

ANTH 3811 Interdisciplinary Isotopes

Instructor Information

Instructor:	Dr. Jessica Metcalfe
E-mail:	jmetcal1@lakeheadu.ca
Office Hours:	Mondays & Wednesdays, 2:30 – 3:30 pm, or by appointment

Class Times: Location:

Mondays & Wednesdays, 1:00 – 2:30 pm TBD

Course Description: Isotopes are everywhere – all matter is made of isotopes. Isotope analysis is fundamental to a wide range of disciplines, including anthropology, biology, and earth sciences. Thanks to isotopes, we know how old the Earth is, when humans evolved, how human and animal diets have changed over time, where people and animals migrated in the past, what ancient climates and environments were like, how old children were when they were weaned, and much more. In this course, students will learn the basic principles underlying various isotope systems, with an emphasis on the biosphere (soil, water, plants, and animals). Using case studies from anthropology, biology, biology, and earth science, we will explore how isotopes are used, and what they can tell us about the world.

Learning Objectives: By the end of this course, students will be able to

- Describe fundamental principles underlying isotopic research
- Describe varied applications of isotope science, including specific examples from anthropology biology, and earth science
- Critically analyze published isotopic case studies
- Interpret isotopic data
- Participate effectively in seminar discussions

Required Readings: All readings will be posted on the course website. It is important that you do the readings <u>before</u> the class for which they are assigned, so that you can participate in the discussions.

Grades Breakdown

Item	Date	Value (%)
Participation	Throughout the course	20
Online Discussion Posts	See course schedule	10
Midterm 1	February 14	20
Midterm 2	March 27	20
Take-home final exam	April 16	30
TOTAL		100

Participation: A large portion of your participation grade is based simply on attendance. If you show up to every class prepared and ready to learn, you will receive a good participation grade. Effective in-class participation also includes listening carefully, thinking about what others have said, asking questions, making comments, providing respectful critiques and creative suggestions, and contributing ideas based on your experience and your understanding of the readings.

Online Discussion Posts: Most weeks (once a week) you will be asked to make a short online post about the week's theme and/or reading. Your post will not be formally evaluated; if you submit a substantive (original and thoughtful) post for each response, you will receive 100% on this assignment. You are encouraged to read and comment on other students' posts, as a way to help you consolidate and expand your understanding of the course content. See the course schedule for discussion post due dates.

Midterms: The midterms will test your understanding of material presented in class and through the required readings, and will also help you to consolidate what you have learned. The midterms will follow a **two-stage format**:

- Stage 1: Each individual will complete the test on their own (in class).
- Stage 2: The whole class will complete the same test as a group (during the same class). One person will fill out the answers on behalf of the whole group. The goal of the two-stage format is to give you a chance to learn from mistakes you made in your original attempt, and to engage in collaborative learning with your classmates. This format has been shown to result in better learning than traditional test formats (e.g., Wieman et al., 2014).
- **Question Format:** Questions may include true/false, multiple choice, short written answers and/or problem-based questions. Further information will be provided in the weeks prior to the midterms.
- **Grading:** The individual component is worth 80% and the group component is worth 20% of your total grade for the test. If you score higher on the individual component, your individual score will count for 100% of the grade for the test. (In other words, the group component can only increase your grade.)
- **Missed Midterms:** You must take the midterm in class on the appointed date in order to receive a grade, or you must contact the instructor ahead of time to schedule an alternative time to take the test. 'Make up' midterms not approved in advance will only be allowed in emergency situations. If you take the midterm outside of the scheduled class time, your entire grade will be based on your individual answers (i.e., you will not be able to take advantage of increasing your grade based on the 'stage 2' group attempt). Please reach out to the instructor if you have questions or concerns.

Take-Home Final Exam: The final exam is take-home and open-book, and will be comprised of questions in which you interpret isotopic data. Each student must submit their own, individual answers, but consulting with other students is allowed. Further information will be provided later in the term.

Tentative Course Schedule

(subject to modification)

Classes will include a mix of lecture and discussions. It is important that you do the readings <u>before</u> the class for which they are assigned, so that you can participate effectively. It is OK if you don't understand everything in the readings! We will work on building your understandings of the topics together, in class.

