DIFFUSION AND OSMOSIS

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Human Physiology Lab

First semester

Week 3

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Outline

- Transport through the membrane
- Diffusion
- Osmosis
- Experiment 1 for Osmosis
- Experiment 2 for Osmosis

Objectives

- Familiarize student methods of transport across the plasma membrane
- Understudying the Diffusion
- Define Osmosis
- Explaining the principles of Osmosis experiments

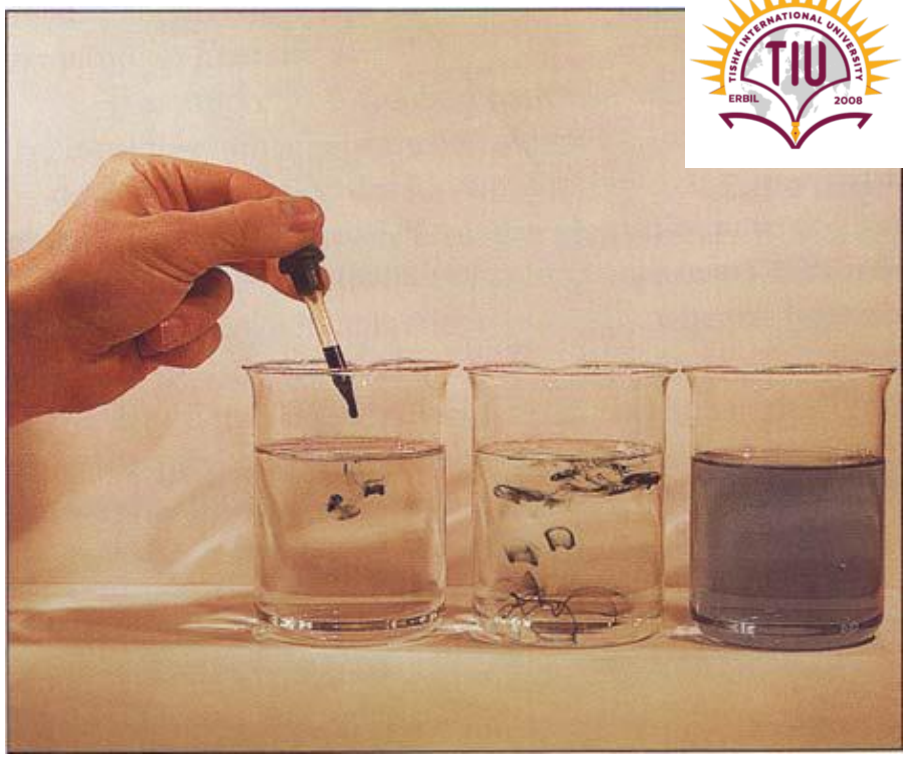
Transport through the animal cell membrane

- The three Ways a Cell regulates what comes into a cell:

1. **Simple Diffusion** – Some materials move into and out of the cell without using energy.
2. **Facilitated Diffusion** – Movement of substances into and out of the cell through a protein in the plasma membrane **(Channel and Carrier)**
3. **Active Transport** – Use energy in the form of ATP to move other molecules into and out of the cell

- Many aspects of the life of a cell depend on the fact that atoms and molecules have kinetic energy and are constantly in motion.
- This kinetic energy causes molecules to bump into each other and move in new directions. One result of this molecular motion is the process of diffusion.

Diffusion



Procedure:-

1- prepare a Beakers of water .

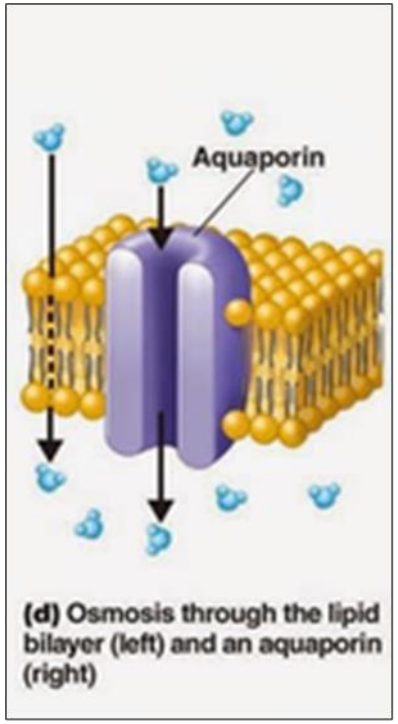
2- Add a drop of a dye.

