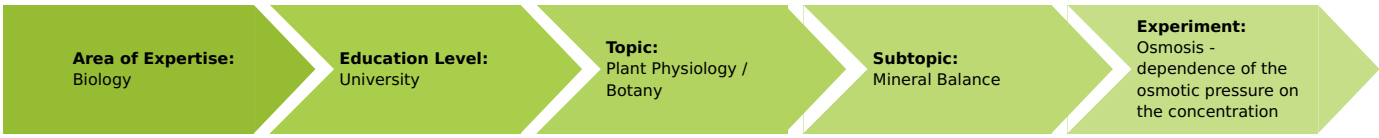
Osmosis - dependence of the osmotic pressure on the concentration (Item No.: P1135700)

Curricular Relevance



Difficulty	Preparation Time	Execution Time	Recommended Group Size
Intermediate	10 Minutes	50 Minutes	2 Students

Additional Requirements:

Experiment Variations:

Keywords:

Osmose, Osmotic pressure, Concentration

Principle and equipment

Principle

Educational objective

Osmosis is an essential process to move solutions of within a biological systems. To simulate osmotic processes, the segment apparatus is useful. You can run quantitative osmosis experiments with which you use different kinds of solutions (e.g. with glucose resp. copper sulphate) with different concentrations to compare their behaviour.

The segment apparatus can also be used for experiments in other areas (e.g. electrochemistry).

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Osmosis instrument with 7 chambers for quantitative experiments

Note

As far as osmosis experiments are concerned, the instrument offers the opportunity to double the effective membrane surface and, thereby, to speed up the osmotic process, which is a considerable advantage for demonstration lessons in particular.

Safety measures


Wear protective glasses and gloves!

Waste disposal
Collect soultions containing heavy metall ions in the collecting container for heavy metall waste.

Equipment

Position No.	Material	Order No.	Quantity
1	Precision Balance, Sartorius ENTRIS623-1S, 620 g / 0,001 g	49294-99	1
2	Osmosis and electrochemistry chamber	35821-00	1
3	Supplement chamber for osmosis / electro chemistry	35821-10	5
4	Filtration stand for 2 funnels	33401-88	1
5	Scale 350 mm	64840-00	7
6	Support rod, stainless steel, 750 mm	02033-00	1
7	D(+)-glucose 1-hydr. 250 g	30237-25	1
8	Support rod, stainless steel, l = 600 mm, d = 10 mm	02037-00	2
9	Cellophane, 300x200 mm, 5 sheets	32987-00	1
10	Copper-II sulphate,cryst. 250 g	30126-25	1
11	Scissors, straight,180 mm	64798-00	1
12	Water, distilled 5 l	31246-81	1
13	Capillary tube,i.d. 1.5mm,l 450mm	05939-00	7
14	Right angle clamp	37697-00	2
15	Glass tube holder with tape measure clamp	05961-00	7
16	Glass beaker DURAN®, tall, 250 ml	36004-00	3
17	Spoon, special steel	33398-00	1
18	Funnel, glass, top dia. 55 mm	34457-00	1
19	Wash bottle, plastic, 500 ml	33931-00	1
20	Glass rod,boro 3.3,l=300mm, d=7mm	40485-05	3

