

BME1410H1 S

Electron Microscopy of Proteins, Cells, and Tissue

Winter 2027 Syllabus

Course Meetings

BME440H1 F

Section	Day & Time	Delivery Mode & Location
LEC0101	Monday, 9:00 AM - 11:00 AM	In Person: AB 114
PRA0101	Wednesday, 12:00 AM - 2:00 PM	In Person: MB 325

Refer to ACORN for the most up-to-date information about the location of the course meetings.

Practical sessions start Wednesday January 6th.

Course Contacts

Instructor: Prof. Lindsey Fiddes

Email: lindsey.fiddes@utoronto.ca

Office Hours and Location: Monday 13:00 - 15:00 in MB 330

Additional Notes: Please email me from your @mail.utoronto.ca email address and include the course code in the subject of your email.

Course Overview

Electron microscopy is an important tool in the field of biology and biomaterials. By delving into the nanoscale the ultrastructure of cells and tissues can be observed. Using scanning electron microscopy (SEM) the surface topography is observed to distinguish cell morphology, bio-integration to biomaterials or implants, and extracellular matrix organization. Using transmission electron microscopy (TEM) changing within the cell are observed at the organelle level. Further testing the limits of resolution, cryo-electron microscopy (cryoEM) is used to image proteins with angstrom resolution.

This course provides a comprehensive deep-dive into the theory and application of TEM, cryoEM, and SEM. Students will explore the interaction of electrons with organic matter, focusing on overcoming the inherent challenges of imaging low-contrast, beam-sensitive biological samples. Sample preparation and imaging will be discussed in theory and demonstrated in hands-on lab time. Students will be grouped into the imaging modality of their interest:

- SEM
- Negative stain TEM of small particles
- Cell/tissue embedding TEM
- CryoEM

Students are encouraged to bring samples from their research lab to image. Model samples (adeno virus, cell pellets, cells on coverslip) will also be provided. Image analysis methods will be discussed and practiced using both conventional object picking and qualitative phenotype scoring methods.

Course Learning Outcomes

Upon completion of this course, you will:

- Understand the physics of electron-matter interactions and signal generation.
- Master biological sample preparation, including ultramicrotomy and cryo-fixation.
- Evaluate the role of image processing algorithms in reducing observer bias.
- Apply microscopy techniques to the characterization of nanoparticles for medicine.

Credit Value: 0.5

Course Materials

See Quercus.

Marking Scheme

Assessment	Percent	Details	Due Date
Quizzes	20%	Weekly in-class multiple choice quizzes.	ongoing
Lab report	20%	A lab report describing sample preparation, instrumentation, image analysis, and discussion of results. Lab report is due 2-weeks after the end of your lab rotation.	Two-weeks after your last lab
Term test	30%	An in-class, open-book, term test will be completed in week 6 of the course. Short and long answer questions will be written digitally or on paper.	February 10, 2027
Presentation	30%	A twenty-minute review presentation on a topic related to EM of biological materials will be presented in class in weeks 11 and 12.	March 24 or 31, 2027

Mark revisions for the mid-term: There is a maximum one-week period after a quiz, lab-report, or term test is returned to you to query re-mark or revision. All grades will be posted to Quercus

as soon as deliverables have been returned to the class. Students have until the date of the final exam to check the accuracy of the scores posted to Quercus. After this date, requests for revisions must be made through the Registrar's Office.

Academic integrity is of utmost importance. Any issues of plagiarism and/or inappropriate collaboration will be taken seriously and reported to the higher authority.

Late Assessment Submissions Policy

Submission deadlines are concrete. Late submissions will have a 5% late penalty per day. This is relevant for all lab deliverables.

