Research Mentorship Program in partnership with Queen's Four Directions Indigenous Student Centre - Winter 2024

Research Mentorship Admin team

Dr. Bruce Elliott, Sherri Dutton, Isabelle Grenier-Pleau, Doriana Taccardi, Jamie Would

Our mentorship program, in partnership with the Queen's Four Directions Indigenous Student Centre since 2017, aims to share knowledge, expertise, and enthusiasm between graduate students and high school youth. Our mentorships are a collaboration led by the interests and goals of our mentees and relevance to their own community. We aim to foster inquiry and problem-solving skills through scientific discovery to help equip our mentees for success in their career pursuits.

During the winter term 2023-24, we were privileged to offer seven weekly sessions in General Science and Human Health with eight Indigenous youth in grades 8-11 at the Katarokwi Learning Centre (KLC) in Kingston. Topics, based on mentees' interests included DNA the blueprint of life, water purification, the amazing world of bacteria, airplane physics, Blood and ABO blood typing, and the total solar eclipse. In addition, mentees enjoyed a field trip on May 17th to the Queen's Elbow Lake Environmental Education Centre to experience a lake sediment coring demonstration, seine netting and Indigenous history of wetlands in the area. We thank Jamie Would and Monica Garvie (Pearl Lab, Dept. Biology), who co-led the above activities with Emily Verhoek (Coordinator, Elbow Lake Environmental Education Centre).

Working alongside Program Coordinator Bruce Elliott (DPMM) are Mentorship-Lead Isabelle Grenier-Pleau (DBMS), Assistant Coordinators Doriana Taccardi (DBMS) and Sherri Dutton (Dept. Public Health). Head Mentor Jamie Would (Biology) provided support for our graduate student mentors Samantha Cockburn, Fateme Babaha & Marco Buttigieg (DPMM), Marie Boddington, Jill Greenwood, Jayne Dent, Nicholas Smith & Yasmine Saini (DBMS), and Aishwarya Rajesh Krishnan & Jaydn Clark (HSCI). *The entire Mentorship Team has found the program a very rewarding bi-directional learning experience!*

We thank KLC Teachers Michelle Nyamekye & Taylor Arndt, and Vice Principal Adam Andrecyke for their strong support and guidance. Our program is supported by the Queen's Inclusive Community Fund and a CIHR Synapse award.

Week 1: Circle Introduction: Teachers Taylor Arndt and Michelle Nyamekye welcomed us, and everyone to participate in a brief Smudge ceremony. All were invited to share their name and a favorite thought about nature.

Rollercoaster Physics: - Jamie Would

Mentees used roller coasters, modeled from marbles and plastic tubing to model potential energy, kinetic energy and momentum. One plan started with a vertical drop from as high as possible to maximize potential energy. A second plan added another drop to propel marbles around a 180º turn! Mentees experimented with upside down loops, sharp turns, hills and more.
*Kinetic and potential energy were discussed in this exciting mode*l!

Week 2: DNA The blueprint of life – Marco Buttigieg, Fateme Babaha & Jadyn Clark

***<u>Making a giant DNA molecule from pool noodles</u>*:**

Different colours were used to represent pairing of the four different "nucleotide pieces". The nucleotide pairs are held together along two sugar phosphate backbones that form a helix structure. The following video of the Central Dogma was shared to show how DNA codes are "read" by cells (nucleus>RNA>Protein:
https://www.youtube.com/watch?v=QCblY7YoyKA
We discussed how a genetic code acts like a recipe to create everything our bodies need. *We all shared what traits we feel we each inherited from our parents!*

<u>Extracting DNA from strawberries:</u>

Humans have 2 copies of every gene (diploid), while strawberries have 8 copies (octoploid)! We therefore extracted DNA from strawberries, using a detergent/salt/alcohol/water mix – which yielded a large jelly-string-like mass. *We discussed that every cell has over 6 feet of DNA, and all the DNA in our cells would stretch out to the sun and back!*
This led to how DNA is coiled tightly into chromosomes, a process that protects DNA from environmental stress factors (excess sunlight, smoking, and poluntants).

