

Report: “Technology goes bio: enzymes to the rescue!”

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Introduction:

Our activity consists in an interactive workshop (“*Technology goes bio: enzymes to the rescue!*”) to be delivered to an audience of upper secondary school students. The idea behind it is to give the students the means to develop a new passion for molecular biosciences and to ultimately show them future career possibilities that they might not have been aware of. In particular, we aim to give small groups of motivated young candidates a concrete taste of what the job of a bio-scientist looks like.

In our workshops, students are taught the concepts of enzymatic digestion, optimal conditions for enzymatic action, electrophoretic migration and gel staining, all while studying a practical example (detergents used to break down a fictional meatball stain on a T-shirt) in a fun and welcoming environment.

The Biochemical Society grant allowed us to gather the necessary material to carry out three of the six workshops scheduled for the 2015/2016 school year. Two of the workshops have already taken place respectively on the 10th and 16th of December, with the last session scheduled for the 17th of February.

The activity, which is organized in collaboration with the “*École des Protéines*” (the Protein School) and PROTEO, the *Québec Network of research on protein function, engineering and applications*, was carried out in the laboratories of the Chemistry Department at Université de Montréal in Québec (Canada).

A typical workshop session:

The set-up of a workshop session requires real teamwork and the definition of specific roles for every participant.

Jean-Daniel Doucet is the full-time project manager of the Protein School and has received awards for his past science outreach projects. He is in charge of making the first contact with the schools and the teachers, and he remains the reference point on the day of the workshop, during which he also delivers the PowerPoint presentations to the students. Jean-Daniel is an expert in the popularizing science for non-specialized audiences.

Our demonstrators are in charge of ordering and preparing the material, setting up the laboratory and helping out the students during the activity. They also take care of writing and modifying the students’ and

demonstrators' manuals together with Jean-Daniel and I. With the help of the Professors involved, they also liaise with the Chemistry Department and the University, for example by taking care of room and laboratory reservations.

I am in charge of the communication and promotion of the workshops through the use social networks (such as Twitter, Facebook, and LinkedIn), pictures and blog posts, when relevant. I also help with the translation from French to English of the documents/manuals and with the general organization of the event. Together with Jean-Daniel we make sure that the sponsors are promoted at all times, for example by adding the Biochemical Society logo to the lab-coats and the apparatus that will be used during the event. The logo is also added to the webpage of the Protein School (<http://www.ecoledesproteines.com/equipe/>).

After Jean-Daniel reaches an agreement with the invited high school, he sends a full program to the teacher in charge and the demonstrators. It is now time to get ready to receive the students!

The activity is scheduled to last approximately three and a half to four hours. The students (in groups of between 7 and 16 participants) are greeted at the entrance of the University by Jean-Daniel, me and one of the demonstrators. Jean-Daniel starts off the session by introducing the experiment to the students through a PowerPoint presentation. Then, it is finally time to get hands-on in the lab. During the experiment, the students

are familiarized with the use of the micropipettes, so that they can perform the experiment themselves, as a professional bio-scientist would do. The aim of the experience is to study the effect of the enzymes contained in a commercial laundry detergent on a fictional meatball stain, which is represented by a solution of the protein Bovine serum albumin (BSA). Geared up in protective lab-wear, the students pipette the detergent and the BSA

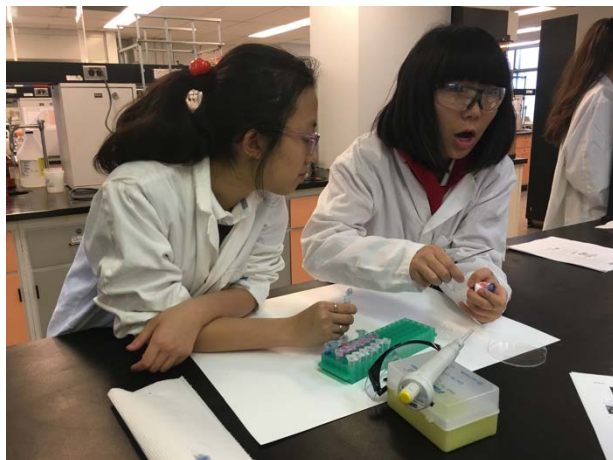


solution together in Eppendorf microtubes, and they study the effect of different temperatures (such as 4°C, room temperature, and 100°C) on the enzymatic digestion. They also learn the concept of a negative control (a sample containing BSA only, and no enzyme).

