Starting Strong: Navigating an Undergraduate Research Thesis

STARTING STRONG: NAVIGATING AN UNDERGRADUATE RESEARCH THESIS

Lab selection, communication skills, and tools for success

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INTRODUCTION

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Hello everyone and welcome to this guide on beginning your journey in undergraduate research.

Whether you are preparing for a fourth-year thesis, exploring experiential learning opportunities, or simply curious about what life in a research lab entails, this resource is designed to help support your research journey.

Our goal with this guide is to provide some insights to help you navigate three key transitions:

- Finding the right supervisor and research environment
- Developing the professional and interpersonal skills needed to thrive in a research lab
- Learning from the experiences and perspectives of supervisors, mentors, and peers

Although this guidebook was created with Biochemistry and Biomedical Sciences students at McMaster University in mind, the guidance, strategies, and insights shared here are intentionally broad. We hope it will serve as a valuable resource for students across disciplines and institutions as they embark on hands-on research for the first time.

Entering a lab for the first time can feel exciting, overwhelming, and everything in between. This guide aims to make the transition clearer, smoother, and more supported. We hope it helps you feel ready, confident, and empowered as you take your next steps into the world of research.

Important Note:

This guide is meant to offer general advice and an overview of common experiences in undergraduate research. It is not a course syllabus, lab manual, or safety document, and it does not replace the official information provided by your program, course coordinators, or research supervisors.

Every course and research environment operates differently. For specific questions about requirements, assessments, lab expectations, or safety procedures, please refer to the appropriate official resource (such as your course syllabus, lab-specific training materials, or guidance from your supervisor, course coordinators, and lab mentors).

Sincerely,

Felicia Vulcu, Caitlin Mullarkey, and Meghan Pepler

APPENDIX OF ENCOURAGEMENT AND ADVICE FROM THESIS STUDENTS, MENTORS, AND FACULTY

As we built this guidebook, we gathered a remarkable amount of encouragement and advice from past thesis students, graduate mentors, and faculty. You'll see many of their words woven throughout the book, but we couldn't fit everything in. This appendix is the full collection that we wanted to share with you as you navigate your upcoming (or ongoing) thesis journey:

STUDENT QUOTES

Integration and Lab Culture

Be yourself and open yourself to everyone in the lab without considering your position in the lab as just a thesis undergrad student which can create a barrier.

I would tell them to be proactive and approachable from day one. Don't wait for others to include you, introduce yourself, ask questions.

I'd tell them to build rapport with the lab manager and the other masters and post grad students.

I'd tell them to volunteer for small side projects early on to meet everyone and learn techniques. Showing willingness to help builds goodwill.

Jump in on communal lab tasks—cleaning, restocking—to show commitment.

Make an effort to know your Masters students and PhD students since they will be able to provide mentorship and support.

Be willing to listen and learn, go into new and old experiences with an open mind.

Ask to help with data entry or literature searches in week one to learn the ropes.

Discuss and set clear expectations first. Learn to ask questions and rely on your mentor early on. Learn to socialize and assimilate to the lab culture.

Learn as much as possible however and whenever you can. Shadow anyone that will let you and ask questions.

Take the initiative to show up in person when you can and be open to learning.

Go to lab meetings, socialize when you can with them, and ask for the expectations from the get go.

Be open to new experiences and ask questions.

Get out of your comfort zone, eat lunch with the students.

Be there even when you have nothing to do.

Encourage thesis students to go to lab meetings!!!
Your thesis story can just be about your journey.

Communication and asking for help

Also, don't be afraid to ask for help or clarification.
Always ask questions.
If you're unsure about something, don't hesitate to ask questions.
Ask questions and don't be afraid.
Relax and ask questions!
I wish I communicated more at the start with my PI.
Work hard, ask lots of questions! Science is hard, 90% of your experiments will probably fail—and that's ok!
Stay curious and don't let your nerves get the best of you! Every expert was once a beginner.
Own up to how much you don't know!!!

