***Observation of Protein Breakdown (Denature) Process at Various Environmental Conditions***

**NATURE Sunday Academy 2020-2021**

**Name of participants, department, and university:**

Wen Sun, PhD student, Department of Chemistry, UND

Di Sun, PhD student, Department of Chemistry, UND

Sarah Reagen, PhD student, Department of Chemistry, UND

Yingfen Wu, PhD student, Department of Chemistry, UND

Dr. Tao Yu, Assistant Professor, Department of Chemistry, UND

Dr. Xusheng Wang, Assistant Professor, Department of Biology, UND

Dr. Julia Zhao, Professor, Department of Chemistry, UND

**1. Description of topic:**

 Students will investigate the breakdown (denature) process of protein in various environmental conditions. Students will explore how egg-white protein structure is sensitive to simple factors, including temperature, ethanol, and salt. The protein breakdown will be clearly detected with the naked eye by identifying white-precipitate generation in water (solid white flakes floating in the solution). By doing this project, students will have a deeper understanding of the important role of environmental conditions in maintaining normal protein structures to perverse healthy life processes.

Proteins carry out essential functionalities for life, and its structure is crucial to preserve all types of biological processes. However, the structure of protein is not chemically stable, and can be easily destroyed. The protein structure breakdown can cause serious implications on cellular behaviors that can negatively affect human health.

This activity is based on direct virtual observations. During the hands-on experiments, you will explore environmental factors affecting protein structures. The protein in egg white is stable in its natural conditions, such as in drinkable tap water. However, when the protein is broken down, a white precipitate will be produced. This activity will help you understand the relationship between the environment and human health; and will show you the importance of protecting your local environment, such as perverse the water quality of rivers for Native American tribes in North Dakota. The activity is also easy to do, inexpensive, fast, and effective. More importantly, it can be carried out remotely at home and can avoid potential negative impacts of the COVID-19 pandemic.

**2. Learning goals and outcomes:**

• The students will learn the basics of protein structure.

• The students will learn the importance of protein structure on life functions.

• The students will learn the environmental impact on protein structure.

• The students will examine and analyze how environmental conditions denature proteins.

**3. Standards covered:**

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 technology and techniques to solve a problem

9-10.8.3 Explain how individuals and groups from different disciplines both inside and outside of science disciplines contribute to scientific research at different levels of complexity

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

11-12.2.1 Understanding Scientific Questioning: Explain how new knowledge and methods emerge from different types of investigations and how scientists communicate to the public

11-12.2.2 Abilities Necessary to Practice Scientific Questioning: Select and use appropriate instruments, measuring tools, and units of measurement to improve scientific investigations

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

**4. Materials needed**

**Provided by Participant**

1. Two eggs
2. A pair of scissors for cutting egg white
3. One teaspoon table salt
4. One bowl for putting egg white, one fork for stirring egg white, one teaspoon and one tablespoon for measuring egg white, water, alcohol and salt.

**Provided by tribal college**:

1. Four disposable plastic cups (transparent, > 100 mL, microwavable)
2. 30 mL 91% isopropyl alcohol (for external use only)
3. A sharpie marker

**Provided by UND**: A video demonstration of the activities in Youtube

<https://youtu.be/HjV-EPn6B5M>

**5. Description of the hands-on activities:**

**Activity 0: *Prepare egg white proteins and solutions***

1. Use a sharpie to label the four disposable cups as “water”, “temperature”, “alcohol”, and “salt”.
2. Add 2 tablespoon (30 mL) tap water into the cups labeled “water”, “temperature”, and “salt”.
3. Crack an egg into a bowl, removing the yolk. Note that the yolk can be saved for your family cooking.
4. Use the scissors to cut the egg white several times into pieces.

**Activity 1: *Preparation of the control***

1. Pour 1 tablespoon of egg white into the cup labeled “water”. Observe whether solution has any white precipitate.
2. Take a picture of the solution using your cell phone. This tap water with egg white cup is actually the control (a scientific control is an experiment or observation designed to minimize the effects of variables other than the independent variable).

**Activity 2: *Detection of protein denature at different temperatures***

a. Heat up the cup with water labeled “temperature” for 30 seconds (~170 °F) using a 900 W (preferred, other power is also acceptable) home microwave oven. **CAUTION: The cup is hot. Make sure you are wearing oven mitts when removing the cup from the microwave oven**. Put 1 tablespoon of egg white into the cup. Observe whether the solution has any white precipitate.

b. Take a picture of the solution using your cell phone.

**Activity 3: *Detection of protein denature in alcohol solution***

1. Use the cup labeled “alcohol” and pour 2 tablespoons (30 mL) of 91% isopropyl alcohol into this cup.
2. Add 1 tablespoon of egg white into the cup, observe if there is any white precipitate ( you should see the changes right away).
3. Take a picture of the solution using your cell phone.

**Activity 4: *Detection of protein denature in salt solution***

1. Use the cup labeled “salt” and add one teaspoon of salt into the cup.
2. Stir until all the salt is dissolved.
3. Add 1 tablespoon of egg white into the cup. Observe if there is any white precipitate. Take a picture of the solution using your cell phone.

**Discussion and Conclusions**

1. Compare the photos you took from the cup of “water” with the cup of “temperature”, “Do the results show that the increased temperature caused protein breakdown?”
2. Compare the photos you took from the cup of “water” with the cup of “alcohol”, “Do the results show that the alcohol caused protein breakdown?”
3. Compare the photos you took from the cup of “water” with the cup from the Activity 4. “Do the results show that the salt caused protein breakdown?”
4. Based on the above discussion, give your conclusions on how environmental factors such as temperature, alcohol, salt would affect protein structure.