While the protein gets digested, the students – guided by the demonstrators – set up the apparatus to run polyacrylamide gels (pre-cast by the

demonstrators). When the samples are ready, the students add the loading dye and, under supervision, they load the samples in the gel, together with a molecular marker.

While the gel is running, Jean-Daniel



entertains the class with the second part of the presentation in which he discusses career choices and opportunities in the biosciences. It is fascinating to see how readily engaged the students are and how many pertinent questions they ask during the presentation. They know little about careers in science, and they want to know more: this is exactly the purpose of our workshop.

The day is almost over, and the students are brought back to the laboratory to analyze the results on the gel (the demonstrators help with

the staining/de-staining process) and they try and answer the questions at the end of their lab manual. Since the staining/de-staining process is quite long, we are planning on integrating an extra activity to make the wait less tedious, for example we could prepare some ice-cream using liquid nitrogen. After the day is over Jean-Daniel sends to the teacher an online feedback questionnaire to be completed by the students. This helps us understand how we did, if the students enjoyed their time with us and how much they learned.

Session of the 10th of December 2015

The first workshop welcomed 16 students from the school Pensionnat Saint-Nom-de-Marie (Montréal) and their teacher Émilie Sauvageau.

Pensionnat Saint-Nom-de-Marie is an all-girls high school, which is in line with our optic to try and engage minorities in our program. The experience was satisfactory, and the students enjoyed their time with us. Thanks to the feedback of the students and the teacher, we gathered information on how to improve our following workshops. In particular, the experience was a bit too long, and the students did not have sufficient time to analyze the gel after destaining. We also reached the conclusion that the manual should be simplified; for example, some steps

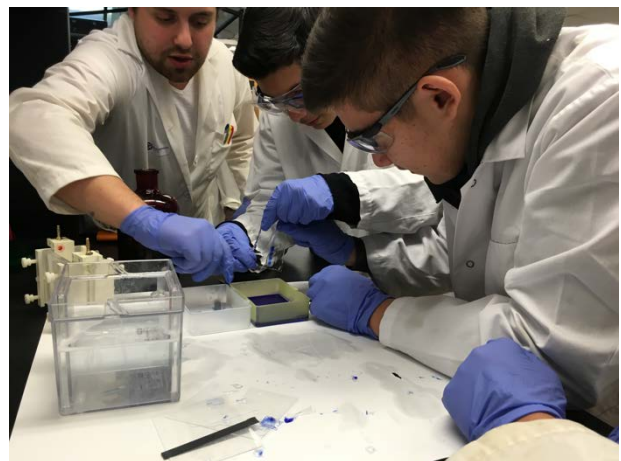
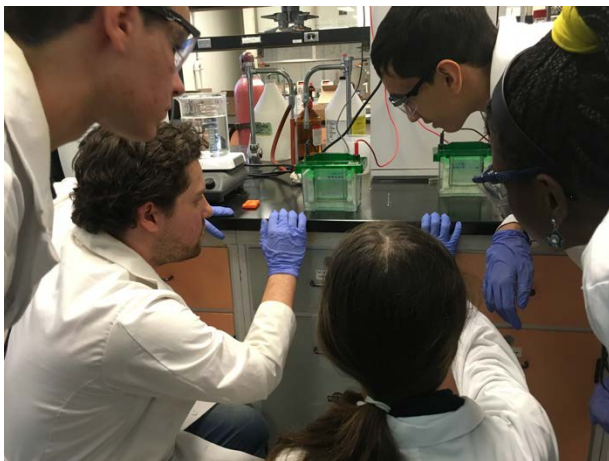
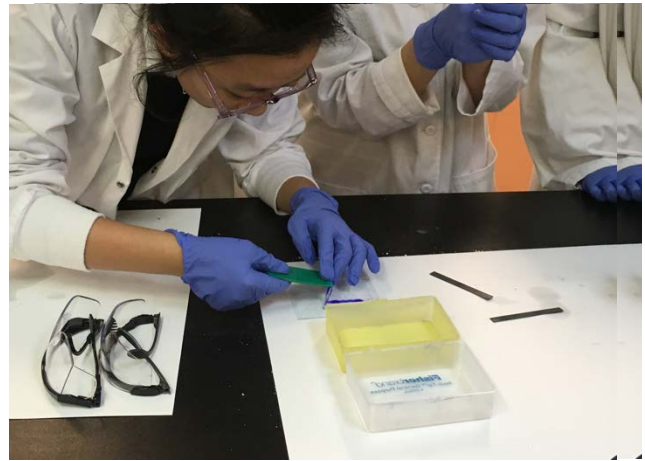


