Public Health Agency of Canada
Agence de la santé publique du Canada

CANADIAN DO-IT-YOURSELF BIOLOGY SUMMIT

PROCEEDINGS

March 16, 2016
Ottawa, Ontario

Canada

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The event proceedings correspond to the language of the Summit. For more information about the event or for questions/comments about the proceedings, you may contact:

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EXECUTIVE SUMMARY

The first ever Canadian Do-It-Yourself Biology (DIY Biology) Summit was hosted by the Public Health Agency of Canada on March 16, 2016. The Summit brought together more than 260 participants (60 in-person and 200 virtual participants) representing various Canadian DIY Biology organizations, biosafety professionals, academia, and federal government to talk about the growing citizen science movement and how it is changing the innovation landscape in Canada.

The DIY Biology spaces in Canada are community-oriented and most are independent of government, universities, and major companies. They serve many purposes including innovative science, art and education, and welcome the general public to attend, get in contact or become involved with their DIY Biology communities. Their websites can be found In Annex 4.

The discussions at the Summit highlighted the importance of collaboration, of adopting a culture of safety, and of increasing transparency through public engagement.

WELCOME REMARKS

Ms. Cindy Evans, Director General, Centre for Biosecurity, Public Health Agency of Canada

Ms. Evans opened her remarks by referring to the accelerated pace of advancement in life science research over the past decade and the converging nature of research and innovation that is bringing together individuals from various academic disciplines. Technological developments have been making it easier for almost anyone to access scientific data and to obtain laboratory equipment for a much lower cost.

Ms. Evans referred to the DIY Biology movement as an increasing global phenomenon. It is founded by science enthusiasts who come from different backgrounds, including biology, engineering, informatics, and many more. DIY biologists pursue science outside of structured institutions, with the purpose of promoting biology education and making science accessible to just about anyone.

The Public Health Agency of Canada values the potential benefits of emerging technologies and encourages individuals to take an active interest in scientific innovation in a safe and responsible manner. In addition to the administration and enforcement of the *Human Pathogens and Toxins Act* and *Regulations* for the safe and secure use of pathogens and toxins in Canada, the Centre for Biosecurity plays an important role in:

- promoting responsible conduct of research in laboratories, and
- identifying new biosafety and biosecurity risks from emerging technologies to allow timely development of effective risk mitigation measures.

On behalf of the Public Health Agency of Canada, Ms. Evans was pleased to convene the first ever Canadian DIY Biology Summit and looked forward to positive outcomes and the continued engagement with this emerging discipline.

Dr. Pascal Michel, Chief Scientist, Office of the Chief Science Officer, Public Health Agency of Canada

On behalf of the Public Health Agency of Canada, Dr. Pascal welcomed the Summit participants. Set-up in April 2014, Dr. Pascal explained that the purpose of the Office of the Chief Science Officer is to:

- lead or coordinate the establishment and monitoring of the Agency's strategic science priorities,
- support excellence and innovation in the Agency's science activities and its integration with Agency programs and priorities, and
- promote the Agency's science and enhance or facilitate collaboration with partners, represent the Agency in various fora with other Science Based Departments and Agencies, and oversee the Agency's science support infrastructure.

Dr. Michel spoke about scientific excellence as an important driver for innovation. Scientific excellence refers to the internal quality and standard of the work being done by any individual scientist or team of experts, which includes readiness for external scrutiny. Equally important, scientific excellence includes taking into consideration the parameters set out in a civil society (i.e., ethical, legal and broader societal implications) during experimentation and testing of hypothesis. Dr. Michel encouraged the participants to consider these important perspectives in the discussions.

Panel I: DIY Bio Canadian Landscape (Present and Future Trend)

Panelist 1: Derek Jacoby founded the Victoria Makerspace in Victoria, British Columbia, Canada's first community biology lab. Derek is a PhD Candidate at the University of Victoria pursuing a dissertation on the creation of low-cost electro-encephalography equipment for the treatment of attention deficit disorder. He helped construct the lab at BioCurious, a community lab in San Francisco, and was actively engaged with the FBI on their DIYbio outreach activities.

In his presentation, Derek pointed out that having easier access to the tools and knowledge empowers the public to understand biology. Originally obtained from traditional establishments (i.e., colleges and universities), biology education is becoming more mainstream. The International Genetic Engineering Machine Competition (iGEM), a renowned global synthetic

biology competition, is an example of an education platform that provides university and high school students with an opportunity to tinker with biology, to collaborate, and to innovate.

