

Techniques in Microscopy and Image Analysis (Lecture & Lab)

Course ID: BIOT 780/880

Term Start and End Dates: Fall 2023 - August 25th, 2023 – December 8th, 2025.

Location and Times: Lecture – P502, MW 3:10pm-5:00pm; Lab – P540, W 5:10-8:00pm

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Office Hours: Tuesdays 3-4pm or by appointment

Course Description

Light microscopy helps uncover biology's mysteries before our very eyes. In many ways seeing is believing. But what techniques are most appropriate to visualize a given specimen? And once an image is acquired, how does one analyze the data quantitatively without bias?

This course begins by outlining the core principles of light physics that enable (and set the limitations of) microscopy. Bioimaging depends on the use of electromagnetic radiation to view (and image) the specimen. The course will then move into practical applications and training in transmitted light techniques. Following transmitted light topics, the principle of fluorescence will be covered, along with the microscopy techniques that image fluorescent molecules, including widefield epifluorescence and confocal microscopy. Image analysis principles, techniques, and best practices will be covered, along with the available software. The course will culminate with a final presentation about the techniques and principals covered and data collected.

Textbook

No textbook required. Any assigned readings or media will be posted on the course canvas website.

Course Learning Objectives

Upon completion of this course students will:

- Comprehend the scientific foundations and the concepts/principles underlying light microscopy.
- Understand under which circumstances different microscopy techniques are most appropriate.
- Be able to operate the available microscopes independently.
- Be able to perform routine image analysis tasks.
- Discuss findings among peers and members of the scientific community.

Course Structure

Canvas is the learning management tool we use for this course.

| <i>Course Navigation</i> | <i>Description</i> |
|--------------------------|--|
| <i>Home Page</i> | Landing Page for the course. Links to individual modules. |
| <i>Syllabus</i> | The syllabus, course schedule and other key class documents are located here. |
| <i>Modules</i> | This area contains the learning Modules (each week is its own module). The course content, activities, and assignments are located in this area. |

Course Schedule (due dates are subject to change)

| Week | Date | Lecture | Lab |
|------|------------------|--|---|
| 1 | Aug 25 Aug 27 | Introduction to Course; Terminology, Lab Report Rubric, Basic Microscopy Quiz 1: In class 8/27 | Same as lecture. |
| 2 | Sep 3 | Light physics, NA, RI, Objectives, WD, Focus No class Sep 1 – Labor Day | Light physics, ball lens lab, sneak peek on transmitted light |
| 3 | Sep 8 Sep 10 | Light microscopy and applications | Transmitted Light Microscopy, LAB 1 DUE 9/10 (see below for lab rubric) |
| 4 | Sep 15 Sep 17 | Transmitted light techniques: DIC, Phase contrast, polarized light Quiz 2: In class 9/15 | Transmitted Light Microscopy (continued) |
| 5 | Sep 22 Sep 24 | What is an image? Bit depth, color channels, sensor types | Same as lecture. LAB 2 DUE 9/24 |
| 6 | Sep 29 Oct 1 | Fluorescence (widefield, epi) Quiz 3: In class 9/29 | Widefield Epifluorescent Microscopy |
| 7 | Oct 6 Oct 8 | Image analysis FIJI/MATLAB, 2D vs 3D & Fourier Midterm Examination: 10/8 | Widefield Epifluorescent Microscopy (continued) |
| 8 | Oct 15 | Confocal microscopy No class Oct 13 – Mid-semester break | Confocal Microscopy LAB 3 DUE 10/15 |
| 9 | Oct 20 Oct 22 | Confocal microscopy 2 Quiz 4: In class 10/20 | Confocal Microscopy (continued) |
| 10 | Oct 27 Oct 29 | Image enhancement/ quantitative methods | Image Analysis (please bring laptops), flex weeks for image acquisition |
| 11 | Nov 3 Nov 5 | Image Segmentation | Image Analysis (please bring laptops), flex weeks for image acquisition LAB 4 DUE 11/5 |
| 12 | Nov 10 Nov 12 | Image Segmentation continued, registration/motion artifacts Quiz 5: In class 11/10 | Image Analysis (please bring laptops), flex weeks for image acquisition |
| 13 | Nov 17 Nov 19 | Intro to Classifiers/AI | Image Analysis (please bring laptops), flex weeks for image acquisition *No class Nov 23 rd |
| 14 | Nov 24 | Frontiers in microscopy/image analysis No Class Nov. 26 | Site visit to an industry location or guest visit (TBD) LAB 5 DUE 11/24 |
| 15 | Dec 1 Dec 3 | Final Project Presentations | Flex extra time for final presentations if needed. See below for information on final presentation and rubric |
| 16 | Dec 8 | Flex time for makeup or cancellations | |

