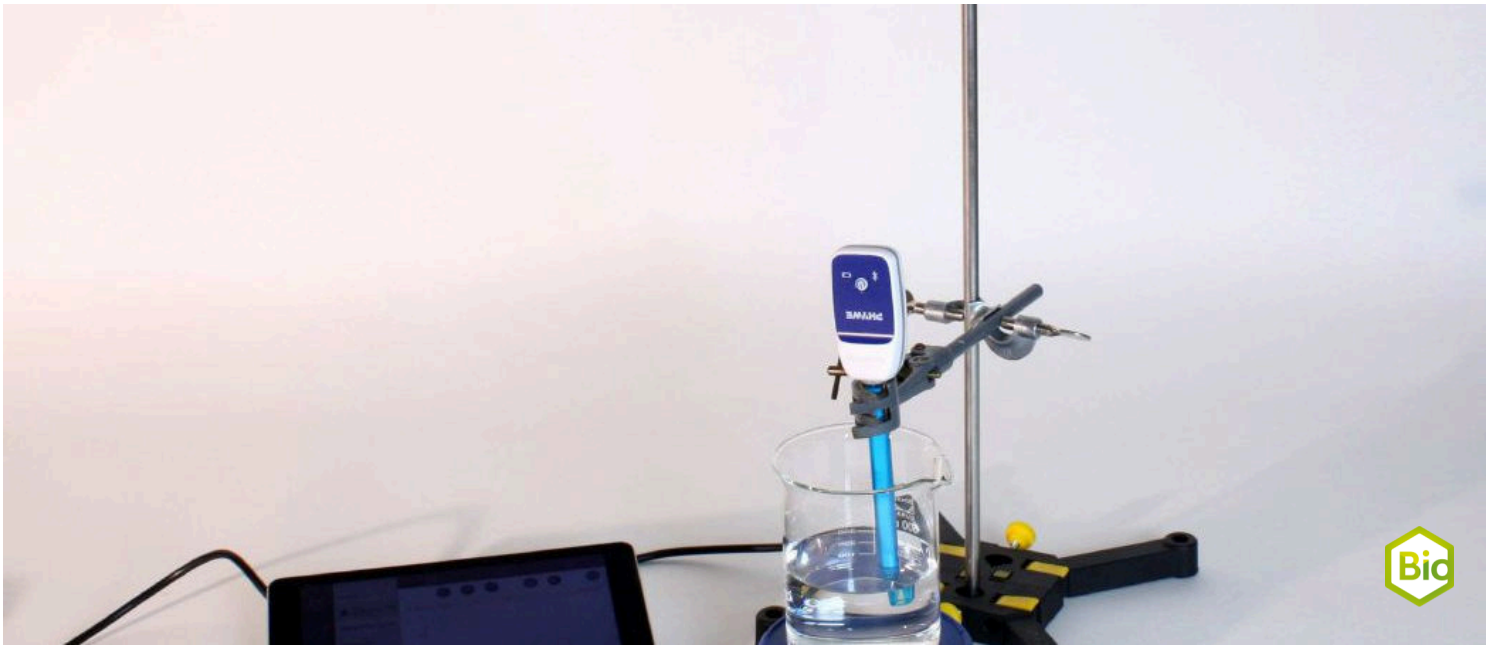
Water quality - contamination by heavy metals- with Cobra SMARTsense



Effect of heavy metals on the activity of enzymes

Biology | Ecology & environment | Water analysis

Difficulty level	Group size	Preparation time	Execution time
-	-	-	-

This content can also be found online at:

http://localhost:1337/c/5ed8f9337f59a10003352333

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Teacher information

Application

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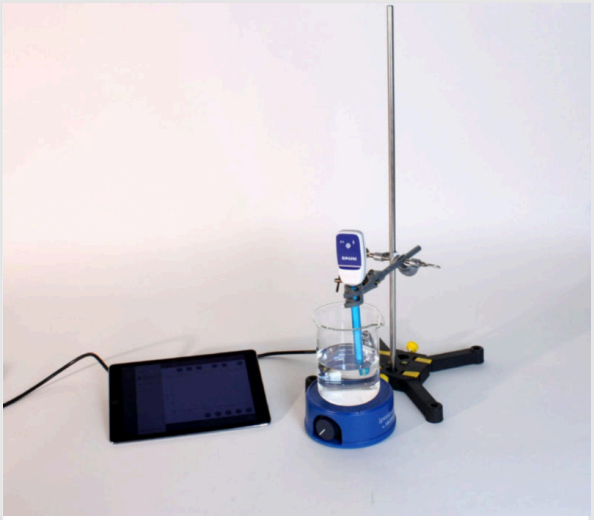

Test setup

Heavy metal ions can enter surface and ground water from mining sites or with insufficiently treated waste water from galvanic or similar operations. They block the action of enzymes, so that processes controlled by them in the metabolism of organisms are disturbed or even prevented. Using urea cleavage by urease, the blockage of enzyme action by heavy metal ions can be measured using common laboratory techniques.

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Other teacher information (1/4)

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Prior knowledge

The students should know the chemical and biological background of enzymatic cleavage and general knowledge of enzyme function.

Principle

The students carry out two experiments with enzymatic cleavage, one with and one without the addition of heavy metals. They compare these with each other.

Other teacher information (2/4)

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Learning objective

The students should recognise that heavy metals can influence the effect of enzymes.

Tasks

The students investigate two enzymatic cleavage processes, one with and one without the addition of heavy metals.

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Other teacher information (3/4)

Result

No change in conductivity can be detected in the urea solution as the urea solution does not dissociate. **First experiment**: if urease is added to the urea solution, the conductivity increases continuously (figure right). This phenomenon is caused by the fact that the urease splits the urea into ammonia and carbon dioxide and dissociates the secondary ammonium carbonate that is formed from it. The more ions are present, i.e. the more ammonium carbonate is formed, the greater the conductivity. It is therefore a measure of the intensity of urea cleavage by urease.

Control measurement without addition of CuSO4

Other teacher information (4/4)

Result

Second experiment: if a solution containing heavy metals is added to the urea-urease mixture (figure on the right), the conductivity initially increases abruptly because additional ions were introduced into the measuring substrate with this solution. Afterwards, however, the conductivity remains constant or increases only slightly, depending on the concentration of the heavy metal-containing solution. The urease effect has been blocked by the heavy metal ions and no or only little urea is split.

Blocking the urease effect by adding CuSO4

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Safety Instructions

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- The general instructions for safe experimentation in science teaching apply to this experiment.

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Student Information

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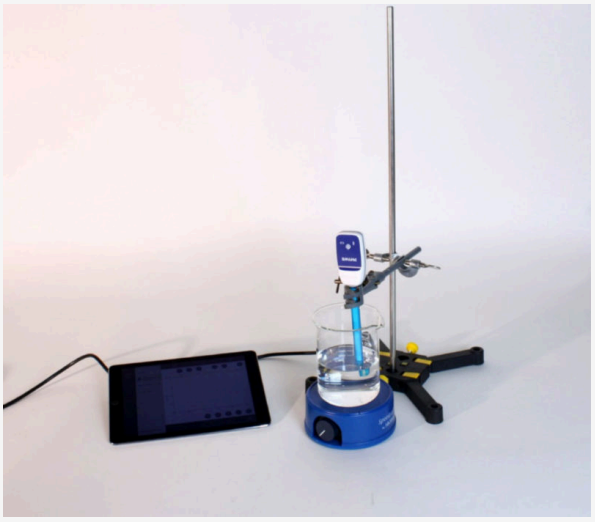
Motivation



Experimental setup

Heavy metal ions can enter surface and ground water from mining sites or with insufficiently treated waste water from galvanic or similar operations. They block the action of enzymes, so that processes controlled by them in the metabolism of organisms are disturbed or even prevented. Using urea cleavage by urease, the blockage of enzyme action by heavy metal ions can be measured using common laboratory techniques.

Tasks

Investigate whether heavy metal ions influence the effect of enzymes.