such as the use of a microcentrifuge and the vortex could be removed. These are very simple steps, but to perform them safely with a class of 16 high-school students requires too much time, which makes it incompatible with such a short workshop.

The demonstrators also needed further training to learn to cope better with the unexpected and with all the questions the students had during the laboratory experience.

The students had a lot of fun discovering the micropipette and the gel apparatus. They were also very engaged in the conversation and asked many career-oriented questions. We were very happy with the safety related to performing science in a real laboratory with young teenagers. The experiment is in itself not dangerous, but it is critical to share our culture for laboratory safety with the students: everybody wore lab coats and goggles and gloves, when necessary.

As the teacher said: *« the girls really enjoyed the experience. I think that the subject and the level were appropriate for their age. »*

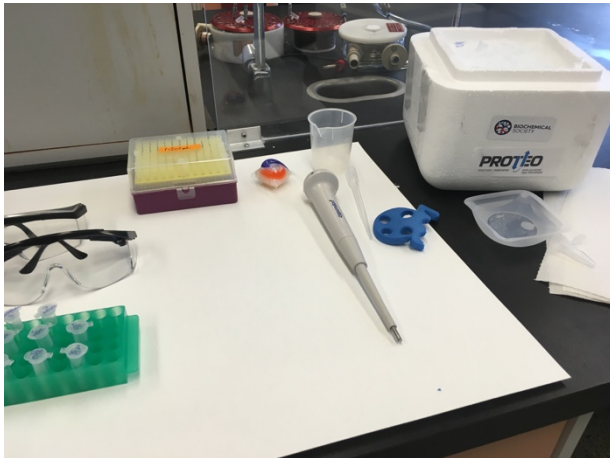


Session of the 16th of December 2015

The second workshop saw a significant improvement compared to the first one. We were happy to host a smaller number of students (7) from the Collège d'Anjou (Montréal), accompanied by their teacher Ms. Geneviève Leclerc. The smaller group allowed us to have better control of the workshop, and it was the perfect occasion to implement the changes that we established to be necessary upon discussion over the first workshop. The simplification of the manual made it easier for the students to understand the experience.

Having to deal with a smaller number of samples and eliminating the centrifugation and vortex steps resulted in a much more relaxed laboratory time. The students found the experience more accessible, and the demonstrators were more comfortable and performed with more confidence. The demonstrators had also been more extensively trained by Jean-Daniel the day before the workshop. We were able to carry out the experiment until the end, and the students had time to observe the destained gel. However, the bands were barely visible, which suggests that it would be best to have a pre-run gel on hand where the results are more visible. It will be prepared in advance by the demonstrators, and shown to the students only in cases where their results are not clear.

We were really pleased with the comment of the teacher, who asked us to *"please let her come back next year with a further group of students."*



Session of the 18th of February 2016

This session will be run in February 2016. With the information gathered during our second workshop, we will now be able to improve our workshop even further. The scheduled participating school is College Notre-Dame, and we are expecting 15 students.

We are also hoping to engage two public schools in the future (we are in contact with the Lucien-Pagé and the École Internationale de Montréal high schools) and schools further afield in the most remote regions of Québec.