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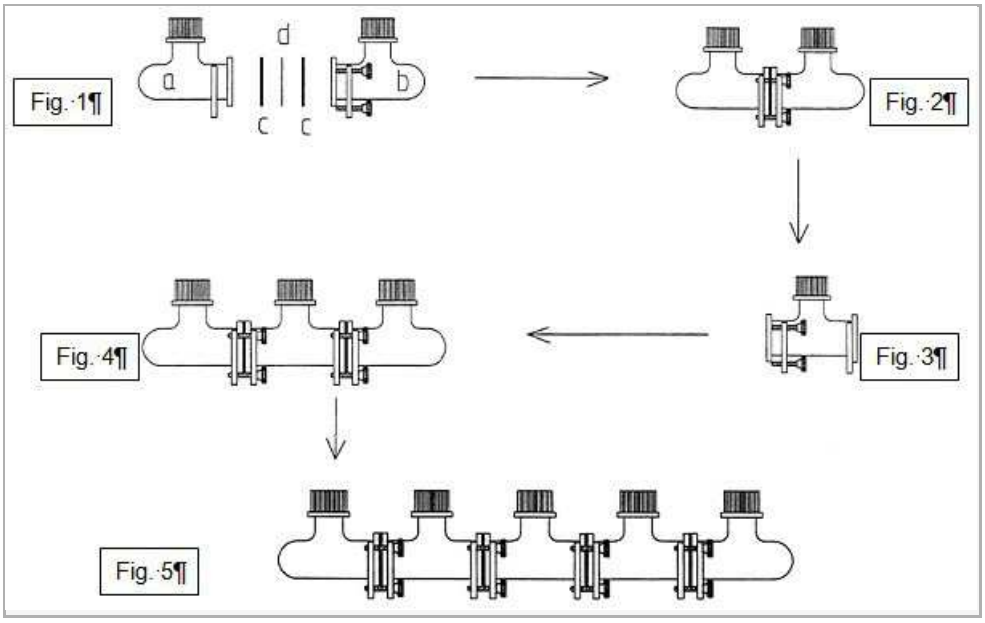
Set-up and procedure

The osmosis and electrochemistry chamber is perfectly suitable for the observation and demonstration of osmotic processes. In its simplest form, this apparatus consists of the two glass end segments a and b (fig. 1) and two rubber sealing rings c that are connected with the aid of the flange holder. Every segment has a short glass tube connector with a GL25 thread onto which a connecting cap with a sealing ring (25/8 mm) can be screwed. For osmosis experiments, glass capillary tubes are inserted into these connecting caps.

If a suitable semipermeable membrane, e.g. made of cellophane, is placed between the two sealing rings (d, fig. 1) and if the two chambers are screwed together, including the sealing rings with the membrane, the result is a double-chamber apparatus as shown in Fig. 2.

Multi-chamber apparatus. Additional chambers (fig. 3) as well as additional flange holders, pairs of sealing rings, and membranes can be used to set up a multi-chamber apparatus (Figs. 4, 5, and 6). As to which set-up should be selected depends on the teaching objective. If the objective is to simply observe the fundamental process of osmosis, the set-up that is shown in Fig. 2 is absolutely sufficient (basic apparatus plus capillaries). If, however, the aim is to also demonstrate the dependence of the osmotic pressure on the concentration of the solutions, a multi-chamber set-up as shown in figs. 5 and 6 should be used.



The membranes are made of cellophane. Since cellophane is only available in large sheets, a circular model with a diameter of 52 mm must be cut out of flat cardboard.

Then, use this model to draw the shape of the membranes on the sheet of cellophane with the aid of a water-soluble marker pen. The membranes thus prepared must then be cut out with a sharp pair of scissors and thereafter be placed in pure water for swelling.

In order to fasten the membranes in the apparatus, always place one membrane between two sealing rings without folding it and place these elements on the horizontal flange of a segment.

Then, attach the next segment with the corresponding flange and screw both segments together with the aid of the flange holder. When joining the segments, ensure that the glass connectors with the screw caps face the same direction.The apparatus thus produced stands on the flange holders.

In order to fix the glass capillaries in place, a support base (taken from the filtration stand) must be divided as shown in fig. 6.

Then, a support rod (l = 600 mm) must be fastened into each of the halves before attaching an additional support rod (l = 750 mm) horizontally between the two vertical support rods with the aid of two right-angle clamps. This horizontal support rod is used to hold the glass tube holders, which – in turn – receive the upper ends of the glass capillaries.

Run different experiments with copper sulphate and with glucose. Copper sulphate has the advantage that colour intensity is an indicator for its concentration - the more intense the colour, the higher the concentration.

