Osmosis in Action

A Lesson on Osmosis

Jennifer Reis
Kutztown Middle School
Kutztown, Pennsylvania
Summer 2008

Research Host:
Dr. Leonard Jefferson
Penn State College of Medicine

Lesson # 7

The American Physiological Society
2009 Works in Progress

Appropriate citation:

Reis, J. Osmosis in Action: A Lesson on Osmosis (APS Archive of Teaching Resources Item #2972). [Online]. Bethesda, MD: American Physiological Society, 2008. http://www.apsarchive.org/resource.cfm?submissionID=2972.

Editor's notes:

Website URLs listed in this resource were current as of publication, but may now be obsolete. If you know of a replacement URL, please suggest it in the resource's "Comments" section http://www.apsarchive.org/resource.cfm?submissionID=2972.

The APS encourages teachers to give students a copy of the "ABC" (Appropriate, Beneficial, Caring) rules for use of animals in the classroom, to discuss the rules, and to ask students to sign the "ABC" rules contract (see References). Also, teachers should have a plan for short term care of the animals (with supporting references for appropriate care guidelines) and for disposal or long-term care of all classroom organisms.

Teachers should carefully review any stimulus or environmental change for an animal being used in experiments or observations before students are allowed to use that stimulus. This is especially important if the stimulus could cause pain or distress to the organism. Teachers may be able to identify a less stressful stimulus for the students to use in their experiment.

Although mammals provide excellent opportunities for observational studies, they require particular care in terms of handling and may cause allergic reactions in some students. The teacher should check local and state guidelines before using mammals in the classroom.

Disclaimer:

This activity was created by the author and reviewed by the American Physiological Society. Any interpretations, statements, or conclusions in this publication are those of the author and do not necessarily represent the views of either the American Physiological Society or the funding agencies supporting the professional development program in which the author participated.

PURPOSE

The purpose of this activity is to encourage students to design and carry out an investigation that will enable them to visualize the different types of osmotic solutions, and how osmosis affects the balance within nature. The activity challenges the students on the process of food preservation and its relationship with osmosis.

OBJECTIVES

Upon completion of this activity, students will be able to:

- define: osmosis, isotonic, hypertonic, and hypotonic.
- generate predictions and observations on posed celery demonstration.
- apply critical thinking skills to a problem.
- navigate through websites in order to explain osmosis, the effects of osmosis, preserving and pickling foods, and salting fish.
- simulate osmosis through a game.
- apply new vocabulary to the designing and conducting of an experiment. Hypothesize, test hypotheses, design procedures, collect and analyze data, draw valid conclusions:
  - How to create a balanced system from an unbalanced one?
  - How does the process of food preservation occur?
  - How can preserved (dried) food be restored to its original state?
- create poster and present experiment with conclusions to class.
- evaluate classmates' work.
- apply new knowledge within a short writing prompt.

GRADE LEVEL

7^{th}-8^{th} grade life science

PRIOR KNOWLEDGE

This lesson should follow a unit on cell structure and function with a slight overview on diffusion. The students should be able to perform basic lab skills and have an understanding of the scientific method.

TIME REQUIRED

7-8 forty minute class periods.

INCLUDING ALL STUDENTS

- Randomly placed in groups of 3, assign roles.
- Modalities:
  - auditory: poster session, lecture, classroom discussion sessions
  - visual: computer, discussion sessions, poster gallery, celery observations
  - tactile: manipulation during experiment, computer, simulation game
- Cultural/historical: Pennsylvania Dutch with pickling and preserving process; early civilization of salting foods
- Accommodations: print copies of Internet material; others as necessary

QUESTIONS TO ASK ALONG THE WAY

- What happened to the dialysis tubing that was left in the solution over night? Why? How?
- Following the celery observations, what happened? What caused this disturbance?
- What happens when you place a tea bag in hot water?
- Why do your hands and feet get wrinkly after being submersed in water for a length of time?
- What is osmosis? What are the different types of osmotic solutions? How are they different?
- What is the importance of osmosis to animal and/or plant cells?
- How can food be preserved? What is salting fish?
- How can the food preservation process be reversed?
- Why is drinking salt water not recommended?

