# ANG 6592 (Section 6471)/ANT 4530 (Section 6474) - SEMINAR IN MOLECULAR ANTHROPOLOGY

Prof. Connie J. Mulligan

Class meets in 217 Little Class time: Tuesdays, 10:40-1:40

> Contact information: 409 Genetics Institute 2033 Mowry Road 273-8092 cmulligan@ufl.edu

Office hours: Tues, 8:30-10:30, B119 Turlington Hall or by appointment in 409 Genetics Institute

**Course summary:** The purpose of this class is to examine current applications of molecular data to questions of human evolution and population genetics. Emergence of modern *Homo sapiens*, Neanderthal genetics, reconstruction of human migrations, and evidence of natural selection on the human genome are among the topics discussed in detail. Examples of ancient DNA studies, admixture, and molecular genetics of human disease are also briefly discussed. Data types include mitochondrial DNA, Y chromosome, nuclear DNA, and various –omic datasets, including genomic, exomic, transcriptomic, etc.

**Course design:** This course is intended for advanced undergraduate and graduate students who have an interest in human evolution as well as in molecular genetics. It is intended for students from all colleges and departments – in the past, I have had students from anthropology, chemistry, history, molecular genetics and microbiology, and zoology. A diverse audience makes for a more interesting class since everyone has different backgrounds, different perspectives and different interests to contribute to class discussions. Active participation is one of the strengths of the class in this regard. It also helps to have a class with undergraduate and graduate students together. Contrary to what one might think, the undergrads are typically as well prepared and as insightful as the graduate students. I do keep separate sets of grades for the undergraduate and graduate classes so that each set of students is only compared to his/her cohort.

**Course objectives and student goals:** All students are expected to gain knowledge on the molecular genetic basis for various theories of human evolution and subsequent population movements. The class is fairly intense and demanding because knowledge across a broad range of fields is fundamental to an exploration of the molecular genetics of human evolution – in fact, this course may be the most challenging course you have ever taken with respect to developing expertise and familiarity with a wide range of scientific fields, materials, techniques, publications, etc. You are expected to do all of the required readings and to follow up with additional readings if you do not understand something. Additional readings are listed in the textbook and can be found in the references in the journal articles; furthermore, you should become familiar with searching PubMed for supplementary, follow-up, or original readings.

**Reading and course format:** Reading material consists of one textbook (Human Evolutionary Genetics by Jobling, Hurles, and Tyler-Smith, <u>available at Orange and Blue Textbooks</u>, <u>309 NW 13th St</u>, <u>375-2707</u>) and a <u>seriescourse pack</u> of approximately 30 related journal articles plus 'news and views' type articles (<u>available on the course Sakai webpage</u>) (the textbook and course pack are available at Orange and Blue Textbooks, <u>309 NW 13th St</u>, <u>375-2707</u>). If students know of additional articles or topics that they would like to discuss, please contact me. The course meets once per week for three hours and the course format is mainly discussion with substantial student participation. Lectures will be supplementary only in order to provide necessary introductory and background material.

**Grading:** Final grades will be determined by the following five categories: 1) **participation** (100 pts), 2) weekly **summary/questions/comments** (100 pts), 3) four homework **exercises** (25 pts each), 4) one **oral presentation** (100 pts total), and 5) one **exam** (100 pts). Possible points total 500. Grades will be based on the following point percentages: 90-100%=A, 87-89%=B+, 80-86%=B, 77-79%=C+, 70-76%=C, 67-69%=D+, 60-66%=D, < 59%=E.

