# Ionic permeability of the cell membrane with Cobra SMARTsense

Chemistry > Organic chemistry > Biochemistry

Biology > Biochemistry

| Difficulty level | Group size | Preparation time | Execution time |
|---|---|---|---|
| medium | - | 20 minutes | 30 minutes |

This content can also be found online at:

http://localhost:1337/c/62ebbdc17956f200031811d0

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# General information

## Application

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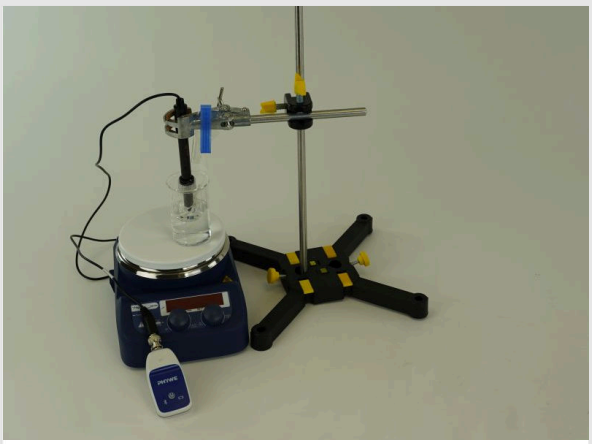

Experimental setup

The cell membrane regulates the transport of nutrients and water into the cell and of waste products and water out of the cell. This can take place passively, e.g. due to osmotic processes, as well as actively. In this experiment, the selective permeability of an artificial membrane (dialysis tube) for H+ and OH- ions is to be investigated.



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Robert-Bosch-Breite 10
37079 Göttingen

Tel.: 0551 604 - 0
Fax: 0551 604 - 107

info@phywe.de
www.phywe.de

## Other information (1/3)

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**Prior knowledge**

The students should already know the structure of the cell and the task of the cell membrane. It is particularly important that they know how the permeability of the cell membrane works and what its task is.

**Principle**

With an artificially created membrane, the selective permeability of a cell membrane can be simulated.

## Other information (2/3)

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**Learning objective**

The students will identify and measure how the selective permeability of an artificial membrane works.

**Tasks**

The students are to investigate the selective permeability of an artificial membrane (dialysis tube) for H+ and OH- ions.



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# Other information (3/3)

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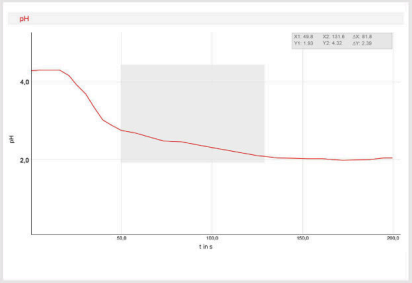
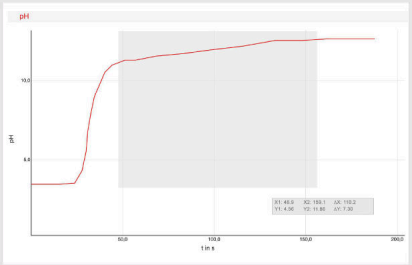
**Further information on the results**

- The illustrations show the pH-time curves for hydrochloric acid and sodium hydroxide solution as they are displayed by the programme after the measurement has been completed.
- The pH value in the beaker decreases due to the escape of H+ ions (top right figure), the pH value increases due to the escape of OH- ions (bottom right figure). The speed of the pH value change can be evaluated with the help of the measurement functions.
- If you use distilled water instead of demineralised water - as was done for this description of the experiment - the pH value may be higher. You can increase the pH value even further by bringing the water to a boil. This expels the carbon dioxide in the water.





# Safety instructions

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- Wear gloves and protective goggles.
- For the H- and P-phrases please refer to the corresponding safety data sheets.
- The general instructions for safe experimentation in science lessons apply to this experiment.



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Robert-Bosch-Breite 10
37079 Göttingen

Tel.: 0551 604 - 0
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# Theory

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Only certain molecules can pass through a selectively permeable membrane. This serves the cell to regulate the nutrient and water balance.

Apart from osmotic processes, active processes can also control this transport. An active process would be, for example, the sodium-potassium pump.

The dialysis tubes used are semi-permeable and differentiate according to the size of the molecules.