Access to open-source information is important in driving scientific innovation. A few examples of DIY community-led projects include the following:

- Open Insulin – initiated by Counter Culture Lab in San Francisco to develop the first open-source protocol to produce insulin simply and economically by inserting an optimized DNA sequence for insulin into *E. coli* to express insulin precursors,
- Zombee – to engage citizens to track, monitor and report bees that are infected or are showing signs of parasitic infection due to *Apocephalus borealis*, and
- DIY Antibiotica- developed by the Waag Society in Amsterdam, the project engages citizens to sample and test soil bacteria from their backyard for antibiotic potential.

With regards to safety, Derek indicated that most of the projects conducted in DIY makerspaces are done under Containment Level 1 and involve organisms that pose no risk to human health or the environment if released. A forthcoming application under the *Human Pathogens and Toxins Act* is envisioned for projects at the Victoria Makerspace that will require higher level of biosafety containment using Risk Group 2 pathogens, including non-attenuated *E. coli*, *Staphylococcus aureus*, etc. Currently, these projects with Risk Group 2 pathogens are conducted in a Containment Level 2 facility at University of Victoria.

DIY Biology community labs foster education beyond the academic settings and push the envelope when it comes to group experimentation. It also allows reskilling of individuals without prior biology background and fosters convergence of many skills. A community lab also has introduced a shift in how businesses are started and run.

Panelist 2: Kevin Chen founded Montreal's biohackerspace Bricobio in 2013. He is the CEO of Hyasynth Bio, a biotech company that uses genetically engineered microorganisms to produce medicine and other products, with a focus on the active molecules of Cannabis.

Kevin provided a brief overview of the following global DIY Biology communities: the Waag Society (Amsterdam), the la Paillasse (Paris), BioCurious (California), and the Counter Culture Lab (California). In his presentation, Kevin offered an insight on his educational path which included quitting his Master Degree Program after 8 months to pursue his entrepreneurial goals. He successfully secured over $800,000 in funding over five years. Kevin also indicated that it cost him $3,000 to start-up his lab, which is significantly lower compared to the cost that is typically required in an academic institution.

Panelist 3: Vipal Jain holds a Bachelor of Science degree with a specialization in genetics and biotechnology from the University of Toronto. She is also co-founding the first DIY Bio community in Ottawa after being introduced to DIY Biology two years ago.

Vipal considered DIY Biology as a grassroot, citizen-driven, collaboration, accessible, open, and cross disciplinary. Vipal spoke about the challenges faced by DIY community groups, which include access to federal funding and ownership of DNA sequences and intellectual property rights. She stressed that Ottawa is a great place to start a DIY Bio community given the availability of resources within the region, such as Makerspace North, ArtEngine, and Andrew Pelling's lab (Ottawa University). In the next few months, Vipal and her team will be looking at securing a space for their community lab. One project that may be pursued is the use of drones to monitor the water quality in Ottawa.

Panelist 4: Scott Pownall helped to co-establish Vancouver's first community lab in 2015 after seeing demand from the DIY-bio Vancouver MeetUp group that was established in 2010. The group currently has a membership of 436 citizen scientists. A core group of individuals incorporated the not-for-profit Open Science Network Society and set about building the community lab. Scott completed his doctoral research in Genetics from the University of British Columbia and has worked in academia and industry. His focus now is in supporting and engaging people in citizen science and bio-entrepreneurship.

Open Science Network provides a space for citizen scientists, students, artists, makers, engineers, writers, tinkerers, biohackers, and professional scientists to share ideas, knowledge, equipment, and opinions. Workshops on, for example, DNA fingerprinting, DNA cutting, and cloning, and aseptic techniques are offered to members and the public, and an open lab is held weekly where science can be discussed and practiced. The group is currently looking for sponsors to fund a project that aims to sequence the genome of organisms that are isolated by the community. Community projects, such as CRISPR gene editing, bioprinting and biofabrication, fermentation, and DNA barcoding are also on-going. The Open Science Network also conducts regular outreach through STEM mentoring of students in grades 5 to 12 at the University of British Columbia and Simon Fraser University. Scott also views community labs as low cost pre-incubators for bio-entrepreneurs who have ideas but no access to expensive laboratory

infrastructure. He is excited about this potential for community biolabs to be the alternate source of scientific innovation in Canada's DNA-based economy.

