

<p><b>Grade:</b> any grade, Grade 10 Science or 11/12 Biology recommended</p>	<p><b>Subject:</b> Science/Biology</p>	<p><b>Unit:</b> Strand A (Careers) + Cells &amp; Tissues (Grade 10)</p>
<p><b>Title: Envisioning the road ahead – planning your career</b></p>		
<p><b>Rationale</b></p> <p>In this lesson series, students are exposed to exciting current research done in Canadian GlycoNet laboratories that relates to therapeutic proteins and their potential impact on human health. There are video clips to listen to scientists at different stages of their careers, including a second year student, co-op students, graduate students, and principal investigators.</p> <p>In addition, students are asked to look within and plan their career journey. It is understood that this is an evolving process. They create a career cluster of related science careers, interview a scientist, and/or develop an Adobe Sparks narrated slideshow to showcase what they have learned about the career that they would like to pursue.</p>		
<p><b>Background Information</b></p> <p>The Wakarchuk lab at Ryerson University (under the umbrella of GlycoNet) is a carbohydrate research lab that uses enzymes for therapeutic purposes. Some of these purposes include:</p> <ul style="list-style-type: none"> <li>• The use of enzymes to add sugars to protein drugs to make these drugs last longer (persist) in the bloodstream, thereby reducing dosage, side effects and cost</li> <li>• Adding sugar molecules to cultured neuronal cell surfaces using enzymes, so that these modified neurons will find their way to where they are needed when placed in Parkinson’s patients</li> <li>• Researching how to make these proteins using bacteria (rather than maintain expensive mammalian cell lines)</li> </ul> <p>Students often spend many years studying science to get to their future goals, yet spend very little time trying to find out about new careers in science. They often choose between three main careers: medicine (nurse and doctor), pharmacy and science teaching. These are choices that were available to their grandparent’s generation. There are many less traditional choices available to them but most students really only find out about them after their third or fourth year of university or college.</p> <p>In addition, people tend to pursue their favourite subject in school, without proper consideration of the fulfilling intersection of personality, interest and aptitude. Ignoring any</p>		

of these three aspects results in a great deal of unhappiness later in life. There is an important fact that cannot be ignored: no one is going to get paid to study. Thus, the experience of a working person is going to be different from that of a student.

### **What can we do as educators?**

We can encourage students to try co-operative education or work/student programs where students get out into the community and work in a professional capacity. This allows for a “trying on” for both the student and the workplace. These experiences are available at the high school or university/college levels. A number of the people interviewed in the video clips are involved in these kinds of experiences.

We can expose students to careers that range beyond the traditional nurse/doctor/dentist/pharmacist/science teacher choices. This is a Strand A (Science Investigative Skills and Careers) expectation that is present in every course and grade of the curriculum.

### **Time Required:**

Three (3) periods (2 x 0.5 periods and 2 x full periods), depending on whether the teacher chooses to give more computer lab time and whether the teacher chooses to have students do the Interview a Scientist assignment or the Adobe Sparks career presentation.

#### Period 1 (0.5 period):

- Watch a five (5) minute career video of Dr. Warren Wakarchuk from Ryerson University, Chair of Biology and Chemistry, and another (2.5 min) video, the GlycoNet Story.

#### Period 2 (full period) - Meet the Scientists:

- Students create a career cluster and watch some video clips of carbohydrate researchers from Ryerson University and University of Toronto labs (part of the GlycoNet Network)
- Students discuss questions in pairs, with homework to watch a 12 minute video about Sugar and Cancer at home.

#### Period 3 (full period):

- Students work on creating their Adobe Sparks slideshow

#### Period 4 (0.5 period):

- Show Adobe Sparks slideshows (a selection of 5-6) and have students view a random selection of them at home for homework.

