***Sensing Oxygen Level in Tribal River Water***

**NATURE Sunday Academy 2019-2020**

**Project Description:**

Students will investigate the oxygen level in local tribal river water using a newly developed fluorescence nanomaterial. The different oxygen levels in water will be virtually observed by the decrease of fluorescence intensity of the sensing solution that is made from fluorescent nanoparticles. The phenomena will be clearly observed by naked eyes under a UV light irradiation. By doing this project, students will have a deeper understanding on the importance of environmental protection to remain a healthy oxygen level in river water.

Dissolved oxygen presented in water is an important parameter in assessing river water quality because of it influences on the organisms within a body of water. The oxygen level that is too high or too low can harm aquatic life and affect water quality.

There are several environmental factors, including air pollution, soil pollution, temperature, salinity and pressure changes could significantly impact the dissolved oxygen concentrations. These influences could decrease the quality of river water and thus affect the aquatic life and human being life. There are a number of rivers in the native American tribes in North Dakota. Monitoring of oxygen level in these rivers is significant for the water quality control of these rivers. The newly developed fluorescent nanomaterials in this project could be used to monitor oxygen concentration in water by the change of the fluorescence intensity. The developed sensor is easy to operate, inexpensive, fast and effective. In this project, a newly developed nanomaterial-Pdots will be used for monitoring oxygen level in river water.

**Project Objectives:**

* The students will learn the basics of oxygen in human life.
* The students will learn the importance of oxygen in water to aquatic life.
* The students will learn environmental effect on the oxygen level in river.
* The students will examine oxygen level using nanomaterials-based sensing technique.
* The students will learn nanoscience and nanotechnology.

**Session Organization:**

*11:00-11:15 Cultural connection and general organization*

*11:15-11:30 Introduction to the Sensing Oxygen Level in Tribal River Water*

*11:30-12:00 Activity 1:* ***Detecting fluorescence of Pdots***

* *Activity 1A: Distribute the Pdots solution and observe the fluorescence of Pdots under UV light*
* *Activity 1B: Boil river water and tap water*

*12:00-12:45 Lunch*

*01:00-01:45 Activity 2:* ***Detection O2 levels in different water***

* *Activity 2A:* *Measure O2 in river water and tap water*
* *Activity 2B: Measure O2 in boiled river water and tap water*
* *Activity 2C: Measure O2* *in the bubble river water and tap water with O2 or N2*

*01:45-02:30 Activity 3:* ***Compare O2 detection using Pdots and standard oxygen meter****.*

* *Activity 3A:* *Measure the O2 level using standard oxygen meter in the previous six water vials.*
* *Activity 3B: Compare the results from Activity 3A and Activity 2.*

*02:30-03:00 Wrap up and clean up*

**ND State Science Standards:**

9-10.2.2 Use appropriate safety equipment and precautions during investigations

9-10.2.6. Design and conduct a guided investigation

9-10.5.4 Identify the short-term and long-term effects of physical processes

9-10.6.1 Use appropriate technologies and techniques to solve a problem

9-10.8.3 Explain how individuals and groups, from different disciplines in and outside of science, contribute to science at different levels of complexity

11-12.1.1 Explain how scientists create and use models to address scientific knowledge

11-12.2.1. Understandings about Scientific Inquiry: Explain how new knowledge and methods emerge from different types of investigations and public communication among scientists

11-12.2.2. Abilities Necessary To Do Scientific Inquiry: Select and use appropriate instruments, measuring tools, and units of measure to improve scientific investigations

11-12.6.2. Technological Design: Identify examples of how new technologies advance science

**Materials and Equipment:**

Balloon filled with Nitrogen. Pdots nanomaterials, UV lamps, Glass wares, River Water

Setup to boil water. Digital oxygen meter

**Activity 1: Detecting fluorescence of Pdots**

**Materials:** Polymer dots (Pdots), 5 glass vial (20 mL) for each group, 1 mL Pipette, UV lamp, River water and tap water, boiling setup.