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Robert-Bosch-Breite 10
37079 Göttingen

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info@phywe.de
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# Equipment

| Position | Material | Item No. | Quantity |
|---|---|---|---|
| 1 | Cobra SMARTsense pH - Sensor for measuring the pH value 0 ... 14 (Bluetooth) | 12921-00 | 1 |
| 2 | Magnetic stirrer with heating, stainless steel, digital, 280 °C, 100-1500 rpm | FHO-RSM10HS | 1 |
| 3 | Magnetic stirring bar, 50 mm, cylindrical | 46299-03 | 1 |
| 4 | Separator for magnetic bars | 35680-03 | 1 |
| 5 | Retort stand, h = 750 mm | 37694-00 | 1 |
| 6 | Boss head | 02043-00 | 2 |
| 7 | Universal clamp | 37715-00 | 2 |
| 8 | Graduated cylinder, borosilicate, 25 ml | 36627-00 | 1 |
| 9 | Funnel, glass, top dia. 50 mm | 34457-00 | 1 |
| 10 | Wash bottle, plastic, 500 ml | 33931-00 | 1 |
| 11 | Beaker, Borosilicate, tall form, 250 ml | 46027-00 | 2 |
| 12 | Beaker, Borosilicate, tall form, 100 ml | 46026-00 | 2 |
| 13 | Dialysis tubing 24A,diam.44mm, 1m | 64208-00 | 1 |
| 14 | Dialysis clips, 2 | 64209-00 | 2 |
| 15 | Disposable gloves, 100pcs,medium | 46359-00 | 1 |
| 16 | Buffer solution tablets pH4, 100 | 30281-10 | 1 |
| 17 | Buffer solution tablets pH10, 100 | 30283-10 | 1 |
| 18 | Hydrochloric acid, 1.0 mol/l, 1000 ml | 48454-70 | 1 |
| 19 | Caustic soda solution, 1.0 m, 1000 ml | 48329-70 | 1 |
| 20 | Water, distilled 5 l | 31246-81 | 1 |
| 21 | measureAPP - the free measurement software for all devices and operating systems | 14581-61 | 1 |



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Robert-Bosch-Breite 10
37079 Göttingen

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info@phywe.de
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## Additional equipment

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| Position | Art. No. | Designation |
|---|---|---|
| 1 | | Mobile device (smartphone / tablet) |
| 2 | 14581-61 | measureAPP |

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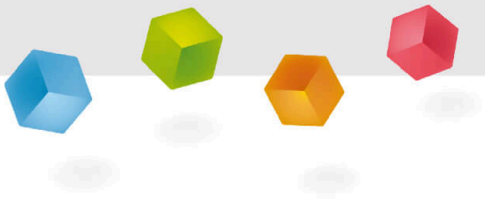

# Set-up & Procedure



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Robert-Bosch-Breite 10
37079 Göttingen

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## Set-up (1/3)

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For measurement with the **Cobra SMARTsense sensors** the **PHYWE measureAPP** is required. The app can be downloaded free of charge from the relevant app store (see below for QR codes). Before starting the app, please check that on your device (smartphone, tablet, desktop PC) **Bluetooth** is **activated**.

iOS

Android

Windows

## Set-up (2/3)

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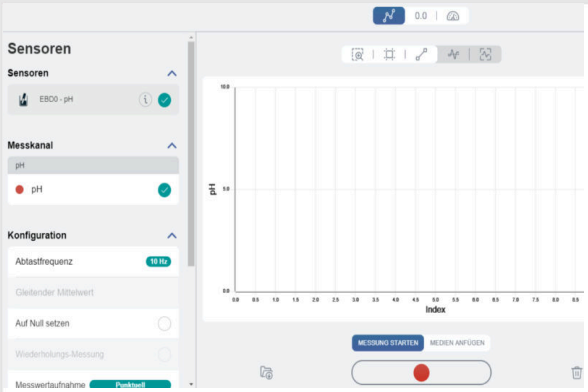


User interface measureApp

in the Windows 10 version

- Switch on the SMARTsense pH sensor by pressing and holding the power button.
- Connect the sensor in the measureAPP under the item "Measure" to the device as shown in the figure on the left.
- The SMARTSense pH sensor is now displayed in the app.



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Robert-Bosch-Breite 10
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## Set-up (3/3)

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- Cut two pieces of dialysis tubing about 15 cm long and close each end with a dialysis clamp. **Tip:** If the dialysis tubing is difficult to open, soften it briefly in distilled water.
- A bag of dialysis tubing is placed in a 250 ml beaker and filled with 15 ml hydrochloric acid (1 mol/l) using a measuring cylinder. **Caution:** Wear protective gloves! The bag is then closed with a dialysis clamp, carefully cleaned on the outside with distilled water and placed on a clean surface.
- In the same way, fill the second bag with sodium hydroxide solution (1 mol/l). Clean the 250 ml beaker beforehand! Both bags must not touch each other!