Jennifer Reis
Kutztown, PA

2008 Frontiers in Physiology Research Teacher
APS Works in Progress

NATIONAL SCIENCE EDUCATION STANDARDS

Grades 5-8

K-12 Unifying Concepts and Processes
- Evidence, models, and explanation
- Form and function

Science as Inquiry
- Abilities necessary to do scientific inquiry
- Understanding about scientific inquiry

Life Science
- Structure and function in living systems

Science in Personal and Social Perspectives
- Personal health

History and Nature of Science
- Nature of science

PENNSYLVANIA STATE SCIENCE EDUCATION STANDARDS

Science & Technology

3.2.7.B. Apply process knowledge to make and interpret observations.
3.2.7.C. Identify and use the elements of scientific inquiry to solve problems.
3.3.7.A. Describe the similarities and differences that characterize diverse living things.
3.3.7.B. Describe the cell as the structural and functional unit of living things.
3.7.7.A. Describe the safe and appropriate use of tools, materials, and techniques to answer questions and solve problems.
3.7.7.E. Explain basic computer communications systems.

MATERIALS

- Beakers/plastic cups
- Plastic zipped sealed sandwich bags
- Celery from bunches
- Potatoes, tomatoes, raisins, apples, carrots, bananas
- Dried: apples, pears, bananas, mangoes, papayas, apricots, and coconuts; beef jerky
- Computers with Internet access
- Sugar, table salt, flour, corn starch, powdered sugar, baking soda, garlic salt
- Tap water
- Construction paper/computer paper/poster board**,** markers, colored pencils, tape, glue, scissors (poster supplies)

SAFETY

The teacher should begin all investigations by reviewing safety procedures and expectations. The students should wear goggles and wash their hands before beginning and when finished. There should be no eating or tasting of any edible items within the investigation. Make sure to discuss allergies regarding food. The space utilized for the investigation should be adequate, cleared of junk, and kept neat and clean. And finally, before the actual investigation can be under way, the teacher must approve the design and provide the materials.

PREPARATION AND PROCEDURE

Preparation:

The morning one day before the lesson: teacher should set up dialysis tubing (plastic zipped sealed sandwich bags work just fine) with water inside and place it inside a beaker filled with heavily salted water.

A. Show the students both the beaker filled with water and salt, dissolved, and the plastic bag filled with water.
B. Ask the students what they think will happen to this overnight, never elude to the idea that there was salt in the beaker.
C. The next day ask what happened and why?

Teacher Tips: *The dialysis tubing (*plastic zipped sealed sandwich bags) *will be used to show the effects of osmosis on the tubing. There are tiny enough pores for the water to be drawn in and out, and with the salty water on the outside, the dialysis tubing should shrink, leading to a hypertonic solution.*

The morning before the lesson (needs to occur at least one hour before class, any shorter and there will be no reactions, any longer than overnight, and the solutions could equalize): teacher should place 3 beakers (plastic cups) for each group of 3 at stations set up around the room

- 1 beaker (cup) filled with 1 celery stalk and salty water
- 1 beaker (cup) filled with 1 celery stalk and water
- 1 beaker (cup) filled with 1 celery stalk and sugary water

Teacher Tips*: Do not let celery or other perishable items sit out for too long, keep in refrigerator or packaging until day of usage. The set-up of the celery demonstration above should be completed without student knowledge to encourage cognitive dissonance and discussion. Be careful not to misuse the idea of osmosis within the human body (dehydration, head trauma, etc.) When discussing preservation of food, for the purpose of the experiment, make sure to only focus on the drying process – reduction in water activity. If frozen or canned foods are used for preservation within the experiment, it will detract from the whole purpose of the lesson: osmosis. The investigations created by the students may not be designed the way you had hoped, as far as outcomes go, but let them create their own ideas, (this means they are truly thinking) and provide back up as to why they chose it the way they did, and then if necessary, revise their design.*

Procedure:

Day 1: Engage

1. As a class, show the students the dialysis tubing that was placed in beaker of salty water from previous day and ask them what happened. What observations and conclusions can they make based on what they have seen or learned about diffusion?
2. Place the students in randomly mixed groups of 3 and direct their attention to the 3 beakers (cups) placed around the room at different stations containing the celery with the different water solutions. *Each water solution should be numbered – do not give out any information regarding the solutions!!! 3 different roles should be assigned so all the students are involved (recorder, presenter, and lead observer).*

PREPARATION AND PROCEDURE

3. Have the students observe each beaker with celery and make a chart to record their observations, specifically aiming at the differences and their appearances. *Ensure they use all of their senses, except for TASTING!* Then, ask the students, in their groups of 3, which piece of celery looks the most fresh or "crisp," providing specifics as to their decision.
4. Class discussion on observations from the celery investigation.