Week 3: Water filtration and purification - Marie Boddington

We discussed that although our planet is covered with water, less than 1% of this water is not available for us to consume. This is because most water is saltwater or in a frozen state which we cannot drink directly, without treating it to remove contaminants and disease-causing germs. Using a project protocol from Science North*, mentees were offered the opportunity to make their own water filter in a plastic pop bottle, using sand, gravel, activated charcoal and coffee filters. *Students experimented with different layers compared to the recommended mix and were very impressed by how clean the latter was*.

Reference:

https://www.sciencenorth.ca/sites/default/files/2018/May%2019%20Grade%208%20Water%20Treatment%20Offline%20ENG.pdf

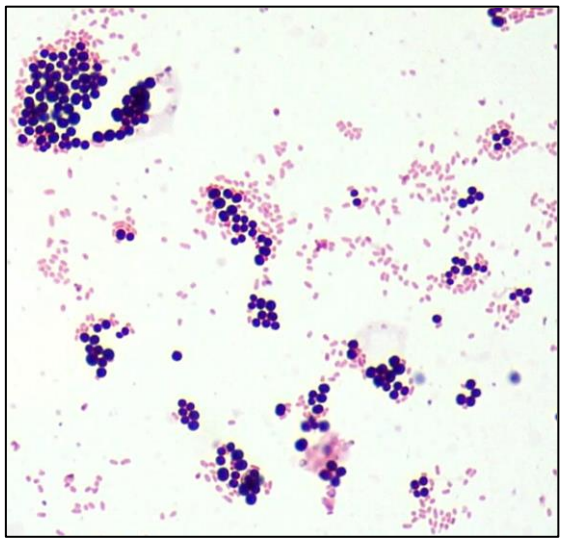
Video: https://mail.google.com/mail/u/0/?ogbl#search/water+purificatio/FMfcgzGxRnbNdxcTctdxsgZDDrmswXGf?projector=1

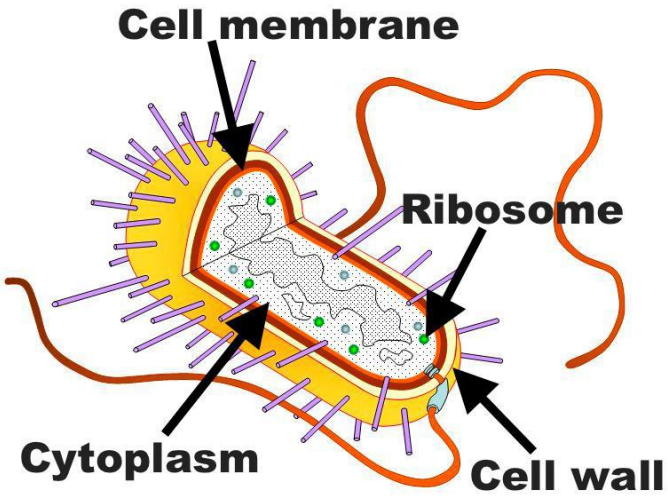
Left (random mix) Right (Recommended mix)

Weeks 4 & 5: The amazing world of microorganisms – Jill Greenwood & Jaydn Clark

Everyone swabbed different surfaces around the classroom and gymnasium, and samples were transferred to agar plates for growth. Bacterial growth was detected in samples from surprising locations! Mentees also compared the effects of Lysol, hand sanitizer and pine sap (a natural antiseptic with anti-bacterial properties), all which reduced bacterial growth. *We learned a lot about hygiene and how to reduce the spread of disease!*

Analysis of bacterium types by microscopy:
Mentees observed fixed preparations of Rounded and rod-shaped bacteria, associated with Specific diseases, such as strep throat, skin infections and pneumonia. *Gram positive (dark blue) staining identifies bacteria that have porous cell walls, which would allow penetration of antibiotics used to fight disease.*





