area(s) and subgroup(s) chosen.

The course will explore how algorithms and software have become essential to biological research, as well as applications of these new technologies to human history, forensics, and personalized medicine.

3. List faculty member(s) who will serve as instructor (give academic rank):
Professor Janet Sinsheimer, faculty mentor; Darren Kessner, teaching fellow

4. Indicate when do you anticipate teaching this course:

	2013-2014	Winter Enrollment	_____	Spring Enrollment	x 16

GE Course Units **5**

5. Please present concise arguments for the GE principles applicable to this course.

❑ General Knowledge	This course emphasizes basic scientific knowledge about DNA sequence analysis, which is essential for reasoning about ethical and public policy issues concerning the use of DNA information.
❑ Integrative Learning	The students will be reading both primary and secondary sources, as well as conducting their own research into a specific application of DNA technology.
❑ Ethical Implications	In all DNA applications discussed in the course, we will be considering the ethical implications of the technology.
❑ Cultural Diversity	No explicit treatment of cultural diversity will be included; however, the implicit underlying theme of DNA sequence analysis in the application to human history is that DNA is universal, and that group identity is a human construct.
❑ Critical Thinking	The students will be expected to contribute to an online discussion of the readings each week, in which they will be asking their own questions in addition to answering their classmates' questions.
❑ Rhetorical Effectiveness	Students will analyze and present one of the readings to the class during the quarter. In addition, they will present their own research project to the class.
❑ Problem-solving	Students will practice their problem-solving skills both in answering their classmates' online questions and in analyzing the implications of new DNA technology in their research paper.
❑ Library & Information Literacy	Students will gain valuable research skills as they work on their research topic; they will need to follow up on references to related work, and decide which information is pertinent to their project.

(A) STUDENT CONTACT PER WEEK (if not applicable write N/A)

1.	Lecture:	**3**	(hours)
2.	Discussion Section:	**N/A**	(hours)
3.	labs	**N/A**	(hours)
4.	Experiential (service learning, internships, other):	**N/A**	(hours)
5.	Field Trips:	**N/A**	(hours)

(A) TOTAL Student Contact Per Week **3** **(HOURS)**

(B) OUT-OF-CLASS HOURS PER WEEK (if not applicable write N/A)

1.	General Review & Preparation:	**2**	(hours)
2.	Reading	**6**	(hours)
3.	Group Projects:		(hours)
4.	Preparation for Quizzes & Exams:		(hours)
5.	Information Literacy Exercises:		(hours)
6.	Written Assignments:	**2**	(hours)
7.	Research Activity:	**2**	(hours)

(B) TOTAL Out-of-class time per week **12** **(HOURS)**

GRAND TOTAL (A) + (B) must equal at least 15 hours/week 15 **(HOURS)**

The Computer is the New Microscope: Bioinformatics and the Interpretation of DNA Sequence Data

Bioinformatics 98T

Darren Kessner

Course Description

Every week, newspaper articles describe new advances, and new controversies, fueled by DNA sequencing technology (e.g. genetic testing, forensics, genetically modified foods, cloning). These advances are enabled by continual improvement in both the DNA sequencing hardware and the specialized bioinformatics software used for analyzing and interpreting sequence data. Clearly, the computer has emerged as an essential tool for modern biology.

The first part of the course will give an overview of modern research in population genetics/genomics, and the current state of DNA sequencing technology and bioinformatics algorithms. The second part of the course will explore applications of these new technologies to questions about human history, forensics, and personalized medicine, with an emphasis on implications for public health and public policy. The common theme running through all topics is the role of computers and algorithms in making sense of large-scale DNA sequence data.

Student objectives:

- to understand the scientific method, including how scientific results are presented in publications, and how to critically evaluate those results
- to develop a context for understanding current research in biology and medicine, so that popular articles about the latest findings can be appreciated
- to understand the role of computer science in the analysis of DNA sequences
- to explore the breadth of applications of DNA sequencing technology
- to participate in an academic "lab" environment, where they collaborate with fellow students in understanding new ideas and provide each other with feedback on their own research
- to practice presenting scientific ideas and thinking clearly about implications for public health and public policy

Topic List

Week 1 Introduction to the Scientific Method and the Study of Genetics

Week 2 Population Genetics I: Patterns of Genetic Variation

Week 3 Population Genetics II: Drift, Selection, and Recombination

Week 4 DNA Sequencing and Bioinformatics Algorithms

Week 5 The Human Genome

Week 6 Application: Human History

Week 7 Application: Personalized Medicine

Week 8 Application: Forensics

Week 9 Application: Metagenomics and Human Health

Week 10 / Finals Week Research Project Presentations

Class Requirements

Weekly meetings

The class will meet twice a week. One primary reading will be assigned for each class session, which will be run in a collaborative "journal club" format where one student presents the paper and leads the class discussion. The purpose of the journal club is to learn how to critically evaluate scientific research, as well as to work with fellow students to understand the material. Students will gain valuable experience in identifying the question asked by the paper, understanding the methods used in the investigation and the experimental results, and evaluating whether the evidence presented supports the authors' conclusions.

