PART ONE: TEACHING PHILOSOPHY

I consider the course that I teach as integral to a student's education. Even an hour's lecture is worth thinking of in these terms. Thus, I emphasize building upon what students already know, expanding and strengthening basic knowledge, knowing how knowledge grows, how new information might fit into, or rock a paradigm, and how it may be used in different contexts: in upper year courses and beyond.

I have had the privilege of teaching MDSC 351 (Honours Cell & Molecular Biology), since its first offering in winter term 2005 as a core course in the Bachelor of Health Sciences program. Through its successive iterations, I have been able to apply, test, and refine my philosophy of teaching.

What should students take away from having been in my cell and molecular biology class for a semester? They should have a firm grasp of the basic concepts, not as facts in isolation but as a framework of knowledge. They should have practiced thinking through and formulating questions. They should have gained fluency in its language, so that they read the literature of the field with understanding, and when they speak or write about cell and molecular biology, they can be understood. They should achieve scientific literacy in cell and molecular biology to enable living in our world: to ask questions, to understand the issues, to respond intelligently, and to act accordingly.

It can be a rather daunting prospect for a second or third year student to hope to learn so much in a winter term. As a teacher, I reflect on the necessity of learning subject matter, and learning it well enough to use and apply it to gain more knowledge. Thus, I think about how one learns, and I am convinced that it must be a collaborative effort that avails of different ways of learning. As a teacher, my job is to provide the environment where such learning can take place.

Engagement

At its very heart, I believe teaching is about communication, in the sense that its success requires social intercourse. When I teach, I am as concerned about what I speak of, as I am with how the material is received by my students. I find that by engaging students right then and there, they are more receptive, and being so, they are more likely to learn.

From the beginning of term, I take care to set a tone of open inquiry that fosters lively questioning and the consideration of alternate views, and always with mutual respect. Students ask questions, discover nuances of the material, and these invite further discussion and discovery. This happened in class this past week, and frankly, it was a delight to see eyes light up, hands shoot skyward, and then to hear students speak their minds thoughtfully and courageously. Here, come alive, was the classroom as I had envisioned it: a place where students can try things out, test their wings; where they might even fail, but safely, and then recover.

Engagement through creative assignments

My cell biology course has the problem summary assignment, for which the graded component is an essay on a question of cell biology that we may have spent very little time in class discussing, but now students are to research and write about. The students write three such essays throughout the term. What distinguishes the problem summary from other writing assignments is that the presentation of each topic is done in a creative manner that hints at important aspects of the question, and often gives clues to useful references in the literature. After the presentation, the students brainstorm questions and issues and prioritize which questions/issues should be discussed in their essay.

In winter term 2016, I made a Star Wars-themed presentation, with scrolling text and music to introduce different non-coding RNA molecules as characters of that movie franchise. The students unfolded origami light sabers to find the tutorial sheet where they recorded ideas and questions from the brainstorming session that followed. Later in the term, to introduce the cell-cell communication essay, I re-wrote the words of "Hello", a popular song at the time, then asked volunteers from the class to sing those new lyrics, while the accompaniment played on the audio-visual system. The entire class

ended up singing along. By design, the students' participation in the presentations increased from the first presentation to the next, to boost their confidence in the exercise. Also by design, each presentation was of a different style, to demonstrate how a topic or question can be presented in a variety of ways.

Modeling different presentation strategies and inviting greater participation helped to prepare the students for the third problem summary exercise. Here, the students worked in groups to develop their own presentation on a topic of cell biology entirely of their choice, which they presented to the class at the end of term, and for which they wrote individual essays.

Through the years, I have read some excellent essays, with well-formed arguments, grounded in the research literature. Each essay a student submitted was often better written, more cogent, more whole, than the one submitted before. I have witnessed students give presentations that have been full of energy and creativity, such as a live choreographed dance to the cell cycle, a stop-action Lego film on cancer, a puppet show on apoptosis, an extracellular matrix take on The Bachelor, a flash mob music video on the nuclear pore complex that went viral on YouTube.

At the end of the term, when asked to evaluate the course, students invariably remark these problem summary assignments as being the most work, but also the course component they learned from the most. Without question, students learn best when they are engaged, when they see the value of what they have learned, when they come up with the questions, and are vested in finding answers.

To quote from Asha Hollis's letter of support: "By allowing groups to pick their own topics, but also providing guidance, she encouraged students to critically think about topics that the students themselves were interested in and excited about." And further in her letter, Asha quotes a classmate: "I admire her dedication towards finding effective and innovative ways to present her lectures, especially her novel problem assignments."

Engagement through meaningful classroom interactions

As a teacher, it is my job to provide plentiful and manifold learning opportunities to engage students with different strengths and learning preferences, and to give frequent and constructive feedback so that students know where they stand. In my class, such opportunities abound: during lectures and discussions, with skits and role-playing, two-minute papers and whiteboard exercises. Students learn from answering questions I pose and from questions they themselves raise. They learn from studying for exams, and from reading the literature for essay assignments. They learn from being given free rein with any cell and molecular biology topic, to develop and to research and then to share with their peers. Finally, they learn from honest reflection upon their work.