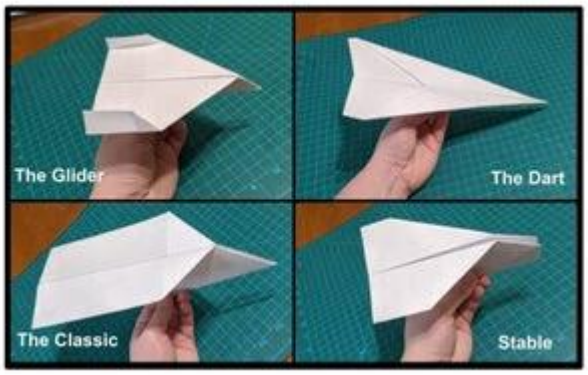
(Stained Bacteria samples were provided by Jenny Thiele (Laboratory Course Content Lead, DBMS)

What are viruses and how are they different from bacteria? – Jadyne Clarke

We learned that viruses are tiny parasites that, unlike bacteria, must infect other living things to survive, and make copies of themselves. They are symmetrical, with tiny spikes. of different patterns with different types, as shown in these origami models. The spikes fit into different “locks” on cells. They can then hijack the cellular DNA/RNA/protein pathway to produce more viruses!
We discussed how vaccines can be produced to block the spikes and inhibit infection, and the importance of good health habits to prevent disease spreading. We learned about “herd immunity”, where it’s hard for a disease to spread in a community already immunized. But it’s a harder concept to apply to the COVID-19 virus, which changes (mutates) readily to a vaccine resistant form. That’s why updated vaccines are important.

Week 6: Exploring physics and chemistry in the world around us!
We noticed that our mentees have a growing interest in **physics** and **chemistry**, so we devoted this week to encouraging these topics.

Airplane Physics: Jayne Dent
We began with Newton's third law of motion: For every Action there is an equal and opposite reaction or force. Using ballons, weights and mentees demonstrated drag, thrust, lift and gravity. Mentees were then invited to choose how they would like their paper airplane to fly: fast, high, low, slow etc. After folding planes according to chosen designs, we all lined up in the gym and test flew them! *Discussion followed about what the best design was and how to improve. Great fun was had by all!*



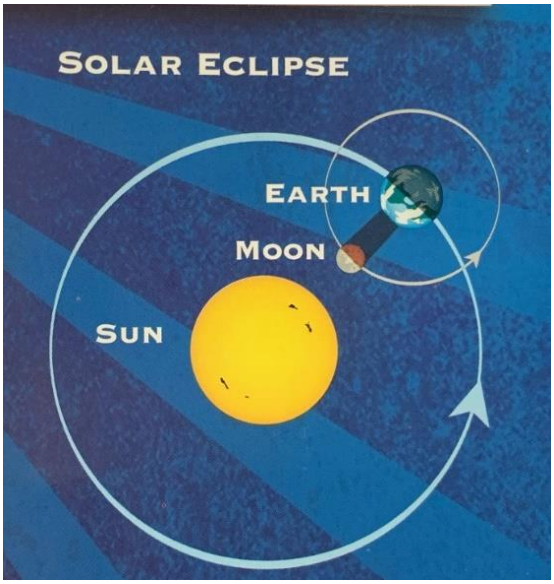
Lava Lamps – Marco Buttigieg, Nicholas Smith & Isabelle Grenier-Pleau
We explored about how density and polarity (electrical charge) affect states of matter (Gas vs Liquid vs Solid). Water is a polar substance. Oil is a non-polar substance. Polar and non-polar substances usually don't mix. When we add a fizzy antacid to the mix, the oil forms bubbles which rise because they are less dense. The patterns are beautiful and are always different.
We discussed what other liquids might have these properties (e.g. fats & gasoline,: e.g. how the unique patterns can be used for security passwords!

