

Career Profile: Investigating a Polysaccharide Targeting Vaccine and Autism

Teacher Resource

Course: Grade 12 University Biology

Ontario Curriculum Expectations

- Scientific Investigation Skills and Career Exploration
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.
- Overall Expectations
B.1 analyse technological application of enzymes in some industrial processes, and evaluate technological advances in the field of cellular biology;
B.2 investigate the chemical structures, functions and chemical properties of biological molecules involved in some common cellular processes and biochemical reactions;
- Relating Science to Technology, Society and the Environment
B1.2 evaluate, on the basis of research, some advances in cellular biology and related technological applications (e.g. new treatment for cancer, HIV/AIDS, and hepatitis C; radioisotopic labelling to study the function of internal organs; fluorescence to study genetic material within cells; forensic biological techniques to aid in crime resolution [IP, PR, AI, C])
- Understanding Basic Concepts
B3.2 describe the structure of important biochemical compounds, including carbohydrates, proteins, lipids, and nucleic acids, and explain their function within cells.

Background

The case study is based on the work of Prof. Mario Monteiro it discusses the use of carbohydrate targeting bacteria in gastrointestinal systems of autistic children. Students have been introduced to bacteria, bacterial structure, antibiotics and vaccines in grade 11 U biology. This activity reviews those concepts in the context of the biochemistry unit of grade 12 U. This activity demonstrates the targeting of specific carbohydrates on the surface of bacteria for vaccine development. It should be completed near the end of the Biochemistry strand in grade 12 U biology.

Last update: April, 2020

Sources for background information

- Dulson, J., Fraser, D., LeDrew., B. & Vavitsas, A. Biology 11. Nelson: Toronto.
- Fraser, D., LeDrew., B., Vavitsas, A & White-McMahon. M. Biology 12. Nelson: Toronto

Websites

- BBC-
<http://www.bbc.co.uk/schools/gcsebitesize/science/aqa/keepinghealthy/defendingagainstinfectionrev1.shtml>
- Center for Disease Control and Prevention: <https://www.cdc.gov/vaccines/>
- How vaccine works: <http://health.howstuffworks.com/wellness/preventive-care/vaccine2.htm>
- How antibiotics work:
<http://health.howstuffworks.com/medicine/medication/question88.htm>
- What are bacteria and what do they do?
<http://www.medicalnewstoday.com/articles/157973.php>
- Microbiology Online (Society for General Microbiology)
<http://www.microbiologyonline.org.uk/about-microbiology/introducing-microbes/bacteria>
- Introduction to Bacteria: <http://www.ucmp.berkeley.edu/bacteria/bacteria.html>

Activity time: 40-50 min

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Answer key to questions:

1. Why were parents so interested in volunteering their autistic children for clinical research?
Many autistic children -90% have severe gastrointestinal upsets, and 75% of these children have chronic diarrhea. This can cause them severe discomfort and force children to remain in diapers even when they reach school age.
2. What is the “gut-brain” balance?
Research in the past decade has shown a connection between the high bacterial loads in the GI tract of autistic children and their neural (brain) disorders.
3. What chemicals released by bacteria in the gut are suspected of causing problems for autistic children? Where to these chemicals cause problems? Explain.
Hydrogen sulfide and propionic acid are metabolites released by gut bacteria. These chemicals can cause irritation in the GI tract. But mice injected with propionic acid show autistic type behaviour, so there may be a connection between these chemicals and the brains of autistic children.
4. What happened when autistic children suffering from diarrhea were prescribed antibiotics?
This reduced the amount of bacteria in the GI tract, and it reduced symptoms of the autism.
5. Compare how polysaccharide vaccines work to conventional vaccines.
For conventional vaccines we use an inactive pathogen or the proteins of such a pathogen and inject this into the blood stream. This causes our body’s immune system to develop antibodies. Polysaccharide vaccines the use polysaccharides like those on the surface of bacteria as antigens to cause the immune response.
6. What is a drawback of polysaccharide vaccines? How is Monteiro and others trying to overcome this problem? (Note: a zwitterion is a molecule with multiple charges but overall neutral)
 - They don’t tend to last as long and require booster shots
 - One method is a conjugation technique that joins the polysaccharide to a protein which reduces the polysaccharide breakdown
 - Monteiro is adding a charge to the polysaccharides
7. What are two benefits of using polysaccharide vaccines? (Note: oligosaccharide is polysaccharide containing approximately 3-9 sugars)
 - Polysaccharides when removed from the bacteria for use in a vaccine keep their conformation giving them higher immunogenicity compared to proteins

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- Because of repetition in the oligosaccharide on the bacteria surface, the antibodies have many places to recognize the polysaccharide
8. How long does it take to bring a vaccine to market?
10-30 years
 9. What is the target for Monteiro's *C. Difficile* vaccine?
The bacteria's surface polysaccharides.

Extension

10. In conversation with Prof. Monteiro he expressed concern that there is a controversial history linking autism and vaccines. He is very careful in how he presents his work in light of this history. Research the connection of autism and vaccines and comment on why you think Prof. Monteiro proceeds cautiously. Answers will vary.

A study was published in 1998 in the British journal the Lancet that claimed a link between the measles-mumps-rubella vaccine (MMR) and autism. This study only involved 12 children. This paper was found to have serious flaws. Eventually the journal retracted the paper because of the flawed research. Concern over a link between autism and this vaccine had some parents refuse to vaccinate their children leading to outbreaks of diseases like measles. Many subsequent studies failed to show a link between autism and this vaccine. Despite this many people still believe a link between autism and the vaccine.

Suggested Websites Resources:

- Autism Science Foundation: <https://autismsciencefoundation.org/what-is-autism/autism-and-vaccines/>
- BBC: http://www.bbc.co.uk/sn/tvradio/programmes/horizon/mmr_prog_summary.shtml
- CBC: <http://www.cbc.ca/news/world/vaccine-autism-tie-an-elaborate-fraud-journal-1.1006438>
- <http://www.cbc.ca/news/technology/autism-and-mmr-vaccine-controversy-1.1006437>
- PBS-Nova (very clear timeline): <http://www.pbs.org/wgbh/nova/body/autism-vaccine-myth.html>
- Science Daily News: <http://www.sciencedaily.com/releases/2015/04/150421111240.htm>

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