Chapter 4

Transportation through Plasma Membrane

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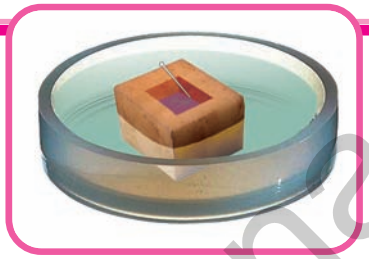


All the organisms in the world are made up of cells. You know that cell is the Basic unit of life. You have learnt about different parts of the cell and their specific duties in the chapter "Structure and functions of the cell". It is very interesting to know how substances pass through cells. There is a wonderful mechanism. Let us learn.

Activity-1

Get in-go out of the cell

Let us look at the substances in the table. Some are used by the cells while some are discarded by the cells.

Identify and tick it with the mark (√) which substances can go in and which substances can go out of the cell in the table.

Table-1

Substance	Can go into the cell	Can go out of the cell
Oxygen		
Glucose		
Proteins		
Fats		
Vitamins		
Minerals		
Carbon dioxide		
Wastes		

- *Which substances can enter the cell? Why?*
- *Which substances can go out of the cell? Why?*
- *Can you name any other substances, which can enter into the cell?*
- *Which substances can enter into the cell and go out of the cell?*

You know that cell performs different functions. For this different types of

substances are required by the cell. They are solids like glucose, liquids like water, and gases like oxygen. To understand the entry or exit of substances through the cell, let us do the following activities.

For doing these activities, we have to prepare different solutions.

Preparing Solutions:

To prepare sugar solution we need sugar and water. In a sugar solution sugar is the solute and water is the solvent. Sugar dissolves in water forming sugar solution.

Preparation of saturated solution :

Take 100 ml of cold water in a beaker. Add sugar/salt. Stir till it is dissolved. Repeat it till a little amount of it is left at the bottom of the beaker which will not dissolve. This is the saturated solution of sugar/salt.

Which one is more concentrated solution?:

Take three beakers with hundred ml. of water in each. Add half teaspoon of sugar to the first beaker, one teaspoon to the second and one and a half teaspoon to the third beaker. Compare the three solutions and answer the following question.

- *The solution of which beaker will be most sugary? What is the reason?*
- *Can we convert the solution of beaker I into solution of beaker III? How?*
- *How can we make the solution of the third beaker indicated to that of the first?*
- *How much water should we add to the solution in the third beaker to make it similar to solution of the first beaker?*

Solutions with different amount of solute dissolved in them are solutions of different concentrations.The amount of sugar present in the 100 ml of water is the concentration of the sugar.

- *Which beaker has the most concentrated solution?*

Lab Activity

Aim : Observation of material in different solutions

Material: 1. Two beakers 2. Tap water 3. Sugar 4. Dry grapes or kishmish

Procedure: Take 100 ml of water in a beaker. Keep dry raisin (kishmish) in it.

Fig-1 : Raisin kept in tap water

Leave it for one hour. Observe what has happened. Take it out and compare it with the dry raisin. Is there any change in the size of raisin? (You may try the same activity with slightly dried carrots and other such vegetables.)

Then take 100 ml of saturated solution of sugar in a beaker, which was already prepared.

Fig-2 : Swollen Raisin kept in Sugar solution

Keep swollen raisin of the previous activity. Leave it overnight in sugar solution and observe in the next morning. Do you find any change in the size of raisin?

- In Fig-1, water will move from ……. to …….
- In Fig-2, water will move from ……. to …….

Let us think how water goes in and out of raisin. Does the layer permits water to pass through? How does it work?

To learn more about the process. Let us do the following activity.

Lab Activity

Osmosis

Materials needed: One raw potato, petridish, two pins, Water, Sharp knife.

Fig-3(a) : Cut the potato into cube shaped

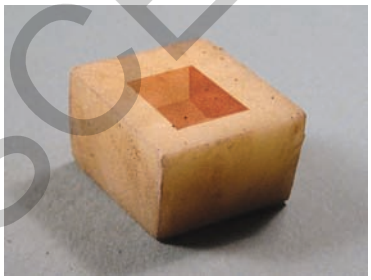


Fig-3(b) : Scoop to make a cup

Procedure: Take a raw potato and peel off its skin. Cut cube shaped cups from them as shown in the Fig-3(b) (you could make some other shapes as well).

Prepare a small amount of saturated sugar solution.

Pour the sugar solution in the potato cup.

Mark the level of sugar solution by piercing the pin.