3- Random movements of water and dye molecules drive diffusion, eventually

- resulting in a uniform distribution of the dye. Convection currents may also help distribute the dye in these solutions

Osmosis (Diffusion of water)

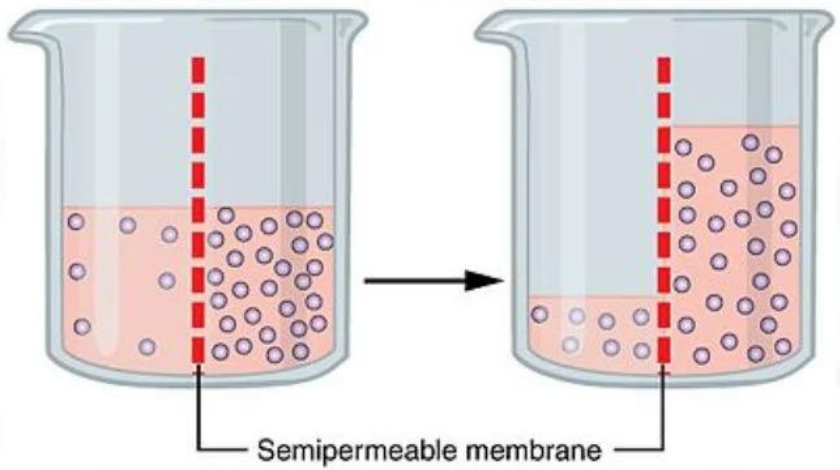
- Osmosis is a special case of diffusion. Osmosis is the diffusion of **water** through a selectively permeable membrane (a membrane that allows for diffusion of certain solutes and water) from a region of higher water potential **(low solute concentration)** to a region of lower water potential **(high solute concentration).** Water potential is the measure of free energy of water in a solution.



(d) Osmosis through the lipid bilayer (left) and an aquaporin (right)

Osmosis

The Chemistry Notes



Osmosis is the movement of water molecules through a semi-permeable membrane from a high-concentration area to a low-concentration area.

Osmolarity

- **Osmolarity** is measure of the total concentration of all solute particles in a solution
- Osmolarity tells how many particles (ions or molecules) are present
- Physiologists and clinicians usually express osmolarity in terms of **milliosmoles per liter (mOsm/L),** a unit of measure that expresses the quantity of nonpermeating particles per liter of solution.
- Blood plasma, tissue fluid, and intracellular fluids measure about 275–295 mOsm/L.
- It reflects the concentration of dissolved substances in plasma — mainly:
  - **Sodium (Na^+)**
  - **Chloride (Cl^-)**
  - **Glucose**
  - **Urea (BUN)**

Tonicity

Tonicity → Describes the **effect of a solution on cell volume depend on the** concentration of a solution as compared to another solution or to inside the cell.

