SCIENCE SPOTLIGHT

GOING WITH THE FLOW

GEN ACTION

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Canada

SASKATCHEWAN SCIENCE CENTRE
Real science. Real fun!

Going with the Flow

Origin Story:
A LIQUID MORE VALUABLE THAN GOLD...

Water is in the highest demand it is ever been. Despite over 70 percent of Earth's surface being covered by water, most is in the salty, salty ocean. Only 3 percent of the Earth's water supply is fresh, and only 0.5 percent is readily available while the rest is stored in the atmosphere, glaciers, ice caps and soil, or is too polluted or deep under the Earth's surface to be used. With limited freshwater availability, access to clean, drinkable water is unequal across the globe.

Clean water is vital for avoiding the spread of disease and producing food, energy, and manufactured goods. With access to safe water comes water usage and wastewater. If released back into the environment, wastewater can contaminate freshwater sources making access to clean drinking water even more difficult. So, it is equally important to treat water both before and after use.

While clean water availability has been a global issue for quite some time, climate change is introducing further complications. With a changing climate comes a changing global water cycle that can make freshwater even scarcer. More concerningly, our current water treatment methods are contributing to climate change. The more water we use, the more water we need to clean, and the more energy is required to pump water and power equipment to do so. This energy usage results in higher greenhouse gas emissions as most of our energy is obtained from burning fossil fuels. Methods to treat drinking water and wastewater are becoming more energy efficient, but sustainable methods are needed to combat climate change.

Water the Odds:
CAN EXISTING TECHNOLOGIES SOLVE NEW WATER QUALITY PROBLEMS?

In today's world, plastics are contributing to the water quality issue as a pollutant because humans now use plastics in almost everything we do. How much plastic have you used today? From food packaging and containers to electronics and clothing, we rely on plastic in a lot of ways, but they are becoming a major source of concern for environmental scientists. **Microplastics**, plastics that are under five millimetres in size due to being made small or from the breakdown of larger plastic pieces, have now been found in the most remote places on Earth and within our blood. They are everywhere, but it is unclear what the full extent of their harm is.

Once introduced to the environment, plastic begins to break down from natural forces into smaller and smaller fragments. The smallest microplastics are called **nanoplastics** and can be small enough to enter cells and potentially disrupt normal function. Additionally, in nature plastics have a strong attraction for pollutants or disease-causing microorganisms known as pathogens, which can be extremely harmful to living things. So, while microplastics themselves are problematic, what they may carry with them is also concerning. Areas with more human activity have more microplastics in the surrounding environments. Once microplastics enter our natural waterways they tend to stay there. Why is this a problem? Well, aside from the damage this does to ecosystems, this is where drinking water is obtained from.

Environmental engineers save countless lives every year by maintaining drinking water quality. However, microplastics pose a challenge as water treatment processes must now remove them for water to be safe for public consumption while simultaneously not increasing the energy requirements to do so. The best method to remove microplastics from water is called **reverse osmosis** and involves pushing water through a filter, which is extremely energy consuming and therefore an unrealistic solution.

The Origin Story was written based on The American River Water Education Center. "Water Facts - Worldwide Water Supply" Bureau of Reclamation. November 4, 2020. https://www.usbr.gov/mp/arwec/water-facts-ww-water-sup.html

Dr. Jinkai Xue is an environmental engineer who researches sustainable water treatment and whose lab is currently working to find sustainable solutions to remove microplastics from drinking water and wastewater. Recently they have performed a study to determine if one of the first steps of our existing drinking water treatment processes, called **coagulation-flocculation-sedimentation**, also removes microplastics! Although classified as being five millimetres or smaller, microplastics range in size, shape and material which can change their properties. This makes them extremely difficult for scientists to detect or study. For this reason, their study looked at one type of microplastic made of polystyrene which is a clear, solid, cheap plastic used to make disposable eating utensils, Styrofoam, electronics and much more. They simulated these microplastics to be "weathered" with a spherical shape of many sizes and used waters from a lake and river that each supply full-scale drinking water treatment plants so they could simulate removing microplastics from the type of waters we drink.

