Instructors: Laodong Guo, Ryan Newton  
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Office: School of Freshwater Sciences, Room 3009 (Guo), Room 3041 (Newton), and Room 1053 (Anderson)

Meeting Time: Wed (1:00 -4:40 pm for lecture/labs)  
Location: 1st floor classroom, School of Freshwater Sciences, 600 East Greenfield Avenue, Milwaukee WI 53204

2. Course Description

This course, Analytical Techniques, will include two parts: a) modern analytical/geochemical techniques (2 credit hours) and b) nucleic acids/genomics principles and methods (1 credit hour).

This course focuses primarily on standard methods for the characterization and examination of water, sediment, and biota samples from aquatic environments. Both lectures and hands-on laboratory experiments will be offered to cover chemical principles, analytical procedures and applications, as well as nucleic acids/genomics principles and methods. On completion of the module, students should be able to Research relevant literature and develop robust experimental procedures; Maintain a laboratory book and document experimental methods; Be familiar with and operate analytical equipment / instruments commonly used in environmental/geochemical/nucleic acid/genomic based procedures; Understand the origin of data generated from chemical and biological experiments and discuss critically the procedures and outcomes.

For analytical and geochemical techniques, Topics to be covered in this course include:
1) Methods for basic water and environmental parameters such as pH, alkalinity, total suspended particles, dissolved inorganic carbon (DIC), pCO₂, dissolved organic carbon (DOC), nutrients (N, P, and Si), and major cations (Na, Ca, Mg);  
2) Methods for optical properties of water samples such as bulk dissolved organic carbon (DOC), chromophoric dissolved organic matter (CDOM) and fluorescence dissolved organic matter (FDOM); and  
3) Instrumentation for the measurements of nutrients, major ions, metals, stable isotopes, organic pollutants, aquatic colloids and nanoparticles, and other chemical species:
   • Autoanalyzer and Ionic chromatography for nutrient species (N, P, and Si);  
   • Ion chromatography for major ions  
   • Atomic absorption and inductively coupled plasma mass spectrometry (ICP-MS),  
   • Picarro water isotopes analyzer for δ²H and δ¹⁸O and delta-V isotopic ratio-mass spectrometry (IR-MS) for carbon and nitrogen isotopic composition (δ¹³C and δ¹⁵N);  
   • Additional instruments such as gas chromatography mass spectrometry (GC-MS) for the analysis of persistent organic pollutants (POPs) such as PAHs and PCBs, Liquid
For Molecular / Genomic Analysis, Topics to be covered in this course include:

1) Introduction to basic lab techniques
   a. Safety
   b. Pipetting
   c. Basic lab etiquette & procedures for minimizing contamination

2) Preparation for sample collection
   a. Sterilization & disinfection techniques
   b. In the field considerations for sample collection
   c. The organisms, understanding what you are collecting & why this matters to sampling choices
   d. In the field storage options
   e. Filtering setup/choices & variations
   f. eDNA collection

3) Nucleic Acids
   a. What are they? Structure and function in cells
   b. How nucleic acids are used to interrogate biology
   c. How to extract nucleic acids, lab procedures – basis of various steps in the procedure - phenol/chloroform & kit based extractions & how they work
   d. Cell disruption, DNA/RNA stabilization
   e. Microbes and common extraction methods
   f. Eukaryotes and common extraction methods

4) Polymerase Chain Reaction (PCR), what it is and how it works
   a. Basic PCR components
   b. Hybridization theory & primer design
   c. Visualizing nucleic acids: gel electrophoresis, fluorescent based detection
   d. Quantifying nucleic acids, Spectrophotometer vs. Fluorescent methods
   e. qPCR and ddPCR, theory and applications

5) Genomic Sequencing Methods
   a. Available Technologies (Illumina, 454, PacBio, Sanger, Nanopore, Ion Torrent) – how they work and what information is produced
   b. Applications of Genomic technologies – genome data production, microbial community composition, RNA-seq / transcriptome, meta-omics
   c. Comparative analysis using genomic information – the basis of BLAST