- **Participation** is required of all students and will be based on each student's contribution of original comments, questions, etc to the class. Students are not graded on the brilliance of their statements, but on their willingness to talk, a demonstration that the assigned material was read, and the originality of their comments. Simply showing up for class does not constitute participation. Remaining silent in class means that the highest grade a student can receive is a B.
- At the beginning of each class, a 1-2 paragraph **summary** and 3 **questions** or **comments** for each journal article assigned for that day's class will be turned in. The summary/questions/comments are required only for the peer-reviewed journal articles, not for the news-and-views type articles that are included in the course pack to provide background or summary information. The summary/questions/comments are intended to ensure that each student has read the required materials for that day and is prepared to actively participate in class discussions.
- There will be a maximum of four homework **exercises** involving the analysis of hypothetical or actual molecular data. The exercises are intended to give students an opportunity to perform data analyses similar to those conducted in the discussion papers and will be graded on effort and accuracy. Exercises must be turned in two weeks after they are assigned. Students who miss the class in which an exercise is assigned are expected to turn the exercise in on time, i.e. two weeks after the missed class.
- Each student will present one 15-20 min **oral presentation** based on journal articles from the course packet. The presentation must use MS Power Point. Regardless of whether a student is presenting an article, all students will read all articles in the course packet and be prepared to participate in class discussions of the articles. Students will sign up for articles for oral presentation on the second day of class (only one student may sign up for each article).
- There will be one **exam** that will consist of short answer and essay questions and questions similar to the homework exercises. Questions must be answered during the class period without reference to books or notes of any kind. Calculators may be used, but no cell phones, iPod, BlackBerry or similar devices will be allowed. Make-up exams will be scheduled only in extenuating circumstances and will require a doctor's note, police report, or similar supporting documentation.

#### Useful websites:

Although basic molecular biological concepts will be reviewed, some knowledge of DNA structure, Mendelian genetics, and molecular biology is expected (such as Intro Bio, BCS 2011). Useful information is provided by several websites:

https://lss.at.ufl.edu/ html - access to Sakai course website

<u>http://www.uflib.ufl.edu/ej/</u> - UF database of available electronic journals (may only be available from a campus computer)

<u>http://www.ncbi.nlm.nih.gov/PubMed</u> - National Library of Medicine database of over 11 million journal articles dating back to the 1960s

http://www.genome.gov/glossary.cfm - NIH-maintained glossary of genetic terms

http://www.genomesonline.org/ - status of genome sequencing projects

<u>http://www.stanford.edu/group/morrinst/hgdp.html</u> – Human Genome Diversity Project (dated, good for historical perspective)

**Class attendance policy:** Because the class meets only one time per week and because the class format is mainly discussion, it is very difficult to make up missed classes by borrowing notes, etc. Therefore, students are strongly encouraged to attend all classes and to arrive on time. Computers are allowed in class for taking notes, but are not allowed during exams. If computer use gets extensive, i.e. if no one is participating and I'm lecturing to a sea of laptop backs, then I will institute a 'no computers' policy. Class discussions/lectures cannot be recorded in any manner without special permission. All cell phones must be turned off during class.

# Strategies for success:

- It is important to complete all the readings on time and it is best to do the readings throughout the week. In this way, you have time to think about and process the information during the week and in between different readings. Ideally, you would read some every night of the week. The amount of reading material is modest, particularly for an anthropology course. This is because it is expected that you will re-read (gasp!) anything you do not understand the first time. I often re-read journal articles and find myself discovering things that I completely missed on the first read. Or new items will come to light after having read a different, but related, article. This is the intent of the readings that they relate to each other and increase your knowledge and expertise in an exponential way. During your reading, you should take copious notes and these notes will form the basis of the summary + questions you must turn in for every article.
- You have two weeks to work on the exercises. These exercises are most likely completely different from anything you've ever done and, thus, you may have lots of questions about how to proceed. The intent is that you will use the first week to start on the exercise and come to class the next week (i.e. the week before the exercise is due) with any questions you have about the exercise. Do not wait until the second week to start the exercise. Also, I am always available by email to ask questions about the exercises.
- For the oral presentation, it is a good idea to practice your entire presentation without any stops the night before your scheduled presentation this ensures your talk is the correct length of time and develops good practice for all public speaking.
- Finally, you should review material throughout the course rather than trying to cram everything in the night before the exam. Ask for help in taking notes, comprehending the material, or preparing any of the written or oral assignments I am available during office hours, you can schedule an appointment outside of office hours, and I am always available by email.

**Copyright information:** Lectures may not be tape-recorded without the prior express written permission of Dr. Connie Mulligan. The contents of the syllabus, lectures, lecture outlines, and handouts for this course are copyrighted and intended for the private use of students registered in ANG 6592/ANT 4530. They therefore cannot legally be reproduced, in part or in whole, by any commercial enterprise or for any commercial purposes.

Accommodations for students with disabilities: If you require accommodation due to a disability, please make an appointment during my office hours so that we may discuss your needs. Students requesting classroom accommodation must first register with the Dean of Students Office. The Dean of Students Office will provide documentation to the student who must then provide this documentation to the Instructor when requesting accommodation.