Keep the potato cup in the petridish as shown in Fig-3(c).

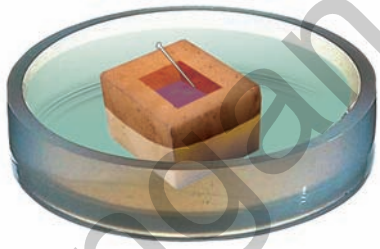


Fig-3(c) : The final arrangement

Pour water in the petridish to half of the height of the potato cup. Ensure that the potato cup does not float or submerge in water.

Leave the arrangement for half an hour and note your observations.

Repeat the above experiment by taking sugar solution in the petridish and water in the potato cup. Note your observation and compare with that of your previous one.

By comparing potato and raisin activities, do you find anything common among them? What is it?

From your observations you can conclude that water always moves toward the sugar solution. What might be the reason?

The movement of water from less solute concertration to more solute concertration across a membrane is called Osmosis (In Greek, Osmos means pushing).

To understand how materials may be moving in and out of cells through the cell membrane, let us do the following activity.

Activity-2

Filtration

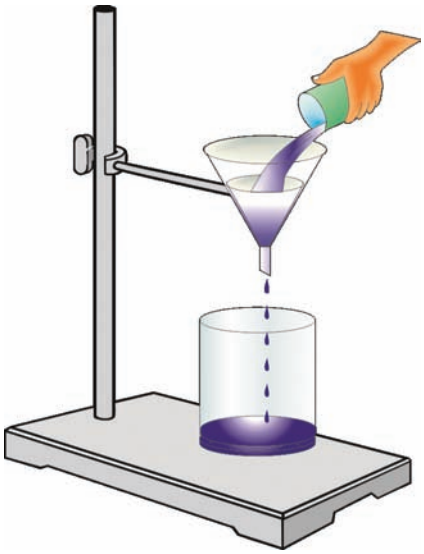


Fig-4(a) : Conventional procedure

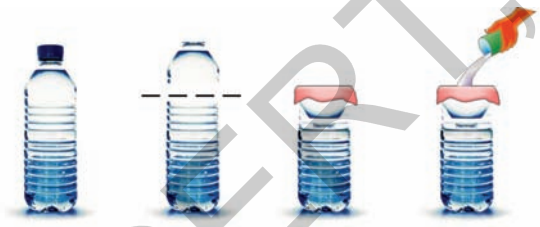


Fig-4(b) : Alternative procedure

To perform this activity we need the following materials:

Two beakers, Funnel, Filter paper, Retort stand, Sugar, Iodine and Wheat / rice flour, 500ml plastic bottle, cotton cloth.

Procedure :

1. Arrange the filtering apparatus as shown in the Fig-4(a) or the alternative method as in Fig-4(b).
2. Prepare wheat or rice flour solution in a beaker by adding one teaspoon of flour in 100ml of water.
3. Add a drop of tincture iodine to the solution.
4. Now pour the solution into the funnel.

Then observe and try to answer the following questions:

- *What remains on the filter paper or the cloth?*
- *What did the filter paper/ cloth allow to pass through?*
- *Which substance is not allowed by the filter paper to pass through?*
- *Why are certain substances not allowed to pass through the filter paper?*

Cells also act in the same way while allowing the substances to pass through the plasma membrane.

With the understanding of above activities let us try to understand the nature of the plasma membrane.

a) It allows water to pass through it.

b) It allows certain materials dissolved in water to pass through.

c) It will not allow certain materials to pass through it.

Allowing materials to pass through is called **permeability.**

In the previous activities we have observed the movement of water and materials in plants.

To know more details about plasma membrane or cell membrane, let us go through the following paragraphs.

The outermost, extremely delicate, elastic and membranous covering of the cell that separates its contents from the external environment is called plasma membrane. Plasma membrane is **selectively permeable** because it allows entry of certain substances, exit of some substances while preventing passage to remaining substances. Plasma membrane is a **living flexible membrane**.

Functions of plasma membrane

Shape : It provides a definite shape to semi fluid contents of the cell.

Mechanical Barrier : It functions as a mechanical barrier that protects the internal contents of the cell.

Selective Permeability : The membrane determines, which substances are to be allowed to enter or exit from the cell.

Endocytosis : The flexibility of the membrane enables the cell to engulf food and other substances (foreign particles) from its external environment by endocytosis. Amoeba acquires its food by this process.

Recognition : It has substances over its surface which function as recognition centres and points of attachment. They help in tissue formation, distinction of foreign substances and defence against microbes.

