

Glycolysis (pressure measurement) with Cobra SMARTsense



Biology

Biochemistry



Difficulty level

medium



Group size

-



Preparation time

20 minutes



Execution time

30 minutes

This content can also be found online at:



<http://localhost:1337/c/5f4c7cf07b2768000356b92d>

PHYWE

General information



Application

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Experiment set-up

During glycolysis, i.e. the decomposition of monosaccharides to pyruvate by baker's yeast (*Saccharomyces cerevisiae*), respiration produces CO_2 . In a sealed container, the production of CO_2 by increasing the pressure.

Other teacher information (1/6)

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Prior knowledge



Students should be familiar with the basic principle and function of glycolysis. They should also know how and why temperature and pH changes can affect glycolysis.

Scientific principle



Detection of glycolysis by measuring the CO₂-production under different experimental conditions (temperature, pH).

Other teacher information (2/6)

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Learning objective



In this experiment, the pupils and students measure whether glycolysis is attenuated or enhanced by changes in temperature and pH value.

Tasks



Pupils and students are supposed to test glycolysis by measuring the CO₂-production (of increasing pressure) and investigate the influence of temperature and pH value on metabolic activity.

Other teacher information (3/6)

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Observations and results

Test 1 (normal conditions): The curve rises sharply. After about 40 minutes at a pressure of about 1150 hPa the rubber stopper was pushed out of the Erlenmeyer flask (figure right).



Other teacher information (4/6)

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Observations and results

Test 2 (temperature reduced): The pressure rises hardly at all at first, but then increases more strongly, but less strongly overall than when measured at room temperature. After about 74 min at a pressure of 1200 hPa, the rubber stopper was pushed out of the Erlenmeyer flask (right figure).



Other teacher information (5/6)

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Observations and results

Test 3 (temperature increased): The curve first falls, then recovers after about 17 minutes and then rises more and more steeply (right figure).

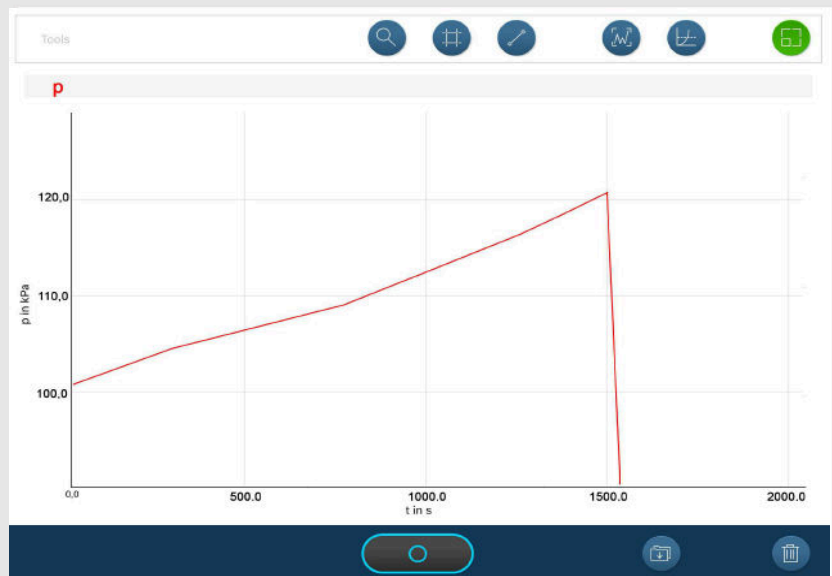


Other teacher information (6/6)

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Observations and results

Test 4 (pH value of the nutrient medium reduced) The curve rises steeply until after about 25 minutes at a pressure of about 1250 hPa the rubber stopper is pushed out of the Erlenmeyer flask (figure on the right).



Safety instructions

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- The general instructions for safe experimentation in science teaching apply to this experiment.
- For the H and P phrases, please refer to the corresponding safety data sheets.

Theory

In glycolysis, i.e. the breakdown of simple sugars (monosaccharides) to pyruvate by baker's yeast (*Saccharomyces cerevisiae*), respiration generates not only energy but also CO₂. In a sealed container, the production of CO₂ by increasing the pressure.

The activity of baker's yeast (*Saccharomyces cerevisiae*) can be influenced by various factors. For example, a change in temperature or pH value can have a considerable effect on the speed of the yeast metabolism.

Equipment

Position	Material	Item No.	Quantity
1	Cobra SMARTsense Absolute Pressure - Sensor for measuring the absolute pressure 20 ... 400 kPa (Bluetooth + USB)	12905-01	1
2	Support base, variable	02001-00	1
3	Boss head	02043-00	2
4	Universal clamp with joint	37716-00	1
5	Magnetic stirrer with heating, stainless steel, digital, 280 °C, 100-1500 rpm	FHO-RSM10HS	1
6	Pt1000 for magnetic stirrer RSM-10HS/HP/A	FHO-RSME320	1
7	Magnetic stirring bar, 50 mm, cylindrical	46299-03	1
8	Erlenmeyer flask, borosilicate, narrow neck, 250 ml	46142-00	1
9	Beaker, Borosilicate, low form, 1000 ml	46057-00	1
10	Beaker, Borosilicate, tall form, 250 ml	46027-00	2
11	Graduated pipette 10 ml	36600-00	1
12	Rubber stopper 26/32, 1 hole 7 mm	39258-01	1
13	Glass tube, straight, l=80 mm, 10/pkg.	MAU-16074541	1
14	PVC tubing, inner dia. = 7 mm, l = 1 m	03985-00	1
15	Glass rod, boro 3.3, l=200mm, d=6mm	40485-04	1
16	Universal clamp	37715-00	1
17	Buffer solution tablets pH4, 100	30281-10	1
18	Buffer solution tablets pH10, 100	30283-10	1
19	Glycerol 99% 100 ml	30084-10	1
20	Wash bottle, plastic, 500 ml	33931-00	1
21	Portable Balance, OHAUS YA302	49213-00	1
22	measureAPP - the free measurement software for all devices and operating systems	14581-61	1