Day 2: Explore

1. Begin the day with a class questioning session, concerning their prior knowledge:
    a. What happens when you place a tea bag in hot water?
        The tea particles diffuse through osmosis into the cup of hot water.
    b. What is preserved food? Can anyone name some examples of preserved foods?
        Preservation - drying process of food to reduce water activity and delay or decrease bacterial growth
        Examples: beef jerky, dried fruit.
    c. Who has ever eaten preserved food? How did the food become preserved? What are the mechanisms driving the food preservation process?
    d. Has anyone ever heard of salting fish? Why might someone want to salt fish?
        Procedure for preserving fish by removing water.
    e. Who has ever been swimming for any length of time, and when you get out of the water notice, how wrinkly both your hands and feet are? Why does that happen?
        Outermost layer of skin has sebum, which lubricates and waterproofs, when placed in water for long periods of time, this wears off, and then water is able to enter through osmosis.
2. The students will then work on the Internet Treasure Hunt worksheets to answer questions concerning osmosis, food preservation, and salting fish. The Internet activity can be done individually, providing there are enough computers, or the students can be placed in pairs or triplets, ensuring that every student has a specific role. Another possibility, to add in expert groups, each group could research one question and share their information with the other groups who researched another question.

Day 3: Explain

1. To provide collaboration, the students will be placed in different groups of 3, than before, to discuss their findings from the Internet Treasure Hunt.
2. To pull all the data together, the teacher will facilitate asking the questions of all the groups, as a large discussion, and elicit one response from each group to place on the front board concerning their findings.
3. In the groups of three, the students will have to draw a picture of one of the specific osmotic solutions, with explanations as to what is occurring. The teacher will randomly draw from a hat, each osmotic

PREPARATION AND PROCEDURE

solution for the groups of students to draw.

4. When finished with the drawing, the students must bring their model to the teacher for approval, and then the teacher will place one group with another of a different osmotic solution, and they will both have to explain to each other their osmotic solution. (Expert groups)
5. Following the modeling/drawing activity, the students will collectively gather up and move outside for an osmosis simulation. ***Teacher Tips:*** *Use caution to ensure students fully understand that cells will not always burst within a hypotonic solution, and that no matter what water always moves in and out, just at different rates.*
    a. Each student will rotate through acting as one of the following: cell membrane, water molecule, and/or salt molecule.
    b. Use approximately 6 students for the cell membrane; arrange them in a circle with each one holding hands to connect. *Place the students close together, so that they are not yanking on one another.*
    c. Place water and salt molecules both inside and outside of the cell membrane.
    d. Model the isotonic solution first; the cell membrane should not change size, but the water and salt molecules should be running in and out to maintain the concentration necessary. Ask the students what should occur? How many salt and water molecules should be inside and outside the cell membrane? What does it mean to have an isotonic solution?
    e. Try either the hypotonic or hypertonic solution next; encourage the students to determine how many salt and water molecules should be inside and outside of the cell membrane. The cell membrane should either shrink or swell, depending on the solution chosen, and the students acting as water and salt molecules need to ensure they are running in and out, creating the correct circumstances for that specific solution. ***Teacher Tips****: For swelling (hypotonic), I would just have the students raise their arms until they can't reach one another's clasp any longer; hence the cell has now burst. For the shrinking (hypertonic), the students can drop hands and move as close to each other as possible, not allowing any more molecules inside or outside.*
6. Collectively gather the students back inside and have them reflect on their experience with both the drawing and simulation of osmosis.

Days 4 & 5 *(may need 3 days):* ***Elaborate***

1. Review lab safety. This is where the inquiry part of the lesson should fall, right after the short introductory demonstrations, activities, and osmosis simulation game. ***Teacher Tips:*** *To run this part of the lesson, it would be in the teacher's best interest to practice working up to guided inquiry throughout the year.*
2. Remind students of good experimental design protocol – show students the experimental design worksheet that is to be completed

PREPARATION AND PROCEDURE

before the experiment can begin. Pass out rubric for poster presentation also to discuss.