Flow of Information: Helps for flow of information amongst different cells of the organism.

Osmosis : It occurs due to presence of tiny water channels in the plasma membrane.

Cell Continuity: At places plasma membranes of adjacent cells become continuous to form plasmodesmata and cell junctions.

Specialization: Plasma membrane gets modified to perform different functions, e.g. absorption in microvilli.

Transport across the plasma membrane

The plasma membrane acts as a physical barrier between the organelles of a cell and the cytoplasm and between the cell and its surrounding environment. The membrane is said to be:

a) Impermeable if the substances do not pass through the membrane.

b) Permeable if the substances, both solute (substance which is dissolved) and solvent (medium in which solute dissolves) can pass readily through the membrane.

c) Semipermeable if the membrane is permeable to solvent but prevents the passage of solutes.

d) Selectively permeable if the membrane allows the passage of solvent and some selected solutes.

* ***Plasma membrane is selectively permeable.***

You already learnt about animal cell. Now let us do another activity to understand the movement of water in animals.

Activity-3

Materials and apparatus required: Three beakers, Petri dish, Salt, Dilute HCl / Toilet cleaning acid, two equal sized raw eggs, Cloth to wipe, A strip of paper for measurement, One table spoon.

Procedure:

- Keep the raw eggs in dil. HCl / toilet cleaning acid for 4 to 5 hours as shown in the Fig. 5(a).

Fig-5(a) : Egg in HCl

- Observe what happens. Take out the egg with the help of table spoon.
- Wash the eggs under tap water.

Fig-5(b) : Washing egg in tap water

- Measure the circumference of each egg with long strip of paper, at its widest place, and mark on the paper with pen or pencil. (For this you need teachers help to take care in measuring perfectly).
- Prepare concentrated salt solution in a beaker.
- Place one egg in the beaker with tap water and place the other in the salt water.

Fig-5(c) *Fig-5(d)*

Fig-5(c) : Deshelled egg in salt solution

Fig-5(d) : Deshelled egg in tap water

- Leave the beakers for 2 to 4 hours.
- Take the eggs out, wipe them and measure the circumference with the same strip of paper. Mark on the paper with pen or pencil.
- Do you find any difference in the circumference of the egg.
- The egg placed in salt water shrinks, the shrinking is due to exit of water.
- The egg placed in the tap water swells, the swelling is due to entry of water.

The process in which water molecules leave the cell is called **Exosmosis.**

The process in which water molecules enter the cell is called **Endosmosis.**

Lab Activity 3

Preparing a semi permeable membrane

When you break a boiled egg you might have observed a thin layer surrounding the egg white. This is the layer which prevents free entry of materials into the egg. Only certain materials are allowed to enter the cell. Thus the membrane is called as **semi permeable**.

(you can make use of the eggs used in the previous activity)

- Take one raw egg.
- Keep the raw eggs in dil.HCl for 4 to 5 hours.
- The shells which are made up of $CaCO_3$ are dissolved.
- Wash the eggs under tap water .
- Carefully pierce a pencil sized hole in the egg membrane and drain the contents.

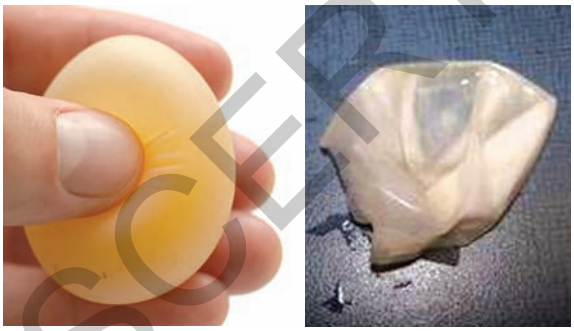


Fig-6(a): The Egg membrane

- Wash the membrane with fresh water. Now your semi permeable membrane is ready.

Now perform the following Activity using the egg membranes.

Materials and apparatus required:

Two egg membranes, Three beakers, Sugar, Water, Thread, Measuring jar, Disposable syringe.

Take one egg membrane and fill it with 10 ml of saturated sugar solution with a syringe. Tie its mouth with a (the pencil sized hole) thread. Measure 100 ml of tap water in a beaker. Keep the egg membrane in fresh water beaker. Leave it for overnight. Take the second egg membrane and fill it with 10 ml of tap water with the syringe. Prepare 100 ml of saturated sugar solution. Leave it overnight (use the same

Fig-6(b) : Egg membrane filled with sugar solution

Fig-6(c) : Egg membrane in fresh water

Fig-6(d) : Egg membrane in sugar solution

sugar solution prepared for the other activity)

Measure the contents of the egg membranes and beakers and note in your book. Give reasons for your observation.

