Science Research in a First Nations Perspective

Summary
This activity is designed to present synchrotron science in an atmosphere supportive to First Nations and Métis cultures. Discussions are based on making connections between daily experiences, life stories, and synchrotron research in the hopes that students are able to identify with the desire to learn more using synchrotron related techniques. This activity could be used as a lead in to an independent study unit in a number of subject areas.

Pan-Canadian Objectives

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<tr>
<th>Science Grade</th>
<th>Knowledge</th>
<th>Science, technology, society and the environment</th>
<th>Skills</th>
<th>ATTITUDES</th>
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<td>10-12</td>
<td>Will vary depending on topic.</td>
<td>112-3, 113-9, 116-1, 117-5, 117-6, 117-8, 117-10, 117-11, 118-1, 118-2, 118-4, 118-5, 118-7</td>
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Canadian Curriculum Suggested Units/Objectives

The inclusion of First Nations and Métis content and perspectives as well as a cross cultural approach to education is an expectation of curriculum guides across Canada in all subjects. While the introduction of scientific tools and technological advances varies from province to province it is present from upper elementary to secondary grades.

Materials
- Chairs arranged in a circle, enough for each participant
- Copies of each appendix applicable for your group

Background
Understanding research techniques employed at the CLS synchrotron is very abstract. Many students struggle with understanding the nature of molecular studies and, therefore, synchrotron science. This activity presents research as simply ‘using another way of knowing’ and of trying to understand relationships. Both of these concepts are presented using a popular play about a youth trying to learn a new way of knowing from his uncle thus setting the stage for the introduction of new research techniques.
The second part of the discussion is designed to take the students from a very broad, common societal problem that they would likely connect to, and spiral in focus to the detailed research conducted on the synchrotron.

**Activities**

1. Welcome the students and invite them to join in the circle for some discussions. Introduce activities by relating a story based on *Only Drunks & Children Tell the Truth*. In this story, an uncle and his nephew spent a great deal of time together walking and stopping to enjoy the countryside. The uncle would listen to the trees. The boy also wanted to be able to listen to the trees. The uncle would observe a frog sunning itself on a rock and wonder how the rock felt about the frog. They would stop and listen.

   “The rock is happy with the frog. Did you hear?” asked the uncle?
   “I didn’t hear nothing!” was always the boy’s reply. “Tell me how you do it? Teach me to hear the wind!”

   The boy and his uncle would spend much time listening in the countryside. Did the boy learn to hear the wind or the trees?

2. This part of the discussion is designed for the students to understand that the uncle had a ‘different way of listening’ and of knowing and learning than the boy. Points to bring out include:
   - Could the uncle explain exactly what he was doing? Could he demonstrate how to listen? The point is that the method of knowing is intangible – there are skills involved that have to be developed over time – not directly experienced
   - What they were learning was also intangible
   - The method of knowing and learning used by the uncle was new to the boy and valuable enough to put in the effort to be able to do it
   - What was learned was also valuable although not immediately applicable

3. Now to connect the story to research at the CLS. Here we are also looking to use a new way of learning. It’s not listening. It’s a different way of seeing. There are types of light that we can’t see but that give information (connect to IR/UV/X-ray light from the sun). We use those and things that can detect them (like skin picking up IR light as heat) to be able to gather information that we wouldn’t otherwise be able to see.

4. Give examples of research using light that would be important and applicable to their lives. The amount of detail used from these examples will vary depending on the subject, ability, and interest of the group.

   **A/ Diabetes**
   - continuing research to help understand exactly how the body and this disease works is essential in working towards treatments and hopefully a cure
   - explanation of what proteins are and some of the roles they play in cells (diagram appendix A)
understanding how protein looks and functions could help treatment research

to determine what a protein looks like and help decipher what it does, researchers use Crystallography a process where they grow a crystal containing the protein in question, obtain a diffraction pattern using X-Rays, and analyzing the information (diagrams appendix A)

show image of the protein as culmination and explain the connection between the protein and diabetes (rate limiting step of body’s production of sugar – less dependent on insulin)

CLS profile publication, “Decoding Proteins” is also an excellent resource http://www.lightsource.ca/brochures/

B/ Environmental contaminants

Understanding what is present is the first step to cleaning contaminants up. CLS can help to identify what elements are present, and even which speciation or form of that element is present (since some forms may be more toxic or some more readily available) – appendix B

This process can be used in a variety of situations where there are environmental contaminants. Images from appendix B include a uranium mine in SK and a nickel smelter in ON

CLS profile publication, “Returning to Green” is also an excellent resource http://www.lightsource.ca/brochures/

C/ Phytoremediation

How do we clean up something that is already in a mess? Mention the commercial that shows Shell working with the local elders in efforts to be more environmentally friendly.

Connect to the desire to naturally clean up. Instead of using more chemicals etc and being unsure as to what do with them – there are ways to do it more naturally.

Example 1 includes research where a synchrotron was used to track the forms of selenium from the toxic state present in the soil through various stages of plant and insect life cycles to the organic (required for plant growth) state in the end (appendix C)

5. Open Discussion

At this point, discussions could easily open up for questions (although they are encouraged all along). Some ideas of topics to further pursue:

Would you like to know how the light is produced?

Are there any other things that you would like to learn about?

Who do you think uses this kind of research/method of knowing?

Would you like to hear about other examples of research that’s been done?

6. Independent study

Depending on the area of interest, students could now look for more information on a number of different topics. The results of this could be presented to the group in a discussion format; as a presentation; in written form; etc. Possible topics to pursue include:

Synchrotron Science Classroom Resources
Properties of light (synchrotron light in particular)
Areas of research using synchrotron techniques (either as a whole or as specific areas of research – environmental research; crystallography; fighting diseases; cancer research; materials studies; etc)
Who uses the synchrotron (career search on researchers, or careers available at CLS)? How do you get to use it (there are a multitude of disciplines that use synchrotron techniques)?
Appendix A: Diabetes

Eukaryotic Cell

[Diagram of a eukaryotic cell with labeled parts]

Synchrotron Science Classroom Resources
Crystal diffraction

X-ray beam,
$\lambda = 1 \, \text{Å}$

Crystal
Diffraction Pattern
Resolved Structure

Images courtesy of Ken Ng, R. Read, Structural Medicine Course, Cambridge University
Appendix B: Environmental Contaminants

The figure below illustrates how a researcher would use synchrotron data to identify the speciations of Arsenic present in the sample from the tailings of a uranium mine. The data from the residue (red) is compared to data taken from reference samples (where the speciation of the As is known) to determine what is present.
At the first trophic level, the plant takes selenate up from the soil and biotransforms a portion of it to organic forms. In the 2nd trophic level the beet armyworm transforms all absorbed selenate to organoselenium (selenomethionine) and releases unabsorbed selenium in the frass. The cocoon and adult emerging adult wasp contain both organoselenium and trimethylselenonium. This work is a proof of a concept than something with commercial applications because beet armyworms are major agricultural pests.

It is known that some plants readily take contaminants out of the soil. Dr. Ingrid Pickering (UofS Geology) used a synchrotron to trace where different forms of selenium were stored in the locoweed plant. Information that is useful in determining how to deal with the plant after it has cleaned the soil.