ANCIENT DNA
ANT 388 AND BIO 384K
SPRING 2013

COURSE INFORMATION: Unique #31440 and 50941
Wednesday 9 am – 12 pm, SAC 5.118

COURSE INSTRUCTOR: Dr. Deborah Bolnick
E-mail: deborah.bolnick@austin.utexas.edu
Phone: (512) 471-7532
Office Hours: SAC 4.148, Wednesdays 2-4 pm *or by appointment*

COURSE DESCRIPTION:
Ancient DNA can be obtained from the remains of organisms that have long been dead (and may now be extinct), and it can be retrieved from a variety of sources — human and animal remains, coprolites, seeds and other plant material, soil, and even some cultural artifacts. The study of ancient DNA makes it possible to directly assess genetic variation in the past, allowing us to track evolutionary changes over time and to reconstruct long-term population dynamics. Furthermore, when ancient DNA is considered in conjunction with archaeological evidence, it can help clarify the social structure, mating and postmarital residence patterns, kinship systems, and burial practices of ancient populations. It can also shed light on prehistoric population movements and interactions.

While ancient DNA studies have the potential to provide important and unique insights about evolution and human prehistory, there are significant challenges associated with the recovery and analysis of ancient DNA. This graduate course will explore the prospects and problems of ancient DNA research, and will consider applications of such research in anthropology, evolutionary biology, paleontology, and archaeology.

Discussion topics and readings will be selected based on the interests of students enrolled in this graduate course.

COURSE REQUIREMENTS:
1. **Seminar Coordination (25%).** Each student will co-organize and lead the class discussion on two days over the course of the semester. Student leaders are expected to (a) help select the assigned readings, (b) briefly present the core ideas found in the readings (PowerPoint slides or handouts may be prepared if you think they would be helpful), and (c) prepare a set of topics, questions, and other relevant classroom activities to help structure the class period and guide our discussion. You should consult with the instructor in office hours or by email as you select readings and prepare to lead the class discussion.
2. **Class Participation (50%).** Each student is expected to complete all assigned readings before class and participate fully in all discussions. To facilitate discussion, all students must come prepared with <u>at least</u> two questions and/or observations about each assigned reading.
3. **Research Paper (25%).** The research paper (approximately 10 pages, double-spaced) will allow you to explore a relevant topic of your choice in more detail. A 1-page synopsis or outline of your proposed topic (5%) is due by March 6. Your final paper (20%) is due on May 1.

COURSE WEBSITE:
Class information, handouts, and required readings will be available at the course website on Blackboard (http://www.courses.utexas.edu). Course updates will also be sent to your university e-mail account. Please check both regularly.

CLASSROOM POLICIES:
(1) Attend all classes and arrive on time whenever possible. (2) Do not use your cell phone, send emails or texts, or visit websites during class. (3) Please let me know if you have any problem that is preventing you from performing satisfactorily in this class.

GRADING POLICIES:
If the research paper is turned in late, the assignment grade will be lowered by 10% for each day that it is late. If a serious issue (i.e. illness, family death, etc.) arises that may prevent you from attending class or turning in the paper on time, contact me by e-mail or phone as soon as possible to discuss a make-up assignment or deadline extension.

Final letter grades will be assigned using the following scale: A (90-100%), B (80-89%), C (70-79%), D (60-69%), F (0-59%). Plus/minus grades will be assigned.

Re-grading Policy: If you believe your paper was graded incorrectly, submit a written request for a re-grade within one week of when the graded paper was returned. The written request should include an explanation of your position and be attached to the graded paper.

Academic Dishonesty: Each student in this course is expected to abide by the University of Texas Honor Code. Any work submitted by a student in this course for academic credit must be the student's own work. Any cheating or plagiarism will be reported to the Dean of Students, and the penalty may also include failure of the course and University disciplinary action. For more information, see http://www.lib.utexas.edu/services/instruction/learningmodules/plagiarism and http://deanofstudents.utexas.edu/sjs.

Accommodations: Students with disabilities or a chronic illness may request appropriate academic accommodations from the Division of Diversity and Community Engagement, Services for Students with Disabilities at http://www.utexas.edu/diversity/ddce/ssd, 471-6259 (voice), or 232-2937 (video phone). Please notify me as soon as possible of any accomodations that will be needed.

Religious Holy Days: By UT Austin policy, you should notify the instructor of your pending absence at least fourteen days prior to the date of observance of a religious holy day. If you must miss a class in order to observe a religious holy day, I will give you an opportunity to make up the missed participation points within a reasonable time after the absence.