What they found in their study was:

1. Smaller microplastics of this type can be well removed from water using existing water treatment technologies.
2. Larger microplastics of this type could likely be removed during later steps in the existing water treatment process.
3. The smaller the microplastic, the more problematic and harder it is to deal with.

Hooray! Dr. Xue and their team discovered that an existing process in most drinking water treatment plants can work to remove microplastics. Therefore, we can avoid having to upgrade these processes and equipment in order to prevent microplastics from coming out of our taps.

This study fully represents the concept of the word sustainability; instead of having to make something new, sometimes we can use something that already exists! While a lot is still unclear about microplastics, studies like this make it easier for us to proceed in dealing with them; especially when the wheel does not have to be reinvented, so to speak!

Coagulation-flocculation-sedimentation is one of the first processes treated water undergoes because it removes solids such as dirt suspended in the water.

Step 1: Adding coagulant to untreated water

Contaminants such as sediment or microplastics are often negatively charged and repel one another. A positively charged chemical called a coagulant is added as it is attracted to these particles.

Step 2: Coagulation

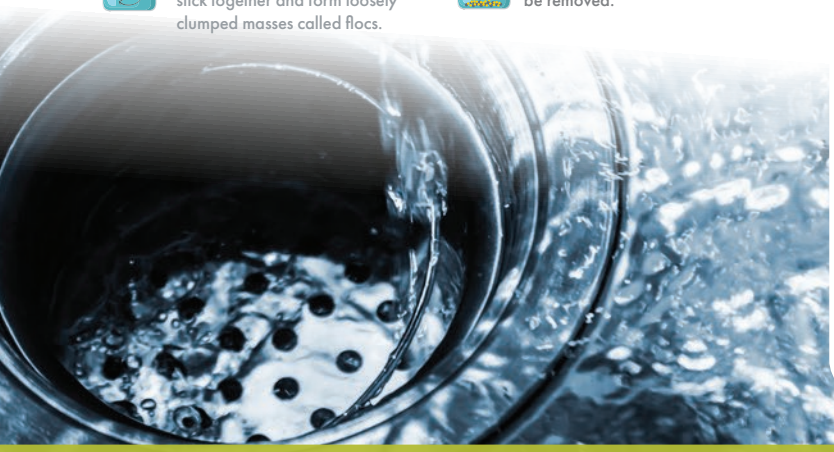
The coagulant joins particles and neutralizes them. The neutral particles no longer repel and are now capable of sticking together.

Step 3: Flocculation

The water is gently mixed, allowing neutral particles to stick together and form loosely clumped masses called flocs.

Step 4: Sedimentation

Larger flocs become heavy and sink to the bottom. The particles can now be removed.



TIME FOR GENACTION!

Try it at Home:
SNEAKY POLLUTANTS

In order to grow crops, we need a lot of water! However, if the water contains pollutants such as microplastics, they can make their way into the plants being grown and contaminate the food chain they supply. Take a look at how this process happens using food colouring and celery.

Materials needed: Leafy celery stalk, food colouring, and mason jar or cup filled with water.

1. Add four to five drops of food colouring to your jar, whichever colour you please.
2. Rip off a stalk of leafy celery and place it into the jar with the leaves facing upwards.
3. Check back every few hours. What do you notice?

In this experiment, the food colouring acts as a pollutant being absorbed by a crop (represented by celery), demonstrating how pollutants can be absorbed into plants, and why water treatment is so important for our collective health.

Climate Action:
WATCH YOUR SINKS, OUR WATER HEALTH IS ON THE BRINK!

Microplastics and other pollutants can enter our ecosystems via wastewater from your household sinks. To combat climate change and protect our ecosystems and health, consider what you do and do not flush or wash down the drain. Things you should not send down the drain include things you can throw away (e.g., plastics, hygiene products), take to a collection centre (e.g., fats, oils and greases or household hazardous wastes), or return to the pharmacy (medications). Preventing pollutants from washing down drains means less can enter the environment and less energy is needed to remove them from our water. The less energy we use, the fewer greenhouse gases enter our atmosphere, and the closer we are to combatting climate change!