Assignment and Grading Details Lab

| Assignment | Description |
|--|--|
| Participation/Attendance 10% of total grade | Attendance and participation in the lab activities are critical to learning the techniques introduced in the course. |
| Lab reports 90% of total grade | Five lab reports covering broadly 1) Ball lens lab; 2) transmitted light techniques; 3) Widefield epifluorescent microscopy; 4) Confocal microscopy; and 5) Image analysis * See lab report rubric on canvas. ** Lowest lab report grade will contribute half as much as the others. (20% per 4-highest reports, 10% for lowest) |

Note that abstracts are only required on lab reports for the BIOT-880 (graduate-level) lab section.

Assignment and Grading Details Lecture

| Assignment | Description |
|--|--|
| Participation/Attendance 10% of total grade | Attendance and participation in the lecture activities are critical to learning the techniques introduced in the course. |
| Quizzes 30% of total grade | Five short (less than 10 questions) in-class quizzes throughout the semester. The content will cover lecture and reading material from the previous week. <u>Lowest score drops.</u> |
| Midterm 30% of total grade | Cumulative 90-minute exam covering content from the first 6 weeks of the semester. Multiple choice, T/F, short answer, diagrammatic. Review guide will be provided. |
| Final Presentation 30% of total grade | Scientific presentation intended to model a short conference talk, including: Introduction, methods, results, discussion. This should present a cohesive story of your work on the imaging techniques used and analysis done. *See rubric on canvas |

Note graduate students will have an extra take-home question on the midterm.

Policy on Late Submissions

Students are expected to submit assignments and take examinations on time. Faculty reserves the right to deny a request to accept a late assignment and if written work is turned in after any negotiated due date or the due date, **the grade will be reduced by 10 points for each day past the due date.**

Class Attendance

Attendance is required.

Lab/Classroom Conduct

- *Laboratory Conduct:* You must wear long pants or a long skirt, wear close-toed shoes, and pull any hair back in the lab.
- *Cell phones:* Please **turn off/silence** and put away your cell phone before you enter the classroom.
- *Computer Use:* You may use a laptop *during lab/lecture* for taking notes ONLY. You should NOT be using your computer for social networking, emailing, playing games, etc. Such behavior distracts you and your classmates from the lecture and is considered disrespectful to the professor and your classmates. If you are judged to be misusing your computer in any way, you will be asked to put it away for the remainder of the lecture.
- *Food:* There is a strict policy of NO food or drinks in the laboratory. However, you may choose to have drinks in the classroom.

Make-up Quizzes/Exams

Exams and quizzes are given only on the announced date. Make-up exams and quizzes will be given ONLY if it is missed for a valid (documented) reason and discussed ahead of time.

Communication Expectations

I will be active in the canvas page daily, Monday through Friday. If you post a question for me in a forum or if you email me, anticipate a response within 24-hours or sooner during weekdays. On the weekends I may not log in at a regular time. If you write to me over the weekend, I may not respond until Monday morning.

How to Reach Me

Questions related to assignments or learning should first be asked, if possible, through canvas. Otherwise, feel free to email me or come to office hours.

Technical Requirements and Technical Support

A personal laptop (apple or windows are both OK) will be needed for the image analysis tasks. You should also bring a usb drive (HDD, flash drive, etc.) for data storage and movement. If you anticipate issues securing any of these, please contact me ASAP.