Panelist 5: David Lloyd received his M.Sc. in Science from the University of Calgary and has worked in various projects ranging from novel DNA assembly methods to biosensors and environmental remediation. David co-founded FREDsense, a biosensor design company. He has developed a high school science based innovation program, and created a synthetic biology lab program for high schools across the province of Alberta.

According to David, the pace of advancement in genome sequencing technology has exceeded Moore's Law. Every two years, the capacity for computing doubles. David indicated that consequently people conducting biological experiments have significantly transformed. David described how the DIY Biology scene is Alberta through iGEM and that it was fuelled by the desire to look at ways to carry on great ideas beyond the competition. According to David, through Alberta's geekStarter Program high school students are engaged through mentorship to solve problems and build solutions. With his help, an extensive guidebook was developed to set-up DIY wet labs in high schools. David also spoke about how iGEM has provided the DIY Biology community with leaders throughout the years and that the competition also influenced many iGEM alumni to start their companies, including FREDsense. In his concluding remarks, David emphasized that synthetic biology is reaching the tipping point of innovation and that there are more exciting things to come from the citizen science community.

Panelist 6: Alaina Hardie is co-founder of and the Education and Outreach coordinator for DIYbio Toronto, a non-profit bio hackerspace. She is a former teaching fellow and now a faculty member at Singularity University[1]. In her professional life she works as a software developer and bioinformatician. She's an advocate for the principles of open science.

Inspired by the California-based DIY community BioCurious, Alaina helped formally set-up DIYbio Toronto in 2015. The goals of this community are to educate the public and to conduct research.

[1] Singularity University is a think tank organization located in California that offers educational programs to individuals and organizations with the mindset, skillset, and network to build breakthrough solutions that leverage emerging technologies like artificial intelligence, robotics, and digital biology (https://su.org/).

Education is delivered through discussion panels and workshops on topics such as directed evolution, bioinformatics (e.g., 23andMe), bacterial transformation, DNA isolation, PCR and gel electrophoresis, and CRISPR/Cas 9 gene editing. Research is done in the lab space by entrepreneurs and by members who are collaborating on lab projects such as DNA sequencing using the MinION nanopore sequencer which costs about $1000 USD. As a community space, DIYbio Toronto wants to have a safe place to conduct their activities, to demonstrate through collaboration and open-access publication that DIY biology is legitimate, and to democratize science by teaching people that they can do biology. Alaina shared the following challenges faced by her community:

- overcoming public perception that science is scary and biology is dangerous,
- significant cost of expanding into containment level 2 facility,
- convincing people that DIY biology is good,
- educating individuals is difficult given that biology is complicated, and
- ensuring compliance with applicable regulations without hindering community goals.

Panelist 7: Andrew Pelling is a Canadian experimental scientist who uses low-cost, open-source materials to discover new biology and create novel living technologies of the future. He runs an interdisciplinary, curiosity-driven lab at the University of Ottawa where he researches non-genetic ways to create artificial tissues and organs. Andrew is the recipient of TED Fellowship (2016) and a Canada Research Chair (2008-2018).

Andrew is motivated and inspired by the increasing collaboration, creativeness and curiosity of people with diverse backgrounds to innovate and to think unconventionally. As an art school drop-out, Andrew switched to biology and now leads a university-based biological research lab, where curiosity and exploration are valued. Unlike conventional scientists, he has published articles in open-sourced biohacking magazines and newsletters, such as BioCoder. Andrew's lab is experimenting with very cheap materials, such as vegetables and fruits, to create scaffolding to grow skin or other organs. He also challenges people to build equipment from discarded household and industrial wastes. For example, his team designed an open-sourced CO_2 incubator prototype for mammalian cell culture using materials that are cheap and readily available. Andrew also works with artists to create bioart installations in public spaces, museums and galleries. He recently launched Spiderwort, a company that is dedicated to developing and providing low cost, open-source, DIY kits for the key equipment needed to provoke and enable science in all economies and environments across the globe. Andrew is also looking at opportunities to open a community- driven, street-level research lab, called PHACKTORY, in Ottawa's ByWard Market.

Panel I Discussion

The following section contains a summary of the discussion during the question and answer period.

Funding

DIY Biology groups have no significant funding and practically all of their activities are self-funded through membership and/or workshop fees. They also rely on crowdfunding and donations from private entities to raise money for equipment and supplies.

iGEM and Start-up Companies

Despite under representation at the annual iGEM competitions due to limited financial support and administrative challenges, Canadian start-up companies that began as iGEM teams are growing in numbers. The DIY community became part of iGEM competition in 2014; however, the cost to participate is prohibitive for members. They would rather use the money to fund their community spaces and their projects.

