Stiftung SimplyScience
Nordstrasse 15 • Postfach 1826
CH - 8021 Zürich
+41 (0) 44 368 17 46
scienceonthemove@simplyscience.ch

3. Conversion of energy - with and without oxygen

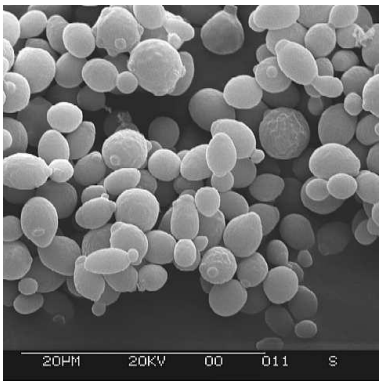


Fig. 1: Yeast Cells in the scanning electron microscope

Introduction:

Baker's yeast is a unicellular fungus, which is able to produce ATP by both, aerobic or anaerobic metabolism. The figure shows yeast cells, pictured with a scanning electron microscope.

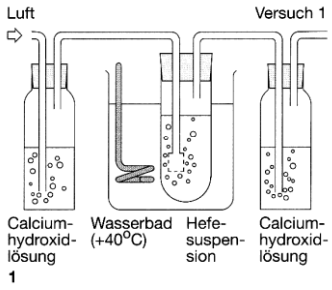
The following reactions describe the stoichiometric equations for the two processes, called respiration and alcoholic fermentation, respectively.

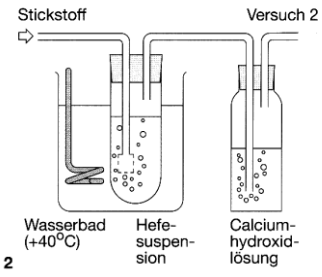
Goal:
During the following experiment you will compare the CO_2 output of cellular respiration and fermentation.

Respiration: $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$

Without oxygen glucose can be degraded just by fermentation. The amount of ATP gained per glucose molecule is much less compared with respiration.

Alcoholic Fermentation: $C_6H_{12}O_6 \rightarrow 2CO_2 + 2C_2H_5OH$





Task 1: Study the arrangement (Fig. 2) of the two experiments. Make a hypothesis - in which one the yeast cells will produce more CO_2 during the same period of time? Explain your hypothesis.

Expected answer: 2-4 sentences.

Fig. 2: Scheme of the experiment

Translation: Calziumhydroxid-Lösung: calcium-hydroxide solution; Wasserbad: water bath; Hefesuspension: yeast suspension

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Task 2: Calcium hydroxide can bind to carbon dioxide. The product is not soluble and will precipitate.

a) How will the pH in the last wash-bottle (1 and 2) change during this experiment?

Expected answer: Explain by using the correct stoichiometric reaction and one sentence.

b) Explain the purpose of the first wash-bottle during the experiment Nr. 1. Why would it make sense to replace the calcium hydroxide solution in the first bottle with concentrated NaOH?

Expected answer: 2-3 sentences.

Task 3: Please assemble the bottles as described in Fig. 1. Both arrangements should be installed in the same water bath to avoid differences in temperature during the experiments.

1. To each of the last wash bottles containing 50ml of a saturated clear calcium hydroxide solution, add three drops of phenolphthalein.
2. Dissolve 20g of baker's yeast and 15g of glucose in 150ml water. Just before starting the experiment, transfer 50 ml of this solution to the wash bottles of both experiment 1 and 2.
3. Start both experiments (1 and 2) at the same time.
4. Measure the times it takes (in experiments 1 and 2) for the pink color in the respective wash bottles to disappear.

Expected answer: Take one picture of your experimental setup. Repeat the experiment 3 times and record the results in a table each time. Calculate the average values for each experiment.

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Task 4: a) Discuss your results. What can you predict about the kinetics of respiration and fermentation?

b) Try to connect your results with the graphics below (Fig. 3)! Do your results agree or disagree with those shown below?

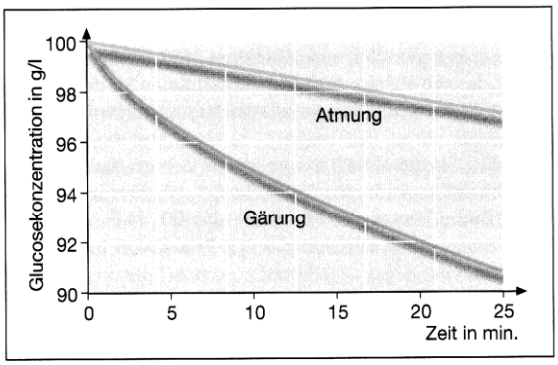

Fig. 3: Decline of glucose concentration in a yeast suspension under aerobic and anaerobic conditions.

Translation: Atmung: respiration; Gärung: fermentation; Glucosekonzentration: glucose concentration; Zeit in min: time in minutes

Expected answer: Answer the two tasks a) and b) with 2-4 sentences each.

Task 5: You would like to investigate the decline of glucose during your experiment yourself. The only equipment you find in your school is a blood sugar meter. How can you find out if this instrument can be used for that purpose? (No experiments have to be performed to solve this problem...)

Expected answer: 2-4 sentences.

List the references used according to the guidelines of SCHWEIZER JUGEND FORSCHT, http://www.sjf.ch.

Do not forget to add the activity list to your documentation! Each class needs to report which member was or is responsible for which portion or aspect of the work. Each person in the class must have participated at least once (during the entire competition) in the experimental portion.
Therefore, **take 3 digital photos per experiment showing the class involvement.** Place them next to the activity list in your documentation file.

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Expected documentation and further information

- Create **a single** PDF file containing all your solutions, pictures, other documenting material and the activity list and name it, following strictly these conventions:

  1. Number of class
     (Find your class number in "Participant" where all the participating classes are presented).
  2. Name of School
  3. Name of class (same as on application form)
  4. Number of experiment
  5. Date (year/month/day)

  → Please use underlines instead of spaces!
  Here is an example: **08_Kantonsschule_Muster_3b_Experiment1_20110222.pdf**

  → The size of the PDF file must not exceed 2 MB (4 pictures: about max. 500 KB per picture)!

- Scores

  A maximum of 10 points is awarded for each experiment. Each question/task (1-5) is rated with a maximum of 2 points.
  If the **references** are listed correctly (according to the guidelines of SCHWEIZER JUGEND FORSCHT) and the **layout** of the whole PDF file is satisfactory, there won't be a penalty on scores. If one of these two aspects is not solved sufficiently, you will receive one point less (for each aspect).

  Example: If you solve the task 1-5 satisfactory (10 points), the layout is good, but the references are not listed correctly, you will only receive 9 points in the end (for one experiment).

Closing date of experiment 3:	**02.05.2011, 18:00**