Resilience, mindset, and the emotional experience

Expect it to be messy, and don't panic when it is.
Trust yourself more—you know more than you think you do.
Accept that things will go wrong.
Rest is not a reward, it's a necessity.
Celebrate small wins.
Start drafting even when you don't feel "ready."
Treat your thesis like a part-time job.
Your thesis won't be groundbreaking, and that's okay.
Don't be afraid to pivot if something isn't working.
Track your work so you don't lose sight of how far you've come.
It is not a race, but a marathon.
Don't stress too much and enjoy the experience.
It is a different type of learning. Didn't know what I was signing up for, but grateful for it in the end.
Don't think you can just grind it out.
Can't just get it done in one evening—you'll burn out.
If someone critiques your work, it doesn't mean that they are critiquing you.
Failing is okay!!!!! Negative results are results.
It's about the progress, not the end results.
Marathon not a sprint.
Not having results is okay!!!
Honestly about what the thesis experiment will look like. You might feel alone. Things are going to be hard, and it's slow, and you're self-directed.

The point of science is to find the truth of what is in your experiments, not to be right!

Practical tips and skill development

Write as you go instead of saving it all for the end.
Choose a topic you're genuinely curious about, not one you think sounds impressive.
Keep your notes and sources organized from day one.
Talk to former thesis students—they're a goldmine of helpful advice.
Don't be afraid to reach out to your supervisor sooner.
Backup your work religiously.
Break the work into smaller, manageable chunks.
Be proactive about seeking feedback.
Read a couple of past theses in your department.
Learn the field well.
Don't be afraid to give your own ideas and do additional research.
Write everything down, and take good notes. Try not to make the same mistake twice.
Being open-minded and trying out a different experiment/technique can work wonders for you.
Be open-minded when choosing projects.
I would remind how important it is to be curious.
Just reach out to labs you are interested in even if you think you are not qualified.
Literature is so helpful, go read!!!

Literature review and Writing

You don't need to read everything—just read strategically.
Start building a writing habit early.
Grammar less important than the words you choose and how you describe work.
Past lit reviews are helpful.
Having the PI edit something small first.
Put real effort into it!

Presentation and sharing your workl

Presentation doesn't have to all be data analysis but can be progressive.
Advice on how to present what you've done even if you don't have results.
Take pics!

MENTOR & FACULTY QUOTES

Why Research Matters and Why You Should Care About It

Be curious and specific about your goals and make sure the answers you are looking for are the same as the labs.

Research teaches us not just about the system we're studying, but how to be resilient, how to work with others, how to ask good questions and how to be open to the unexpected.

The most important medical breakthroughs didn't come from chasing short-term applications. They came from scientists trying to understand how the world works at the most fundamental level.

Science is a long game and even the smallest steps matter.

Research is a chance to ask questions no one has answered yet—and sometimes, to find answers that can make a real difference.

Research is a way of thinking, forcing you to slow down and question what you think you know.

Scientific research is the foundation of innovation.

The only way to solve the world's most pressing challenges is through science/research.

Science is ultimately focused on understanding the world. I can think of no better way to spend one's life than by learning more about how it all works.

The naive questions students ask can be very important because they provide an opportunity to reflect.

The pure joy of discovery that young students experience is a great reminder of why we got into this business.

Expectations and Advice for Thesis students

Be curious and don't worry about guidelines.

If you miss a week—you need to make up that time.

Understanding where your research fits into the larger research goals of the lab.

Learn how to make good figures and how to tell a story.

Keep it simple, and worry about main messages only.

ABOUT THE AUTHORS

This guidebook was developed as part of a grant funded by The McMaster OER Grant Program (which is supported by McMaster's MacPherson Institute, the McMaster Student's Union, the Office of the Provost, and the University Libraries). The aim was to support students embarking on their undergraduate research journey by providing a comprehensive, flexible resource that guides them through key transitions, such as finding the right supervisor, developing essential research skills, and learning from the experiences of mentors and peers.

The creation of this guidebook was a true collaborative effort which showed us that the project was more than writing a guide. It was an opportunity to reflect on our own experiences, work together effectively, and develop a resource that we hope will be useful not only to Biochemistry and Biomedical Sciences students at McMaster University, but also to students across disciplines and institutions as they navigate the world of research.

We hope this guide provides clarity, confidence, and inspiration to students as they begin their own research journeys.

