We're recruiting undergraduate and master's students to work on the corrosion of critical metals!

Posted by Dr. Daniel S. Grégoire, Chemistry Department, Institute of Biochemistry
This is a template adapted from Dr. Paul Carini's newsletter *Uncultured*

Please see instructions at the end of this document for details on how to apply

What you need to know

You will lead your own research project examining how microbially-induced corrosion can be used to recover the critical metal cobalt. This research is funded by an NSERC Discovery Grant awarded to Dr. Grégoire.

Your work will expand our understanding of the metals that can be corroded by microbial metabolism. Your work will lay the basis for sustainable cobalt reclamation strategies that can be applied to electronic waste. You will use a combination of microbial physiology experiments, biochemical analyses, and analytical chemistry to test hypotheses related to metal corrosion. You will optimize microbial strains through genetic manipulations to recover cobalt from complex waste streams.

You will work with Dr. Daniel Grégoire, who will use a "learning-by-doing" approach to teach you the different skills needed for your research. You will play an integral role in building the lab's capacity to characterize microbial corrosion and pilot biological approaches to metal recovery. Once you are comfortable, you'll be encouraged to take more ownership over your research. We're open to hearing your creative ideas!

Background on the projects

Microbial metal corrosion (MMC) costs the global economy trillions of dollars through extensive damage to essential infrastructure. MMC can occur through direct pathways controlled by redox cycling proteins and indirect pathways controlled by redox active metabolites. These pathways oxidize metals in their elemental state to soluble ionic forms, leading to pitting. Mechanistic studies on MMC have focused on Fe^0 and stainless steel used in construction. Whether similar pathways can solubilize valuable metals and support their recovery remains largely unexplored. This knowledge gap is crucial to address to design sustainable strategies to recover critical raw materials.

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This project focusses on cobalt corrosion controlled by microbially-produced phenazines. Phenazines are produced by diverse bacteria to help them navigate oxidative stress and competition in the environment. Phenazines have previously been linked to the corrosion of iron and other metals including copper, nickel, and titanium. Whether these same pathways apply to critical metals such as cobalt is what we're focussing on as part of this work.

Previous work frames microbially-induced corrosion as a problem, but we see the potential to develop sustainable metal reclamation strategies for critical metals. Cobalt is a major component of battery waste and has similar redox properties as iron making it a promising target for corrosion and recovery. This project was initiated by undergraduate students who wanted to explore this idea and has since become a major focus of the lab. We want to expand on our initial studies to provide more mechanistic details on microbial corrosion of cobalt and validate the use of biological platforms in cobalt recovery from electronic waste.

What you will be doing

There is no one skillset that will define who we hire for these projects because our lab is interdisciplinary by nature. Your research will require you to characterize how microbes change metal redox chemistry under different growth conditions and genetic backgrounds. We're looking for someone with broad experience in **microbiology, biochemical analyses, geochemistry, or synthetic biology.**

You may be skilled in microbial cultivation having worked with microbes from diverse habitats with unique metabolisms. You may also be well-versed in analyzing small metabolites produced by model organisms. You may have expertise examining environmental processes that change metal redox chemistry. We encourage you to apply if you have experience in any of these areas and we will help fill in the gaps once you're on the project.

In our lab, you can expect to grow your skills in analytical chemistry for metals, microbial physiology, microscopy, and synthetic biology. We will work with you to build your skills in experimental design, project management, and science communication. You can expect to be part of an inclusive group that will support your growth and help with troubleshooting. Your initial onboarding will involve reading literature and summary documents to help you plan your research. We will also give you time to get used to balancing research with your academic commitments. We will work on an individual development plan to ensure your training aligns with your career goals. We want you to access diverse career paths inside and outside of academia.

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Specific skills we are interested in

We are looking for people that are excited about hypothesis-driven research that couples microbial metabolic analyses to fundamental concepts in metal redox chemistry. You'll have an interest in designing microbial cultivation experiments where model bacteria are grown under different conditions to compare metal corrosion. You're interested in developing analytical approaches for phenazines or other metabolites to test your mechanistic hypotheses. You're keen to build the lab's capacity in manipulating genes involved in metal cycling. You will want to share your research with a broad audience through written documents and presentations.