In the activities done so far, we have observed how water move across membranes from solutions of less concentration to the higher through a process called as osmosis.

Importance of osmosis to living organisms

- Water enters the roots through osmosis.
- Water moves between the cells through osmosis.
- It helps in opening and closing of stomata.
- It brings about movement of water and minerals in certain plants.
- In our body waste materials are filtered from the blood.
- In our body useful materials are absorbed along with water through osmosis.

Diffusion

There are other ways in which materials move in a medium. Let us study one such process by the following activity.

If a bottle of scent is opened in one corner of a room, what will happen?

How do we feel? Its smell spreads in the entire room. Let us think of the following.

- How does the smell spread in the entire room?
- Is the smell spreading uniformly in the entire room?
- Can you reach the scent bottle if you are blind folded?
- When blind folded how you are able to locate the scent bottle?
- Can you give any other such examples?

There are other processes in which substances move in a medium. Let us study another such process by the following activity.

Do you know?

Three fourth of the earth is covered with oceans. Though plenty of water is there, we cannot use it, since it is salty. If we remove salts from it we can use it. When heavy pressure is applied on salt solution, which is separated from fresh water with semi permeable membrane, the water moves from salt solution into fresh water leaving the salt behind. This process is known as **'reverse osmosis'**. Nowadays domestically used reverse osmosis machines are available in the market, which filters salt water through three to five membranes.

Activity-4

Diffusion with coffee powder

Experiment with coffee powder. Let us Take half bowl of water. Prepare a small ball of coffee powder. Slowly put it in water. Observe what happens. Write a note on what you observed.

Do this activity as many ways as you could like.

- Putting the pinch of coffee powder first and adding water slowly.
- Pouring hot water on the pinch of coffee powder etc.

List your observations for each situation and write it down in your notebook.

Let us see whether other substances also behave in the same manner.

Activity-5

- Keep a small Crystal of $KMnO_4$ (Potassium permanganate) in the centre of the Petridish with the help of a Forceps.
- Carefully fill the Petridish with water. (It is better to use filler or dropper)
- Observe the movement of Pink Colour in the Petri dish every minute.

Also observe the spreading of colour from center to periphery.

Repeat the experiment with other substances (E.g.: copper sulphate) and compare the result.

- Do you find any relation between Time and Movement?

For better understanding, the movements of molecules in water, observe the following activity.

Activity-6

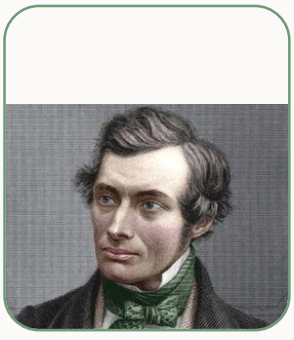
This activity can be done with other substances like copper sulphate crystals, water based ink etc. Compare the movement of coffee powder and $KMnO_4$, copper sulphate, ink in water and write your inference in your notebook.

The process, by which some materials when kept in a medium like air and water spread equally throughout is called **Diffusion.**

So far we have studied about osmosis and diffusion. There are other processes that occur across the cell membrane about which we shall study in higher classes.

Do you know?

Thomas Graham, Scottish physical chemist, worked on diffusion of gases. Graham measured the rate of diffusion of gases and also studied about diffusion of substances in solutions. He had inferred that a more soluble substance in a medium diffuse faster than a less soluble substance. This popularly known as 'Graham's law of diffusion.



Key words

Diffusion, Osmosis, Permeability, Semi Permeable membrane, Plasma membrane, Solute, Saturated solution.

What we have learnt?

- The cell transports various substances like solids, liquids and gases through them.
- The plasma membrane is not permeable to all the substances equally.
- The materials are transported across the membrane by the process called diffusion, osmosis and other methods.
- The processes are useful in daily life also. Air freshners, agarbathi, mosquito repellents works on the principle of diffusion.
- Reverse osmosis work on the principle of osmosis.
- Osmosis does not take place in dead cells.