## **Curriculum Connections:**

### **Strand A: Scientific Investigation Skills (SIS)**

- A1.3 identify and locate a variety of print and electronic sources that enable them to address research topics fully and appropriately
- A1.7 select, organize, and record relevant information on research topics from a variety of appropriate sources, including electronic, print, and/or human sources, using suitable formats and an accepted form of academic documentation
- A1.11 communicate ideas, plans, procedures, results, and conclusions orally, in writing, and/or in electronic presentations, using appropriate language and a variety of formats (e.g., data tables, laboratory reports, presentations, debates, simulations, models)

### **A2. Career Exploration**

- A2.1 identify and describe a variety of careers related to the fields of science under study (e.g., zoologist, botanist, geneticist, ecologist, pharmacologist, farmer, forester, horticulturalist) and the education and training necessary for these careers
- A2.2 describe the contributions of scientists, including Canadians (e.g., Colin D’Cunha, Louis Bernatchez, Lap-Chee Tsui, Helen Battle, Memory Elvin-Lewis), to the fields under study

### **Grade 11 Biology – Genetics Processes**

- D1.2 evaluate, on the basis of research, the importance of some recent contributions to knowledge, techniques, and technologies related to genetic processes (e.g., research into the cystic fibrosis gene; the use of safflowers to produce insulin for human use) [IP, PR, AI, C]
- D3.5 describe some reproductive technologies (e.g., cloning, artificial insemination, in vitro fertilization, recombinant DNA), and explain how their use can increase the genetic diversity of a species (e.g., farm animals, crops)

### **Grade 12 U Biology – Molecular Genetics Unit (depends on which researchers students listen to)**

- D3.5 describe some examples of genetic modification, and explain how it is applied in industry and agriculture (e.g., the processes involved in cloning, or in the sequencing of DNA bases; the processes involved in the manipulation of genetic material and protein synthesis; the development and mechanisms of the polymerization chain reaction)
- D3.6 describe the functions of some of the cell components used in biotechnology (e.g., the roles of plasmids, restriction enzymes, recombinant DNA, and vectors in

genetic engineering)

### **Grade 12 U Biology – Biotechnology Unit**

- B1.1 analyse technological applications related to enzyme activity in the food and pharmaceutical industries (e.g., the production of dairy products; breadmaking; the use of enzymes to control reaction rates in pharmaceuticals) [AI, C]

### **Grade 12 U Biology - Career Exploration**

- A2.1 identify and describe a variety of careers related to the fields of science under study (e.g., scientific journalist, fisheries and wildlife officer, physician, infectious disease researcher, geneticist) and the education and training necessary for these careers
- A2.2 describe the contributions of scientists, including Canadians (e.g., Evelyn Roden Nelson, Maude Menten, Albert Juan Aguayo, Kimberley J. Fernie, Michael Archer), to the fields under study

### **Lesson Objectives/Concepts**

- Students will learn about Canadian biotechnology (role of enzymes, therapeutic proteins, biofilms, immunology) and genetics research carried out by GlycoNet researchers at Ryerson University and the University of Toronto, and about career possibilities in these fields
- Student will develop a career cluster of three (3) related science careers
- Students will interview a scientist and create a career profile and/or will create an Adobe Sparks presentation about their chosen career

### **Materials**

- Careers Assignment (Student Resource) – with four tasks
  - Task 1: Create a career cluster
  - Task 2: Meet the Scientists
  - Task 3: Interview a Scientist (optional)
  - Task 4: Create an Adobe Sparks narrated slideshow of your future career
- Document, “How to create an Adobe Sparks Narrated Slideshow” (included classroom handout)
- Weebly website [www.glycobiology.weebly.com](http://www.glycobiology.weebly.com) to be used with Task 2: Meet the GlycoNet Scientists
- Document, “Adobe Sparks Career Assignment & Rubric” (included in classroom handout)
- Access to a computer lab
- Students – bring their own earphones to listen to video clips

## Activities/Procedure

Pre-activity preparation: book the library computers or computer lab and ask students to bring earphones.

### Period 1 (0.5 period)

If a meeting space with a computer and projector is available, have the students watch the 5 minute career video of Dr. Warren Wakarchuk (<http://tinyurl.com/ybrwhjbq>) as well as the short video The GlycoNet Story (<https://www.youtube.com/watch?v=CQGEGloqTpQ>). If there is no such meeting space in the computer lab or library, consider doing this part the period before in the classroom.