Week 1: Introduction and overview

Mon. Jan. 8: Introductions and course expectations *Readings: Course outline*

<u>Wed. Jan. 10</u>: What is an isotope? Brief history of isotope analyses. Range of applications in anthropology, biology and earth science. *Readings: Sharp 2017 Ch. 1, pp. 1-1 to 1-9* *Online discussion post due within 24 hours <u>after</u> class time

Week 2: Foundational principles

<u>Mon. Jan. 15</u>: Basic principles underlying isotope analysis and isotopic fractionation; analytical principles (methods for isotope ratio mass spectrometry) *Readings: Sharp 2017, Section 2.7, pp. 2-19 to 2-20. Ambrose 1993 pp. 59-71.*

<u>Wed. Jan. 17</u>: Introduction to sample preparation, laboratory tours. *Readings: Ambrose 1993, pp. 71-81* *Online discussion post due within 24 hrs <u>after</u> class time

Weeks 3 – 5: Carbon & Nitrogen isotopes

Carbon isotopes: Basic principles

Mon. Jan 22: Carbon isotopes in photosynthesis (C₃, C₄, CAM). Carbon isotope fractionations (atmospheric CO₂, aquatic carbon, plants, animals). *Readings: O'Leary 1988, pp. 328-329 (first section). Ambrose 1993, pp. 86-95*

Wed. Jan. 24: Human and animal diets.

Readings: Van der Merwe 1982.

[Important note: this paper contains a photograph of a human skeleton and data derived from human skeletal remains that may have been obtained in an unethical manner – that is, without the permission of living descendants. Despite these serious issues, this paper was assigned because it contains the simplest and most comprehensive explanation of carbon isotopes in archaeology that I could find.] *Online discussion post is due prior to start of class

Mon. Jan 29: Carbon isotope variability in plants and animals *Readings*: Tiezen 1991

Nitrogen isotopes: Basic Principles

<u>Wed. Jan 31:</u> Trophic enrichment and implications for paleodiet and foodweb reconstruction.

Readings: Minagawa & Wada 1984 *Online discussion post is due <u>prior</u> to start of class

Mon. Feb. 5: Dietary reconstruction using nitrogen isotope compositions. *Readings: Sharp 2017, Sections 9.5*

Carbon and Nitrogen isotope analysis overview

<u>Wed. Feb 7</u>: Overview of C and N isotope applications in archaeology *Readings*: Lee-Thorp 2008 *Online discussion post is due prior to start of class

Week 6: Review & Midterm I

- Mon. Feb 12: Review Readings: Review previously assigned readings and notes.
- Wed. Feb 14: Midterm (during class time) Readings: None

Feb 19-23: Study Break. No classes.

Week 7: Sulfur Isotopes

<u>Mon. Feb. 26</u>: Use of sulfur isotopes for determining marine versus terrestrial resource consumption and coastal-inland migration. *Readings: Nehlich (2015)*

<u>Wed. Feb. 28</u>: Use of sulfur isotopes to reconstruct wetland ecology and use. *Readings: Stevens et al. (2022)* *Online discussion post due within 24 hours <u>after</u> the end of class

Week 8: Oxygen isotopes

- <u>Mon. Mar. 4</u>: Oxygen isotope variations in the hydrosphere and biosphere *Readings*: Pederzani & Britton 2019, Sections 1 - 3 (pp. 77 – 83)
- <u>Wed. Mar. 6</u>: Oxygen isotope applications to mammalian skeletal remains *Readings*: Pederzani & Britton 2019, Sections 4 – 5 (pp. 83 –96) *Online discussion post is due <u>prior</u> to start of class

Week 9: Strontium isotopes

Mon. Mar. 11: Sources of strontium isotope variations; applications of Sr isotope analysis to archaeology

Readings: Slovak & Paytan 2011

<u>Wed. Mar. 13</u>: Strontium isoscapes and applications to archaeology *Readings:* Bataille et al. 2020 *Online discussion post due within 24 hours after end of class

Week 10: Megafauna!