Graduate and undergraduate students from freshwater sciences, biological/environmental sciences and geosciences will benefit from this course. The course is offered to students, both within and external to the School of Freshwater Sciences, who are interested in gaining knowledge of modern analytical techniques and instrumentation. Prerequisite courses include basic chemistry, biology, and/or permission of instructors.
Research component in this class include literature research, student presentations, labs, and projects in sampling and comprehensive characterization of sediment, biota, river water, lake water, rainwater, or groundwater.

3. Course Objectives
This course is designed to provide students with hands on experience in analytical techniques in geochemistry and genomics and standard methods for the sampling and characterization of bulk water, sediment and biota samples from freshwater environments. Students will gain an understanding of chemical principles, procedures, and applications of analytical methods and instrumentation. Knowledge and skills gained from this course could add a broad range of approaches to student thesis research and understanding environmental issues/problems in freshwater systems. Students will

- Become familiar with lab and sampling equipment preparation and use in nucleic acid based analyses
- Become familiar with theoretical and practical aspects of basic nucleic acid laboratory procedures that lead to genomic data generation
- Understand how genomic methods can be applied to address aquatic environmental questions
- Understand the type of data produced from various genomic analyses and the insights and limitations of these data types
- Develop collaborative skills in a laboratory setting

Workload
This is a 3 credit-hour course (2+1) consisting both lectures and hands-on laboratory components. Students should expect to devote at least 2 hours of work for each 1 h lecture and 6-9 hours for sampling, sample processing and lab work. This time commitment will include:
- In-class time and labs (approximately 1 hour lecture and 4-6 hrs lab per week);
- Reading assignments
- Completion of lab assignments and lab reports
- Preparation for research projects
- Preparation of presentations

4. Recommended Books (There is no assigned textbook)

- Or TBD

Suggested Readings
Learning in this course will rely heavily on reading of scientific literature. There is no assigned textbook. However, students may find any of the following textbooks useful:
Internet resources

- Science Direct (http://www.sciencedirect.com/)
- Web of science (http://apps.isiknowledge.com/)
- UWM Libraries Online Resources
- Google Scholar (https://scholar.google.com/)

5. Course Grading

There will be lectures and/or labs corresponding 3 contact hours. Homework includes problem sets from lectures/labs, reading assignments, and laboratory reports. Students will be required to conduct a research project covering experimental design, sampling, sample processing, measurements and data processing and interpretation. Students will also give presentations based on instrumentation and/or assigned projects. There will be not final exam and Grades will be determined based on the following formula.

Grading (for graduate students)
Participation (10%)
Homework/Lab reports: (50%)
Presentations (10%)
Research Project (30%)

The grading scale for the final grade is:

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<th>Grade</th>
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Assignment Details

Homework and Lab reports (50%):
There will be problems sets utilizing data from laboratory experiments, lectures, or reading assignments. Assignments must be written in a style consistent with the major publication style in your field and turned in at the beginning of class on the assigned due date.

Presentations (10%):  
Students will give presentations based on assigned projects and instruments.

Research Project (30%):  
Students will be required to design and conduct a research project, including sampling, sample processing, and characterization/measurements using available techniques/instruments in SFS.
Project report should be developed to including hypothesis, goals, procedures, expect outcomes and data interpretation.

**Deadlines and Attendance Policy**

- Students are expected to be in attendance at each class/lab. Unexcused absences may result in deductions from class participation grade.
- All homework and papers are due at the beginning of the class on the due date. Late submissions may result in a grade deduction.
- There are no make-up exams except for extreme emergencies, which require official documentation. In such an event, contact instructor as soon as possible to discuss options. An un-excused absence will result in lost points for that exam.

