Osmosis

Course
Anatomy & Physiology

Unit III
Cellular Biology

Essential Question
How does osmosis affect the human body?

TEKS
130.206(c)
1A
2B,2C,2E,2F, 2G,2H
6A,6B
10A,10B,10C, 10D

Prior Student Learning
Basic understanding of the anatomy of a cell

Estimated time
Red cell test: 11/2 hr (see Teacher Note)
Eggsperiment Activity 1: 30 minutes a day for 3 days
Activity 2: 15 minutes a day for 3 days

Rationale
Osmosis is an integral part of maintaining homeostasis.

Objectives
Upon completion of this lesson, the student will be able to:

- Relate the changes made by osmosis in the egg to changes that occur at the cellular level in humans
- Investigate how different solutions effect osmosis
- Hypothesize how they can change the concentration of solution to make changes at the cellular level
- Investigate the process of osmosis and the effects of various solutions on red cells

Engage
During your ER rotation you notice that the patient in room #1 needs an IV because they are dehydrated and that makes sense. However, the patient in room #2 also needs an IV, but they are suffering from edema and very swollen. Won't the extra fluid hurt the patient?

Key Points

I. Osmosis is the passage of water from a region of high water concentration through a semi-permeable membrane to a region of low water concentration.

II. Osmotic pressure is the force that moves water through the membrane. The pressure depends on the concentration of solutes. The greater the number of solutes, the greater the pressure. Osmotic pressure may be thought of as a pulling pressure since water follows the solutes.
    A. Semi-permeable membranes are very thin layers of material (cell membranes are semi-permeable) which allow some things to pass through them, but prevent other things from passing through.
    B. A region of high concentration of water is either a very dilute solution of something like sucrose or it's pure water. In each case there is a high concentration of water.
    C. A region of low concentration of water is a concentrated solution of something like sucrose.
    D. Tonicity- the effects of solutions on cells.

III. When you put a cell into liquid containing water one of three things will happen.
    A. Isotonic - If the concentration of solute is equal on both sides, the water will move back in forth but it won't have any result on the

Teacher Note
If looking to use the red cell test you need to check on ordering in sheep red blood cells early

overall amount of water on either side**; "ISO**" means the same.

B. Hypotonic - The word **"HYPO"** means less. In this case there are fewer solute molecules outside the cell; water will move into the cell. The cell will gain water and grow larger. The cell may be in danger of bursting; organelles called contractile vacuoles will pump water out of the cell to prevent this.
C. Hypertonic - The word **"HYPER**" means more. In this case there are more solute molecules outside the cell, which causes the water to be sucked in that direction. The cells shrink and may die.

IV. **Fetal Alcohol Syndrome (FAS)** - If a woman drinks alcohol during her pregnancy, her baby can be born with FAS, a lifelong, physically and mentally disabling condition
   A. abnormal facial features
   B. growth deficiencies
   C. central nervous system (CNS) problems
   D. people with FAS may have problems with learning, memory, attention span, communication, vision, and/or hearing
   E. FAS is a permanent condition

Activity

I. Completion of the Osmosis and Red Blood Cell Laboratory Investigation.
II. Completion of *Eggsperiment* I or II

Assessment

Laboratory Investigation Rubric

Materials for Osmosis and Red Blood Cell Laboratory Investigation
Gloves
Goggles.
Blood (sheep blood, cow blood, pre-tested blood donated by a medical laboratory, etc.)
Microscopes, microscope slides, cover slips
Eye dropper
Wax pencil
Isotonic solution (.9% saline solution)
Hypotonic solution (Distilled water)
Hypertonic solution (2 % saline solution)
Biohazard containers
Surface disinfectant
Paper towels

Materials for *Eggsperiment*
Raw eggs
Vinegar
Salt water
Syrup
Soda or other drinking solutions
Rubbing alcohol
16 oz. clear plastic cups
Aluminum foil
Graduated cylinders
Triple beam balance

Accommodations for Learning Differences
For reinforcement the student will review and repeat the laboratory investigation.

For enrichment, the student will research and report on the function of the kidneys in congestive heart failure and determine the cause of ascites.