A student (CS) from MDSC 351 W2013 wrote this reflection: "…I had two things I wanted to do: research more beforehand and spend more time on it. I definitely did the first task much better. I may have spent about the same amount of time on this as I did on PS1, but I was much more focused and worked more efficiently in a forward direction."

Reflection

Reflection is a practice that I do myself. I keep a teaching log where I document things I try to do in class and how well they worked or not, tips to remember the next time I teach a particular topic, or new ideas I dream up to test out in class. Reflection has informed my own development as a teacher. So convinced of its value, I am eager for my students to learn reflection and reap its benefits.

The practice of reflection is an exercise I introduce early in the term. Since I require students to write a personal reflection to accompany every major assignment, I devote a tutorial session to showing what it is and how it is done, and then give the students a chance to practice. A few balk at the idea, but with every attempt, many students become more insightful, more expressive, more open to what their reflections show. Through the short paragraphs they append to their essays, students chronicle how they take responsibility for their own learning, which is as it should be. This is not to say that, as a

teacher, I am absolved of blame when students don't learn, or unworthy of praise when they do. I believe that a teacher has very much to do with a student's making that leap of taking charge, and providing the avenue of the personal reflection is one way that a teacher does that.

Collaboration and the creation of new knowledge

Since 2011, I have been involved in the mentorship and supervision of students on the iGEM (international Genetically Engineered Machines) team. Over the course of about 9 months, undergraduate students from faculties across the University campus work together to develop and execute a project that addresses a real-world problem using the tools and approaches of synthetic biology. The students then present their project in competition against teams from around the world.

I conduct a special problems course (MDSC 507- Synthetic biology 1) for the iGEM students in the winter term, where the students learn the fundamentals of synthetic biology and examine how these principles have been applied in past iGEM projects. The students put forward project ideas, evaluate strengths and weaknesses, and decide on a project to pursue for the spring/summer terms. They formulate plans for the research and for other aspects of the project, such as consulting experts and engaging the general public. In the fall term, I offer Synthetic biology 2, which follows the completion of the project, its documentation in a web-based laboratory notebook (the Wi-ki), and presentation by poster and by oral delivery in world competition. In 2017, I am teaching a second winter term iGEM course for returning team members (MDSC 507- Synthetic biology 3), where members of last year's team will have the opportunity to engage in peer-teaching and mentorship of the new team.

Mentoring these multi-disciplinary iGEM teams and developing courses to address their needs have given me the opportunity to refine my teaching philosophy. That learning should be an engaging experience still holds. That it should build upon previous knowledge is a given. That is should be collaborative is taken to an entirely new level, as these students come with different backgrounds and perspectives, interests and skill sets, and must work together toward a common objective.

That learning should seek to be the means of creating new knowledge is an invaluable opportunity that the iGEM experience provides, which can only be dreamed of in the classroom setting of MDSC 351. In iGEM, the students participate in the creation of knowledge through scientific research: planning and running experiments, making observations, and figuring out what they mean, and what comes next. In 2013, the iGEM team published a paper on their project that year, so that they not only created new knowledge, but importantly, disseminated that knowledge. In that same spirit, the 2016 iGEM team has submitted a policy brief for publication, and they have collaborated in a virtual workspace to write a research manuscript for submission.

A work in progress

From time to time during the term, I ask the MDSC 351 students the clearest and muddiest points of a lecture, then spend the next class going over these points, giving students the opportunity to explain concepts to one another. Students "vote" on topics to focus on for exam review sessions, and then come up with questions to quiz one another. Aside from USRIs, students fill in a questionnaire at the end of term, where they evaluate how well different course components contributed to their learning. Over the years, comments have helped to shape the course and how it is delivered, such as clarifying expectations and providing summative feedback at intermediate stages of student work.

The MDSC 507 courses for the iGEM team were developed with input from present and former team members, and they continue to be refined from year to year, responsive to the needs of a diverse group of students. That diversity also brings a wealth of talent in students who can be inspired to accomplish much more than succeeding at world competition, as with exploring entrepreneurship and founding a start-up biotechnology company, such as one that had its roots in the iGEM project of 2011.

Being able to teach successfully depends very much on knowing one's students, which harks back to teaching as communication and knowing one's audience. I take that task very seriously, spending considerable time getting to know my students individually.

My educational philosophy has gone through tests and refinements through the years. Its essence, however, has remained intact. Teaching's reason for being is learning, so its energies are well spent if it focuses on providing the best environment for learning. Defining that best environment is an ongoing process that at times will blur the roles of teacher and student, as learning proves to be multi-directional. It is worth teaching well because then, learning continues well past the last day of class. It becomes a habit of mind, a practice of life.