Academic Integrity

Unless otherwise specified, the use of Automated Writing Tools, including artificial intelligence (AI) tools, is strictly prohibited in this course, even when properly attributed. The use of automated writing tools is considered plagiarism (as defined by UNH's

[Academic Integrity Policy](#)) and will be handled in accordance with existing policy. Students are expected to review these policies.

<https://catalog.unh.edu/srrr/university-policies-regulations/academic-honesty/>
PLAGIARISM (from SRRR)

Use or submission of intellectual property, ideas, evidence produced by another person, including computer generated text or work outsourced to third-parties, in whole or in part as one's own in any academic assessment without providing proper citation or attribution. In some cases, reusing one's own previous work without acknowledging or citing the original work can constitute self-plagiarism.

UNH Manchester Campus Support

Student Wellness Support- Mental Health Services

In partnership with The Mental Health Center of Greater Manchester, UNH Manchester offers consultation visits on campus and virtually during the academic year with a mental health counselor Monday-Thursday. Students can make counseling appointments directly through an online scheduling system located on the [UNH Manchester Wellness page](#).

Services include:

- Free confidential screening & consultation with a licensed mental health therapist.
- Referrals to mental health or substance misuse treatment.
- And assistance in understanding how to afford additional treatment (with or without insurance!) or find free services.

Basic Needs Resources:

UNH has many resources that can help students who are experiencing food insecurity, housing or other financial concerns. All enrolled students are eligible for Basic Needs resources and services. A complete listing of university and local basic needs resources can be found on the [UNH Manchester Basic Needs webpage](#). The following UNH resources students are referred to most frequently are listed below:

The Student Emergency Financial Assistance Fund (SEFA) provides UNH undergraduate and graduate students unable to meet essential expenses due to a temporary or unexpected hardship with short-term financial assistance once per academic year. *Please note that funding is currently limited due to high demand and UNH had to pause funding for graduate students at this time.* We encourage graduate students to schedule a time to meet with the Basic Needs team to discuss their options and connect them to additional resources at basic.needs@unh.edu.

UNH received a grant from Granite Edvance to support our Student Emergency Financial Assistance program specifically for undergraduate students.

To request SEFA students must complete the [Student Emergency Financial Assistance Request Form](#)

- **UNH Manchester Wildcat Cupboard**, located on the second floor, Room 290, is available to all UNH Manchester undergraduate and graduate students, staff or

faculty who need access to free, nourishing food. There are an assortment of items including pasta, canned food, cereal, milk, eggs, fresh fruits and vegetables, which are purchased from the NH Food Bank through a grant or donated by members of the community. The Cupboard is open Tuesdays and Thursdays from 12:30-3:30 pm and Wednesdays from 3:00-6:00 pm. Walk ins are welcomed and no appointments are needed.

- **The UNH Manchester Wildcat Wardrobe** provides students with access to new and gently used professional attire for interviews, career fairs, networking events, and the workplace. Students can visit the Wildcat Wardrobe, located on the second floor in Room 288 (next to the Wildcat Cupboard) Monday-Friday from 9-5 pm. Items are completely free.

Confidentiality and Mandatory Reporting

The University of New Hampshire and its faculty are committed to assuring a safe and productive educational environment for all students and for the university as a whole. To this end, the university requires faculty members to report to the university's Title IX Coordinator (Bo Zarycky, Bo.Zarycky@unh.edu, 603-862-2930/1527 TTY) any incidents of sexual violence and harassment shared by students. All employees are subject to this mandatory reporting. If faculty or staff wish report an incident while on campus they can speak with Manchester's Title IX Deputy Intake Coordinator and Assistant Dean Lisa Enright 603-641-4336. Lisa's office is located on the second floor in the Library and Engagement Center, Room 236.