Teachers can choose to have students fill in the “Career Connection: Warren Wakarchuk” question sheet (another resource from GlycoNet high school resource webpage: <https://canadianglycomics.ca/training/high-school-resources/>) or use the following more general discussion questions.

Group students in pairs to discuss Dr. Warren Wakarchuk’s Career Interview. Have them consider the following questions:

1. Does his job sound appealing?
2. What kinds of skills are necessary for a job like his?
3. Do you think that you would like to have a job like his?
4. Dr. Wakarchuk talks about the best and worst parts of his job. Would those balance out for you if you were in his shoes?

Discussion Questions for “The GlycoNet Story” Video (2:47 min)

Let the video play. Stop at the 1 minute mark.

1. What is the importance of understanding glycomics (the study of sugars)?  
**Communication by cells or invasion into cells is often mediated by sugars. If we understand glycomics, we can interfere with infection processes.**
2. What is GlycoNet?  
**GlycoNet is a pan-Canadian network of researchers that formed in 2015 to develop solutions to unmet health needs.**
3. Why bring these researchers together?  
**This pooling of efforts should result in a streamlined process to get products to market**

as well as compete more effectively on the international stage.

Play video from 1 min – 2:47

4. What kind of good can result from these GlycoNet partnerships?

Anything ranging from new vaccines to new medicines for diseases that are currently difficult to treat.

5. What areas have they made progress in?

Influenza and diabetes

Homework – watch Carolyn Bertozzi’s Tedx talk “the sugar coating on your cells is trying to tell you something” and answer questions

Period 2 – Full work period in the computer lab (remind students to bring earphones)

Individual Work – Meet the Scientists (videos)

- Students listen to and discuss the GlycoNet researchers and their areas of research (<https://glycobiology.weebly.com/>) by themselves. If they need to re-watch them at home, they can.
- Students work on developing a career cluster of three career goals as the teacher moves around the room, responding to student questions and asking probing questions.

Period 3 (full period)

Second library/computer lab period to work on the Adobe Sparks slideshow. Students need to create an account before proceeding to work on this. The teacher may want to demonstrate how to do this so that they can see how easy it is or have them watch a video clip about how to do it (a link is included in the Student Resource sheet)

Students need to know what the final product is going to look like in order to meet the expectations. There are many examples on the Adobe Sparks home page that you can show to them. For teachers, some advantages of using Adobe Sparks are that it is free and students can use copyright-free images (they have to select this) and music that comes with the account. If you are not a tech-savvy teacher, do not worry! Your students are and they will help each other. You just have to figure out the main idea; you do not have to be an expert.

Students should decide the kind of product that they want in the end. Adobe Sparks is a good choice for a narrated slide show with voiceovers and music. If you want to make a video with more flexibility, a video editing software program such as Windows Movie Maker, iMovie or

Adobe Premiere Elements might be right for you. Students may find it convenient to use an iPad since they can take the video and pictures and edit it on the same tablet and the software is not expensive (usually around \$5 for iMovie).

You do not have to train students – they will figure it out, ask each other, or Google it. See the accompanying “How to Create an Adobe Sparks Narrated Slideshow” resource for step-by-step instructions. These instructions are for teachers and students.

Please Note: Adobe Sparks makes high quality narrated slideshows in a very short amount of time. It is very important, however, to resist recording the voiceovers when others are around. Students may want to work on the voiceovers at home or take a school tablet into a library workroom or an empty classroom. It is recommended to work on the pictures and text overlays at school and the voiceovers at home.

#### Period 4

A selection (5-6) of students present their Adobe Sparks slideshow to the class. This can be students that volunteer, the best ones (according to the teacher) or a random selection (recommended).

Since this might result in up to 30 presentations, the teacher can create a Google doc with a numbered list of Adobe Sparks links and post it to Google classroom. Students can submit their presentations by e-mailing a link to the teacher or adding it to a class Google doc. As a homework assignment, students can be required to watch 3-5 of the videos (students can be directed to roll dice to randomly select videos). Here is a link to online dice: <http://dice.virtuworld.net/>. If there are 30 presentations that could be watched, choose 5 dice with 6 sides.