National and State Education Standards
National Health Science Cluster Standards
HLC01.01 Academic Foundations
Health care workers will know the academic subject matter required (in addition to state high school graduation requirements) for proficiency within their area. They will use this knowledge as needed in their role.
HLC1O.01 Technical Skills
Health Care Workers will apply technical skills required for all career specialties. They will demonstrate skills and knowledge as appropriate.

TEKS
130.206 (c)
6A. Investigate and describe the integration of the chemical and physical processes, including equilibrium, temperature, pH balance, chemical reactions, passive transport, active transport, and biofeedback, that contribute to homeostasis;
6B. determine the consequences of the failure to maintain homeostasis.

Texas College and Career Readiness Standards
English Language Arts
II. B. Understand new vocabulary and concepts and use them accurately in reading, writing, and speaking
III. B. Develop effective speaking styles for both group and one-on-one situations
IV. A. Apply listening skills as an individual, and as a member of a group in a variety of settings
IV. B. 2. Listen actively and effectively in one-on-one communication

situations
Science
1.A.1. Utilize skepticism, logic, and professional ethics in science
1.A.2. Use creativity and insight to recognize and describe patterns in natural phenomena
1.A.3. Formulate appropriate questions to test understanding of a natural phenomenon
1.A.4. Relay on reproducible observations of empirical evidence when constructing analyzing, and evaluating explanations of natural events and processes
1.E.2. Use essential vocabulary of the discipline being studied
3.A.1. Use correct applications of writing practices in scientific communication

OSMOSIS AND RED BLOOD CELL
Laboratory Investigation

Purpose:
In this laboratory investigation, the student will investigate the process of osmosis and the effects of various solutions on red blood cells.

Background Information:

Materials:
Gloves
Goggles
Blood supplied by the teacher
Microscopes, microscope slides, cover slips
Eye dropper
Wax pencil
Isotonic solution (.9% saline solution)
Hypotonic solution (Distilled water)
Hypertonic solution (2 % saline solution)
Biohazard containers
Surface disinfectant
Paper towels

Procedure:
1. Wash hands and put on gloves and goggles.
2. Assemble equipment and materials. Obtain blood sample from instructor.
3. Prepare work area.
4. Label the microscope slides as Isotonic, Hypertonic or Hypotonic.
5. Place a drop of blood on each slide and place a cover slip on it.
6. Place the slide on the microscope.
7. Observe and draw red blood cell.
8. Add a drop of the appropriate solution to the slide labeled as Isotonic, Hypotonic or Hypertonic. Place the drop on the outer edge of the coverslip. Observe and draw red blood cell.
9. Repeat for each slide.
10. Observe any changes in the red blood cell as osmosis takes place.
11. Clean work area with surface disinfectant. Remove goggles and gloves and wash hands.

Data:

1. Observe and draw a red blood cell.

2. Observe and draw a red blood cell in an isotonic solution.

3. Observe and draw a red blood cell in a hypertonic solution.

4. Observe and draw a red blood cell in a hypotonic solution.

Conclusion:

1. Explain the relationship of a red blood cell's shape to its function.

2. Explain what happens to cells when placed in an isotonic solution. Describe the effect on its function.

3. Explain what happens to the cell when placed in a hypertonic solution. How would this affect the red blood cell's function?

4. Explain what happens to the cell when placed in a hypertonic solution. How would this affect the red blood cell's function?

5. Predict how the body attempts to restore homeostasis.

6. Describe two diseases/disorders related to electrolyte imbalance including information about hypertonic and hypotonic conditions of nitrogen, calcium, sodium, and potassium.

Complete the Osmosis Investigation using the measurement method. Does require more time for students to measure and fill in observation form.

Osmosis Procedure Activity #1

Day One

1. Measure 150ml of vinegar and pour into three plastic cups.
2. Put one raw egg into each of the cups. This will dissolve the calcium carbonate egg shell, exposing the differentially-permeable cell membrane.
3. Cover the plastic cup tightly with aluminum foil and let set overnight.