Open-Access versus Intellectual Property Protection

The biohacking community is generally transparent, which brings forth certain challenges on how to maintain IP while being completely open. Open-access enables biohackers to carry out collaborative work, foster interdisciplinary dialogues, and empowers individuals to build on existing work quickly.

Community of Practice

Although the DIY Bio movement in Canada is growing, it is still in its infancy. Canadian groups are currently driven independently, and there is value and desire to create a network of members similar to US' DIYbio.org.

Cloud Labs

Automated cloud laboratories are in existence and are used to accelerate scientific research. By outsourcing the expensive cost of conducting experiments, companies may save time and money by utilizing cloud base systems to reduce cost of labor, expertise, and equipment. These are envisioned to supplement, but not completely replace hands-on work.

Laboratory Safety

Community lab members are not working with organisms that are inherently hazardous. They typically use risk group 1 organisms and follow safety protocols. While equipment is getting cheaper and information is easier to access, it is still hard for individuals in community spaces to purposely create harmful products or dangerous pathogens. Each member of a community is responsible for adhering to a community space's laboratory safety practices. There was a recognition, however, that gaps may exist and biosafety training is not consistently provided. Members behave in a culture of transparency and are encouraged to work collaboratively to prevent laboratory accidents or deter malicious intent, as much as possible.

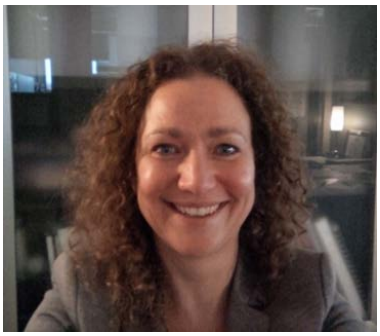
Most community spaces are set-up by DIY biologists with microbiology background, have training on basic laboratory safety protocols, and have some knowledge of the national biosafety

requirements. There is also recognition that founders of the DIY bio community spaces are aware that they are legally responsible for activities being conducted in their respective facilities, and as such are motivated to ensure that members and/or users are properly trained on all relevant safety protocols.

The Public Health Agency of Canada is currently developing a guideline document that is focused on providing risk-based biosafety recommendations for individuals and facilities, including DIY Biologists that are handling Risk Group 1 micro-organisms.

Engagement of Environmental Groups
As the DIY biology becomes more prevalent, it is important to reach out to environmental groups within their community. For example, Victoria Makerspace and the LifeCycles Program, an organic farming community in Victoria, engaged in a dialogue about the desire of the DIY bio community to contribute towards enhancing quality of life and environment, as opposed to profit driven enhancements.

Panel II: Building a Culture of Safety



Panelist 1: Marianne Heisz is the Director of the Office of Biosafety Programs and Planning at the Centre for Biosecurity. She oversees the delivery of biosafety awareness training and technical assistance to stakeholders to promote and enforce safe and secure biosafety practices and laboratory environments under the *Human Pathogens and Toxins Act* (HPTA) and *Regulations* (HPTR).

Safeguarding science in all types of scientific activities, whether conducted in institutional settings, community laboratories, or public spaces, is important in securing research integrity and in preventing accidents or deliberate misuse. Marianne emphasized that biosafety is a shared responsibility. Everyone with an interest in the potential benefits and risks associated with scientific innovation is accountable for fostering or upholding a culture of safety. In addition to the administration and enforcement of the HPTA and HPTR, PHAC plays an important role in developing standards and guidance materials (e.g., *Canadian Biosafety Standard,* Canadian Biosafety Handbook and associated guidelines, mobile apps), biosafety learning resources (e.g., on-line courses and instructional videos), and other technical documents (e.g., Pathogen Safety Data Sheets).

Panelist 2: Ayoob Ghalami is the senior biosafety officer for the University of Toronto where he has developed and taught courses in general biosafety, blood borne pathogens and transportation of dangerous goods within safety and academic streams. His main interests are teaching, program development and systemic biosafety management.

