470134-768

AP® Biology Investigation #4:
diffusion and osmosis

Meets Revised College Board AP Biology Standards

WACP470132-874 - Rev. 8/14

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abstract

This lab addresses osmosis and diffusion and the function of these processes in maintaining homeostasis in the cell. In Activity 1, students use pre-made agar cubes of varying sizes to simulate cells and explore the relationship between surface area-to-volume ratio and diffusion rate. In Activity 2, the concept of selective permeability of the cell membrane is simulated using dialysis tubing, and salt, protein, and sugar solutions. In Activity 3, students study osmosis in plant samples, using sugar solutions of unknown concentrations.

required prior knowledge

Students should be able to:

- Calculate surface area and volume of a cube.
- Use a balance.

Students should have a basic understanding of:

- The cell membrane
- Osmosis and diffusion

activity learning objectives

Through these exercises students will be able to explain how surface area-to-volume ratio can affect diffusion rate. Using simple models, students will explore the concept of selective permeability of cell membranes. Additionally students will develop their scientific inquiry skills through developing and testing hypotheses of their own design.

materials checklist

For a list of replacement items, visit: www.wardsci.com, and click on the AP Biology tab for this kit/item #.
Download the latest digital activity guide for this item at connect.wardsci.com

materials included in kit:

- 4 dialysis tubing, 10 ft. roll
- 1 cork borer, 3/16"
- 5 disposable beakers, 1000-mL
- 50 plastic cups, 12-oz.
- 1 pkg./20 disposable Petri dishes
- 100 g albumin (egg), lab grade
- 500 g sucrose, lab grade
- 500 g sodium chloride, lab grade
- 1 bottle vinegar, white, 473 mL
- 500 g glucose anhydrous, lab grade
- 1 sucrose solution set (to mix 0.2 M, 0.4 M, 0.6 M, 0.8 M and 1.0 M solutions)
- 1 pkg. of food coloring, 4 bottles, 3 oz. each
- 8 rulers, 6"
- 8 plastic knives
- 8 plastic spoons
- 1 Live/Perishable Materials Coupon for agar cubes
- 1 Instructions (this booklet)
- 1 Student Guide copymaster

materials needed but not provided:

- Balance
- String
- Cellophane
- Scale
- Graduated cylinder, 1 L
- Plastic beakers, 2 L
- Distilled water
- Paper towels
- 16 celery sticks
- White potato
- Timer
- Forceps
- Lab Notebook
- Optional materials as determined by students' experimental design (open inquiry portion of activity)

number of uses:

Sufficient materials are provided for 8 groups of 2-4 students.

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standards alignment

This lab activity is aligned with the 2012 AP Biology Curriculum (registered trademark of the College Board). Listed below are the aligned Content Areas (Big Ideas and Enduring Understandings), the Science Practices, and the Learning Objectives of the lab as described in AP Biology Investigative Labs: An Inquiry-Based Approach (2012). *This is a publication of the College Board that can be found at:*

http://media.collegeboard.com/digitalServices/pdf/ap/APBioTeacherLabManual2012_2ndPrt_lkd.pdf