Day Two

1. Carefully remove each egg from their plastic cup.
2. Gently rub the calcium shell from the egg under running water and dry it.
3. Make observations and weigh the egg on the triple beam balance and record data in table one. Repeat with each egg.
4. Measure the amount of vinegar remaining in the cup and record. Repeat with each egg.
5. Discard the vinegar, rinse the cups, and choose three solutions from vinegar, salt water, syrup, soda, or rubbing alcohol to simulate hypertonic, isotonic, hypotonic solutions and the denaturalization of protein. Pour 150 ml of each chosen solution into one of your three cups.
6. Return the eggs to the cups and cover with foil; let set overnight.

Day Three

1. Carefully remove the eggs and gently rinse to remove solution. Dry the eggs.
2. Make observations, weigh the eggs, and record the data.
3. Measure the amount of solution remaining in the cups and record.
4. Dispose of the cups.

Results for Egg #1

	Amount of Fluid	Wt. of Egg	Solution	Observations
Day 1				
Day 2				
Day 3				

Results for Egg #2

	Amount of Fluid	Wt. of Egg	Solution	Observations
Day 1				
Day 2				
Day 3				

Results for Egg #3

	Amount of Fluid	Wt. of Egg	Solution	Observations
Day 1				
Day 2				
Day 3				

Activity 2

Day One

1. Cover the raw eggs with vinegar in a large plastic or glass bowl. This will dissolve the calcium carbonate egg shell, exposing the differentially – permeable cell membrane.
2. Cover the bowl tightly with aluminum foil and let set overnight.

Day Two

1. Carefully remove the egg from the bowl.
2. Gently rub the calcium shell from the egg under running water and dry it.
3. Make observations. Discard the vinegar.
4. Place the egg into a clear plastic cup.
5. Choose one of the available solutions. Solution suggestions include vinegar, salt water, syrup, soda, or rubbing alcohol to simulate hypertonic, isotonic, hypotonic solutions and the denaturalization of protein.
6. Cover the egg with the new solution.
7. Return the eggs to the cups and cover with foil and let set overnight.

Day Three

1. Make observations of both the solution and egg.
2. Record the data on your work sheet.
3. If time allows, soak egg in a different solution and make a hypothesis of the reaction.

EGGS-PERIMENT Work Sheet

Yesterday we soaked the eggs in vinegar to remove the calcium carbonate shell of the egg.

Then you chose a different solution to soak the egg in, overnight. Some of the solutions were isotonic, some hypertonic, and some were hypotonic.

Your task today is to observe your egg and answer the following questions based on that observation.

1. What type of solution would you call vinegar based on the eggs reaction? Is it isotonic, hypotonic or hypertonic? _____

2. Explain your answer for #1: _____.

3. What solution did you put your egg in after cleaning off the shell?

_____

4. Describe what your findings were when you examined the egg today:

_____

_____

_____

5. Determine what solution your egg was soaked in:

Isotonic Hypertonic Hypotonic Denaturing

6. What type of solution would you give your patient to correct any problem you observed in #4 and why? _____

_____

7. Using the example from the student notes draw a diagram showing what your solution looked like molecularly:

If time allows you may soak your egg in a different solution for the next day.
Hypothesis of what will happen to your egg after soaking it this third solution: _____