Ayoob referred to the moral obligation of all to meet legal obligations. He underscored the importance of adhering to the letter and spirit of international treaties (e.g., Biological Weapons Convention), national legislation and regulations (e.g., HPTA, *Health of Animals Act*, *Canadian Environmental Protection Act*, *Export and Import Act*, *Transportation of Dangerous Goods*), and biosafety procedures. The key concern with recombinant DNA and genetic manipulation is that users need to appreciate that things can go awry. The potential could be alleviated with the presence of a comprehensive biosafety management that considers the nature of the work and takes into account the training (i.e., both institutional and task specific), use of appropriate containment, engagement of biosafety committees and other experts, availability of medical surveillance (e.g., pre- and post-exposure treatments), and the plan for emergency response (including the relationship with first responders).

Panelist 3: Marc Saner is an Associate Professor at the University of Ottawa (Geography, cross-appointed at the Graduate School of Public and International Affairs and the Institute for Science, Society and Policy). His interests are the science/policy interface, the governance of emerging technologies, science policy, and environmental risk management, ethics and governance.

Marc discussed what it means to create a "culture of safety" in the DIY Biology context. He stressed that this culture needs to be a co-production between regulatory authorities and DIY practitioners. It should contain three elements: (1) Design, (2) Mitigation and (3) Adaptation. The design of a culture of safety will require engagement with the community – and it will be more meaningful to "get them to come" to the regulators, rather than "finding them". The design step should be based on the full breadth of values (including innovation and safety values) and a long-term, sustainability view. The mitigation element should not focus entirely on *a priori* rules, but include monitoring and soft-regulation mechanism. The adaptation element gives credit to the fact that we can neither predict nor control a DIY system perfectly. As a result, governance needs to be adaptive, contain emergency preparedness (a "rolodex" of contacts, for example) and should use new tools such as data mining. The combination of design, mitigation and adaptation fulfills the demands of the emerging concept of "responsible innovation" (www.ricah.ca).

Panel II Discussion

The following section contains a summary of the discussion during the question and answer period.

Access to Biosafety Experts

In the USA, members of the DIYBio.org have access to experts, including biological safety officers, for guidance and advice. In Canada, DIY communities are eager to get biosafety guidance. Academic institutions, such as University of Ottawa, have wealth of knowledge; however, fundamental to providing support to the DIY bio community is an understanding of the following elements:

- the baseline information on who the community members are,
- the appropriate level and type of information to share, and
- the liability associated with sharing guidelines and providing advice, including disclaimers.

The Canadian Association for Biological Safety (CABS), which is the Canadian affiliate of the American Biological Safety Association (ABSA), is also a great resource. The current CABS President encouraged the DIY Biology community to contact CABS anytime for information and welcomed an opportunity to start a dialogue with the DIY biologists to discuss various approaches to information sharing.

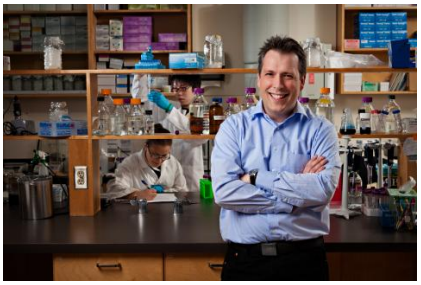
The Centre for Biosecurity is also available to provide biosafety guidance and has developed on-line biosafety courses that are available to everyone for free.

Regulatory Oversight

North American DIY Biologists have an advantage over their European counterparts. In contrast to North America, the DIY biologists in Europe need to obtain a license in order to carry out any type of genetic engineering experiment, including on risk group 1 micro-organisms. In Canada, facilities conducting scientific activities with risk group 1 agents are exempt from the licensing requirements under the HPTR. While this is already the case for most DIY biologists, individuals are encouraged to adhere with basic laboratory safety practices. Depending on the activities and products developed, there may be a requirement for DIY biologists to comply with other national regulations (e.g., New Substances Notification Regulations under the *Canadian Environmental Protection Act*).

Given Canada's geography and population, there will be challenges with reaching out to all DIY Biologists. Continued engagement with the community provides regulators with an understanding of how the DIY Bio movement is changing the science and innovation landscape in Canada. Meetings, such as this Summit, are integral for maintaining the level of awareness among the DIY bio enthusiasts and the government.

Panel III: Opportunities for Collaboration



Panelist 1: Hans-Joachim (HJ) Wieden is an Associate Professor in the Department of Chemistry and Biochemistry at the University of Lethbridge. He is the founding Director of the Alberta RNA Research and Training Institute (ARRTI) and recently launched SynBridge, a synthetic biology makerspace at the University of Lethbridge.

