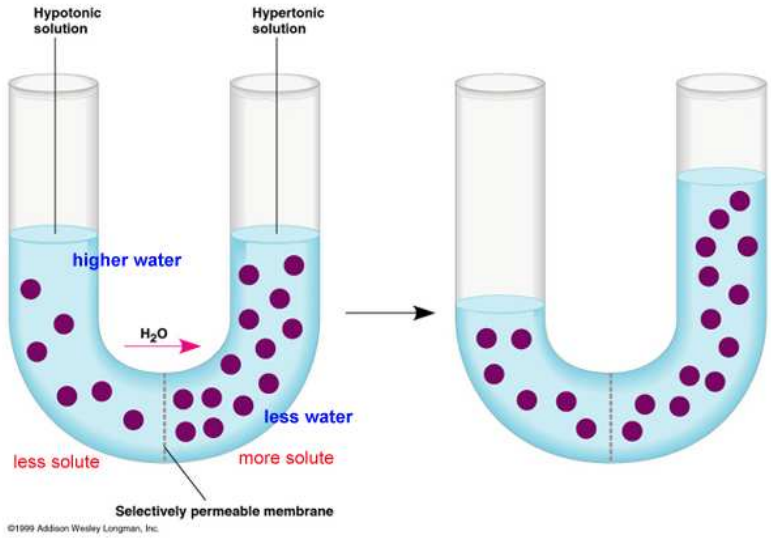
Osmosis

Biology coursework



By Gareth Ball

Preliminary work

Definition

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.

The definition contains three important statements:

1. 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.
2. 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.
3. 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**.

It does not matter too much which order you put these statements in. Nor does it matter if you write the definition as one sentence or three sentences. All that matters in your exam is that you make all three points when you explain what osmosis is.

Explanation

When you put an animal or plant cell into a liquid containing water one of three things will happen.

1. If the medium surrounding the cell has a higher water concentration than the cell (a very dilute solution) the cell will gain water by osmosis.

   Water molecules are free to pass across the cell membrane in both directions, but more water will come into the cell than will leave. The net (overall) result is that water enters the cell. The cell is likely to swell up.
2. If the medium is exactly the same water concentration as the cell there will be no net movement of water across the cell membrane.

Water crosses the cell membrane in both directions, but the amount going in is the same as the amount going out, so there is no overall movement of water. The cell will stay the same size.

3. If the medium has a lower concentration of water than the cell (a very concentrated solution) the cell will lose water by osmosis.

   Again, water crosses the cell membrane in both directions, but this time more water leaves the cell than enters it. Therefore the cell will shrink.

The Consequences of Osmosis in Plant Cells

Plant cells always have a strong cell wall surrounding them. When the take up water by osmosis they start to swell, but the cell wall prevents them from bursting. Plant cells become "turgid" when they are put in dilute solutions. Turgid means swollen and hard. The pressure inside the cell rises, eventually the internal pressure of the cell is so high that no more water can enter the cell. This liquid or hydrostatic pressure works against osmosis. Turgidity is very important to plants because this is what makes the green parts of the plant "stand up" into the sunlight.

When plant cells are placed in concentrated sugar solutions they lose water by osmosis and they become "flaccid"; this is the exact opposite of "turgid". If you put plant cells into concentrated sugar solutions and look at them under a microscope you would see that the contents of the cells have shrunk and pulled away from the cell wall: they are said to be plasmolysed.