#### **Summary**

As a class, students listen to a full (five minute) career interview with Dr. Warren Wakarchuk, Network Investigator with GlycoNet and Chair of Biology and Chemistry at Ryerson University. Then they listen to short (1 minute) video clips of a variety of scientists (co-op students, graduate students and full professors) talk about their areas of research or their typical day. The following period, the students work on creating a career cluster of three (3) related careers for themselves and then create an Adobe Sparks slideshow about their future intended career (shown to the class at a later date). Another option is to have students interview a scientist and create a career profile. The profiles would be joined together in a career magazine that can be used with other students.

**Assessment:** See Student Rubrics for “Interview with a Scientist” and “Adobe Sparks Narrated Slideshow” in the classroom handout

**Extension:**

1. If time permits, you can purchase and play the self-assessment game so that they can see how their interests and abilities line up. Remember, Strand A (Careers) is in every grade and science course. <http://careers.yorku.ca/the-who-am-i-self-assessment-game/>
2. Sugar and cancer – Tedx talk (12:27) by the famous Stanford researcher Carolyn Bertozzi, “The sugar coating on your cells is trying to tell you something” which is about how sugars on your cells are responsible for familiar things like blood typing. She asserts that there is an increase in the density of sialic acid (a type of sugar) in cancer cells. <https://www.youtube.com/watch?v=BPeFy4iyzn0>

**References**

- “Make a Career Plan.” *Make a Career Plan | MyMnCareers | CAREERwise Education*, Minnesota State, <https://careerwise.minnstate.edu/mymncareers/advance-career/make-career-plan.html>
- “Thin Layer Chromatography”, University of Massachusetts. <http://www.chem.umass.edu/~samal/269/tlc.pdf>

**Answer Key:**

Task 2: Meet the GlycoNet Scientists

Homework: Watch Carolyn Bertozzi's Tedx talk (12:27) by the famous Stanford researcher Carolyn Bertozzi, entitled "The sugar coating on your cells is trying to tell you something."  
<https://www.youtube.com/watch?v=5HeZaYtfDf8>

1. How do sugars determine your blood type?  
Different sugars on the cell surface mean Type O, A, B, or AB
2. What type of sugar appears on the surface of cancer cells?  
Sialic acid
3. How do immune cells protect you?  
They recognize and destroy invaders.
4. How do cancer cells trick the immune system cells?  
The cancer cells have a lot of sialic acid chains and it "mesmerizes" the immune system cells to move on instead of destroying them.
5. What strategy is being worked on now to try to beat cancer?  
Immune system boosters and medicines that act as a "lawnmower" to clip off the extra sugars. The cancer cells will no longer mesmerize the immune system cells, which will then kill the cancer cells like they should.

Click on [www.glycobiology.weebly.com](http://www.glycobiology.weebly.com). Watch Nakita's video (53 seconds) explaining the Wakarchuk lab's main research interests. Everyone in the laboratory, from the second year student to principal investigator, works in some way to contribute to this research (therapeutic proteins).

Questions to ponder:

1. Which diseases could the Wakarchuk lab's research help to treat?  
Influenza and hepatitis
2. What are they hoping to achieve with these modifications of the therapeutic proteins?  
The modifications are made with the goal to reduce the dosage (and therefore side effects) and cost by keeping the medicine in the bloodstream longer.
3. What is the second area of research that Nakita mentions?  
Spinal cord injuries.

4. Summarize the research strategy that Nakita describes for this second area.  
**They add chains to proteins to signal to other helper proteins to come and fix the area.**

Out of the following six video clips, choose four to view. Answer only the questions that pertain to those videos. Use a pair of online dice to choose.