The University of Lethbridge received $1.5M in funding from the Government of Canada through the Western Economic Diversification Canada to enable the creation of a supervised synthetic biology makerspace. It is the first of its kind in Canada. Conceptualized in 2014, SynBridge is designed to foster a community of practice for university scientists, high school students and teachers, DIY biologists, and entrepreneurs. Currently in its infrastructure implementation phase, the facility will be equipped for a variety of synthetic biology, biochemistry and molecular biology applications. The for-fee service will allow users to access the infrastructure, equipment, bench space, training, and also tap into technical and entrepreneurial expertise. Hans-Joachim envisions that SynBridge will provide entrepreneurial-minded individuals in Lethbridge, including iGEM teams, a facility where they can efficiently perform the design-build-test cycle to bring their ideas to the proof-of-principle stage. In winter 2015, the facility hosted 60 high school students from five iGEM teams in the region for a 2-day synthetic biology workshop.

Panelist 2: John Pezacki is a Professor at Department of Chemistry and Biomolecular Sciences at University of Ottawa. John helped create the University's Centre for Chemical and Synthetic Biology. He is a former Senior Researcher at the National Research Council.

The Centre for Chemical and Synthetic Biology provides a multidisciplinary, collaborative environment where chemistry and biology students, post-doctoral fellows and professional staff work together to develop new chemical and biophysical tools for studying living systems. The Centre brings together more than 10 research laboratories from the Department of Chemistry and Biomolecular Sciences with state-of-the-art facilities that include a chemistry, microbiology, and a cell biology lab. John invites the DIY biology community, universities, and government to visit the Centre.

Panelist 3: Tagny Duff is an artist and scholar working across media art and microbiology, with a particular interest in microbial interaction and scientific practices from a cultural point of view. Tagny is an Associate Professor in the Department of Communication Studies at Concordia University and is the director/founder of Fluxmedia, a network for artists, scientists, and humanities researchers to engage in collaboration across art and the life sciences located at Concordia University.

Active since 2009, Fluxmedia is a research-creation network that explores the intersections of art, science and technology through informal and formal collaborations and affiliations with local and international research labs, DIY biology community (e.g., Bricobio), artists, and scholars. Their Hybrid Media Lab includes a containment level 2 wet lab, macrophotography and animation workstation with inverted phase microscope and electronic media workstations for DIYelectronic and bioDIY projects. It also hosts lectures and workshops in art, tissue culture engineering, microbiology, and bioengineering. Through collaboration, Tagny hoped to alleviate some challenges related to:

- collaborating with partners who are working across institutions when negotiating storage, delivery and purchasing of science equipment/disposables and specimens for an art studio,
- combining diverse disciplinary language, cultures, and protocols to develop new methods and ways of considering biology and art-based practices,
- certification and training on environmental health and safety for students and researchers who do not have a background in science, and
- adapting and reconfiguring current health and safety protocols and biosafety standards to consider fine arts and media art-based practices.

With respect to the last item, Tagny and collaborators from University of Ottawa and University of Windsor are working on developing a paper on best practices for bioartists and have indicated desire to work with PHAC to advance this effort.

Panel III Discussion

The following section contains a summary of the discussion during the question and answer period.

Innovation

Creativity and the pursuit for innovation requires a renewed way of thinking regarding the culture within an establishment, the responsibility of organizations, the integration of various backgrounds, skills, and/or academic disciplines, circumventing obstacles, educating the environment, and engaging the broader community.

Collaboration
The DIY biology movement highly regards the importance of conducting their activities independently from academic institutions, but they also value collaboration and openness. Establishing partnerships with existing academic institutions could help DIY Biology communities access financial support, equipment and/or expertise.

As the DIY Biology communities in Canada mature, there is an opportunity for academic institutions, private entities, and government to harness the innovative ideas from the DIY movement. Canada's economy stands to gain from potential advancements, while competitiveness could stall if potential opportunities are not embraced or if over regulated.

Rees Kassen, a Professor at the University of Ottawa and former co-chair of the Global Young Academy, referred to a presentation he made on DIY Synthetic Biology to the InterAcademy Partnership Conference on Science Advice in March 2016. Rees noted that while promising, there are some challenges with this emerging discipline that concern traditional scientific establishments. As such, Canadian DIY biologists are encouraged to organize their communities to come up with a coordinated approach to inform the general public, institutions, funders, and government officials about the DIY biology movement, including who they are and how the community addresses issues such as ethics, biosafety, and biosecurity.