Big Idea	**2**	Biological systems utilize energy and molecular building blocks to grow, to reproduce, and to maintain homeostasis.
Enduring Understandings	**2.A3**	Organisms must exchange matter with the environment to grow, reproduce, and maintain organization.
	2.B	Growth, reproduction, and dynamic homeostasis require that cells create and maintain internal environments that are different from their external environments.
	2.B1	Cell membranes are selectively permeable due to their structure.
	2.B2	Growth and dynamic homeostasis are maintained by the constant movement of molecules across membranes.
Science Practices	**2.1**	The student can justify the selection of a mathematical routine to solve problems.
	2.2	The student can apply mathematical routines to quantities that describe natural phenomena.
	4.2	The student can design a plan for collecting data to answer a particular scientific question.
	4.3	The student can collect data to answer a particular scientific question.
	4.4	The student can evaluate sources of data to answer a particular scientific question.
	5.1	The student can analyze data to identify patterns or relationships.
	5.2	The student can refine observations and measurements based on data analysis.
	5.3	The student can evaluate the evidence provided by data sets in relation to a particular scientific question.
Learning Objectives	**2.6**	The student is able to use calculated surface area-to-volume ratios to predict which cell(s) might eliminate wastes or procure nutrients faster by diffusion.
	2.7	The student is able to explain how cell size and shape affect the overall rate of nutrient intake and the rate of waste elimination.
	2.10	The student is able to use representations and models to pose scientific questions about the properties of cell membranes and selective permeability based on molecular structure.
	2.11	The student is able to construct models that connect the movement of molecules across membranes with membrane structure and function.
	2.12	The student is able to use representations and models to analyze situations or solve problems qualitatively and quantitatively to investigate whether dynamic homeostasis is maintained by the active movement of molecules across membranes.

time requirements

	TIME FRAME	TEACHER TASK(S)	STUDENT TASK(S)
PRE-LAB PREP	2 weeks to 1 day before the lab	Redeem coupon for perishable materials (at least 2 weeks in advance) Review specific pre lab tasks associated with each activity (see pages 11-12)	Read background and complete pre-lab questions (1 day before).
Activity 1	Structured Inquiry: 5 minutes Guided Inquiry: 45 minutes Open Inquiry: Will vary, depending on students' experimental designs	Distribute celery sticks and agar cubes. Assist with experimental techniques and data recording.	Test relationship between surface area-to-volume ratio and diffusion rate.
Activity 2	Structured Inquiry: 45 minutes Guided Inquiry: 45 minutes Open Inquiry: Will vary, depending on students' experimental designs	Identify experimental goals and model setup of dialysis tubing.	Model semi-permeable membrane properties using dialysis tubing.
Activity 3	Guided Inquiry: 45 minutes Open Inquiry: Will vary, depending on students' experimental designs	Prepare potato cores. Suggest or critique ideas for open inquiry.	Study osmosis in plant tissues. Test unknown solutions to determine which are hypertonic or hypotonic relative to cells.
Analyzing Results and Class Discussion	45 minutes		

lab-specific safety:

- White vinegar and phenolphthalein agar are used in this kit. Both are irritants to the skin and eyes. Use with caution. Review the Safety Data Sheets (SDSs) for additional safety precautions, handling procedures, storage, and other information.

general safety:

- The teacher should 1) be familiar with safety practices and regulations in his/her school (district and state) and 2) know what needs to be treated as hazardous waste and how to properly dispose of non-hazardous chemicals or biological material.
- Consider establishing a **safety contract** that students and their parents must read and sign. This is a good way to identify students with allergies (e.g., latex) so that you (and they) will be reminded of specific lab materials that may pose risks to individuals.
- Students should know where all **emergency equipment** (safety shower, eyewash station, fire extinguisher, fire blanket, first aid kit etc.) is located.
- Require students to remove all dangling jewelry and tie back long hair before they begin.
- Remind students to **read all instructions, SDSs and live care sheets** before starting the lab activities, and to ask questions about safety and safe laboratory procedures. The SDSs and the most updated versions of the live care sheets can be found at www.**wardsci.com**. (Click on the "Teacher Resources" tab.) Updated SDSs can also usually be found on each chemical manufacturer's website.
- In student directed investigations, make sure that collecting safety information (like SDSs) is part of the experiment procedure.
- As general laboratory practice, it is recommended that students **wear proper protective equipment**, such as gloves, safety goggles, and a lab apron.

at the end of the lab:

- Review local regulations or consult with local authorities before disposing of any chemicals in the trash or down the drain.
- All laboratory bench tops should be wiped down with a 10% bleach solution or disinfectant to ensure cleanliness.
- Remind students to wash their hands thoroughly with soap and water before leaving the laboratory.

teacher notes

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