**Academic honesty:** As a result of completing the registration form at the University of Florida, every student has signed the following statement: "I understand that the University of Florida expects its students to be honest in all their academic work. I agree to adhere to this commitment to academic honesty and understand that my failure to comply with this commitment may result in disciplinary action up to and including expulsion from the University."

An excellent website that discusses plagiarism (it provides a definition and many useful examples) is <u>http://www.csubak.edu/ssric/Modules/Other/plagiarism.htm</u>. All students should read this material at least once.

**UF Counseling Services:** On-campus services are available for students having personal problems or lacking clear career and academic goals. They include:

- 1. University Counseling Center, 301 Peabody Hall, 392-1575, personal and career counseling
- 2. Student Mental Health, Student Health Care Center, 392-1171, personal counseling
- 3. Sexual Assault Recovery Services (SARS), Student Health Care Center, 392-1161, sexual assault counseling
- 4. Career Resource Center, Reitz Union, 392-1601, career development assistance and counseling
- 5. Additionally, student web-based resources on sexual harassment are available at http://www.ufsa.ufl.edu/students/sh/sexualharassment.shtml

# Course schedule (this is a preliminary schedule - due dates for exercises and oral presentations are subject to change):

# August 23 Introduction Lecture – background material Video – <u>The Gene Hunters</u> (example of a study conducted under the Human Genome Diversity Program)

# August 30The human genome

Reading material

- Human Evolutionary Genetics (HEG), Chpts 1 (Why study human evolutionary genetics?), 2 (Structure, function and inheritance of the human genome) AND pp 88-89 (PCR amplification)
- Sakai website
  - "Beyond Stones and Bones", Newsweek, March 19, 2007"Population geneticists move beyond the single gene", Science, June 22, 2007
  - "Human genetic variation", Science, Dec 21, 2007
  - "Working the (gene count) numbers: Finally, a firm answer", Science, May 25, 2007
  - "DNA study forces rethink of what it means to be a gene", Science, June 15, 2007
  - "Genomic clues to DNA treasure sometimes lead to nowhere", Science, July 10, 2009
  - "Science after the sequence", Nature, June 2010
  - Challenges in human genetic diversity: Demographic history and adaptation, Balaresque et al, 2007, Human Molecular Genetics, 16:R134-R139.

#### Lecture

- Background material
- Discussion of oral presentations

Sign up for oral presentation

Assign Exercise #1

# September 6 Human genetic diversity

#### Reading material

- HEG Chpts 3 (The diversity of the human genome read lightly, mainly for vocabulary), 4 (Discovering and assaying genome diversity read lightly)
- Sakai website
  - A map of human genome variation from population-scale sequencing, The 1000 Genomes Project Consortium, Nature, 2010, 467:1061-1073
  - Widespread RNA and DNA sequence differences in the human transcriptome, Li et al, 2011, Science, 333:53-58 (oral presentation)
  - Use of Y chromosome and mitochondrial DNA population structure in tracing human migrations, Underhill and Kivisild, Annual Review Genetics, 2007, 41:539-564 (undergrads stop reading on page 548, up to "Stepped Clinal Haplogroup Progression") (grad oral presentation)

#### September 13 Processes that shape genetic diversity

Reading material

- HEG Chpt 5 (Processes shaping diversity)
- Sakai website
  - Classic selective sweeps were rare in recent human evolution, Hernandez et al, 2011, Science, 331: 920-924 (grad oral presentation)

- Detecting ancient admixture and estimating demographic parameters in multiple human populations, Wall et al., 2009, Mol Biol Evol, 26:1823-1827 (oral presentation)
- Can a sex-biased human demography account for the reduced effective population size of chromosome X in non-Africans? Keinan and Reich, 2010, Mol Biol Evol, 27:2312-2321

Exercise #1 due

#### September 20 Making inferences from diversity

Reading material

- HEG Chpt 6 (Making inferences from diversity)
- Sakai website
  - "Are human brains still evolving?" AND Ongoing adaptive evolution of ASPM, a brain size determinant in *Homo sapiens*, Mekel-Bobrov et al., Science, 2005 AND 2007 Comment on "Ongoing adaptive evolution of ASPM, a brain size determinant in *Homo sapiens*" (oral presentation)
  - The ongoing adaptive evolution of *ASPM* and *Microcephalin* is not explained by increased intelligence, Mekel-Bobrov et al., Hum Mol Genet, 2007, 16:600-608
  - Positive selection in *ASPM* is correlated with cerebral cortex evolution across primates but not with whole-brain size, Ali and Meier, Mol Biol Evol, 2008, 25:2247-2250
  - Additional reading Adaptive evolution of four microcephaly genes and the evolution of brain size in anthropoid primates, Montgomery et al, 2010, Mol Biol Evol, 28:625-638