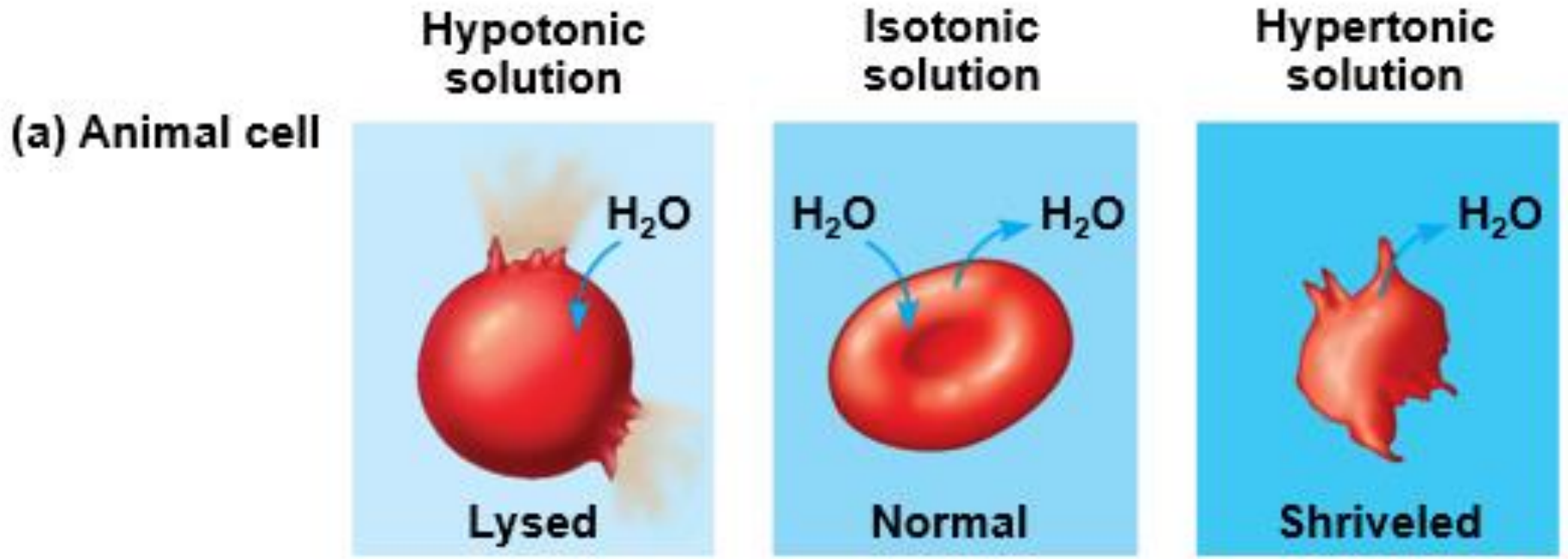
1. **Isotonic** solution: Solute concentration is same as that inside the cell; **no net water movement across the plasma membrane**
2. **Hypertonic** solution: Solute concentration is greater than that inside the cell; **cell loses water**
3. **Hypotonic** solution: Solute concentration is less than that inside the cell; cell gains water

Osmolarity Vs Tonicity

- **Tonicity** and **osmolarity** both describe solute concentration, but they differ in what they measure:
- **Osmolarity** → Measures the **total concentration of all solute particles** in a solution (both permeable and non-permeable).
- **Tonicity** → Describes the **effect of a solution on cell volume**,
- **In short:**