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Material

Position	Material	Item No.	Quantity
1	Cobra SMARTsense - Conductivity, 0...20000 µS/cm, 0...100°C (Bluetooth)	12922-00	1
2	Wash bottle, plastic, 500 ml	33931-00	1
3	Standard solution 1413µS/cm(25°C), 460ml	47070-02	1
4	Magnetic stirrer without heating, 3 ltr., 230 V	35761-99	1
5	Magnetic stirring bar 8 mm, cylindrical	46299-00	1
6	Digital stopwatch, 24 h, 1/100 s and 1 s	24025-00	1
7	Beaker,DURAN®, tall form, 50 ml	36001-00	1
8	Beaker, DURAN®, tall form, 100 ml	36002-00	1
9	Glass beaker, low form, 250 ml	36013-00	1
10	Glass rod, boro 3.3, l=200mm, d=5mm	40485-03	2
11	Graduated cylinder, Borosilicate, 100 ml	36629-00	1
12	Graduated cylinder, Borosilicate, 10 ml	36625-00	1
13	Graduated pipette, 1 ml	36595-00	1
14	Water, distilled 5 l	31246-81	1
15	Urea, 250 g	30086-25	1
16	Urease, lyophilized 5 g	31923-02	1
17	Copper-II sulphate,cryst. 250 g	30126-25	1
18	measureAPP - the free measurement software for all devices and operating systems	14581-61	1

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Set-up

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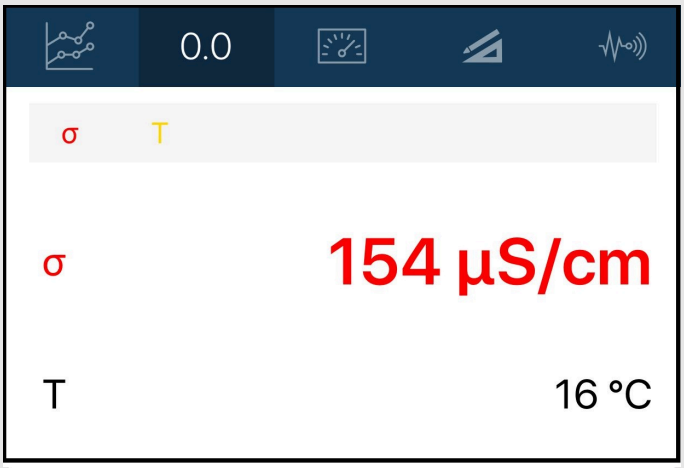
- To measure conductivity, the Cobra SMARTsense 'Conductivity' is switched on by pressing the power button.
- Make sure that Bluetooth is enabled on the device.
- Open the PHYWE measure App and select the sensor "Conductivity".



Select the sensor "Conductivity\

Procedure

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First experiment (control experiment)

Add 10 ml of a 1 % urease suspension to the urea solution (0,1 g per 10 ml of distilled water). At the same time as the urea solution is added, start recording the measured values. Stop the measurement after a few minutes (e.g. after 6 minutes).

Second experiment (simulation of a heavy metal load with a copper sulphate solution):

For the measurement repeat the first experiment and add 0.5 ml of a 1% copper sulphate solution of the urea-urease mixture a few minutes (e.g. 3 minutes) after starting the measurement and continue the measurement as long as in the control experiment.

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Report

Task 1

Choose the right answer.

- Heavy metal ions can enter surface and ground water from mining sites or with insufficiently treated waste water from galvanic or similar operations.
- Heavy metal ions sink directly to the substrate due to their weight and have no influence on the enzyme effect.
- None of the answers is correct.
- Heavy metal ions cannot get into the water by any means.

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Task 2

Heavy metals block the action of enzymes, so that processes in the metabolism of organisms controlled by them are disturbed or even prevented.

○ True ○ False

Check

Heavy metals do not block the action of enzymes. Enzymatically controlled processes can take place as usual.

○ True ○ False

Check

Slide	Score / Total
Slide 15: Heavy metal ions	0/1
Slide 16: Multiple tasks	0/2

Total amount 0 / 3

Solutions Repeat

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