Assign Exercise #2

#### September 27 Humans as apes

Reading material

- HEG Chpt 7 (Humans as apes)
- Sakai website
  - "Genomicists tackle the primate tree", Science, April 13, 2007
    - "Relative differences: The myth of 1%", Science, June 29, 2007
  - "The fickle Y chromosome", Nature, Jan 13, 2010
  - Implications of natural selection in shaping 99.4% nonsynonymous DNA identity between humans and chimpanzees: Enlarging genus *Homo*, Wildman et al., 2003, Proc Natl Acad Sci USA, 100:7181-7188
  - Parallel patterns of evolution in the genomes and transcriptomes of humans and chimpanzees, Khaitovich et al., Science, 2005, 309:1850-1854 (oral presentation)
  - Chimpanzee vocal signaling points to a multimodal origin of human language, Taglialatela et al, PLoS ONE, 2011, 6: e18852

#### October 4 Origins of modern humans

Reading material

- HEG Chpt 8, pp236-260 (Origins of modern humans)
- Sakai website
  - POSSIBLY OPTIONAL Global patterns of linkage disequilibrium at the CD4 locus and modern human origins, Tishkoff et al, Science, 1996, 271:1380-1387 AND Technical comment by Milford AND Response by Tishkoff et al.
  - Hunter-gatherer genomic diversity suggests a southern African origin for modern humans, Henn et al, PNAS, 2011, 108:5154-5162 AND "Human history writ large in a single genome", Nature, July 13, 2011 AND Inference of human population

history from individual whole-genome sequences, Li and Durban, Nature, 2011, in press (grad oral presentation)

Phonemic diversity supports a serial founder effect model of language expansion from Africa, Atkinson, Science, 2011, 332:346-349

Exercise #2 due

#### October 11 Genetic ancestry, race and racial disparities in health

Mulligan absent - American Society of Human Genetics meeting Reading material

- Sakai website
  - <u>http://www.pbs.org/race/000\_About/002\_04-background-01-07.htm</u> Race: The Power of an Illusion, interview with Alan Goodman
  - o In our Blood, Newsweek, Feb 6, 2006
  - o "Genetic testing regulation", Nature, Aug 12, 2010
  - Inferring Genetic Ancestry: Opportunities, Challenges, and Implications, Royal et al., Am J Hum Genet, 2010, 86:661-673 (oral presentation)
  - POSSIBLY Psychological and Ethical Issues Related to Identity and Inferring Ancestry of African Americans, Winston and Kittles, in: Biological Anthropology and Ethics, ed. TR Turner, 2005, SUNY Press, pp209-229
- Video African American Lives

# October 18 Origins of modern humans

# Reading material

- HEG Chpt 8, pp260-267 (Neanderthals)
- Sakai website
  - "Anthropologists cast doubt on human DNA evidence" AND "Were Cro-Magnons too like us for DNA to tell?" AND Evidence for a genetic discontinuity between Neandertals and 24,000-year-old anatomically modern Europeans, Caramelli et al., PNAS, 2003, 100:6593-6597 (oral presentation)
  - A draft sequence of the Neanderthal genome, Green et al, Science, 2010, 328:710-722 AND Drafting human ancestry: What does the Neanderthal genome tell us about hominid evolution? Commentary on Green et al. (2010), Hofreiter, Hum Biol, 2011, 83:1-11 (grad oral presentation)

Assign Exercise #3

# October 25 Global distribution of diversity

#### Reading material

- HEG Chpt 9 (The distribution of diversity out of Africa and into Asia, Australia and Europe)
- Sakai website
  - Ice ages and the mitochondrial DNA chronology of human dispersals: A review, Forster, 2004, Phil Trans R Soc Lond B, 359:255-264
  - Evidence for gradients of human genetic diversity within and among continents, Serre and Paabo, Genome Res, 2004, 14:1679-1685 (oral presentation)
  - Novelty-seeking DRD4 polymorphisms are associated with human migration distance out-of-Africa after controlling for neutral population gene structure, Matthews and Butler, Am J Phys Anthropol, 2011, 145:382-389 (oral presentation)
  - Trailblazers across Arabia, Petraglia, Nature, 2011, 470:50-51
  - "Did Early Human Go North or South?", Science, 2005, 308:965-966
  - Single, rapid coastal settlement of Asia revealed by analysis of complete mitochondrial genomes, Macaulay et al., Science, 2005, 308:1034-1036