Equipment

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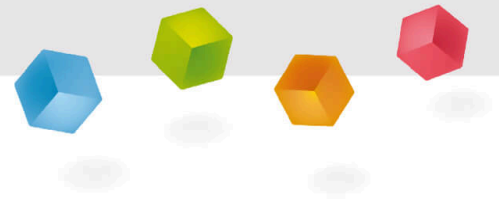
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7	Magnetic stirring bar, 50 mm, cylindrical	46299-03	1
8	Erlenmeyer flask, borosilicate, narrow neck, 250 ml	46142-00	1
9	Beaker, Borosilicate, low form, 1000 ml	46057-00	1
10	Beaker, Borosilicate, tall form, 250 ml	46027-00	2

Additional equipment

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Position	Art. No.	Designation
1		mobile device (Smartphone / Tablet) or PC with Windows 10
2	14581-61	measureAPP
3		Grape juice
4		fresh baker's yeast (<i>Saccharomyces cerevisiae</i>)
5		Ice cube

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Setup and procedure

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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measureApp user interface

- Turn on the SMARTsense Absolute Pressure Sensor by pressing and holding the power button.
- Connect the sensor in the measureAPP under the point "Measure" to the device as shown in the figure on the left.
- The SMARTSense Absolute Pressure sensor is now displayed in the app.

Set-up (3/3)

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- Set up the devices as shown in the figure on the right.
- Place the Erlenmeyer flask on the magnetic stirrer and lock it with the universal clamp and the double sleeve below the pressure module. Screw the glass tube with a little glycerine into the rubber stopper. Then connect the pressure module with the glass tube using the shortest possible piece of tubing.



Procedure (1/3)

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Test 1

- Heat 150 ml grape juice to 30-35°C.
- Weigh 10 g baker's yeast, pour into a 250 ml beaker, fill up to 100 ml with warm tap water and mix with the glass rod.
- Place the heated fruit juice, 10 ml of the yeast suspension and the stirring rod in the 250 ml Erlenmeyer flask.
- Close the Erlenmeyer flask with the rubber stopper, place it on a magnetic stirrer and fix it with the universal clamp. Set small stirring step and connect to pressure module.
- Start the measurement and continue measuring until usable measured values are obtained for comparison with the other partial tests.

Procedure (2/3)

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Test 2

- Fill 1000 ml beaker halfway with tap water. Place the Erlenmeyer flask in the beaker and add some ice cubes. Seal the Erlenmeyer flask with the stopper and start the measurement. Measure until the results are usable for comparison with the other partial tests.

Test 3

- Fill 1000 ml beaker halfway with hot tap water (try different temperatures, e.g. 50/70/90°C).
- Place the Erlenmeyer flask in the beaker, close it with stopper and start the measurement. Measure until you obtain usable results for comparison with the other partial tests.

Procedure (3/3)

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Test 4

- Add different buffer solutions (e.g. 20 ml buffer solution pH 4.01 or pH 10.01). For this purpose, add one buffer tablet to 20 ml of water.
- Seal the Erlenmeyer flask with the stopper and start the measurement. Measure until the results are usable for comparison with the other partial tests.

Report

Task 1

What role does an elevated temperature play in glycolysis by yeast?

- ☐ If the temperature is too high, the yeasts' metabolism ceases; if the temperature rises above 45°C in the long term, the metabolic activity increases exponentially.
- ☐ If the temperature is too high, the yeasts' metabolism stops, if the temperature rises above 45°C for a long time, the yeast dies.
- ☐ Temperatures which are in the optimum range of the yeast (approx. 32°C) promote the metabolic activity.

✓ Check

Task 2

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What role does cold play in glycolysis by yeast?

- ☐ Due to the influence of the cold, the metabolism of the yeasts slows down, which is particularly noticeable at the beginning.
- ☐ Glycolysis is independent of temperature.
- ☐ The influence of the cold leads to an acceleration of the metabolism of the yeasts, which is particularly noticeable in the beginning.
- ☐ The glycolysis is temperature-dependent.

✓ Check

Task 3

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Select the correct statements on the influence of the pH value on the metabolic activity of the yeast.

- ☐ With an acidic buffer solution the living conditions of the yeast are no longer optimal and the metabolic activity decreases.
- ☐ With a basic buffer solution the living conditions of the yeast are no longer optimal and the metabolic activity decreases.
- ☐ Since yeasts prefer a range of pH 3.8-5.2, the addition of an acidic buffer solution results in a significant increase in metabolic activity.

 Check