First, fill the segments that are to hold the solutions (segments 2, 3, and 4 in fig. 6). This also provides the membranes with the correct tension. For the multi-chamber set-up that is shown here, a 5%, 10%, and 15% copper sulphate solution or a corresponding series of sugar solutions is used:

There are 7 segments. Eventually, the following solutions must be filled into the following segments:

Segment 2: 5% solution
Segment 4: 10% solution
Segment 6: 15% solution
Segment 1, 3, 5, 7: water

After the solutions have been filled into the apparatus, check the membranes for leaks. It must be absolutely ensured that none of the solutions can flow into the neighbouring chambers!

Then, fill the remaining chambers with pure water (segment 1 in fig. 6). The solutions and the water should reach the upper rim of the glass connectors. Now, the screw caps with the sealing rings are screwed on. Insert the capillary tubes into the sealing ring and push them in so that the liquid rises to approximately 100 mm in all of the capillary tubes.

Lastly, the scales are pushed onto the capillary tubes from behind. This initial position can be marked with a suitable glass marker pen. The capillary tubes are held in place at their upper ends.

Eventually, the experimental setup for quantitative readings looks as in fig. 6.

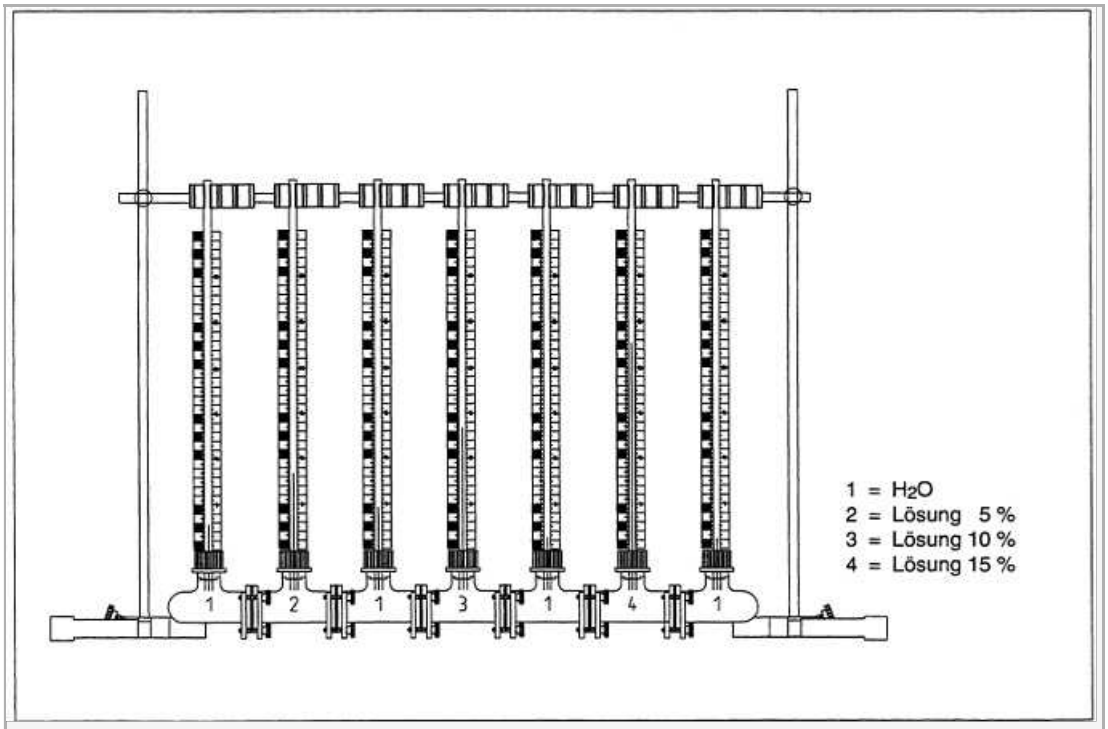


Fig. 6

Observation and evaluation

The solutions rise in the capillary tubes while the pure water descends in the capillary tubes. The higher the concentration of a solution is, the more quickly it rises.
To take measurements, use a watch to measure the time it takes for the solutions with their different concentrations to rise.

Create a chart and enter the readings as a function of time and analyse the data.

Eventually, compare your experimental findings with your assumptions which you made before running the experiment.

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