BEHAVIOR CONCERNS ADVICE LINE (BCAL):
If you are worried about someone who is acting differently, you may use the Behavior Concerns Advice Line to discuss by phone your concerns about another individual's behavior. This service is provided through a partnership among the Office of the Dean of Students, the Counseling and Mental Health Center (CMHC), the Employee Assistance Program (EAP), and The University of Texas Police Department (UTPD). Call 512-232-5050 or visit http://www.utexas.edu/safety/bcal.

EMERGENCY EVACUATION POLICY:
Occupants of UT buildings are required to evacuate and assemble outside when a fire alarm is activated or an announcement is made. Please be aware of these evacuation policies: (1) Familiarize yourself with exits to the classroom and building. The nearest exit may not be the one you used when you entered the building. (2) If you require assistance to evacuate, inform the instructor in writing during the first week of class. (3) In the event of an evacuation, follow the instructor's directions. (4) Do not re-enter a building unless you're given instructions by the Austin Fire Department, the UT Austin Police Department, or the Fire Prevention Services office.

SCHEDULE OF TOPICS, READINGS, AND IMPORTANT DATES:

January 16 Introduction
- history of aDNA research; overview of the issues

January 23 Obtaining and Analyzing Ancient DNA (48 pp)

Required Readings:

Wandeler P, Hoeck PEA, Keller LF. 2007. Back to the future: museum specimens in population genetics. *Trends in Ecology and Evolution* 22:634-642.

Shapiro B, Hofreiter M. 2012. *Ancient DNA: Methods and Protocols*. New York: Humana Press. pp v-vii.

Campos PF, Craig OE, Turner-Walker G, Peacock E, Willerslev E, Gilbert MTP. 2012. DNA in ancient bone – where is it located and how should we extract it? *Annals of Anatomy* 194:7-16.

Bengtsson CF, Olsen ME, Brandt LO, Bertelsen MF, Willerslev E, Tobin DJ, Wilson AS, Gilbert MTP. 2012. DNA from keratinous tissue, part I: hair and nail. *Annals of Anatomy* 194:17-25.

Clack AA, MacPhee RDE, Poinar HN. 2012. *Mylodon darwinii* DNA sequences from ancient fecal hair shafts. *Annals of Anatomy* 194:26-30.

Olsen ME, Bengtsson CF, Bertelsen MF, Willerslev E, Gilbert MTP. 2012. DNA from keratinous tissue, part II: feather. *Annals of Anatomy* 194:31-35.

Allentoft ME, Rawlence NJ. 2012. Moa's ark or volant ghosts of Gondwana? Insights from nineteen years of ancient DNA research on the extinct moa (Aves: Dinornithiformes) of New Zealand. *Annals of Anatomy* 194:36-51.

Additional Relevant References (Optional Readings):

Clark DP, Pazdernik NJ. 2012. *Molecular Biology: Understanding the Genomic Revolution*. Second edition. Waltham, MA: Elsevier. pp 164-169, 111-113, 134-135, 227-232, 235-242.

Rohland N, Hofreiter M. 2007. Comparison and optimization of ancient DNA extraction. *Biotechniques* 42:343-352.

Millar CD, Huynen L, Subramanian S, Mohandesan E, Lambert EM. 2008. New developments in ancient genomics. *Trends in Ecology and Evolution* 23:386-393.

January 30 Post-Mortem DNA Degradation and Preservation (50 pp)

Required Readings:

Burger J, Hummel S, Herrmann B, Henke W. 1999. DNA preservation: a microsatellite-DNA

study on ancient skeletal remains. *Electrophoresis* 20:1722-1728.
Adler CJ, Haak W, Donlon D, Cooper A, The Genographic Consortium. 2011. Survival and recovery of DNA from ancient teeth and bones. *Journal of Archaeological Science* 38:956-964.
Zimmermann J, Hajibabaei M, Blackburn DC, Hanken J, Cantin E, Posfai J, Evans Jr TC. 2008. DNA damage in preserved specimens and tissues samples: a molecular assessment. *Frontiers in Zoology* 5:18.
Pruvost M, Schwarz R, Correia VB, Champlot S, Braguier S, Morel N, Fernandez-Jalvo Y, Grange T, Geigl E-M. 2007. Freshly excavated fossil bones are best for amplification of ancient DNA. *Proceedings of the National Academy of the Sciences USA* 104:739-744.
Briggs AW, Stenzel U, Johnson PLF, Green RE, Kelso J, Prufer K, Meyer M, Krause J, Ronan MT, Lachmann M, Paabo S. 2007. Patterns of damage in genomic DNA sequences from a Neandertal. *Proceedings of the National Academy of the Sciences USA* 104:14616-14621.
Lamers R, Hayter S, Matheson CD. 2009. Postmortem miscoding lesions in sequence analysis of human ancient mitochondrial DNA. *Journal of Molecular Evolution* 68:40-55.