Our specific aims and how we achieved them:

The workshop was designed to provide an invaluable experience for everyone involved:

- 1) Our activity promoted the molecular biosciences field. We were able to create a welcoming laboratory environment that resembled that of every professional molecular biology laboratory. The students were very excited to learn how to use a pipette and to run polyacrylamide protein gels.
- 2) Before and after the hands-on laboratory session, we presented two PowerPoint presentations. The first described to the students the science behind the experiment they were about to perform, whilst the second allowed time to focus on career opportunities and paths related to the biosciences. The students seemed to be very interested in understanding their career opportunities in the field and during both workshops this brought very interesting discussions. The students were given the opportunity to ask questions to professionals in the field: the demonstrators (Ph.D. students), the main organizer and science communicator (Jean-Daniel Doucet) and myself (postdoctoral researcher also in charge of media and communication during the workshops). Our demonstrators come from different countries (including Spain, Italy, and Canada) and are therefore perfect international examples of scientific researchers.
- 3) One of our original primary targets was that of involving “hard to reach” students, in particular, public school students preferably coming from remote regions of Québec. Unfortunately, mainly due to an ongoing strike in the public sector in Québec, recruiting students from this pool was harder than expected. We, therefore, accepted students coming from public and private schools in the Montréal area, but were fortunate to recruit a class from an all-girls school. Women in science are still a minority, and it is very important for us to contribute to ignite passion in young women. We are now also in contact with a number of public schools, including one from a remote region of Québec. We are confident that we will be able to engage this audience in our future workshops.
- 4) We put a great effort into making the students aware that English is the language of science. Even though the French language is prevalent in Québec, we provided both French and English copies of the laboratory manuals.
- 5) The demonstrators were heavily involved in the organization of the activity (i.e. buying and gathering all the necessary material, reserve and prepare the laboratory and classroom space needed for the activity, liaise with the university personnel). They gained insight on

how to set up a successful outreach activity and how to communicate high-level scientific information to a non-specialized audience.

- 6) The workshop helped with the promotion of the participating laboratories and the university. The sponsors (The Biochemical Society and PROTEO) were mentioned at all times. In fact, stickers with the logos were ordered to be ironed on the lab coats of the demonstrators and the students and to be placed, where possible, on the laboratory material used during the workshop. The event was highly publicized through Twitter, LinkedIn, Facebook and a blog post on jobs.ac.uk (<https://blogs.jobs.ac.uk/science-and-technology/2015/11/25/scientific-outreach-bother/>).

Due to our international connections, we were able to also engage with a distant audience and make the international public aware of our activity.

Problems encountered and objectives modifications:

- Our initial objective was to recruit the most promising students coming from remote areas of Québec, where they are less likely to come into contact with people who have a career in bioscience. We were hoping to be able to achieve this thanks to the involvement of Jean Daniel with the Protein School and the implementation of his traveling interactive presentation with which he has been able to reach more than 1300 students from Montréal to Amqui (about 600 km of territory).

We did not envisage how difficult it would be to recruit students from these areas, even with this incredible network. The main problem was a teachers' strike in the public sector that coincided with the time in which we wanted to start our workshops. This unforeseen circumstance made it extremely hard to recruit students from the public sector. Furthermore, we had not appropriately considered the prohibitive cost of recruiting the most talented students from several schools in distant areas of the region. In fact, the cost of transport and of replacement teachers is very high already when students coming from one school (and one class) are brought in for the workshop.

Faced with those circumstances, we decided not to delay our project any further and to bring in available students, initially from private schools of the greater Montréal area, focusing primarily on young women. We are hoping to be able to bring in public school students during the future workshops to be held in the first months of 2016.

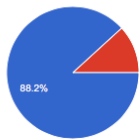
- Even though Université de Montréal has provided the laboratory and classroom space for the activity as well as hourly salary for the demonstrators, they were, unfortunately, unable to help us fund our activity as had been envisaged. Furthermore, we will need to allocate

more money to buy lab coats for the students in 2016 because of the new lab coats format that has been introduced in the Chemistry department, where we are based. Luckily, the Biochemistry department of the University of Laval loaned us part of the equipment (i.e. Miniprotean apparatus for gel running), and this allowed us to save some money from the Biochemical Society grant, which were re-allocated to cover some of the unexpected consumables' cost, partial cost for the new lab coats and partial transport expenses for the students. We are seeking further contribution from PROTEO, and we will be requesting a grant extension from the Biochemical Society.

Feedback:

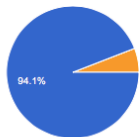
We are still collecting feedback from the students through our on-line questionnaire. Here is a partial analysis of our data on a sample of 17 students (more than a third of the expected responses).

Avez-vous apprécié l'atelier La techno tourne bio : digère ta saleté? - Did you enjoy the "Technology goes bio: enzymes to the rescue" workshop?