  👉 *Osmolarity = measurement of total solutes*

  👉 *Tonicity = effect on cells (water movement)*



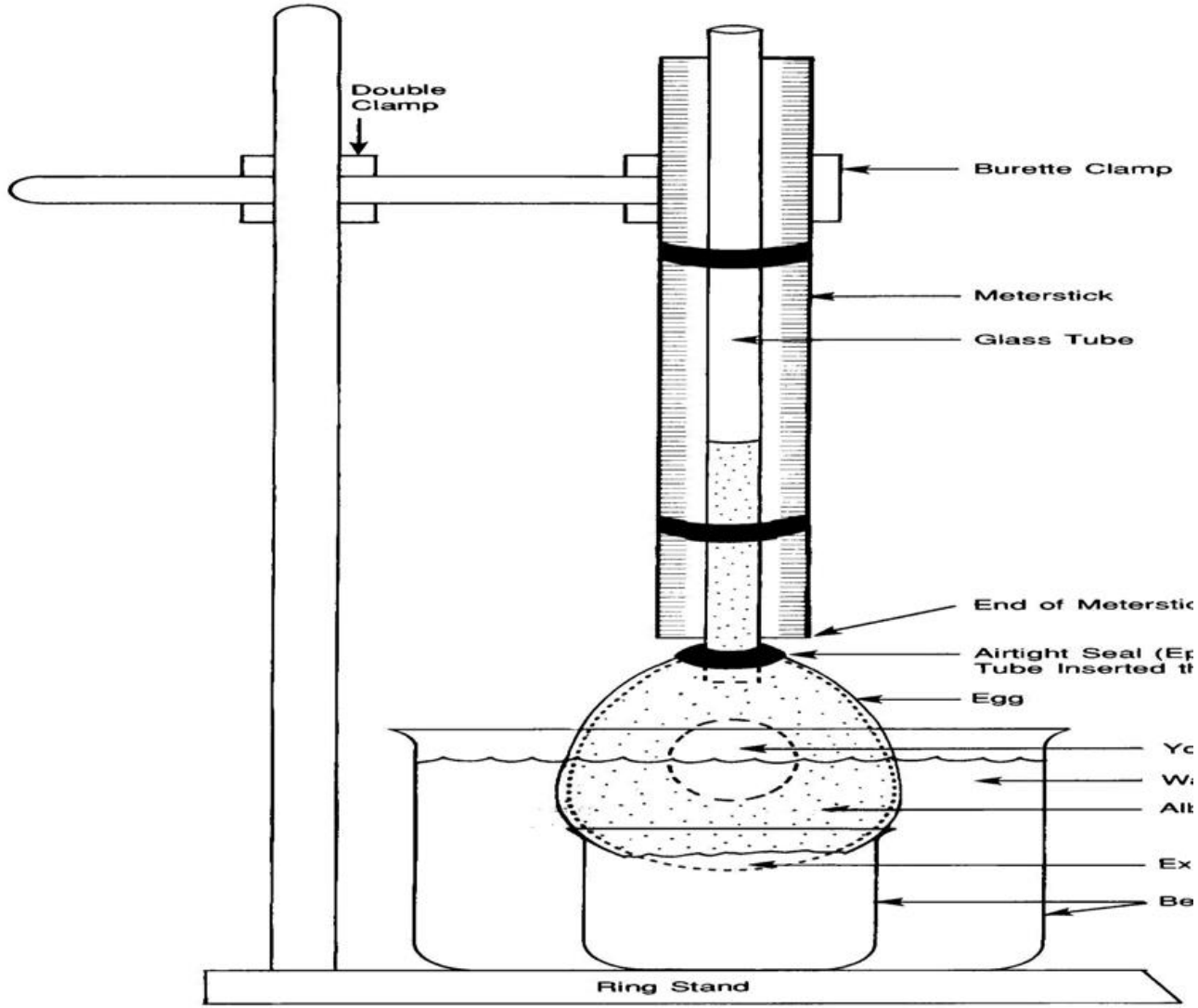
Video link

https://www.youtube.com/watch?app=desktop&v=A8cI6FkcG4c

Osmosis in Biological Membrane

Procedure 1

1. Removing the shell from one end of the egg, exposing the inner membrane.
2. A glass tube was inserted into the other end (through both the shell and inner membrane) and sealed in place with wax.
3. The egg was then immersed in a beaker of water (figure). Record the rise of fluid in the glass tube at 30-minute intervals for 90 mm
4. Repeat same procedure place the egg in the refrigerator
5. Repeat same procedure use salty solution instead of water in the glass