Additional Relevant References (Optional Readings):

Lindahl T. 1993. Instability and decay of the primary structure of DNA. *Nature* 362:709-715.
Gilbert MTP, Hansen AJ, Willerslev E, Rudbeck L, Barnes I, Lynnerup N, Cooper A. 2003. Characterization of genetic miscoding lesions caused by postmortem damage. *American Journal of Human Genetics* 72:48-61.
Schwarz C, Debruyne R, Kuch M, McNally E, Schwarcz H, Aubrey AD, Bada J, Poinar H. 2009. New insights from old bones: DNA preservation and degradation in permafrost preserved mammoth remains. *Nucleic Acid Research* 37:3215-3229.
Ginolhac A, Rasmussen M, Gilbert MTP, Willerslev E, Orlando L. 2011. mapDamage: testing for damage patterns in ancient DNA sequences. *Bioinformatics* 27:2153-2155.

February 6 Consequences of Postmortem Damage for PCR and DNA datasets (41 pp)

Required Readings:

Hofreiter M, Jaenicke V, Serre D, von Haeseler A, Paabo S. 2001. DNA sequences from multiple amplifications reveal artifacts induced by cytosine deamination in ancient DNA. *Nucleic Acids Research* 29:4793-4799.
Gilbert MTP, Shapiro B, Drummond A, Cooper A. 2005. Post-mortem DNA damage hotspots in Bison (*Bison bison*) provide evidence for both damage and mutational hotspots in human mitochondrial DNA. *Journal of Archaeological Science* 32:1053-1060.
Ho SYW, Heupink TH, Rambaut A, Shapiro B. 2007. Bayesian estimation of sequence damage in ancient DNA. *Molecular Biology and Evolution* 24:1416-1422.
Alaeddini R. 2012. Forensic implications of PCR inhibition: a review. *Forensic Science International-Genetics* 6:297-305.
Kemp BM, Monroe C, Smith DG. 2006. Repeat silica extraction: a simple technique for the removal of PCR inhibitors from DNA extracts. *Journal of Archaeological Science* 33:1680-1689.
King CE, Debruyne R, Kuch M, Schwarz C, Poinar HN. 2009. A quantitative approach to detect and overcome PCR inhibition in ancient DNA extracts. *Biotechniques* 47:941-949.

Additional Relevant References (Optional Readings):

Gilbert MTP, Willerslev E, Hansen AJ, Barnes I, Rudbeck L, Lynnerup N, Cooper A. 2003.

Distribution patterns of postmortem damage in human mitochondrial DNA. *American Journal of Human Genetics* 72:32-47.

Molak M, Ho SYW. 2011. Evaluating the impact of post-mortem damage in ancient DNA: a theoretical approach. *Journal of Molecular Evolution* 73:244-255.

Feuillie C, Merheb MM, Gillet B, Montagnac G, Hanni C, Daniel I. 2012. Enzyme-free detection and quantification of double-stranded nucleic acids. *Analytical and Bioanalytical Chemistry* 404:415-422.

February 13 Detecting and Preventing Contamination (41 pp)

Required Readings:

Yang DY, Watt K. 2005. Contamination controls when preparing archaeological remains for ancient DNA analysis. *Journal of Archaeological Science* 32:331-336.

Sampietro ML, Gilbert MTP, Lao O, Caramelli D, Lari M, Lalueza-Fox C. 2006. Tracking down human contamination in ancient human teeth. *Molecular Biology and Evolution* 23:1801-1807.

Leonard JA, Shanks O, Hofreiter M, Kreuz E, Hodges L, Ream W, Wayne RK, Fleischer RC. 2007. Animal DNA in PCR reagents plagues ancient DNA research. *Journal of Archaeological Science* 34:1361-1366.

Gilbert MTP, Menez L, Janaway RC, Tobin DJ, Cooper A, Wilson AS. 2006. Resistance of degraded hair shafts to contaminant DNA. *Forensic Science International* 156:208-212.

Kemp BM, Smith DG. 2005. Use of bleach to eliminate contaminating DNA from the surface of bones and teeth. *Forensic Science International* 154:53-61.