**Activity 1A:** *Distribute the Pdots solution and observe the fluorescence of Pdots under UV light*

1. Obtain 6 mL Pdots solution from the demonstration Team for each group.
2. Get five 20 mL galss vials for each group
3. Pipette 1 mL Pdots solution into each vial.
4. Put the two vials on the top of a UV lamp.
5. Turn on the UV lamp and turn off the light in the room to observe the fluorescence from the solutions.
6. Using the cell phone to take an image of the fluorescent Pdots solution.

**Activity 1B:** *Boil river water and tap water*

1. Obtain 10 mL river water and tap water from the demonstration Team.
2. Setup the boiling device with help of the teachers.
3. Boil the river water and tap water for 5 min each.
4. Put the boiled river water and tap water on the desk to cool them down.
5. Using the cell phone to take an image of the boiled water under the UV lamp.

**Activity 2: *Detection O2 levels in different water***

***Materials:*** Polymer dots (Pdots), 1 mL Pipette, UV lamp, River water and tap water, boiling setup, balloon filled with nitrogen.

**Activity 2A:** *Measure O2 in river water and tap water*

1. Obtain 2 vials in Activity 1A.
2. Pipette 5 mL river water and tap water into the vails in step a, respectively.
3. Label the vails with “river water” and “tap water”.
4. Shake the vails gently for 30s.
5. Turn on the UV lamp and turn off the light in the room to observe the fluorescence difference from the two solutions.
6. Using the cell phone to take an image under the UV lamp.
7. Compare the fluorescence intensity of these two solutions. The higher the intensity, the lower the oxygen concentration.

**Activity 2B:** *Measure O2 in the boiled river water and tap water*

1. Obtain another 2 vials in Activity 1A.
2. Pipette 5 mL boiled river water and tap water (from Activity 1B) into the vails in step a, respectively.
3. Label the vails with “boiled river water” and “boiled tap water”.
4. Shake the vails gently for 30s.
5. Turn on the UV lamp and turn off the light in the room to observe the fluorescence difference from the two solutions.
6. Using the cell phone to take an image under the UV lamp.
7. Compare the fluorescence intensity of these two solutions. The higher the intensity, the lower the oxygen concentration.
8. Compare the fluorescence intensify of the samples “river water” and “boiled river water”
9. Compare the fluorescence intensity of the samples “tap water” and “boiled tap water”

**Activity 2C:** *Bubble river water and tap water with N2*

1. Obtain 2 vials and then pipette 5 mL river water and tap water.
2. Bubble N2 into these two vials for 5 min to exclude O2.
3. Turn on the UV lamp and turn off the light in the room to observe the fluorescence difference from the two solutions.
4. Using the cell phone to take an image under the UV lamp.
5. Compare the fluorescence intensify of the samples “river water”, “boiled river water”, and “bubbled river water”.
6. Compare the fluorescence intensity of the samples “tap water”, “boiled tap water”, and “bubbled tap water.

**Activity 3: Compare O2 detection using Pdots and standard oxygen meter.**

**Activity 3A:** *Measure the O2 level using standard oxygen meter in the previous six water vials.*

1. Insert the probe of the standard oxygen meter into the water body.
2. Once the reading is stable, record the value for the oxygen concentration.
3. In those six vials, measure the O2 level using the standard oxygen meter. Record the oxygen concentrations.

**Activity 3B:** *Compare the results from the Activity 3A and Activity 2.*

1. Find out the trend of the oxygen level in different water body, which are measured by standard oxygen meter.
2. Find out the trend of the oxygen level in different water body, which are measured by Pdots fluorescence intensity.
3. Compare the results from step a and step b.

**Discussion:**

1. *List the order of the oxygen concentration of water body, which were measured by the standard oxygen meter.*
2. *List the order of the fluorescence intensity of water body, which were treated with the Pdots.*
3. *Compare the two orders to check if they are match with each other.*