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Improve your learning

1. The structure which controls the entry and exit of the materials through the cell is (AS1)
   (a) Cell wall (b) Cell membrane (c) Both (d) None of them
2. Fill in the blanks (AS 1)
   (a) The smell of flowers reaches us through the process of ……..
   (b) The MIC gas of Bhopal tragedy was spread throughout the city through the process of ……..
   (c) Water enters the potato osmometer due to a process called ……..
   (d) The fresh grape wrinkles, if kept in salt water because of ……..
3. What do you mean by permeability of membrane? Explain with suitable example. (AS 1)
4. If the dried vegetables are kept in water they become fresh. What is the reason? (AS 1)
5. Name the process by which we can get fresh water from sea water? (AS 1)
6. What will happen to a marine fish if kept in fresh water aquarium? Support your answer with reasons. (AS 2)
7. Why do the doctors administer saline only, not the distilled water. (AS 2)
8. What will happen if 50% glucose solution is injected intravenously (into vein)? (AS 2)
9. What will happen if cells do not have ability of permeability? (AS 2)
10. What are your observations in experiments to know about diffusion. (AS 7)

11. Discuss with your friends and write the list of incidences where diffusion occurs?

12. Draw the flowchart showing different stages in doing the experimnet with egg. (AS 5)

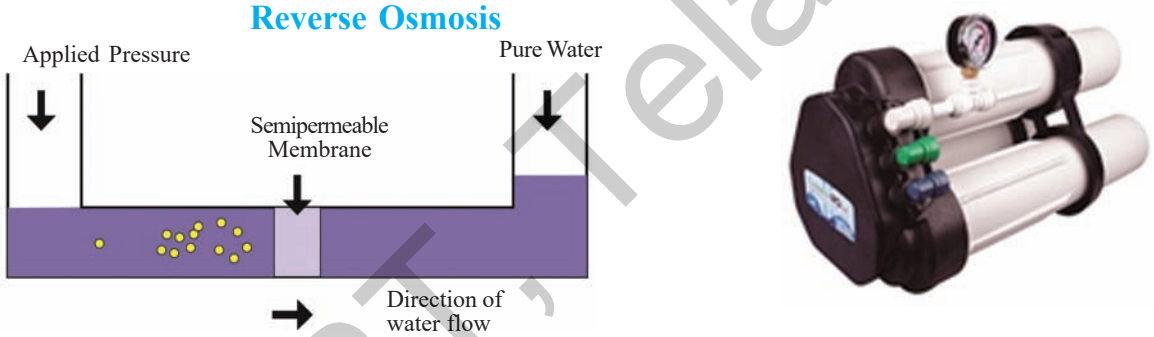
13. You have purchased a coconut in the market. By shaking it you found that there is less water in the coconut. Can you fill the coconut with water without making a hole in it? (AS 6)

14. How diffusion is useful in everyday life? (AS 7)

15. Give examples of three daily life activities in which osmosis is involved. (AS 7)

ANNEXURE

1. Have you ever seen water purifier. Generally we use water filter which contains purifying candles. If you want to get pure water you need reverse Osmometer.This instrument purifies water by the process of reverse osmosis.



2. Dialysis :

In our body the kidneys filter waste materials from blood by the process of osmosis. When the kidneys fail to filter, the toxic material remains in the body. The body will be poisoned by this, resulting in death.

Dr. William Kolff a Dutch physician in the year 1947 constructed the dialysis machine. (Dialysis is a Greek word. Dia means through; Lysis means splitting).

The body wastes are filtered by machine. The machine works on simple principle of Osmosis and filtration across a semi permeable membrane.

3. Effect of different solutions on blood cells :

When the animal cells which are without a cell wall like that of plant cells, undergo drastic changes when placed in different types of solutions. When red blood cells are placed

in hypertonic solution shrink. The red blood cells placed in hypotonic solution, like distilled water, swell and burst.

Point to be remembered. The animal cell if kept in hypotonic solution will burst due to lack of cell wall. The plant cell will not burst due to the presence of cell wall.

Do you want to drink a cool drink when you are thirsty?

What will all the animals and birds do when they are thirsty? They drink water.

The modern people are drinking cool drinks to quench their thirst. Do the cool drinks really quench thirst as water does?

The cool drink is prepared with sugar and dissolved CO_2 in it. The cool drink is a concentrated solution of sugar.

What will you think will be the effect of cool drink on our body?

Do you eat preserved, sugared food during journey?

The answer generally will be **YES.** When we are traveling in a bus we get dehydrated faster than when we walk, due to high air velocity. The solted food like potato chips or other food stuff in attractive packing will naturally water your mouth. After eating the 50gms. of chips, did you observe we feel thirstier? Why did this happen?

After eating preserved food like potato chips we feel thirstier. The balance between the salt and water is disturbed. To maintain the balance we have to drink more water after eating salted food.

What is the better food during a journey?

The natural fruits with 80% to 90% water in them, not only quench your thirst but also reduce your hunger.