CLOSING REMARKS

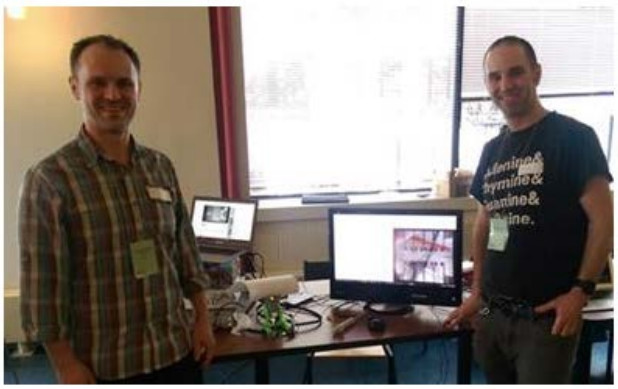
Cindy Evans concluded the Summit by thanking all the panelists for their engaging talks and all the participants, both in person and via phone. As heard during the plenaries, Cindy reiterated the importance for the DIY Biology groups to inform their community and the general public of their activities and the profound positive impacts that their contributions can have on improving human health, the environment, and society. She hoped that the event facilitated some networking and that it serves as a catalyst for future discussions and collaboration between the DIY Bio, academia and federal government. The Public Health Agency of Canada looks forward to collaborating with the community to develop best practices.

DIY BIO FAIR

The Summit concluded with a DIY Bio Fair showcasing interactive demos and displays of DIY molecular biology kits, experimental designs, robotics and equipment, and bioart. Below are some of the exhibits.

Exhibitor: Pelling Lab – experiment with apples and human tissue

Exhibitor: Bricobio and their portable DIY Bio "Bento Lab"



Exhibitor: Wheeler Microfluidics' lab on a chip

Exhibitor: Whitefeather Hunter and her Incubatrix Neith

ANNEX 1: List of Participants[2]

	Name	Organization
1.	Ali, Kassim	Health Canada
2.	Anderson, Cori	National Defence and the Armed Forces
3.	Beaudoin, Christine	University of Ottawa
4.	Chen, Kevin	Bricobio - Montreal
5.	Colton, Brian	National Research Council
6.	Cuerrier, Charles	University of Ottawa
7.	Doucette, Nicholas	Agriculture and Agri-food Canada
8.	Duff, Tagny	Concordia University
9.	El Ouakfaoui, Souad	Environment and Climate Change Canada
10.	Evans, Cindy	Public Health Agency of Canada
11.	Fobel, Christian	University of Toronto
12.	Fobel, Ryan	University of Toronto
13.	Gerson, Helen	Canadian Border Services Agency
14.	Ghalami, Ayoob	University of Toronto
15.	Girgis, John	University of Ottawa
16.	Hadjiantoniou, Sebastian	University of Ottawa
17.	Halliday, Christopher Andrew	Global Affairs Canada
18.	Hardie, Alaina	DIYBIo Toronto
19.	Heisz, Marianne	Public Health Agency of Canada
20.	Hitcon, Andrea	Canadian Food Inspection Agency
21.	Holtzman, Jennifer	Health Canada
22.	Hunter, WhiteFeather	Concordia University
23.	Jacoby, Derek	Victoria Makerspace - Victoria
24.	Jain, Vipal	BioTown - Ottawa
25.	Johnson, Neville	Fisheries and Oceans Canada
26.	Kaern, Mads	University of Ottawa
27.	Kassen, Rees	Ottawa University
28.	Kim, Sabrina	Innovation, Science and Economic Development Canada
29.	Levac, Dylan	Canadian Food Inspection Agency
30.	Lloyd, David	FREDsense - Calgary
31.	Martinez, Dan	Public Safety Canada
32.	McMillen, David	University of Toronto
33.	Michel, Pascal	Public Health Agency of Canada
34.	Modulevsky, Daniel	University of Ottawa
35.	Pelling, Andrew	University of Ottawa
36.	Pezacki, John	University of Ottawa
37.	Poliquin, Andre	Environment and Climate Change Canada
38.	Pownall, Scott	Open Science Network -Vancouver
39.	Rooney, Ian	University of Ottawa
40.	Saner, Marc	University of Ottawa
41.	Semalulu, Souleh	Health Canada
42.	Shwed, Phil	Health Canada
43.	Simmons, Kateland	University of Ottawa
44.	Sowden Plunkett, Louis	University of Ottawa
45.	Stec, Ryan	ArtEngine
46.	Tayabali, Azam	Health Canada
47.	Vincelli, Matthew	Natural Sciences and Engineering Research Council of Canada
48.	Wieden, Hans-Joachim	University of Lethbridge
49.	Yambao, Kathrina	Public Health Agency of Canada

[2] List does not include approximately 20 observers from the Public Health Agency of Canada and approximately 200 who joined via teleconference.