## Procedure (1/2)

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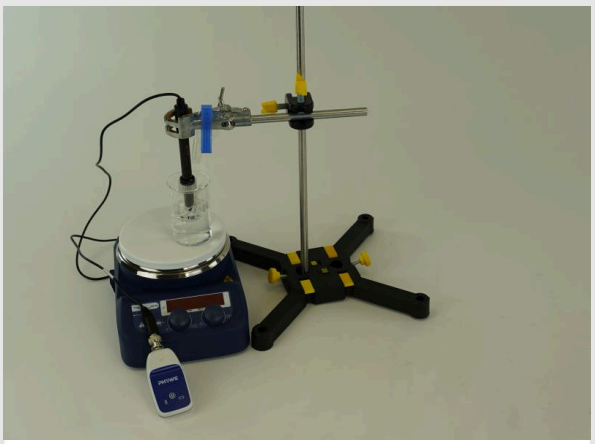
- Attach the universal clamps to the rod of the stand using the boss head.
- Put the magnetic stirring bar into the 250 ml beaker, pour in about 150 ml distilled water and place the beaker on the magnetic stirrer.
- Attach the pH electrode using one of the universal clamps so that it is completely immersed in the distilled water.
- Set the stirrer to a medium stirring speed (caution: the magnetic stirring bar must not hit the pH electrode!).



Experimental setup



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Robert-Bosch-Breite 10
37079 Göttingen

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info@phywe.de
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## Procedure (2/2)

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- Start measurement.
- Lower the dialysis bag filled with hydrochloric acid into the beaker approx. 20 s after starting the measurement and secure it with the second universal clamp.
- Follow the time curve of the reaction in the software. A running time of 200 seconds is sufficient.
- Save data after measurement.

Repeat the measurement in the same way with the dialysis bag filled with sodium hydroxide solution (rinse the beaker, pH electrode and magnetic stirring bar thoroughly with distilled water beforehand!)

# Report



PHYWE
Robert-Bosch-Breite 10
37079 Göttingen
Tel.: 0551 604 - 0
Fax: 0551 604 - 107
info@phywe.de
www.phywe.de

# Task 1

Drag the words into the correct places.

The cell membrane regulates the transport of nutrients and water _____ the cell and of waste products and water _____ the cell. This can be both passive, e.g. due to _____ processes, and active.
Selective permeability means that only _____ molecules are allowed to pass through.

osmotic
into
certain
out of

Check

# Task 2

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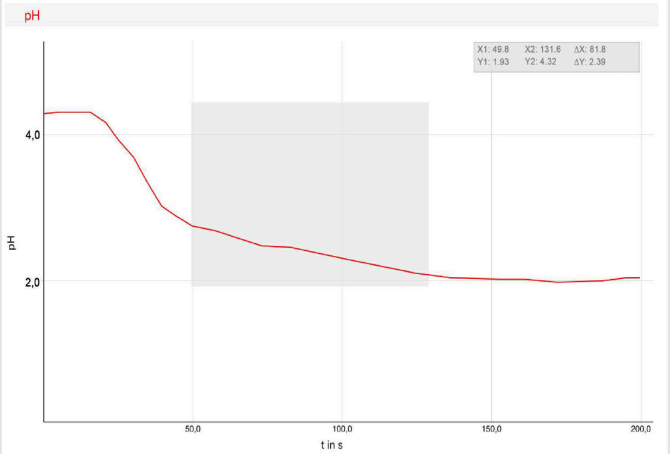
Does the curve on the right represent the exit of H+ ions or the exit of OH- ions?

The escape of OH- ions.

The escape of H+ ions.

Neither of them.



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# Task 3

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Select the correct statements.

- ○ With the semi-permeable membrane, only certain molecules are allowed to pass, whereas with a selectively permeable membrane, only molecules below a certain size are allowed to pass.
- ○ With selective permeability, only certain molecules are allowed to pass, whereas with a semi-permeable membrane, only molecules below a certain size are allowed to pass.
- ○ Every cell membrane is semi-permeable.

Check

| Slide | Score / Total |
|---|---|
| Slide 17: Cell membrane | 0/4 |
| Slide 18: Ion leakage | 0/1 |
| Slide 19: Permeability | 0/1 |

**Total** 0 / 6

Solutions Repeat



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Robert-Bosch-Breite 10
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