About the authors

Dr. Felicia Vulcu is an Associate Professor (teaching stream) in the Department of Biochemistry and Biomedical Sciences (BBS) at McMaster University. Her teaching is deeply rooted in promoting mental health awareness, with a personal commitment to fostering environments where students feel respected, heard, and empowered. Her teaching practices are built on a foundation of safety, respect, and inclusivity. She believes in creating nurturing spaces that support lifelong learning. Felicia's approach includes integrating innovative techniques such as team think tanks, flipped-classroom case studies, and virtual labs, where students apply biochemistry skills to real-world biomedical issues, like drug discovery. Felicia has taught Biochemistry lab courses for many years, with a focus on introducing students to the research process in a environment. She believes that lab courses provide students with the opportunity to experience the true wonder of research, while also building fundamental frameworks for tackling experimental design, whether for research, thesis courses, or grad school. Her main approach emphasizes breaking down complex experimental tasks into four key stages: experimental design, readout, interpretation, and challenging assumptions in the system. Felicia is dedicated to fostering reflective research practices, which she believes enhance lifelong learning. She is also passionate about exploring accessibility in teaching lab spaces to ensure inclusivity and support for all students. A key achievement in her teaching journey has been the development of a second-year undergraduate laboratory course that introduces students to the research process. She has also co-developed

online learning resources with the design of a popular Massive Open Online Course (MOOC) and a range of Open Educational Resources (OER)s to offer flexible and learning opportunities for students.

Felicia was also involved in the design and implementation of McMaster's Biomedical Discovery and Commercialization (BDC) program and continues to shape the curriculum in ways that reflect her commitment to student well-being and academic growth.

Dr. Caitlin Mullarkey is an Associate Professor and the Associate Chair of Undergraduate Education in the department of Biochemistry and Biomedical Sciences. She is focused on providing undergraduates with a rigorous and cutting-edge scientific education that will allow them to excel in diverse careers and graduate/professional school. With extensive training and expertise in infectious disease and vaccine development, she teaches virology, cell biology, biochemistry, and immunology to undergraduates at all levels. She is keenly interested in developing new curricula and her current scholarship centers on exploring advanced methods of delivering learning content.
Dr. Mullarkey received her doctorate from the University of Oxford, where she studied as a Rhodes Scholar. She subsequently completed a postdoctoral fellowship in viral immunology at the Icahn School of Medicine at Mount Sinai (New York City) under the mentorship of Dr. Peter Palese. Her teaching and scholarship have been recognized with numerous accolades. In 2024, she received the Minister of Colleges and Universities' Award of Excellence. She was also awarded the President's Award for Outstanding Contributions to Teaching and Learning in 2023 and is a three-time recipient of the McMaster Student Union Teaching Award for the Faculty of Health Sciences for her instruction in virology and advanced immunology.

Meghan Pepler is a PhD Candidate in Dr. Marie Elliot's lab at McMaster University, where her research focuses on RNA-based regulation in *Streptomyces venezuelae*. She is funded by the NSERC Canada Graduate Scholarship–Doctoral and has been recognized with multiple departmental awards for research excellence and scientific communication. Meghan completed her BSc Honours in Molecular Biology and Genetics (Co-op) at McMaster, where she also conducted her undergraduate thesis. As a graduate student, she has since trained several thesis students in the Elliot lab, supporting their development as emerging researchers.

Alongside her research, Meghan has developed a strong interest in teaching and pedagogy. She has twice served as a Sessional Instructor for *Techniques in Molecular Genetics (MOL BIOL 3V03)* and has contributed to curriculum development and inclusive learning material design. She completed the Teaching and Learning Theory and Inquiry Certificate through McMaster's MacPherson Institute and has recently been nominated for the CCUBC–oCUBE Emerging Educational Leader Award in recognition of her growing contributions to undergraduate teaching and mentorship.

Meghan's longitudinal experience at McMaster as both an undergraduate thesis student and a thesis student mentor, along with her involvement in departmental teaching, has given her a deep understanding of the

program. This perspective inspired her to help write and shape this guidebook as a resource to make the experience more transparent, approachable, and empowering for future students.