ANNEX 2: List of Participating Organizations and Academic Institutions

ANNEX 3: Summit Agenda

Canadian Do-It-Yourself Biology Summit
March 16, 2016
130 Colonnade Rd. Ottawa, Ontario (Media Room)

8:00	**Arrival**	
8:30 - 9:00	**Welcome Remarks**	
	Pascal Michel	Chief Science Officer, PHAC
	Cindy Evans	Director General, PHAC
9:00 – 10:45	**Panel Discussion: DIY Bio Canadian Landscape (Present and Future Trend)**	
	Derek Jacoby	Victoria Makerspace, Victoria
	Kevin Chen	Bricobio, Montreal
	Vipal Jain	DIY Bio, Ottawa
	Scott Pownall	Open Science Network, Vancouver
	David Lloyd	FREDsense, Calgary
	Alaina Hardie	DIY Bio, Toronto
	Andrew Pelling	University of Ottawa
10:45 - 11:00	**Health Break**	
11:00 – 12:00	**Panel Discussion: Building a Culture of Safety**	
	Marianne Heisz	Centre for Biosecurity, PHAC
	Ayoob Ghalami	University of Toronto
	Marc Saner	University of Ottawa
12:00 - 13:00	**Lunch**	
13:00 - 14:00	**Panel Discussion: Opportunities for Collaboration**	
	Hans-Joachim Wieden	SynBridge, University of Lethbridge
	John Pezacki	University of Ottawa
	Tagny Duff	Concordia University
14:00 - 14:15	**Closing Remarks**	
14:15 - 14:30	**Health Break**	
14:30 – 17:00	**DIY Bio Fair**	

VIRTUAL ACCESS TO THE EVENT:
https://gts-ee.webex.com/gts-ee/j.php?MTID=me1d7f753f54cc6b00304f1e7ddf71aff

AUDIO CONNECTION:
Toll Free (Canada/US): 877-413-4814
Local and International: 613-960-7526
Conference ID: 9382625

ANNEX 4: Resources

Biosafety

PHAC Laboratory Biosafety and Biosecurity
www.phac-aspc.gc.ca/lab-bio/index-eng.php

Canadian Biosafety Standards and Guidelines
canadianbiosafetystandards.collaboration.gc.ca

PHAC E-Learning Portal
www.publichealth.gc.ca/training

Pathogen Safety Data Sheets
www.phac-aspc.gc.ca/lab-bio/res/psds-ftss/index-eng.php

Canadian Association for Biological Safety
http://www.cabs-acsb.ca/

Canadian DIY Communities

Open Science Network (Vancouver)
http://www.opensciencenet.org

Bricobio (Montreal)
http://brico.bio/

Victoria Makerspace (Victoria)
http://www.makerspace.ca/cpages/home

DIYBio.To (Toronto)
http://diybio.to/

BioTown (Ottawa)
http://biotown.ca

Nelson BC DIYBio (Nelson)
http://nelson-bc-diybio.weebly.com/

Academia

Pelling Lab – University of Ottawa
http://www.pellinglab.net/

Pezacki Lab Centre for Chemical and Synthetic Biology – University of Ottawa
http://mysite.science.uottawa.ca/jpezacki/

Synbridge – University of Lethbridge
http://www.uleth.ca/artsci/biochemistry/synbridge-infrastructure

FluxMedia – Concordia University
http://fluxmedia.concordia.ca/

Start-up Companies

FREDsense Technologies (Calgary)
http://www.fredsense.com/

Hyasynth Biologicals Inc. (Montreal)
http://hyasynthbio.com/

Spiderwort (Ottawa)
http://spiderwort.bio

Others

Virtual Institute for Responsible Innovation
https://cns.asu.edu/viri

International Genetically Engineered Machine (iGEM)
http://igem.org/Main_Page

InterAcademy Partnership (Presentation on DIY SynBio – Rees Kassen)
http://www.interacademies.net/File.aspx?id=30262