3. Place students in randomly assigned groups of 3 – different from before, to complete an investigation of one of the questions listed below.
4. Provide half the students in the class with the question, "How does the process of food preservation work," and the other half with the question, "How can preserved food be restored to its original state?" For this experiment, preservation refers to the drying process: elimination of water.
   Teacher Tips: *Garlic salt and table salt were the two materials that worked best in preserving some of the fruit (apples and bananas) and vegetable (potatoes and carrots) pieces. Dried mangoes, apples and bananas were the three dried fruits that showed, by observation alone, (no eating in the lab) the best data for returning the process of preservation to its original state. Beef jerky did not seem to be restored at all!*
5. Show the students the different materials available for use in investigating the above question. Be sure to remind the students the discussions that were had during the demonstrations, game, and Internet Treasure Hunt, in order to push them into the right direction with their experimental design.
6. Have the students work collaboratively in their groups of 3 to design an experiment, listing their protocol in step-by-step fashion, with all materials listed, their hypothesis, and specific details regarding how they will collect data. The teacher should be walking around facilitating throughout the designing of the experiment, in order to listen in and possibly add to the dialogue the students are immersed in, guiding them, if necessary, into a well-designed investigation.
   Teacher Tips: *This information needs to be filled in on their experimental design worksheet and showed to the teacher for approval, before the students may begin the actual investigation.*
7. Once approved, the students will work through their experiment and begin preparing for their poster presentation.

Days 6 & 7: Evaluate

1. In the groups of 3, the students will create a poster that matches the rubric provided.
2. The students will then present their poster to the entire class, describing all portions, as noted through the rubric.
3. Following the presentation, the students will tape their posters to the wall, and the entire class will participate in a gallery walk, where they will look through each poster for 2 minutes and then when the teacher yells STOP, they will fill out a peer evaluation for the poster they are stopped in front of, keeping things entirely random.
4. Lastly, the students will write a one paragraph response to the following question, in order to apply everything they learned: If you were stranded at sea, why would it be wise to not drink the salt water?

WHERE TO GO FROM HERE

- Discussion of homeostasis in other living organisms:
  - saline solution in human cells
  - osmosis and it reactions with red blood cells
  - the different ways osmosis affects human diseases
  - aqua porins and the Nobel Laureates
- Invite parents (guest speaker) to discuss the food preservation process
- Invite microbiologist in to discuss food preservation.

SUGGESTIONS FOR ASSESSMENT

- Celery observations recorded
- Internet Treasure Hunt
- Experimental Design worksheet
- Poster Presentation
- Peer Evaluation
- Writing Prompt

REFERENCES AND RESOURCES

1. *Canning Pantry*
http://www.canningpantry.com/canning-technique.html
This is a company that sells all types of canning and preserving of food supplies, but also has many pages to access concerning the process of food preservation. Accessed on August 9, 2008.

2. *Colorado State University Extension – Nutrition Resources*
http://www.ext.colostate.edu/pubs/foodnut/pubfood.html
This website is filled with resources that specifically deal in nutrition, including: food safety, health, preparation, and preservation. Accessed on August 9, 2008.

3. *Indiana University School of Medicine*
http://www.soundmedicine.iu.edu/archive/2003/mystery/prunySkin.html
This is a short page that discusses the possible reasoning behind the skin on your hands and feet getting pruny, after being in the water for any length of time. Accessed on August 9, 2008.

4. *John R. McCandless, Jr.*
http://biology.arizona.edu/sciconn/lessons/mccandless/default.html
This is an integrated science unit focused on diffusion, osmosis, and cell membranes written by a teacher. Accessed on August 9, 2008.

5. *KidsHealth*
http://kidshealth.org/kid/talk/qa/wrinkly_fingers.html
This is a kid-friendly short page that discusses the possible reasoning behind the skin on your hands and feet getting pruny, after being in the water for any length of time. Accessed on August 9, 2008.

6. *Molo Molecular Logic*
http://molo.concord.org/database/activities/223.html
This website contains a few lessons on osmosis and diffusion, with a great simulation. Accessed on August 9, 2008.

Jennifer Reis
Kutztown, PA

REFERENCES AND RESOURCES

7. *Orange County Marine Institute*
http://sealevel.jpl.nasa.gov/education/activities/ts3siac1.pdf
This website discusses osmosis and it's effect on other living organisms, but also shows an investigation on preserving and disturbing the balance of nature in carrots and celery with further extensions on plants. Accessed on August 9, 2008.

8. *Osmosis Lab*
http://science-class.net/Osmosis/osmosis.pdf
Here you will find a cookbook lab using celery, raisins, and carrots to identify the effects of osmosis. Accessed on August 9, 2008.

9. *Osmosis on Celery*
http://www.edu.pe.ca/gray/class_pages/rcfleming/cells/osmosis.htm
Diagrams of celery and the effects of osmosis can be found here, along with explanations for the different types of osmotic solutions. Accessed on August 9, 2008.