**1) University of Waterloo student Nicole Thompson talks about her work (47s)**

- a) What is the main focus of her work?  
**She takes small proteins and tries to add sugar molecules on them.**
- b) What does she do with these sugar-tagged proteins?  
**She will use those proteins to screen for inhibitors of proteases, which are enzymes that bacteria use to break down proteins. Proteins with sugars attached to them are components of the protective mucus layers that protect body tissues, and certain bacteria need to get rid of this layer of mucus to establish an infection. Preventing mucus breakdown prevents infection.**
- c) Where do the enzymes come into play?  
**The enzymes work to put the sugars onto the protein, which are then used in a further reaction later.**
- d) Would you consider doing a work/student program in college or university as part of your training and career planning? Why or why not?  
**Answers will vary**
- e) What is the most important factor that makes work interesting to you? Is it the context or the day-to-day work itself?  
**Answers will vary**

**2) University of Toronto Professor Dr. Mark Nitz talks about biofilms (35 s)**

- a) What is his area of research?  
**How bacteria stick to surfaces and what kind of carbohydrates they use to stick to surfaces.**
- b) Why do bacteria like to stick to surfaces?  
**It makes them much more resistant to antibiotics, and much more difficult to treat.**
- c) How can researchers prevent bacteria from sticking?  
**They can make inhibitors to block this process.**

- d) With all of this talk about bacteria, what department is Dr. Nitz a part of? Is this surprising to you?

**Dr. Nitz is part of the Department of Chemistry**

### 3) Tasnim Abukar (Graduate student) – video clip #3 (24 s)

- a) What does Tasnim want to do in the future and why?  
**Tasnim wants to be a pharmaceutical chemist because she wants to develop new drugs to help patients in need.**
- b) What is a pharmaceutical chemist? Research this profession.  
**Answers may vary.**

### 4) Dr. Ting Du (Post-doctoral Fellow) Video clip #4 (33 s)

- a) What is a post-doctoral fellow? (research this) What career stage is Dr. Du at?  
**She is working temporarily on a contract until she can find a full time research and/or professor position.**
- b) She mentions adding the O-glycan to the therapeutic protein. What is the reason for doing this?  
**The purpose is to modify it so that it will stay longer in the bloodstream.**
- c) What is a half-life? What does “in vivo” mean? (research this)  
**A half-life is how long it takes for half of the dose of medication to clear out of the bloodstream. “In vivo” means in the living body.**
- d) What would be two advantages of the therapeutic proteins staying longer in the blood of a patient?  
**It reduces side effects because of the reduced dosage and it would cost less.  
Therapeutic proteins are inherently costly to produce.**

### 5) Ray Martinez-Rodriguez (Summer student) Video clip #5 (1:06 min)

- a) How did Ray hear about the Wakarchuk lab?  
**He heard from an e-mail newsletter from Ryerson, where he studies as a student.**
- b) What intrigued him about the work done in this lab?  
**The work was with therapeutic proteins to help people who have Parkinson’s Disease.**
- c) How did he get the job that he has now?

Ray e-mailed Dr. Wakarchuk and set up a meeting with him to talk about working on one of the projects. He needed to do some training so that is what he is doing this summer.

### 6) Laura Kell, Research Technician video clip #6 (58 s)

As Laura talks about her job, she mentions two main responsibilities. One of them is training and mentoring other team members and assisting them to advance the projects.

- a) Is it surprising to you that a research technician has this job responsibility?  
*Answers will vary.*
- b) What is the other (research) part of her job?  
*Her research includes using lab techniques such as protein purification using FPLC (a form of liquid chromatography to analyze and purify proteins). She also uses enzyme assays with fluorescently labeled substrates (molecules that are acted upon by an enzyme to produce a product) which are reacted with enzymes and then developed on a TLC (thin layer chromatography) plate.*
- c) Laura describes her typical day and says, “Well, there is no typical day.” Does this appeal to you? Would you like a job where there are different things happening day-to-day or something more consistent?  
*Answers will vary.*
- d) What is TLC (thin layer chromatography)?  
*TLC is used to separate mixtures. A sample is spotted on a plate (the solid phase) and there is a solvent that moves along the plate by capillary action, separating the components based on their polarity. The spots are then visualized, sometimes with fluorescent tagging.*
- e) What is an enzyme and substrate? Research these two concepts.  
*An enzyme is a large protein that helps to break down, build up, or modify other molecules. A substrate is a molecule that an enzyme acts upon to create a product. An example is the enzyme lactase, which helps to break down the disaccharide (double sugar) lactose (a sugar found in milk) into single sugars.*