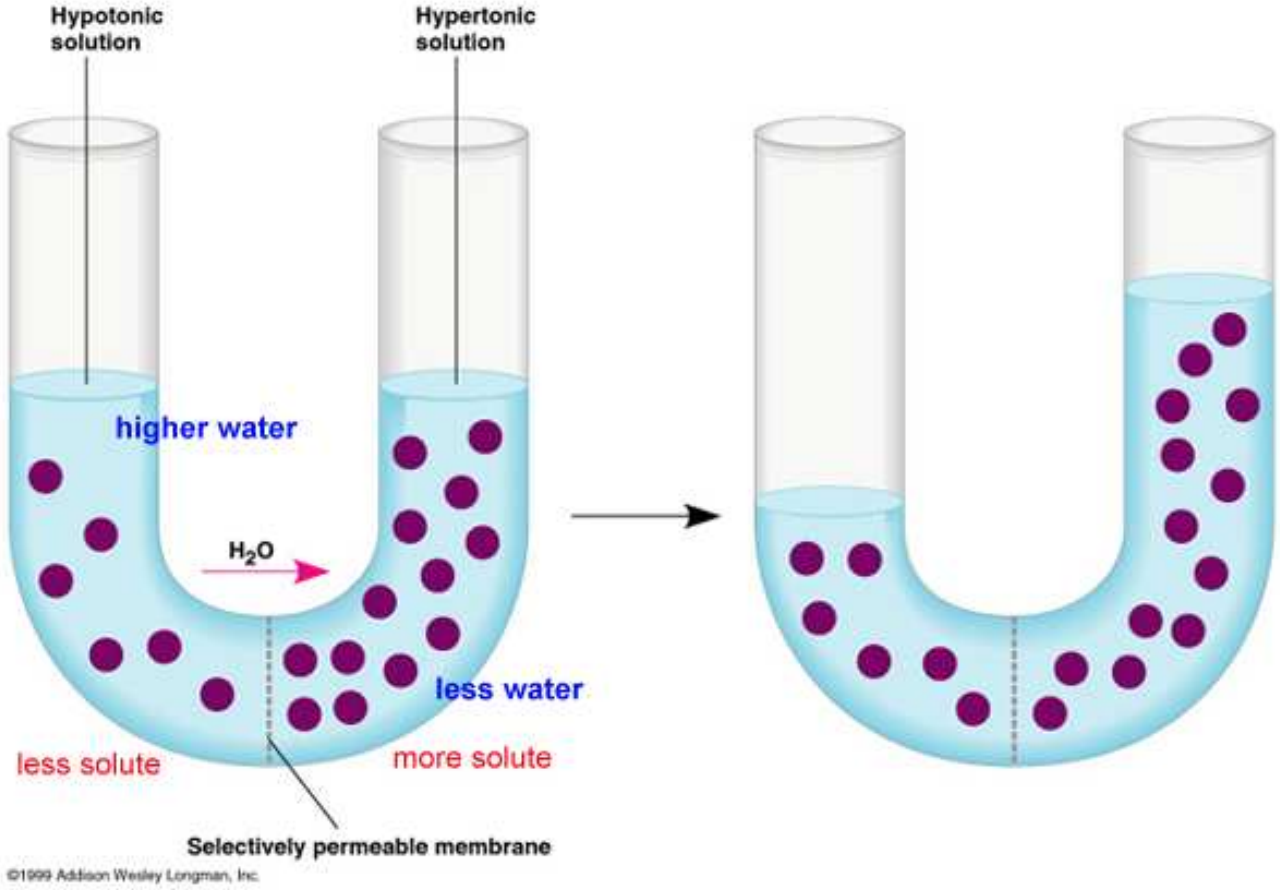
When plant cells are placed in a solution, which has exactly the same osmotic strength as the cells they are in a state between turgidity and flaccidity. We call this incipient plasmolysis. "Incipient" means "about to be". When I forget to water the potted plants in my study you will see their leaves droop. Although their cells are not plasmolsysed, they are not turgid and so they do not hold the leaves up into the sunlight.

The Consequences of Osmosis in animal Cells

When animal cells are placed in sugar solutions things may be rather different because animal cells do not have cell walls. In very dilute solutions, animal cells swell up and burst: they do not become turgid

because there is no cell wall to support the cell membrane. In concentrated solutions, water is sucked out of the cell by osmosis and the cell shrinks. In either case there is a problem. So animal cells must always be bathed in a solution having the same osmotic strength as their cytoplasm. This is one of the reasons why we have kidneys. The exact amount of water and salt removed from our blood by our kidneys is under the control of a part of the brain called the hypothalamus. The process of regulating the amounts of water and mineral salts in the blood is called **osmoregulation.** My insulin page will tell you more about other homeostatic mechanisms.

Animals which live on dry land must conserve water; so must animals which live in the sea (the sea is very salty!), but animals which live in freshwater have the opposite problem; they must get rid of excess water as fast as it gets into their bodies by osmosis.

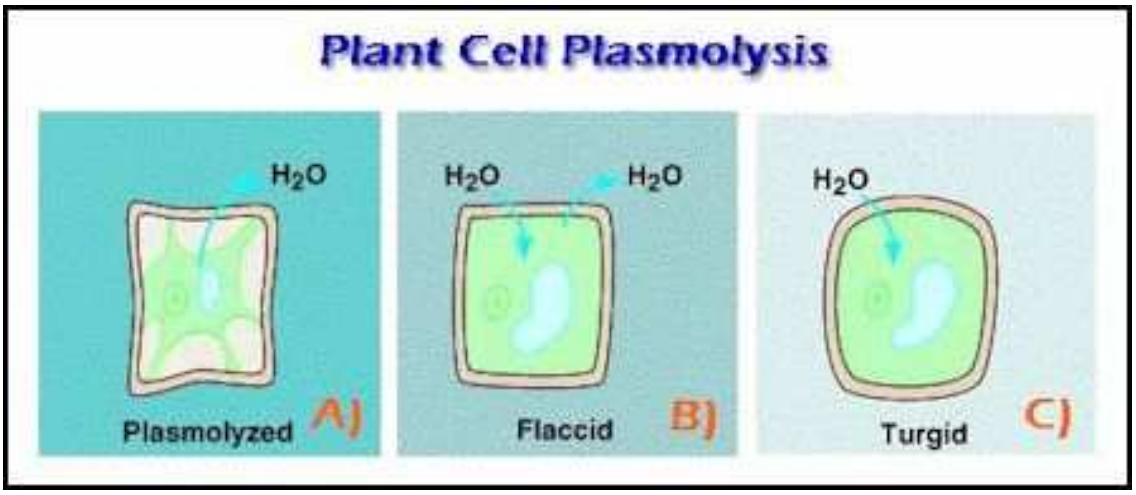


Plasmolysis

Plasmolysis occurs when a plant cells membrane shrinks away from its cell wall. This phenomenon occurs when water is drawn out of the cell an into the outside cell fluid. The movement of water occurs across the membrane moving from an area of high water concentration to an area of lower water concentration outside the cell.