Double
Clamp
Burette Clamp
Meterstick
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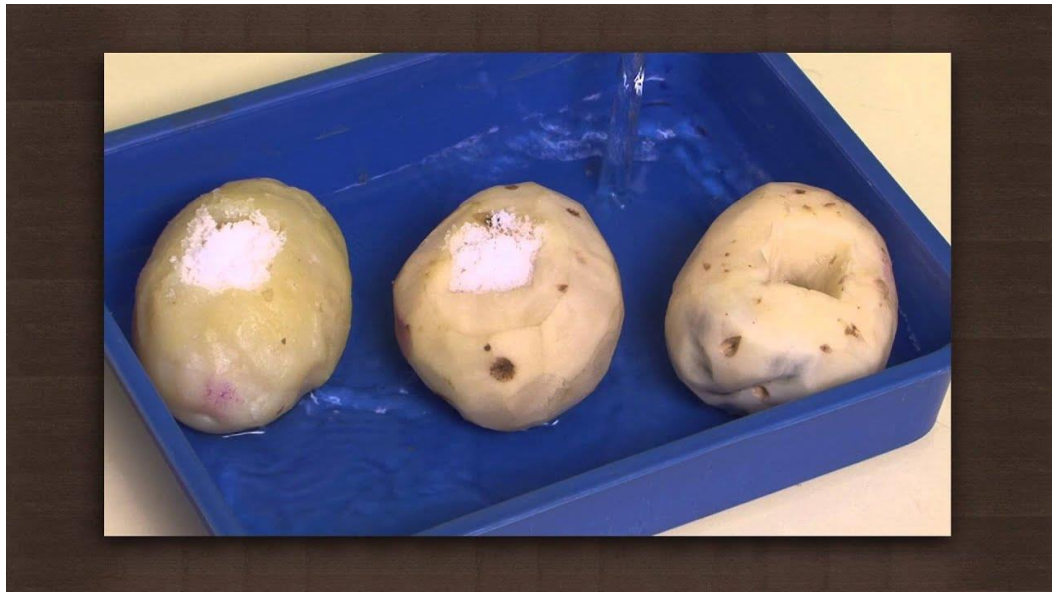
- The space inside the egg between the yolk and the inner membrane contains a large amount of albumin, a protein that cannot diffuse through the inner membrane.
- The inner membrane is permeable to water; therefore, water will diffuse from the beaker through the inner membrane into the albumin space of the egg. As pressure in the albumin space increases, water and albumin will rise in the glass tube. The rate of the rise is directly proportional to the rate of osmosis at the exposed inner membrane.

Procedure 2

- Clean two potatoes, cook one on them ½ hour
- Peel off the skins and then make a hall in the center of potatoes
- Add equal amount of NaCl in the halls (pith)
- Put the potatoes in the plate, fill the plate with distilled water
- Observe the results after 10 minutes

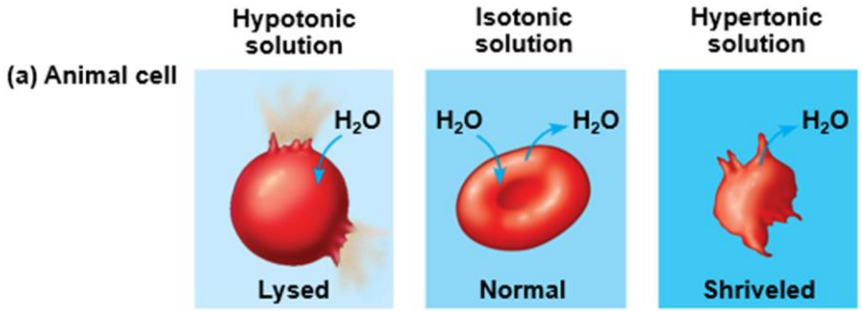


Excrement 3: Osmosis through RBC membrane

Materials

Prepare

1. 0.9% NaCL solution as ISOTONIC solution
2. 0.5 NaCl Hypotonic solution
3. 2% NaCl Hypertonic Solution



Add one drop of blood to each solution

- Prepare a slide from each solution
- Add one drop of solution on the slide, place cover slide and observe under the microscope
- Observe the shape of RBC cells in each solution , write your report

Excrement 4

Demonstration of Osmotic Pressure (Egg Membrane Model)

Aim:

To model osmosis using a decalcified egg as a semi-permeable membrane.

Materials:

- Fresh egg
- Vinegar (to dissolve shell)
- Sugar syrup (hypertonic solution)
- Distilled water

Procedure:

1. Soak egg in vinegar overnight to remove shell (leaving membrane intact).
2. Place one egg in sugar syrup, another in distilled water.
3. Observe after a few hours.

Expected Result:

- Egg in syrup shrinks (water moves out).
- Egg in water swells (water moves in).

References

- Ghai, C. L., M.D. (2012). A Textbook of Practical Physiology. Jaypee Brothers Medical Pub.
- Hall, J. E., & Hall, M. E. (2020). Guyton and Hall Textbook of Medical Physiology. Elsevier.
- Saladin, K. (2020). Anatomy & Physiology: The Unity of Form and Function. McGraw-Hill Education.