We're looking for someone with good project management skills that can lead this priority area in the lab. We value someone who is a self-starter, autonomous, and can commit to a decision while clearly outlining their logic. We want to work with someone who understands the importance of troubleshooting and documenting solutions to transfer knowledge to others. We recognize that mistakes will be made along the way, but we see these mistakes as an essential part of your learning.

We hope you will pay this forward because you'll play a key role in transferring knowledge to incoming students as the lab grows. We want people who see value in incorporating feedback into their work. This is a two-way street, and you can expect that your voice will be heard. We will strive to provide you with professional development opportunities and attending conferences to help meet your career goals.

Where you will work

You will be working in Ottawa, which is a fantastic city to do research in and pursue your education. You will be in a city where you can easily connect with people working in the private biotech industry or the government contributing to policy. Ottawa has several means of public transport (bus and train) and bike paths that make it easy to get to campus from most places in the city. Carleton Chemistry's Department and Institute of Biochemistry are interdisciplinary environments that equip students for diverse career paths after they graduate. If you'd like to learn more about what we have going on in the lab, go to https://carleton.ca/envbiotech/.

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Job logistics and pay

The Environmental Biogeochemistry and Biotechnology lab is located on Carleton University's campus in room 432 in the Steacie Building. This work will necessitate working in a large lab space that will be shared with other research groups. This work will also require coordinating access to the Nanoimaging Facility at Carleton. You'll be supervised by a combination of in-person and remote supervision.

Pay for undergraduates applying through the I-CUREUS or NSERC USRA program will be in line with those program requirements. Undergraduates applying through the Honours thesis program will receive academic credit towards the completion of their program. Pay for graduate students will be in line with Carleton's Chemistry Department norms. Information on benefits for graduate students can be found here: https://gsacarleton.ca/healthplan/. We will do our best to help you apply for any scholarships that will help you succeed during your time with us.

We want you to have a sustainable relationship with your work and will help you strike a good work-life balance. **Graduate students** are expected to work in the lab 20-24 hours a week while balancing their academic duties. **Honours students** are expected to work between 12-16 hours a week and we recognize that your course load is a priority. Undergraduates working through the **I-CUREUS** program will work 150 hours over an internship that can last 8 months. Undergraduates working through the **NSERC USRA** program are expected to work 40 hours a week over a 16-week period.

Diversity matters to us. We strongly encourage candidates of all different backgrounds and identities to apply. Equity, diversity, and inclusion are crucial to supporting innovation in academia by bringing people with diverse lived experiences together. This means that we want a diverse team that includes people from different backgrounds, experiences, and identities. If you identify as being part of a marginalized community, you are welcome here! We will put the work into providing you with an inclusive and supportive environment to do your research.

Please submit an application that speaks directly to this position

Please prepare an application that consists of your CV and a statement outlining your research experience and interests. This statement should be succinct and highlight why you are a good fit for the lab. All applications can be emailed to danielgregoire@cunet.carleton.ca. We will be evaluating applications on a rolling basis until we find the right candidates. Master's students would ideally start in **September 2025**. Undergraduate students can start in **January, May, or September 2025**.

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Once we have your application, you will hear from us in two weeks about advancement to the interview stage. We expect one interview that will be an hour and a half long to take place remotely or in person (your choice). We will send questions in advance so there are no surprises. These questions will focus on your professional experience, problem-solving ability, and communication skills.

For graduate students, if we decide to work together, you must be formally accepted into one of the M.Sc. programs in Chemistry at Carleton before you can start in the lab: https://graduate.carleton.ca/cu-programs/chemistry-masters/. After you are accepted into your M.Sc. program, we will work with the Department of Chemistry to draft a formal offer and send it you. We will aim for this letter to be sent shortly before the start of the Fall 2025 semester.

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