Plant cells where the water flow into the cell and out of the cell are in equilibrium are not capable of providing the cell with support. Flaccid is a term used to indicate that the cell, although it contains water, does not have enough internal turgor pressure to provide structural support.

As mentioned earlier, turgor pressure is the build-up of water within the plant cell. Because of the rigidity of the cell wall, the cell does not rupture, but instead the internal pressure increases. This increased internal pressure gives the plant cells structure that can support the plant.



Plan

- Prediction

I predict that in the main experiment the weaker the sugar solution the longer the potato chips will end up. The stronger the sugar solution, the shorter the potato will be.

- Apparatus

- British baking potato
- Different concentrations of sugar solutions
- Borer
- Ruler
- Sticky labels
- Water
- Measuring cylinder – more than 1
- Metal pin
- Boiling tubes
- Test tube rack

- Method

THIS IS HOW TO CONDUCT THE EXPERIMENT

- Using a borer, make 25 potato cylinders of equal length. (2cm) 5 for each strength solution.
- Put the potato chips in the different solutions. (Water, 0.25m, 0.5m, 0.75m and 1m) 5 in each strength
- Leave them for 24 hours.
- After 24 hours, pour out the sugar solution to retrieve the potato chips.
- Measure each chip and record results.
- Get average length (in cm) for each tube.
- Record own results then collect other group's averages to compare with your results.

- Fair testing

- THE THINGS I WILL KEEP THE SAME ARE:
- To make this experiment a fair test, I will use the same type of potato to make each chip.
- I will keep the length of each chip the same.
- I will the same number of chips in each test tube.
- I will keep the chips in the solution for the same amount of time.

- THE THINGS I WILL CHANGE ARE…

- The strength of each sugar solution.

- <u>Results</u>

Experiment	Water	0.25 molar	0.50m	0.75m	1m
Piece 1	2.10	2.10	1.70	1.90	1.70
Piece 2	2.10	2.00	1.70	1.80	1.70
Piece 3	2.20	2.00	1.90	1.70	1.60
Piece 4	2.30	2.10	1.80	1.80	1.70
Piece 5	2.30	2.00	1.80	1.70	1.50
Average	2.20	2.04	1.78	1.78	1.64

Length of original chip	Group	Water	0.25m	0.5m	0.75m	1.00m
1cm	1 (David)	1.12	1.08	1.04	1.02	0.94
2cm	2 (me)	2.20	2.04	1.78	1.78	1.64
2cm	3 (Rachel	2.02	2.02	1.94	1.90	1.84
2cm	4 (Clifford)	2.32	2.10	1.88	1.78	1.84
Average (with group 1)	/ \ / \ / \ / \ / \ / \ / \ / \ / \ / \ / \ / \	1.92	1.81	1.66	1.62	1.57
Average (without group 1)	\ / \ / \ / \ / \ / \ / \ / \ / \ / \ / \ / \ /	2.18	2.05	1.87	1.85	1.77

I did an average without group 1 as well as an avera ge with them because they only used 1cm chips and every other group used 2cm chips so it would make a difference to the results as you can see.

- **<u>Observations</u>**
  - The stronger the sugar solution was, the shorter the chip ended up. The weaker the sugar solution, the longer the chip got.
  - I noticed a dramatic change in the average when I didn't include group 1. The results were more like my results without group 1.
  - Groups 2, 3 and 4 had some similar averages but not all of them were similar.
  - Each of the 5 pieces of potato for my group in each tube were fairly similar but they weren't ever all the same length.

- The results I got were not very consistent. Although the majority were, there were some results that I would have expected to be different. For example, I would have expected piece 1 in the 0.75m to be around 1.70cm judging by the other results but it was 1.90.

- **Safety**
  - Don't run in the lab.
  - Listen carefully to instructions.
  - Keep the benches and floor clear of bags and coats.
  - Always wear safety goggles when instructed to.
  - Tie back loose hair and fasten up loose clothing
  - Don't touch gas taps, electrical sockets or other equipment unless instructed.
  - Don't eat or drink in the lab.
  - Light a Bunsen burner properly on a heatproof mat.
  - If you break anything tell your teacher straight away.
  - Always clean up spills and put things away.
  - Don't distract other pupils while they conducting experiments.
  - Be careful when using the borer as it can hurt you because it is sharp.

Analysis
evaluation