10. *The University of Arizona*
http://marinediscovery.arizona.edu/lessonsS01/blennies/2.html
This website provides background information on passive transport and displays an osmosis experiment dealing with marine organisms. Accessed on August 9, 2008.

11. *The University of Georgia: College of Family & Consumer Sciences*
http://www.uga.edu/nchfp/
The National Center for Home Food Preservation is your source for current research-based recommendations for most methods of home food preservation. Accessed on August 9, 2008.

12. *Wikimedia Foundation, Inc.*
http://en.wikipedia.org/wiki/Food_preservation
This online encyclopedia discusses, in length, all types of information surrounding food preservation. Accessed on December 8, 2008.

Internet Treasure Hunt
Osmosis and Its Effects

Name: _____ Date: _____

This web info search will help you find information about osmosis. You will be looking at pre-selected web sites to answer each question. It is important to not only find the information at the site, but also to consider who wrote the site, what their purpose is in writing it, and how credible (accurate) you think the information is.

Question 1:	**What is osmosis? What are the different solutions osmosis can occur in and how are they different?**	
	Site 1 *Osmosis* www.tvdsb.on.ca/westmin/science/sbi3a1/Cells/Osmosis.htm	**Site 2** *Osmosis* www.vivo.colostate.edu/hbooks/cmb/cells/pmemb/osmosis.html
Who created this web site (organization, etc.)?		
Why did they create it? (check all that apply)	☐ To provide factual information ☐ To influence the reader's opinion ☐ To sell a product or service ☐ I'm not sure	☐ To provide factual information ☐ To influence the reader's opinion ☐ To sell a product or service ☐ I'm not sure
How credible (accurate) do you think the info is?	☐ Very accurate ☐ Somewhat accurate ☐ Not very accurate ☐ I'm not sure	☐ Very accurate ☐ Somewhat accurate ☐ Not very accurate ☐ I'm not sure
What did you learn?		

Jennifer Reis
Kutztown, PA
2008 Frontiers in Physiology Research Teacher
APS Works in Progress

Internet Treasure Hunt
Osmosis and Its Effects

Name: _____ Date: _____

This web info search will help you find information about osmosis. You will be looking at pre-selected web sites to answer each question. It is important to not only find the information at the site, but also to consider who wrote the site, what their purpose is in writing it, and how credible (accurate) you think the information is.

Question 2:	**What is the importance of osmosis to plant and animal cells?**	
	Site 1 *Osmosis* www.purchon.com/biology/osmosis.htm	**Site 2** *Osmosis Operation in Animal Cells* www.biotopics.co.uk/life/osmdia.html
Who created this web site (organization, etc.)?		
Why did they create it? (check all that apply)	☐ To provide factual information ☐ To influence the reader's opinion ☐ To sell a product or service ☐ I'm not sure	☐ To provide factual information ☐ To influence the reader's opinion ☐ To sell a product or service ☐ I'm not sure
How credible (accurate) do you think the info is?	☐ Very accurate ☐ Somewhat accurate ☐ Not very accurate ☐ I'm not sure	☐ Very accurate ☐ Somewhat accurate ☐ Not very accurate ☐ I'm not sure
What did you learn?		

Internet Treasure Hunt
Osmosis and Its Effects

Name: _____ Date: _____

This web info search will help you find information about osmosis. You will be looking at pre-selected web sites to answer each question. It is important to not only find the information at the site, but also to consider who wrote the site, what their purpose is in writing it, and how credible (accurate) you think the information is.

Question 3:	**How is salt used in preserving foods?**	
	Site 1 *Common Methods of Preserving Food* http://ezinearticles.com/?Common-Methods-of-Processing-and-Preserving-Food&id=765776	**Site 2** *Food Preservation* www.nos.org/SecHmscicour/english/LESSON_05.pdf
Who created this web site (organization, etc.)?		
Why did they create it? (check all that apply)	☐ To provide factual information ☐ To influence the reader's opinion ☐ To sell a product or service ☐ I'm not sure	☐ To provide factual information ☐ To influence the reader's opinion ☐ To sell a product or service ☐ I'm not sure
How credible (accurate) do you think the info is?	☐ Very accurate ☐ Somewhat accurate ☐ Not very accurate ☐ I'm not sure	☐ Very accurate ☐ Somewhat accurate ☐ Not very accurate ☐ I'm not sure
What did you learn?		