Mon. Mar. 18: Stable isotope compositions of proboscideans (mammoths and mastodons)

Readings: Metcalfe et al. 2011

Wed. Mar. 20: Stable isotope compositions of bison Readings: Metcalfe et al. 2021 *Online discussion post due within 24 hours after end of class

Week 11: Review and Midterm II

Mon. Mar. 25: Review Readings: Schoeninger 2010

Wed. Mar. 27: Midterm II (in class) Readings: None

April 1 is Easter Monday: No classes.

Week 12: Course summary, farewells, and final exam preparation.

<u>Wed. Apr. 3</u>: Celebration of learning & final exam preparation *Readings:* None

<u>Tues. Apr. 9:</u> (note: the university designated TUESDAY as the makeup day for classes not held on Easter Monday): Final exam preparation *Readings*: None

The **take-home final exam is due on Tuesday April 16*** **at midnight.** *There will be an automatic grace period* (with no late penalties) until Thursday April 18 at midnight. However, you must contact the instructor in advance of the April 16 deadline if you wish to take advantage of the grace period. You do not need to provide a justification for requesting the April 18 extension; no questions will be asked. After April 18, final exams will not be accepted without emergency justification.

Readings List

Ambrose, S.H., 1993. Isotopic analysis of paleodiets: Methodological and interpretive considerations. In: Sandford, M.K. (Ed.), *Investigations of Ancient Human Tissue: Chemical Analyses in Anthropology*, Gordon and Breach Science Publishers, Langhorne, PA, pp. 59-130.

Bataille, C.P., Crowley, B.E., Wooller, M.J., Bowen, G.J., 2020. Advances in global bioavailable strontium isoscapes. *Palaeogeography, Palaeoclimatology, Palaeoecology* 555, 109849.

Lee-Thorp, J.A., 2008. On isotopes and old bones. Archaeometry 50, 925-950.

Metcalfe, J.Z., Longstaffe, F.J., Ballenger, J.A.M., Haynes, C.V., 2011. Isotopic paleoecology of Clovis mammoths from Arizona. *Proceedings of the National Academy of Sciences* 108, 17916-17920.

Metcalfe, J.Z., Ives, J.W., Shirazi, S., Gilmore, K.P., Hallson, J., Brock, F., Clark, B.J., Shapiro, B., 2021. Isotopic evidence for long-distance connections of the AD thirteenth-century Promontory caves occupants. *American Antiquity* 86, 526-548.

Minagawa, M., Wada, E., 1984. Stepwise enrichment of ¹⁵N along food chains: Further evidence and the relation between δ^{15} N and animal age. *Geochimica et Cosmochimica Acta* 48, 1135-1140.

Nehlich, O., 2015. The application of sulphur isotope analyses in archaeological research: A review. *Earth Science Reviews* 142, 1-17.

O'Leary, M.H., 1988. Carbon isotopes in photosynthesis. *Bioscience* 38, 328-336.

Pederzani, S., Britton, K., 2019. Oxygen isotopes in bioarchaeology: Principles and applications, challenges and opportunities. *Earth-Science Reviews* 188, 77-107.

Schoeninger, M.J., 2010. Diet reconstruction and ecology using stable isotope ratios. In: Larsen, C.S. (Ed.), *A Companion to Biological Anthropology*. Wiley-Blackwell, pp. 445-464.

Sharp, Z., 2017. Principles of Stable Isotope Geochemistry, 2nd edition, Pearson/Prentice Hall, Upper Saddle River, N.J.

Slovak, N.M., Paytan, A., 2011. Applications of Sr isotopes in archaeology. In: Baskaran, M. (Ed.), *Handbook of Environmental Isotope Geochemistry*, Springer-Verlag, Berlin, pp. 743-768.

Stevens, R.E., Reade, H., Read, D.S., Bottrell, S.H., Fremondeau, D., Wexler, S.A., 2022. Isowetlands: unlocking wetland ecologies and agriculture in prehistory through sulfur isotopes. *Archaeology International* 25, 168-176.