Week 7: Final wrap-up

ABO Blood Typing and solving a mystery! – Samantha Cockburn & Isabelle Grenier-Pleau
Our aim was to provide a general understanding of the circulatory system and ABO Blood System. We next applied this knowledge of ABO Blood System by identifying positive and negative blood agglutination reactions. We also modeled ABO Blood types using clay models of Red Blood Cells Then, students and mentors observed the various blood reactions to solve a mysterious event at KLC (A missing artist!). *Through molding clay models of red blood cells, students engaged in re-creating A and B proteins on the surfaces of our red blood cells, mimicking the various blood types.*




Title: The Total Solar Eclipse – Bruce Elliott
We marveled that historically this event would be Kingston's first Total Solar Eclipse in almost 700 years! We then acted out the phases of the Moon, and what causes a solar eclipse, using two balls (earth and Moon) and the sun. Only a New Moon can cause an eclipse! Next, we created a scale model using clay balls of the appropriate size for Earth and Moon, mounted on a metre stick. Using the sun light (or a flashlight if cloudy), the challenge was to hold the stick so that the shadow of the Moon fell on the Earth ball (actually very difficult!) Finally we demonstrated why we do NOT have an eclipse every month: the Moon's orbit around Earth is at a 5-degree angle to the orbital plane of Earth around the Sun😊 Eclipses can only happen at most twice per year! We then showed mentees how to safely watch the eclipse using Eclipse glasses. *We wished everyone a happy eclipse time with their family and friends.*



Eclipse to scale: Metre stick with Moon and Earth (above). Shadow of Moon on Earth (right).

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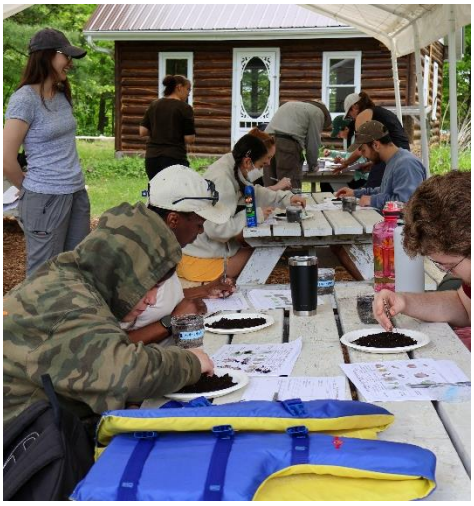
May 17th Field Trip – Queen's Elbow Lake – Jamie Would, Monica Garvie, Isabelle Grenier-Pleau and Emily Verhoek

To capture the essence of paleolimnology without using real lake sediments (as these must first be processed in a laboratory before being analyzed), Jamie and Monica created a hands-on simulation game. Various items that are often used to reconstruct natural history (for example, aquatic animal fossils, algae with glass cell walls, and pollen) were made using a combination of 'shrinky dink' paper (aquatic animals), 3D printers (diatoms), and play dough (pollen grains). Small chunks of burnt wood and plastics were also included to simulate charcoal from a forest fire and microplastic pollution. These items were then strategically placed in different containers filled with 'sediment' (plant soil), where each container represented a decade of time. Using 15 containers, each student could pick through the dirt of one container each, find these items, and assess what the environment looked like during their decade.

Once the hands-on component was complete, Jamie and Monica led a group discussion to synthesize each student's findings which revealed how the lake and surrounding environment changed over the last 150 years of simulated time!

The second activity focused on fish sampling techniques and identification. Emily Verhoek (Elbow Lake Outreach and Teaching coordinator) taught mentees and mentors how to properly use seine nets to catch fish and other aquatic organisms along the shoreline of Elbow Lake. Each student had the opportunity to wear chest waders, apply seining techniques, and build their teamwork skills. Collectively, the group successfully caught (and later released) a total of four fish, numerous aquatic insects, and identified them all successfully! KLC Mentees (8-10) & Teachers (2), as well as Mentors (6) and Program Coordinators (4) enjoyed learning together about the multitude of scientific techniques that can be used to assess the health of aquatic ecosystems over time and space.

Watching the coring demonstration and sample collection



Hands on simulation of sample collection and identification

Learning how to use seine nets!

Finding out what we caught!

Everyone worked as a team and enjoyed learning about aquatic ecosystems!

Words of appreciation from the KLC EducatorTeam:

Teachers Taylor Arnt and Michelle Nyamekye & Niki Boytchuk-Hale (Teacher Assistant)

“First of all we would like to extend a huge thank you once again to the entire Mentorship team for all of the hard work that went into the mentorship programming. Although student attendance wasn't ideal, I can assure you that the impact on the students that regularly participated, especially on the field trip, was huge!”