**Water Works: Cells & Osmosis**

**Subject area/course**: Science, Biology

**Grade level/band**: 11–12

**INSTRUCTOR PROCEDURES**

1. **Task overview**:

This task demonstrates the importance of osmotic balance for cells to function properly, and what the consequences are when that balance is not met. This task fits into the curriculum of basic cell biology. After researching diffusion and osmosis, students will test their understanding by doing experiments to explore how solute concentration affects diffusion and how cells react when placed in different kinds of solutions. Students will develop hypotheses based on their understanding of diffusion and osmosis and will write a 4-page lab report, including an introduction, methods, results (including a graph), and discussion section.

1. **Prior knowledge required:**

Students should be able to:

* Define diffusion and osmosis.
* Define hypertonic, hypotonic, and isotonic
* Identify the basic parts of a cell on a slide
* Understand the anatomy of dialysis tubing
* Use an electronic scale

1. **Common Core State Standards aligned to this task:**

CCSS.ELA-Literacy.W.11-12.2.a. Introduce a topic and organize complex ideas, concepts, and information so that each new element builds on that which precedes it to create a unified whole, including formatting, graphics, and multimedia when useful to aiding comprehension

CCSS.ELA-Literacy.W.11-12.2.e.Provide a concluding statement or section that follows from or supports the information or explanation presented

[CCSS.ELA-Literacy.W.11-12.7](http://www.corestandards.org/ELA-Literacy/W/11-12/7/) Conduct short as well as more sustained research projects to answer a question (including a self-‐generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

[CCSS.ELA-Literacy.L.11-12.6](http://www.corestandards.org/ELA-Literacy/L/11-12/6/) Acquire and use accurately general academic and domain-specific words and phrases, sufficient for reading, writing, speaking, and listening at the college and career readiness level; demonstrate independence in gathering vocabulary knowledge when considering a word or phrase important to comprehension or expression.

[CCSS.ELA-Literacy.RST.11‐12.3](http://www.corestandards.org/ELA-Literacy/RST/11-12/3/) Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.

[CCSS.ELA-Literacy.RST.11‐12.9](http://www.corestandards.org/ELA-Literacy/RST/11-12/9/) Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.

**Next Generation Science Standards**

From Molecules to Organisms: Structures and Processes:

**LS1.A: Structure and Function**

* Feedback mechanisms maintain a living system’s internal conditions within certain limits and mediate behaviors, allowing it to remain alive and functional even as external conditions change within some range. Feedback mechanisms can encourage (through positive feedback) or discourage (through negative feedback) what is going on inside the living system.

1. **Time requirements:**

This experiment should be able to be completed in about 1 week in the class/lab. Students should spend an additional 1 to 2 hours outside of class writing their lab report. The report should be due approximately one week after the class/lab exercise.

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| Before experiment at home | Research Diffusion and Osmosis |
| Day 1 | Design experiments with group and make hypothesis’ |
| Day 2 | Do Methylene Blue experiment, create data tables, finish designing osmosis experiment |
| Day 3 | Do Dialysis tubing experiment, create data tables, share data |
| Day 4 | Share data, make graphs, collaborate and make conclusions |
| Day 5 | Share data, make graphs, collaborate and make conclusions |

1. **Instructor materials to use during administration:**

Instructor materials:

1. Online exercise in diffusion/osmosis from Pearson. <http://www.phschool.com/science/biology_place/labbench/lab1/intro.html>
2. Online demo of the difference between hypotonic, isotonic, and hypertonic solutions and their effects on cells. <http://www.glencoe.com/sites/common_assets/science/virtual_labs/LS03/LS03.html>
3. Variation of this lab described online, with great pictures. Good to show afterwards if you don’t have a microscope capable of projecting images. [http://www.csun.edu/~laa50120/sed695b/elodea\_plasmolysis/index.htm](http://www.csun.edu/%252525257Elaa50120/sed695b/elodea_plasmolysis/index.htm)

Student materials:

* Agar plates (in petri dishes with lids)
* .25%, .5%, .75%, 1.0%, 1.25%, 1.5%, 1.75%, 2.0%, 2.25% Methylene blue (or any combination teacher wants to give as options for the students)
* Cork borer
* Wax pencil or sharpie
* Ruler
* 9 inch dialysis tubing strips
* 5% salt solution
* Distilled water
* 1% salt solution (Extracellular fluid is approximately .9% NaCl)
* Scale