**Other Class Policies**

- There is no extra credit available for this course.
- Attendance is expected and mandatory. Arrival on time is required.
- There is no make-up for analytical experiments/laboratory. Lab work requires your flexibility in scheduling.
- Return all equipment and materials to their proper location and clean your space of debris and refuse.
- Please discuss any special circumstances with your instructor.

**Academic Misconduct:**

All UWM students are required to adhere to University standards of student conduct especially with regard to academic honesty and plagiarism. Plagiarizing is prohibited. Cheating, plagiarism, and other misconduct will result in severe penalty, as per University of Wisconsin System Chapter 1: [http://www.uwm.edu/Dept/OSL/DOS/conduct.html](http://www.uwm.edu/Dept/OSL/DOS/conduct.html). If you are uncertain about what constitutes plagiarism, consult: [http://www.plagiarism.org/learning_center/what_is_plagiarism.html](http://www.plagiarism.org/learning_center/what_is_plagiarism.html).

**University Policies**

The Secretary of the University web site contains the university policies. [http://www4.uwm.edu/secu/SyllabusLinks.pdf](http://www4.uwm.edu/secu/SyllabusLinks.pdf)

1. **Students with disabilities.** Special accommodations are provided to meet learning and testing needs in a timely manner. [http://www4.uwm.edu/sac/](http://www4.uwm.edu/sac/)

2. **Religious observances.** Accommodations for absences due to religious observance. [http://www4.uwm.edu/secu/docs/other/S1.5.htm](http://www4.uwm.edu/secu/docs/other/S1.5.htm)

3. **Students called to active military duty.** Accommodations for absences due to call-up of reserves to active military duty. [http://www4.uwm.edu/current_students/military_call_up.cfm](http://www4.uwm.edu/current_students/military_call_up.cfm)
4. Incompletes. A notation of "incomplete" may be given in lieu of a final grade to a student who has carried a subject successfully until the end of a semester but who, because of illness or other unusual and substantiated cause beyond the student's control, has been unable to take or complete the final examination or to complete some limited amount of term work. [http://www4.uwm.edu/secu/docs/other/S31.pdf](http://www4.uwm.edu/secu/docs/other/S31.pdf)

5. Discriminatory conduct (such as sexual harassment). Discriminatory conduct will not be tolerated by the University. It poisons the work and learning environment of the University and threatens the careers, educational experience, and well-being of students, faculty, and staff. [http://www4.uwm.edu/secu/docs/other/S47.pdf](http://www4.uwm.edu/secu/docs/other/S47.pdf)

6. Academic misconduct. Cheating on exams or plagiarism are violations of the academic honor code and carry severe sanctions, including failing a course or even suspension or dismissal from the University. [http://www4.uwm.edu/osl/dean/conduct.cfm](http://www4.uwm.edu/osl/dean/conduct.cfm)

7. Complaint procedures. Students may direct complaints to the head of the academic unit or department in which the complaint occurs. If the complaint allegedly violates a specific university policy, it may be directed to the head of the department or academic unit in which the complaint occurred or to the appropriate university office responsible for enforcing the policy. [http://www4.uwm.edu/secu/docs/other/S49.7.htm](http://www4.uwm.edu/secu/docs/other/S49.7.htm)

8. Grade appeal procedures. A student may appeal a grade on the grounds that it is based on a capricious or arbitrary decision of the course instructor. Such an appeal shall follow the established procedures adopted by the department, college, or school in which the course resides or in the case of graduate students, the Graduate School. These procedures are available in writing from the respective department chairperson or the Academic Dean of the College/School. [http://www4.uwm.edu/secu/docs/other/S28.htm](http://www4.uwm.edu/secu/docs/other/S28.htm)

9. Other. The final exam requirement, the final exam date requirement, etc. [http://www4.uwm.edu/secu/docs/other/S22.htm](http://www4.uwm.edu/secu/docs/other/S22.htm)
6. Tentative Schedule (FRSHWTR-650)

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Total contact hours:
3 credits = 45 hours of lecture
1 credit lab = 2 hours lab time