Tieszen, L.L., 1991. Natural variations in the carbon isotope values of plants: Implications for archaeology, ecology, and paleoecology. *Journal of Archaeological Science* 18, 227-248.

van der Merwe, N.J., 1982. Carbon isotopes, photosynthesis, and archaeology: Different pathways of photosynthesis cause characteristic changes in carbon isotope ratios that make possible the study of prehistoric human diets. *American Scientist* 70, 596-606.

General Information

Regulations - from the Lakehead University Academic Calendar

It is the responsibility of each student registered at Lakehead University to be familiar with, and comply with all the terms, requirements, regulations, policies and conditions in the Lakehead University Academic Calendar. This includes, but is not limited to, Academic Program Requirements, Academic Schedule of Dates, University and Faculty/School Policies and Regulations and the Fees and Refund Policies and Schedules.

Academic Integrity

For a range of resources related to Academic Integrity, see the <u>Student Conduct –</u> <u>Resources</u> page. A breach of Academic Integrity is a serious offence. The principle of Academic Integrity, particularly of doing one's own work, documenting properly (including use of quotation marks, appropriate paraphrasing and referencing/citation), collaborating appropriately, and avoiding misrepresentation, is a core principle in university study. Students are strongly advised to familiarize themselves with the Student Code of Conduct - Academic Integrity (<u>"The Code"</u>) - and, in particular, **sections 26 and 83 through 85**. Non-compliance with the Code will NOT be tolerated in this course and the Code will be adhered to in terms of disciplinary action. The Code provides a full description of academic offences, procedures when Academic Integrity breaches are suspected and sanctions for breaches of Academic Integrity.

Use of Al

Generative artificial intelligence (Generative AI or GenAI) is a category of AI systems capable of generating text, images, or other media in response to prompts. **Unless otherwise indicated, use of GenAI systems to produce assignments for this course is not permitted.** All work submitted for evaluation in this course must be the student's original work. The submission of any work containing AI generated content, unless specifically allowed by the instructor, will be considered a violation of academic integrity ("Use of Unauthorized Materials").

Copyright

Students should be aware that all instructional, reference, and administrative materials prepared for this course are protected in their entirety by copyright. Students are expected to comply with this copyright by only accessing and using the course materials for personal educational use related to the course, and that the materials cannot be shared in any way, without the written authorization of the course instructor. If this copyright is infringed in anyway, students may be prosecuted under the Lakehead University Student Code of Conduct – Academic Integrity, which requires students to act ethically and with integrity in academic matters and to demonstrate behaviours that support the University's academic values.

Supports for Students – there are many resources available to support students, including:

Health and Wellness

- <u>Student Success Centre</u>
- <u>Student Accessibility Centre</u>
- <u>Academic Support Zone</u> (Writing and Math Tutoring Centre)
- Library
- Lakehead International
- Indigenous Initiatives

Lakehead University is committed to achieving full **accessibility** for persons with disabilities. Part of this commitment includes arranging academic accommodations for students with disabilities and/or medical conditions to ensure they have an equitable opportunity to participate in all of their academic activities. If you are a student with a disability and think you may need accommodations, you are strongly encouraged to contact Student Accessibility Services (SAS) and register as early as possible. For more information, please contact <u>Student Accessibility Services</u> (SC0003, 343-8047 or <u>sas@lakeheadu.ca</u>)

As a university student, you may sometimes **experience mental health concerns or stressful events** that interfere with your academic performance and negatively impact your daily activities. All of us can benefit from support during times of struggle. If you or anyone you know experiences academic stress, difficult life events or feelings of anxiety or depression, **Student Health and Wellness** is there to help. Their services are free for Lakehead Students and appointments are available. You can learn more about confidential mental health services available on and off campus at <u>lakeheadu.ca/shw</u>. Remember that getting help is a smart and courageous thing to dofor yourself, for those you care about, and for those who care about you. Asking for support sooner rather than later is almost always helpful.

Important Dates for Winter 2024

First day of classes: Mon Jan 8 Add date: Fri Jan 19 Study Break: Mon Feb 19 – Fri Feb 23 Drop/Withdraw date: Fri March 8 Holidays: Good Friday (April 7) & Easter Monday (April 10) Last day of classes: Tues Apr. 9 (Mon Apr 8 is makeup for Good Friday, Tues Apr 9 is makeup for Easter Monday)