1. **Instructor procedures during administration:**

* Start by placing diffusion/osmosis in an applied context. Intravenous therapy, as discussed in Section A above, is a good jumping off point.
* Students should engage in some initial discussion of diffusion and osmosis, and possible results due to water moving in and out of cells, like creanation and lysis.
* Review details of diffusion and osmosis.
* Review the difference between hypotonic, isotonic, hypertonic.
* Explain the two experiments, one for diffusion, one for osmosis and/or give students the student experiment instructions.
* Diffusion experiment:
  + Students decide on 2 percentagess of methylene blue that they might use to show different diffusion rates.
  + Students write down their hypothesis about how the solute concentration should affect diffusion rate.
  + Each student or student group should have two agar plates. Using the cork borer, cut a hole in the middle of the plates.
  + Place the lid on the petri dish and mark the middle of the hole with a wax pencil or Sharpie.
  + Fill each of the two holes with a different methylene blue solution.
  + Record the distance methylene blue moves at intervals. The students determine if the experiment runs from 40 to 45 minutes. They can place the lid back on, mark the edge of diffusion, and measure the distance.
  + When finished, make an appropriate display of the data (e.g. table, graph, etc.).
  + Between measurement intervals, students can design the osmosis/dialysis tubing experiment.
* Osmosis experiment:
  + Students are given 3 dialysis tubes and a choice of 3 salt solutions and must determine an experiment to figure out direction and rate of movement of molecules.
  + Write down their hypothesis about what should happen to the dialysis tube when placed in each of the following solutions: hypotonic, hypertonic, and isotonic.
  + Place a determined amount of substance into dialysis tubing.
  + Weigh bags and record.
  + Place the dialysis tubing into a predetermined solution for 20-30 minutes depending on length of class time.
  + Weigh bags.
  + Mathematically determine the percent difference between start mass and final mass.
  + Don’t forget to draw bag results and determine which substances are hypertonic, hypotonic, isotonic, what happened in each case and why.
* Wrap up with a discussion.
  + Discuss what happened in each experiment.

1. **Student support:**

The following suggestions are examples of scaffolding that can be used to meet the diverse student needs within the classroom.

* Provide class time for research on students’ topics.
* Provide definitions of new vocabulary words ahead of time.
* For the final product, all learners will benefit from peer assistance while brainstorming their topics, as well as a peer or teacher review of their papers before final submission.
* Some students will have good research skills, but some will need guidance in the determination of appropriate sources and where to look for them. It is important to spend class time in review of what constitutes an appropriate source in advance of students’ independent work time.
* Students in need of help with experimental methods would benefit from teacher feedback around their proposed procedures before completing their experiment.
* If students are unfamiliar with how to use a microscope or need a review, training on how to use a microscope could be incorporated into this lab

1. **Extensions or variations:**

* Students can be given .25% methylene blue and 2.5% methylene blue so all students have constant data or students can design their own experiment using possible percents of methylene blue (for example .25%, .5%, .75%, 1.0%, 1.25%, 1.5%, 1.75%, 2.0%, 2.25%). If varied percents are used, students can collaborate and share data from all different percents.
* Students could present the results of their research to the class via an oral or multi-media presentation.
* A panel could be organized where students present the results of different experimental techniques and discuss the implications.

1. **Scoring and assessment considerations:**

EPIC developed the *College and Career Ready (CCR) Task Bank Scoring Rubric* *for Scientific Research Plans and Reports* to accompany this task. If your school or department uses a standardized rubric that would fit the content and requirements of this task, you may choose to use your existing rubric. The following notes and suggestions are meant to clarify the intent of the rubric and include considerations for the assessment of student work.

* When assigning the task, provide students with the rubric that will be used to score their final product and discuss it as a class.
* Unlike some rubrics, the *CCR Task Bank Rubric* does not predetermine “point values” for the scoring criteria. The rubric thus allows for flexibility with different instructors’ scoring systems and individual determination of the “weight” of each criterion.
* Student work that scores at the *Accomplished* level is considered to be entry-level college work.
* The *Exceeds* category on the rubric provides an example of how a student can go above and beyond the *Accomplished* level. These examples are intended to be only ONE way a work product can exceed expectations, thus allowing room for your professional judgment.
* If needed, consider including task-specific criteria as an additional scoring category to the rubric or providing a checklist of requirements for the task.