Also, during most class sessions I will present a mini-lecture to introduce the topics addressed in the next paper to be read.

Online discussion

In addition to the in-class discussion, students will be expected to contribute to an online discussion of the papers ahead of time. This online discussion will take place in a message-board forum, where each student will be expected to ask at least two questions about the readings, and answer at least one of their classmates' questions. The online discussion is intended to encourage students to delve more deeply into the subject, as well as to help each other understand the technical aspects of the papers.

Research project and peer review

Students will also write a research paper (12–15 pages) on a topic of their choosing, related to an application of DNA technology. In the research paper, the student will summarize the scientific background, describe the current state of the technology or application, evaluate the immediate benefits of the technology, and analyze the implications for society as the technology progresses. Students will also develop a short presentation ($\sim$ 15 minutes) describing their research, to be given in class at the end of the quarter.

Additionally, students will participate in a peer review, in which a draft version of each student's research paper will be reviewed by two of their classmates. The review process provides the student with valuable feedback on their research, pointing out areas where they can improve their analysis. This will also give the student reviewers experience in giving clear, constructive suggestions. Peer reviews will include a list of specific points that should each be addressed by the author in writing and submitted with the final research paper.

Draft versions of the research paper will be due Week 8, with written peer reviews due Week 9 so that feedback can be incorporated into the final version of the paper due Week 10. Research presentations will be given during Week 10 and Finals Week.

Grading

Weekly online discussion	15%
Weekly in-class discussion	15%
Reading presentation	15%
Peer review	15%
Research paper	25%
Research presentation	15%

Weekly Topics and Readings

Note that the primary readings will be supplemented each week with current newspaper/newsmagazine articles describing new discoveries (e.g. New York Times, Economist, Scientific American).

Week 1 – Introduction to the Scientific Method and the Study of Genetics

Session 1:

Topics: course logistics, molecular biology background and history of genetics, overview of applications

Reading: (supplementary/optional) Zien A. 2004. "A Primer on Molecular Biology" (Chapter 1 of Kernel Methods in Computational Biology, freely available online).

Session 2:

Topics: Mendel's methods of investigation, Mendel's laws of inheritance and segregation

Reading: Mendel, Gregor. 1866. Experiments in Plant Hybridization. (English translation by William Bateson and Roger Blumberg)

Week 2 – Population Genetics I: Patterns of Genetic Variation

Session 1:

Topics: patterns of genetic variation; mutation and polymorphism

Reading: Kreitman, M. 1983. Nucleotide polymorphism at the alcohol dehydrogenase locus of *Drosophila melanogaster*. Nature 304:412-417.

Session 2:

Topics: human genetic variation

Reading: Novembre J et al. 2008. Genes mirror geography within Europe. Nature 456:98-101.

Week 3 – Population Genetics II: Drift, Selection, and Recombination

Session 1:

Topics: mathematical models in population genetics; effects of mutation, drift, selection, recombination

Reading: McDonald J and Kreitman M. 1991. Adaptive protein evolution at the *Adh* locus in *Drosophila*. Nature 351:652-654.

Session 2:

Topics: haplotypes and signatures of selection

Reading: Bersaglieri et al. Genetic Signatures of Strong Recent Positive Selection at the Lactase Gene. Am. J. Hum. Genet. 74:11111120.

Week 4 – DNA Sequencing and Bioinformatics Algorithms

Session 1:

Topics: DNA sequencing technology

Reading: Pettersson et al. 2009. Generations of sequencing technologies. Genomics 93:105–111.

Session 2:

Topics: bioinformatics algorithms

Reading: Eddy, S. 2004. What is dynamic programming? Nature Biotechnology 22:909–910.

Week 5 – The Human Genome

Session 1:

Topics: Human Genome Project

Reading: Collins F et al. 2003. The Human Genome Project: Lessons from Large-Scale Biology. Science 300:286.

Session 2:

Topics: resequencing studies

Reading: Nelson et al. 2012. An Abundance of Rare Functional Variants in 202 Drug Target Genes Sequenced in 14,002 People. Science 337(6090):100–104.

Week 6 – Application: Human History

Session 1:

Topics: DNA analysis and human history; demographic inference

Reading: Stoneking M and Krause J. 2011. Learning about human population history from ancient and modern genomes. Nature Reviews Genetics 12:603–614.

Session 2:

Topics: ancient DNA

Reading: Green, R. E. et al. 2010. A draft sequence of the Neandertal genome. Science 328, 710722

Week 7 – Application: Personalized Medicine

Session 1:

Topics: Genome-wide Association Studies (GWAS), personal genomics

Reading: The Wellcome Trust Case Control Consortium. 2007. Genome-wide association study of 14,000 cases of seven common diseases and 3,000 shared controls. Nature 447:661-678.

Session 2:

Topics: personal genomic data; public health, public policy, privacy and ethical issues

Reading: McEwen J et al. 2013. Evolving approaches to the ethical management of genomic data. Trends in Genetics (in press).

Week 8 – Application: Forensics

Session 1:

Topics: forensic DNA testing

Reading: McDonald J and Lehman D. 2012. Forensic DNA Analysis. Clinical Laboratory Science 25:109–113.