#### November 1 Agricultural expansions

#### Reading material

- HEG Chpt 10 (Agricultural expansions)
- Sakai website
  - Genes mirror geography within Europe, Novembre et al. Nature, 2008, 456:98-103
  - Genetics and the population history of Europe, Barbujani and Bertorelle, 2001, Proc Natl Acad Sci USA, 98:22-25
  - DNAs from the European Neolithic, Barbujani and Chikhi, Heredity, 2006, 1-2
  - "Ancient DNA says Europe's first farmers came from afar", Science, Sept 4, 2009 AND Genetic discontinuity between local hunter-gatherers and central Europe's first farmers, Bramanti et al. Science, 2009 (oral presentation)
  - Rapid, global demographic expansions after the origins of agriculture, Gignoux et al, Proc Natl Acad Sci, 2011, 108:6044-6049

Exercise 3 due

# November 8 Peopling of the Americas and the Pacific

Reading material

- HEG Chpt 11 (Into new found lands)
- Sakai website
  - A three-stage colonization model for the peopling of the Americas, Kitchen et al., PLoS ONE, 2008, 3:e1596
  - DNA from pre-Clovis human coprolites in Oregon, North America, Gilbert et al., Science, 2008, 320:786-789 (oral presentation)

Assign Exercise 4

#### November 15 Admixture

Reading material

- HEG Chpt 12 (What happens when populations meet?)
- Sakai website
  - Ancestral proportions and admixture dynamics in geographically defined African Americans living in South Carolina, Parra et al., Am J Phys Anthropol, 2001, 114:18-29 (oral presentation)
  - "Y chromosome bears witness to story of the Jewish diaspora" AND Jewish and Middle Eastern non-Jewish populations share a common pool of Y-chromosome biallelic haplotypes, Hammer et al., PNAS, 2000, 97:6769-6774
  - Optional Y chromosomes traveling south: The Cohen modal haplotype and the origins of the Lemba the "Black Jews of southern Africa", Thomas et al., AJHG, 2000, 66:674-686

#### November 22 Phenotypic variation/adaptation

#### Reading material

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- HEG Chpt 13 (Understanding the past and future of phenotypic variation)
- Sakai website
  - "Are humans still evolving?", Science, July 8, 2005
  - "European skin turned pale only recently, gene suggests", Science, April 20, 2007
  - "Ancient DNA reveals Neandethals with red hair, fair complexions", Science, Oct 26, 2007
  - Genetic evidence for the convergent evolution of light skin in Europeans and East Asian, Norton et al, Mol Biol Evol, 2007, 24:710-722 (oral presentation)

- "Tracing evolution's recent fingerprints"
- Sequencing of 50 human exomes reveals adaptation to high altitude, Yi et al, Science, 2010, 329:75-78
- Origin of clothing lice indicates early clothing use by anatomically modern humans in Africa, Toups et al., Mol Biol Evol, 2011, 28:29-32 (oral presentation)

Exercise 4 due

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#### November 29 Genetics of disease/Forensic genetics

Reading material

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- HEG Chpts 14 (Health implications of our evolutionary heritage), 15 (Forensic genetics)
- Sakai website
  - "Parsing the genetics of behavior", Science, Nov 7, 2008
  - "Deflating the genomic bubble", Science, Feb 18, 2011
  - Genomics for the world, Bustamante et al, Nature, 2011, 475:163-165
    - "In genetic control of disease, does 'race' matter?", Nature Genetics, Dec 2004
  - Genetic ancestry, social classification, and racial inequalities in blood pressure in southeastern Puerto Rico, Gravlee et al. PLoS ONE, in press
  - The coming shift in forensic identification science, Saks and Koehler, Science, 2005, 309:892-895
  - "Genes in police files", book review of "Genetic Justice: DNA Data Banks, Criminal Investigations and Civil Liberties", Science, April 15, 2011
- "Familial DNA testing scores a win in serial killer case", Science, July 16, 2010 view for exam

Review for exam

December 6 Exam