Course Schedule

Week	Description
Week 1	The Physics of the Beam - Wave-particle duality; De Broglie wavelength; Magnetic lenses.
Week 2	SEM - Elastic vs. Inelastic scattering; Secondary vs. Backscattered electrons; EDX
Week 3	TEM – Fast Fourier transform, spherical aberrations, the Rayleigh criterion in EM
Week 4	Cryo-Electron Microscopy - Vitrification; Low-dose imaging; Single-particle reconstruction.
Week 5	Crystalline Materials – Electron diffraction
Week 6	Term test
Week 7	Biological Sample Prep - Chemical fixation (Glutaraldehyde/OsO ₄); Dehydration & Resin embedding.
Week 8	Ultramicrotomy - Sectioning techniques; Knife geometry; Thermal vs. Mechanical feed.
Week 9	Contrast Enhancement - Heavy metal staining (Lead citrate, Uranyl acetate); Negative staining.

Week 10	Image analysis – Particle counting; Morphometric analysis; Scoring
Week 11	Review Presentations
Week 12	Review Presentations

Policies & Statements

University Land Acknowledgement

I wish to acknowledge this land on which the University of Toronto operates. For thousands of years, it has been the traditional land of the Huron-Wendat, the Seneca, and the Mississaugas of the Credit. Today, this meeting place is still the home to many Indigenous people from across Turtle Island and we are grateful to have the opportunity to work on this land.

Learn more about Canada's relationship with Indigenous Peoples [here](#).

Indigenous Students' Supports

If you are an Indigenous engineering student, you are invited to join a private Discord channel to meet other Indigenous students, professors, and staff, chat about scholarships, awards, work opportunities, Indigenous-related events, and receive mentorship. Email [Professor Bazylak](#) if you are interested.

Indigenous students at U of T are also invited to visit Nations House's (FNH) Indigenous Student Services for culturally relevant programs and services. If you want more information on how to apply for Indigenous specific funding opportunities, cultural programs, traditional medicines, academic support, monthly social events or receive the weekly newsletter, go to the FNH [website](#), [email](#) or follow FNH on social media: [Facebook](#), [Instagram](#), or [TikTok](#). A full event calendar is on the CLNX platform. Check CLNX often to see what new events are added!

Wellness and Mental Health Support

Your personal wellness and mental health are important. The University of Toronto and the Faculty of Applied Science & Engineering offer a wide range of free and confidential services that can support your well-being.

As a U of T Engineering student, you have a Departmental [Undergraduate Advisor](#) or a Departmental [Graduate Administrator](#) who can support you by advising on personal matters that impact your academics. Other resources that you may find helpful are listed on the [U of T Engineering Mental Health & Wellness webpage](#), and a small selection are also included here:

- [U of T Engineering's Student & Community Wellness Coordinator](#)
- [Health & Wellness](#) and the [On-Location Engineering Wellness Counsellor](#)
- [Health & Wellness Peer Support Program](#)
- [Accessibility Services](#) & the [On-Location Advisor](#)
- [Graduate Engineering Council of Students' Mental Wellness Commission](#)

- [SKULE™ Mental Wellness](#)
- [U of T Engineering's Learning Strategist](#) and [Centre for Learning Strategy Support](#)
- [Registrar's Office](#) and [Scholarships & Financial Aid Office & Advisor](#)

We encourage you to access these resources as soon as you feel you need support; no issue is too small. You may reach out to the counsellors at [U of T Telus Health Student Support](#) for 24/7 free and confidential counselling support.

If you find yourself feeling distressed and in need of more immediate support visit uoft.me/feelingdistressed or U of T Engineering's [Urgent Support – Talk to Someone Right Now](#).

Accommodations

The University of Toronto supports accommodations for students with diverse learning needs, which may be associated with mental health conditions, learning disabilities, autism spectrum, ADHD, mobility impairments, functional/fine motor impairments, concussion or head injury, visual impairments, chronic health conditions, addictions, D/deaf, deafened or hard of hearing, communication disorders and/or temporary disabilities, such as fractures and severe sprains, or recovery from an operation.