Session 2:

Topics: disaster victim identification

Reading: Leclair et al. 2007. Bioinformatics and Human Identification in Mass Fatality Incidents: The World Trade Center Disaster. Journal of Forensic Sciences 52:806–819.

Week 9 – Application: Metagenomics and Human Health

Session 1:

Topics: metagenomics; Human Microbiome Project

Reading: Morgan X et al. 2013. Biodiversity and functional genomics in the human microbiome. Trends in Genetics 29:51–58.

Session 2:

Topics: human microbiome and disease: obesity, malnutrition, fecal transplants

Reading: Ley R et al. 2006. Human gut microbes associated with obesity. Nature 444:1022–1023.

Smith M et al. 2013. Gut Microbiomes of Malawian Twin Pairs Discordant for Kwashiorkor. Science 339:548–554.

Week 10 / Finals Week – Research Project Presentations

no readings

UCLA Course Inventory Management System

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New Course Proposal

	Bioinformatics, Undergraduate 98T Computer Is New Microscope: Bioinformatics and Interpretation of DNA Sequence Data
Course Number	**Bioinformatics, Undergraduate 98T**
Title	**Computer Is New Microscope: Bioinformatics and Interpretation of DNA Sequence Data**
Short Title	**DNA SEQUENCE DATA**
Units	Fixed: **5**
Grading Basis	**Letter grade only**
Instructional Format	**Seminar - 3 hours per week**
TIE Code	**SEMT - Seminar (Topical) [T]**
GE Requirement	**Yes**
Major or Minor Requirement	**No**
Requisites	**Enforced: Satisfaction of entry-level Writing requirement. Freshmen and sophomores preferred.**
Course Description	**Seminar, three hours. Enforced requisite: satisfaction of Entry-Level Writing requirement. Freshmen/sophomores preferred. Exploration of how computers and specialized algorithms are used to interpret DNA sequence data, with applications to biology, human history, personalized medicine, and forensics and emphasis on implications for human health and public policy. Letter grading.**
Justification	**Part of the series of seminars offered through the Collegium of University Teaching Fellows.**
Syllabus	File *Bioinformatics 98T syllabus.pdf* was previously uploaded. You may view the file by clicking on the file name.
Supplemental Information	**Professor Janet Sinsheimer is the faculty mentor for this seminar.**
Grading Structure	**Weekly online discussion - 15%; weekly in-class discussion - 15%; reading presentation - 15%; peer review I- 15%; research paper - 25%; research presentation - 15%**
Effective Date	**Spring 2014**
Discontinue Date	**Summer 1 2014**
Instructor	Name: **Darren Kessner** — Title: **Teaching Fellow**
Quarters Taught	☑ Fall ☑ Winter ☑ Spring ☐ Summer
Department	**Computer Science**
Contact	Name: **CATHERINE GENTILE** — E-mail: **cgentile@oid.ucla.edu**
Routing Help	

ROUTING STATUS

Role:	Registrar's Office

Status:	Processing Completed

Role:	Registrar's Publications Office - Hennig, Leann Jean (LHENNIG@REGISTRAR.UCLA.EDU) - 56704
Status:	Added to SRS on 8/29/2013 12:29:41 PM
Changes:	Title, Description
Comments:	Edited course description into official version.

Role:	Registrar's Scheduling Office - Bartholomew, Janet Gosser (JBARTHOLOMEW@REGISTRAR.UCLA.EDU) - 51441
Status:	Added to SRS on 8/20/2013 2:51:39 PM
Changes:	Title, Short Title
Comments:	Took 'The' off of the full title. Added a short title.

Role:	L&S FEC Coordinator - Castillo, Myrna Dee Figurac (MCASTILLO@COLLEGE.UCLA.EDU) - 45040
Status:	Returned for Additional Info on 8/16/2013 11:05:44 AM
Changes:	No Changes Made
Comments:	Routing to Doug Thomson in the Registrar's Office.

Role:	FEC Chair or Designee - Palmer, Christina (CPALMER@MEDNET.UCLA.EDU) - 44796
Status:	Approved on 8/15/2013 3:18:27 PM
Changes:	No Changes Made
Comments:	No Comments

Role:	FEC Chair or Designee - Castillo, Myrna Dee Figurac (MCASTILLO@COLLEGE.UCLA.EDU) - 45040
Status:	Returned for Additional Info on 8/14/2013 3:20:53 PM
Changes:	Requisites
Comments:	Routing to Christina Palmer for FEC approval.

Role:	CUTF Coordinator - Gentile, Catherine (CGENTILE@OID.UCLA.EDU) - 68998
Status:	Approved on 8/14/2013 9:26:02 AM
Changes:	No Changes Made
Comments:	on behalf of Professor Kathleen Komar, chair, Collegium of University Teaching Fellows

Role:	Initiator/Submitter - Gentile, Catherine (CGENTILE@OID.UCLA.EDU) - 68998
Status:	Submitted on 8/14/2013 9:25:19 AM
Comments:	Initiated a New Course Proposal

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Comments or questions? Contact the Registrar's Office at
cims@registrar.ucla.edu or (310) 206-7045