MEET OUR LOCAL SCIENCE HERO:

Q: What is your favourite part about being an environmental engineer?

"I find myself really excited when solving engineering challenges, it's like playing Lego!"

Jinkai Xue Ph.D., P.Eng.
Assistant Professor,
Environmental Systems Engineering

This Science Spotlight was written based on the ongoing work of Dr. Xue, as well as Xue, Jinkai, Sigrid Peldszus, Michele I. Van Dyke, and Peter M. Huck. "Removal of polystyrene microplastic spheres by alum-based coagulation-flocculation-sedimentation (CFS) treatment of surface waters." Chemical Engineering Journal 422 (2021): https://doi.org/10.1016/j.cej.2021.130023.

Climate Action section was developed based on City of Toronto. "What Not to Flush or Pour Down the Drain." City of Toronto. Last modified October 14, 2021. https://www.toronto.ca/services-payments/water-environment/water-sewer-related-permits-and-bylaws/sewers-by-law/what-not-to-flush-or-pour-down-the-drain/

Climate Change
Past, Present, and Future

Earth is the only planet in the solar system known to support life. What makes our home so special? Earth has an atmosphere, a layer of gases between our planet and space. Some of these gases, like carbon dioxide, are called **greenhouse gases**. They are crucial parts of our atmosphere; they trap in the heat of the sun, similar to how heat is trapped in a greenhouse, or in a car on a hot day. This process, called the **greenhouse effect**, keeps Earth's temperature warm enough for living things to thrive.

The sun's rays hit our round, tilted planet unevenly. This uneven heating of Earth's surface leads to differences in temperature, which drives weather patterns. We call the patterns in temperature and weather over long periods of time **climate**. Different parts of the world have vastly different climates; it depends on how much heat they receive, as well as what landscape features are nearby. Water, mountains, ocean currents, and forests all impact our climate. In turn, living things around the world have adapted to the climate they live in.

Something, though, is changing. Over the past two hundred years, humans have been burning fossil fuels, such as coal and oil, to make energy to power our daily lives. Fossil fuels are made from decomposed plant matter and microscopic life millions of years old. This matter is full of carbon, and, burning it releases, or emits, billions of tonnes of **carbon dioxide** gas into the atmosphere every year. When too much carbon dioxide is emitted, the delicate balance of greenhouse gases maintaining

Earth's climate is upset. More and more heat is trapped, causing the planet to warm. Weather patterns change, water levels rise, storms get worse.

Climate has changed many times throughout Earth's history, from ice ages to periods much hotter than today. So why is this time any different? Scientists agree on two things. One, temperatures are rising faster than they ever have in documented climate history. Two, this climate change is driven by human activities, due primarily to greenhouse gas emissions.
Climate change is already impacting people's ways of life all over the world. Powerful storms, droughts, forest fires, and floods are threatening people's access to food, water, and safe homes.

The most important step we can take to prevent serious climate change is to reduce greenhouse gas emissions. Incredibly brave and caring people around the world are finding new ways to reduce emissions and make our communities climate resilient every single day. And you can join them! These Science Spotlights are here to help us learn more about climate change and how you can take action.

Our Commitment to the Decolonization of Science

Institutions of GenAction initiative respect and affirm the inherent and Treaty Rights of all Indigenous Peoples across what we now know as Canada. We give thanks to the Indigenous Peoples who care for this land since time immemorial and pay respect to their traditions and ways of knowing. We acknowledge their many contributions to innovations in Science, Technology, Engineering, and Mathematics, past and present, and are committed to deepening engagement and collaborating with Indigenous Peoples as partners in order to advance truth and reconciliation and the decolonization of science.

Climate Change: Past, Present, and Future is based on...Delmotte, Masson, V., P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M.I. Gomis, et al. 2021. "Summary for Policymakers. In: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change." Intergovernmental Panel on Climate Change. Cambridge University Press. In Press.