If you have a learning need requiring an accommodation the University of Toronto recommends that students [register with Accessibility Services](#) as soon as possible.

We know that many students may be hesitant to reach out to Accessibility Services for accommodations. The process of accommodation is private; we will not share details of your needs or condition with any instructor.

If you feel hesitant to register with us, we encourage you to reach out for further information and resources on how we can support. It may feel difficult to ask for help, but it can make all the difference during your time here.

Phone: 416-978-8060

Email: accessibility.services@utoronto.ca

Equity, Diversity and Inclusion

Looking for community? Feeling isolated? Not being understood or heard?

You are not alone. You can talk to anyone in the Faculty that you feel comfortable approaching, anytime – professors, instructors, teaching assistants, [first-year](#) or [upper years](#) academic advisors, student leaders or the [Assistant Dean of Diversity, Inclusion and Professionalism](#).

You belong here. In this class, the participation and perspectives of everyone is invited and encouraged. The broad range of identities and the intersections of those identities are valued and create an inclusive team environment that will help you achieve academic success. You

can read the evidence for this approach [here](#).

You have rights. The [University Code of Student Conduct](#) and the [Ontario Human Rights Code](#) protect you against all forms of harassment or discrimination, including but not limited to acts of racism, sexism, Islamophobia, antisemitism, homophobia, transphobia, ableism, classism and ageism. Engineering denounces unprofessionalism or intolerance in language, actions or interactions, in person or online, on- or off-campus. Engineering takes these concerns extremely seriously and you can confidentially disclose directly to the Assistant Dean for help [here](#).

Resource List:

- [Engineering Equity, Diversity & Inclusion Groups, Initiatives & Student Resources](#)
- [Engineering Positive Space Resources](#)
- Request a religious-based accommodation [here](#)
- Email Marisa Sterling, P.Eng, the Assistant Dean, Diversity, Inclusion & Professionalism [here](#)
- Make a confidential disclosure of harassment, discrimination or unprofessionalism [here](#) or email engineering@utoronto.ca or call 416.946.3986
- Email the Engineering Society Equity & Inclusivity Director [here](#)
- [U of T Equity Offices & First Nations House Resources](#)

Academic Integrity

All students, faculty and staff are expected to follow the University's guidelines and policies on academic integrity. For students, this means following the standards of academic honesty when writing assignments, collaborating with fellow students, and writing tests and exams. Ensure that the work you submit for grading represents your own honest efforts. Plagiarism—representing someone else's work as your own or submitting work that you have previously submitted for marks in another class or program—is a serious offence that can result in sanctions. Speak to me or your TA for advice on anything that you find unclear. To learn more about how to cite and use source material appropriately and for other writing support, see the [U of T writing support website](#). Consult the [Code of Behaviour on Academic Matters](#) for a complete outline of the University's policy and expectations. For more information, please see the [U of T Academic Integrity website](#).

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Quercus Information

This course uses the University's learning management system, Quercus, to post information about the course. This includes posting readings and other materials required to complete class activities and course assignments, as well as sharing important announcements and updates. The site is dynamic and new information and resources will be posted regularly as we move through the term, so please make it a habit to log in to the site on a regular, even daily, basis. To access the course website, go to the U of T Quercus log-in page at <https://q.utoronto.ca>. Once you have logged in to Quercus using your UTORid and password, you should see the link or "card" for this course. You may need to scroll through other cards to find this. Click on this link to open our course area, view the latest announcements and access your course resources. There are Quercus help guides for students that you can access by clicking on the "?" icon in the left side column.

SPECIAL NOTE ABOUT GRADES POSTED ONLINE: Please also note that any grades posted are for your information only, so you can view and track your progress through the course. No grades are considered official, including any posted in Quercus at any point in the term, until they have been formally approved and posted on ACORN at the end of the course. Please contact me as soon as possible if you think there is an error in any grade posted on Quercus.

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