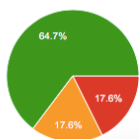
Oui - Yes	15	88.2%
Indifférent - Indifferent	2	11.8%
Pas du tout - Not at all	0	0%

Avez-vous acquis de nouvelles notions pendant l'atelier? - Did you acquire new knowledge during the workshop?



Oui - Yes	16	94.1%
Indifférent - Indifferent	0	0%
Ne m'intéresse pas - It did not interest me	1	5.9%

J'envisageais déjà poursuivre des études en biotechnologies - I was already thinking of pursuing studies in biotechnology



Certainement - Yes	0	0%
Il y a des chances - A bit	3	17.6%
Je dois y penser - Not sure	3	17.6%
Non - No	11	64.7%

L'atelier m'amène à envisager une carrière dans les biotechnologies... - The workshop helped me to understand what a career in biotechnology would look like



L'atelier a changé ma perception de la recherche en laboratoire... - The workshop changed my perception of laboratory-based research



Here are some of the comments that we found most rewarding:

"I really appreciated the manipulations during the laboratory and also the PowerPoint presentation at the beginning of the workshop. However, the protocol was a bit too complicated. In brief, it has been a pleasure to do the experiment with you. Thank you."

"I loved the fact that we were able to use technologies that are not available at school. I found that the activity gave me a better idea of what biotechnology is."

"I liked very much that we had the possibility to use some instruments that we don't have in school, such as the micropipette."

We also received a few less positive comments which had mainly to do with the length of the workshop (i.e. *I found the activity too long and the protocols were too complicated*), from the students involved in the first section. We addressed their concerns during the second workshop.

Our overall comments:

We are very happy with the outcome of our first workshops, in particular with the improvements we implemented during the second session. It was truly rewarding to see the students' involvement and curiosity. Everyone who participated in the preparation and delivery of the workshop worked professionally and was able to share his/her passion for science with our young audience.

Overall, I believe the activity met the criteria of the Biochemical Society Scientific Outreach Grants. We have been able to disseminate information about biosciences to young students delivering an engaging workshop experience that allowed the participants to perform hands-on a scientific

experiment that has a real-world application (enzymes in the commercially available detergents).

We were, furthermore, able to reach a great number of people from the public through sharing our experience via Social Media. A blog post was also produced for jobs.ac.uk in which I spoke about our workshop as a successful example of outreach activity. In fact, I will also write an article for the Biochemical Society to be published in their Biochemistry journal or as a blog post, as they see fit.

We engaged many young women in our workshops, and we are aiming to reach an audience coming from public and “further afield” schools in Québec.

Our feedback questionnaire is allowing us to collect feedback from the students, and the teachers are also providing helpful comments about what they liked and what they would improve.

We are looking forward to delivering the next four workshops for the year 2015/2016. Following the establishment of the “Technology goes bio: enzymes to the rescue!” activity at Université de Montréal, we will expand our workshop into new host universities through members of the PROTEO network. Pierre Lavigne, a biochemistry professor at Université de Sherbrooke, has already expressed great interest in hosting the workshop in his lab. At a later stage, we will also develop new activities to nurture a “returning user” pool.

Everybody who participated in the activity was enriched by it: Jean Daniel, myself, the University and the sponsors got great visibility through social networks and blog posts.

As we mentioned in our proposal, the activity will be further publicized, and the sponsors will be acknowledged in different venues. Participating university communication services are also being involved to help get the word out (official twitter account of Université de Montréal).

Our demonstrators received training in teaching to a non-specialized audience composed by young students. The students in return, were able to ask us many relevant questions, not only about the laboratory experience but also on possible career opportunities: “do you really need a Masters after graduating?”, “What about Ph.D.? How long is a Ph.D. thesis?”, “How much can you expect your salary to be with a career in science”?

I certainly wish I had somebody to ask all those questions to when I was their age. The fact that we were able to give a glimpse of what a career in the biosciences looks like to our young audience is for us source of great pride.

References:

1) Saperas, N.; Fonfría-Subirós, E., Proteolytic Enzymes in Detergents: Evidence of Their Presence through Activity Measurements Based on Electrophoresis. *Journal of Chemical Education* **2011**, *88* (12), 1702-1706.