

Yeast steps on the gas

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Saccharomyces cerevisiae as Modell Organism

Baker's yeast is a eukaryotic (unicellular) fungus. The effect of yeast activity on food was probably discovered by chance. For thousands of years, however, it remained unclear how these "biotechnological" processes worked. It was not until 1680 when the Dutchman Antoni van Leeuwenhoek saw yeast cells under his microscope for the first time. And another 200 years later the Frenchman Louis Pasteur succeeded in proving that these yeasts were responsible for the formation of fermentation products.

Yeast is used as a leavening agent in baking. The scientific name "*Saccharomyces cerevisiae*" is derived from beer brewing and the yeast cells also produce the desired alcohol in wine and beer production. In recent years, yeasts have become increasingly important in the production of ethanol fuels. They are also used in the so-called biosorption of heavy metals from wastewater. In genetic and medical research, yeast continues to serve as a model organism for eukaryotic cells. Last but not least, yeast is also used as a source of protein and vitamins for humans and animals in the food industry.

Project Description

With this collection of experiments, we want to approach the phenomenon of "yeast" from different angles. Different basic concepts of biology are addressed. The experiments can be carried out at secondary school and high school level. Certain experiments can be extended to primary school level. Aspects of chemistry, computer science and maths are also included.



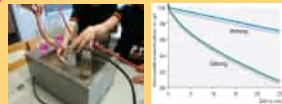
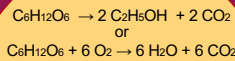
Fermentable Sugars

Yeast ferment only those carbohydrates that are absorbed into the cells and can be enzymatically broken down there. The preferred carbohydrates are glucose, fructose & sucrose. Yeast cells cannot metabolise



lactose from milk because they lack the enzyme lactase. Artificial sweeteners such as cyclamate and saccharin cannot be used as an energy source either. Simple fermentation tests show this quickly and cost-effectively.

Respiration vs Fermentation



Alcohol is toxic for yeast cells and they only survive an alcohol content of up to 19%. The energy gain during alcoholic fermentation is very low compared to cellular respiration and is compensated by a high metabolic rate (= Pasteur effect).

pH-Value in Yeast Cells

Neutral red is used as an indicator for biological investigations such as the determination cell viability. From pH 13 to 7.5 it is uncharged and yellow in colour and it is membrane permeable. From pH 7.4, the dye is protonated and takes on a red-violet colour. As a cation, neutral red is no longer able to penetrate membranes. It therefore accumulates in acidic compartments of cells (= ion trap).



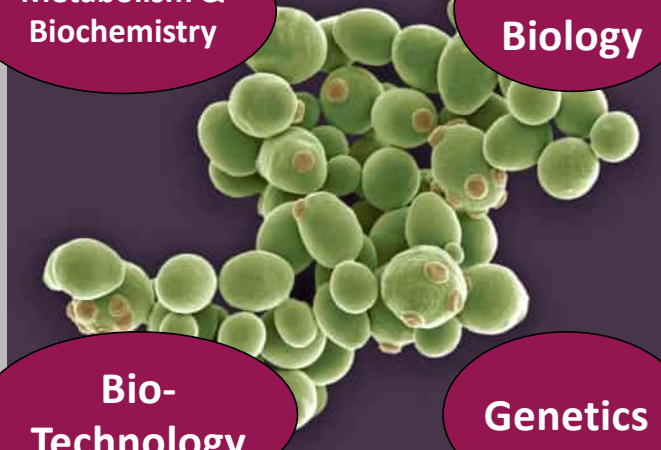
Make CO₂ visible

The carbon dioxide development can be observed directly under the microscope. At certain points gas accumulates under the cover slip. These bubbles become larger over time.



Metabolism & Biochemistry

Cell Biology



Bio-Technology

Genetics

Measure CO₂

For quantitative CO₂ measurements, sensors can be used. If you have thermo-controllable magnetic stirrers, the temperature dependence of the metabolic process can be shown.



The sensors can also be used to show how quickly the yeast can utilise different types of sugar.

Count Yeast Cells

How many cells are there in 1 gram of yeast? Using dilution series, the cell count is determined by using two methods:

1. plating on YPD plates
2. microscopy with the counting chamber



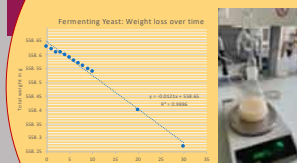
Immobilise Yeast Cells

Immobilised yeast cells can be used for the production of bottle-fermented sparkling wines. Instead of using «free» yeast cells, the cells are encapsulated in calcium alginate gel.



Energy requirement

During alcoholic fermentation, the yeast gains energy in the form of ATP.



The energy requirement of the yeast can be determined indirectly through the weight loss caused by the carbon dioxide release.

Substrate Induction

Yeast cells produce the enzymes for galactose degradation only if the sugar is actually present in the medium (= substrate induction). Once the genes in a cell have been switched on, galactose degradation is then faster compared to cells that previously had no contact with galactose.



Transcription factors are necessary to enable the gene expression.

Block Mitosis

High-energy UV-B radiation is absorbed by DNA bases. This can lead to dimer formation. These dimers are the origin of UV-induced DNA mutations.



Yeast cells irradiated with UV light are inhibited in cell division. The longer the duration of exposure, the less cell growth can be measured.