If a student wishes to speak to a confidential support service provider who does not have this reporting responsibility because their discussions with clients are subject to legal privilege, here is a list of confidential service providers. Including a statement of confidentiality and mandatory reporting along with links of supports for students is important for helping our community stay in compliance with Title IX, as well as living up to our commitment of building a safe community for everyone:

- [The SHARPP Center for Interpersonal Violence Awareness, Prevention, and Advocacy](#) at (603) 862-7233/TTY (800) 735-2964. SHARPP's Expanded Services Coordinator, Caroline Young, is available to meet virtually year-round Mondays-Fridays 9am-4pm and is on Manchester's campus Mondays during the Fall and Spring semesters (in Room 471). If you'd like to book a confidential appointment with her [schedule an appointment here](#). SHARPP Advocates are also available 24/7 via our Crisis Line: 603-862-SAFE (7233).

- [REACH Crisis Services](#): 24/7 Support Line: 603-668-2299. SMS/Text (M-F 8:30 AM-5:00 PM): 603-836-9620.

- For more information about what happens when a student reports, how the university treats your information once a report is made to the Title IX Coordinator, your rights and reporting options at UNH (including anonymous reporting options) [please visit student reporting options](#).

- The [uSafeUS](#) app is also available for students to keep reporting options and resources easily accessible on their phones.

Help us improve our campus and community climate. If you have observed or experienced an incident of bias, discrimination or harassment, please report the incident by contacting the Civil Rights & Equity Office at UNH.civilrights@unh.edu or TEL # (603) 862-2930 voice/ (603) 862-1527 TTY /

Library: The UNH Manchester librarians are available to assist you with the research process. Visit our website at <https://cps.unh.edu/library> to explore library services and search for reliable academic sources. You can also contact the library at 603-641-4173 or unhm.library@unh.edu.

Helpful links for students:

- **Make a Research Appointment:** <https://libraryguides.unh.edu/remotearchive/researchhelp>
- **Library Search Box:** https://libraryguides.unh.edu/librarysearchbox_unhmanchester
- **Reserve a Study Room:** <https://cps.unh.edu/library/support-services>
- **Citing Sources:** <https://libraryguides.unh.edu/unhmcitingsources>
- **Evaluating Sources:** <https://libraryguides.unh.edu/ENGL401UNHManchester/evaluatingresources>

Knack Peer Tutoring

Knack is a peer-to-peer tutoring platform available to all enrolled students for all undergraduate courses in Durham and Manchester and is offered at no charge to students. Students looking for additional assistance outside of the classroom are advised to consider working with a peer tutor through Knack. UNH has partnered with Knack to provide students with access to verified tutors who have successfully completed your course. To view available tutors, visit: unh.joinknack.com. Sign in with your student account.

Questions about Knack Tutoring can be sent to Stephanie Kirylych, Director of Advising, at stephanie.kirylych@unh.edu.

Connors Writing Center (CWC)

The [Connors Writing Center](#) offers one-on-one writing conferences to current UNH students (undergraduate and graduate). They work with writers from all disciplines on many kinds of writing. Our conferences are conducted by trained writing assistants who are UNH undergraduate and graduate students. The CWC offers both in-person and virtual appointments, available to any current UNH student. The online sessions are synchronous (real-time) appointments designed to help students have one-on-one conversations about their writing at any stage of the process, mirroring what we do during in-person appointments. **[Students can schedule an appointment any time during the semester.](#)**

Online Writing Lab (OWL)

The [Online Writing Lab \(OWL\)](#) assists students via asynchronous remote collaboration with qualified writing assistants. The OWL is not an editing or manuscript preparation service. Feedback may include reference to mechanics on the submitted paper, but it will be targeted to bring attention to patterns and issues to help the writer self-correct the paper and carry forward lessons to improve future writing. Students in all fields of study can submit up to 20 double-spaced pages of any form of writing, including course papers, resumes, creative essays, or personal statements. Within 3 business days, writing assistants provide feedback that can be printed or viewed on screen. The OWL is accessible through any computer that has an Internet connection and Microsoft Word. **To submit a paper, students can sign in at unh.mywconline.com and select the "Online Writing Lab" schedule.**

Note: This syllabus is subject to change. Students will be promptly notified of any changes.