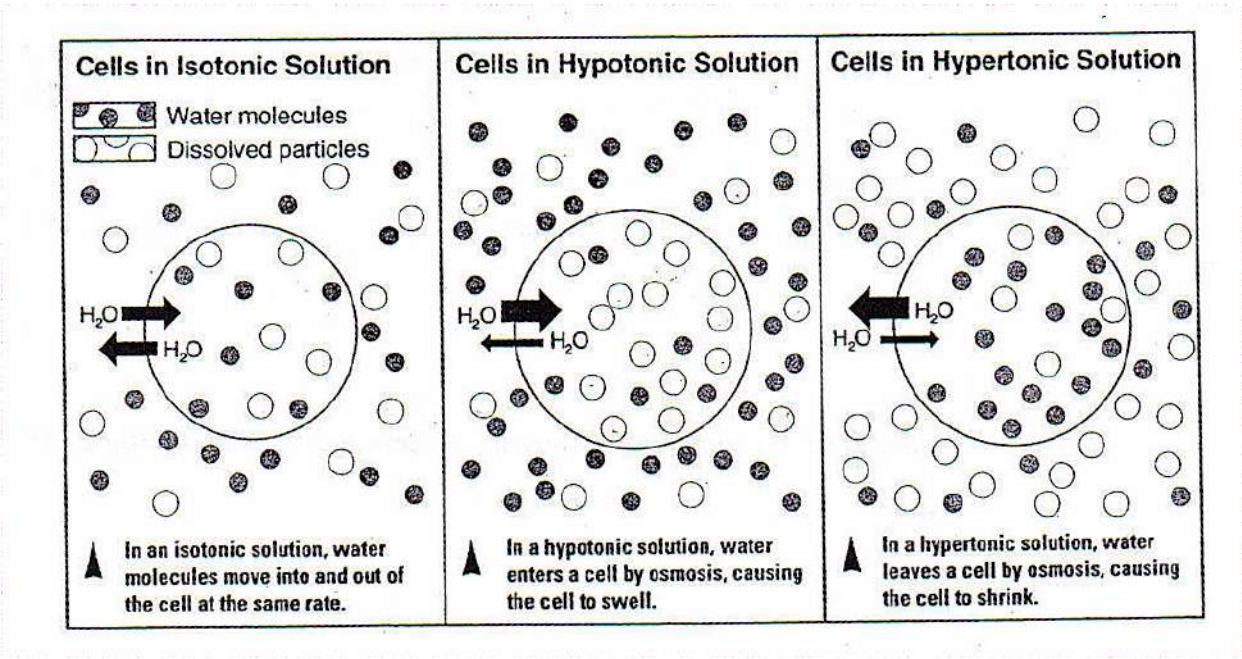
_____

Student observation notes: The EGG becomes a single cell in the human body.

LOOK AT THE EGG WHICH IS HUGE: If the egg that is all swollen looks like a human cell that has edema, the teacher can reinforce the concept to students of how this will make a difference in the type of IV solution they would give the patient. The Cell sitting in a **HYPOTONIC** solution grew larger because the solution contained fewer solutes than the cell. This imbalance made the water leave the outside solution and move into the cell, resulting in cell enlargement. Therefore we would give a *Hypertonic* solution (such as salt water or saline) to the patient, which would cause water to leave the cell by osmosis, resulting in shrinkage of the cell, because the cell would contain fewer solutes than the outside fluid.

LOOK AT THE EGG THAT IS ALL SHRIVELED: This egg looks like a human cell which is dehydrated. The cell or egg is sitting in a **HYPERTONIC** solution, one that contains more solutes than the surrounding cells. Therefore, the physician would want to give a *Hypotonic* solution, forcing the cell to accept fluid. The fluid would be very close to pure water and contain very few solutes; with the cell (egg) containing more solutes than the water, osmosis would occur, causing the water would move over into the cell, causing the cell to expand.

LOOK AT THE EGG WHICH IS ALL WHITE: This egg looks like it has been cooked, but the alcohol has **denaturized** the protein. *(Explain that denaturized means to turn protein into a permanent state; in the human body, proteins are normally able to change as required in order to perform the everyday functions needed by the body and for growth.)* (BREAK OPEN EGG) However, when fetal cells come in contact with alcohol, they denaturize and cannot change or grow. So if the alcohol hits the forming brain, the child will have brain damage. If the arms or legs are forming they may not be complete, resulting in only one arm bud at birth. Babies born with problems like this have a condition commonly called Fetal Alcohol Syndrome.



Laboratory Investigation Rubric

Student: _____

Course: _____

Date: _____

Scoring Criteria	4 Excellent	3 Good	2 Needs Some Improvement	1 Needs Much Improvement	N/A
Problem is appropriately identified.					
Problem is precise, clear, and relevant.					
Association between the problem and the predicted results is direct and relevant.					
All variables are clearly operationalized.					
Demonstrates comprehension of the use of scientific concepts and vocabulary.					
All significant data is measured.					
Data is recorded effectively and efficiently.					
Data table is well designed to the task requirements.					
All graphs are appropriate.					
All data accurately plotted.					
Graph visually compelling, highlights conclusions of the study.					
Conclusion relates directly to hypothesis.					
Conclusion has relevancy in resolution of the original problem.					
Conclusion relates the study to general interest.					