Garcia-Garcera M, Gigli E, Sanchez-Quinto F, Ramirez O, Calafell F, Civit S, Lalueza-Fox C. 2011. Fragmentation of contaminant and endogenous DNA in ancient samples determined by shotgun sequencing; prospects for human paleogenomics. *PLoS ONE* 6(8);e24161.

Olivieri C, Ermini L, Rizzi E, Corti G, Bonnal R, Luciani S, Marota I, De Bellis G, Rollo F. 2010. Characterization of nucleotide misincorporation patterns in the Iceman's mitochondrial DNA. *PLoS ONE* 5(1):e8629.

Additional Relevant References (Optional Readings):

Salamon M, Tuross N, Arensburg B, Weiner S. 2005. Relatively well preserved DNA is present in the crystal aggregates of fossil bones. *Proceedings of the National Academy of the Sciences USA* 102:13783-13788.

Champlot S, Berthelot C, Pruvost M, Bennett EA, Grange T, Geigl E-M. An efficient multistrategy DNA decontamination procedure of PCR reagents for hypersensitive PCR applications. *PLoS ONE* 5(9):e13042.

February 20 Authentication and Ethics of Ancient DNA Research (44 pp)

Required Readings:

Cooper A, Poinar HN. 2000. Ancient DNA: do it right or not at all. *Science* 289:13.

Knapp M, Clarke AC, Horsburgh KA, Matisoo-Smith EA. 2012. Setting the stage – building and working in an ancient DNA laboratory. *Annals of Anatomy* 194:3-6.

Gilbert MTP, Bandelt H-J, Hofreiter M, Barnes I. 2005. Assessing ancient DNA studies. *TRENDS in Ecology and Evolution* 20:541-544.

Kemp BM, Smith DG. 2010. Ancient DNA methodology: thoughts from Brian M. Kemp and David Glenn Smith on "Mitochondrial DNA of protohistoric remains of an Arikara

population from South Dakota". *Human Biology* 82:227-238.
Winters M, Barta JL, Monroe C, Kemp BM. 2011. To clone or not to clone: method analysis for retrieving consensus sequences in ancient DNA samples. *PLoS ONE* 6(6):e21247.
Holm S. 2001. The privacy of Tutankhamen – utilising the genetic information in stored tissue samples. *Theoretical Medicine* 22:437-449.
Kaestle FA, Horsburgh KA. 2002. Ancient DNA in anthropology: methods, applications, and ethics. *Yearbook of Physical Anthropology* 45:92-130. Only read pp 106-109.
Bolnick DA, Bonine HM, Mata-Míguez J, Kemp BM, Snow MH, LeBlanc SA. 2012. Nondestructive sampling of human skeletal remains yields ancient nuclear and mitochondrial DNA. *American Journal of Physical Anthropology* 147:293-300.

Additional Relevant References (Optional Readings):
Paabo S, Poinar H, Serre D, Jaenicke-Despres V, Hebler J, Rohland N, Kuch M, Krause J, Vigilant L, Hofreiter M. 2004. Genetic analyses from ancient DNA. *Annual Review of Genetics* 38:645-679.

February 27 Neandertals, Denisovans, and Human Evolution (36 pp)
Required Readings:
Stoneking M, Krause J. 2011. Learning about human population history from ancient and modern genomes. *Nature Reviews Genetics* 12:603-614.
Green RE, et al. 2010. A draft sequence of the Neandertal genome. *Science* 328:710-722.
Reich D, et al. 2010. Genetic history of an archaic hominin group from Denisova Cave in Siberia. *Nature* 468:1053-1060.
Skoglund P, Jakobsson M. 2011. Archaic human ancestry in East Asia. *Proceedings of the National Academy of the Sciences USA* 108:18301-18306.

Additional Relevant References (Optional Readings)
Gibbons A. 2010. Close encounters of the prehistoric kind. *Science* 328:680-684.
Others to be announced.

March 6 Prehistoric Human Migration; Research Paper Synopsis/Outline Due
Readings TBA

March 13 *No Class (Spring Break)*

March 20 Biomolecular Archaeology
Readings TBA

March 27 Reconstructing Population Dynamics and Demographic History
Readings TBA

April 3 Phylogenetic and Demographic Inferences: Case Studies
Readings TBA

April 10 *No Class (AAPA Meeting)*

April 17 **Estimating the Rate of Molecular Evolution**
Readings TBA

April 24 **Paleopathology, Disease, and Ancient Microbes**
Readings TBA

May 1 **Topic TBA; Research Paper Due**
Readings TBA