Internet Treasure Hunt
Osmosis and Its Effects

Name: _____ Date: _____

This web info search will help you find information about osmosis. You will be looking at pre-selected web sites to answer each question. It is important to not only find the information at the site, but also to consider who wrote the site, what their purpose is in writing it, and how credible (accurate) you think the information is.

Question 4:	**Why is salting fish important? When and how did it begin?**	
	Site 1 *Salting Fish – An 18th Century Event* www.1771.org/ev_salt_fish.htm	**Site 2** *Salted Fish in the Mediterranean* www.cliffordawright.com/caw/food/entries/display.php/id/79/
Who created this web site (organization, etc.)?		
Why did they create it? (check all that apply)	☐ To provide factual information ☐ To influence the reader's opinion ☐ To sell a product or service ☐ I'm not sure	☐ To provide factual information ☐ To influence the reader's opinion ☐ To sell a product or service ☐ I'm not sure
How credible (accurate) do you think the info is?	☐ Very accurate ☐ Somewhat accurate ☐ Not very accurate ☐ I'm not sure	☐ Very accurate ☐ Somewhat accurate ☐ Not very accurate ☐ I'm not sure
What did you learn?		

Jennifer Reis
Kutztown, PA
2008 Frontiers in Physiology Research Teacher
APS Works in Progress

Experimental Design Worksheet Names:

Question:

Hypothesis *(prediction of what will happen)* **If, then…:**

Materials:

Experimental Protocol *(What will be done? How? Step-by-step, logical approach)***:**

Data *(chart)***:**

Analysis *(graph, diagram, model)***:**

Conclusion *(accurate interpretation of the results, was your hypothesis correct or not, suggestions of possible error, how could your design be improved?)***:**

Jennifer Reis
Kutztown, PA
2008 Frontiers in Physiology Research Teacher
APS Works in Progress

POSTER PRESENTATION RUBRIC

REQUIREMENTS	5	3	1
Title	Has title that describes experiment accurately.	Has title that does not completely describe experiment.	Has no title.
Question	Has detailed question to answer during experiment.	Has question to answer during experiment.	Does not list question to be answered during experiment.
Hypothesis	Lists detailed prediction that correlates to variables of what is expected AND uses if, then…	Lists detailed prediction of what is expected.	Lists prediction.
Experimental Protocol	Lists exactly what will be done and how, in a logical step-by-step approach.	Lists what will be done and how.	Minimally lists what will be done.
Data	Created chart with axis labeled that depicts the best format for collecting information in this experiment.	Created chart with labeled axis.	Information thrown down in no true format.
Analysis	Detailed graph, model, or diagram that accurately depicts knowledge of results.	Has graph, model, or diagram.	Minimal description.
Conclusion	Interprets results, relates results to hypothesis, provides sources of error and suggestions for improvement.	Interprets results and relates results to hypothesis, with either error sources OR improvement suggestions.	Interprets results.
Presentation	Organized, eye contact, voice volume, rehearsed, all content covered and can answer questions.	Organized, minimal eye contact, voice volume, and rehearsal, and all content covered.	Not organized, well rehearsed, and missing content pieces.
Co-operation	Great team member with positive attitude, listens and shares ideas, and stayed on task.	Great team member with positive attitude, and wealth of knowledge, but sometimes caused distractions.	Did not work well with group members.
Overall Appearance	Lots of color and stands out.	Minimal color and looking normal (no extra work put in).	No color and not attractive.

Peer Evaluation Form Name: _____

Date: _____ Period: _____

Title of Poster: _____

Circle the appropriate category that matches the poster:

Requirements	**5**	**3**	**1**
Hypothesis	Lists detailed prediction that correlates to variables of what is expected AND uses if, then…	Lists detailed prediction of what is expected.	Lists prediction.
Experimental Protocol	Lists exactly what will be done and how, in a logical step-by-step approach.	Lists what will be done and how.	Minimally lists what will be done.
Data	Created chart with axis labeled that depicts the best format for collecting information in this experiment.	Created chart with labeled axis.	Information thrown down in no true format.
Analysis	Detailed graph, model, or diagram that accurately depicts knowledge of results.	Has graph, model, or diagram.	Minimal description.
Conclusion	Interprets results, relates results to hypothesis, provides sources of error and suggestions for improvement.	Interprets results and relates results to hypothesis, with either error sources OR improvement suggestions.	Interprets results.

What was the best part of the poster?

What suggestions could you provide to improve the experiment, not the poster?