

SI GOB - Full Discipline Demo

GOB-Metabolism of Polysaccharides and Anaerobic

Final Report - Answer Guide

Institution	Science Interactive University
Session	SI GOB - Full Discipline Demo
Course	SI GOB - Full Discipline Demo
Instructor	Sales SI Demo

Test Your Knowledge

Categorize the following molecules as a macromolecule or a small molecule

	Macromolecules	Small Molecules
☐ Starch	1	2
☐ Glucose		
☐ Protein		
☐ Amino acid		
☐ Urea		
☐ Fatty acid		
☐ DNA		
☐ Triglycerides		

Correct answers:

1 Triglycerides DNA Protein Starch

2 Urea Fatty acid Glucose Amino acid

Categorize each transformation by the metabolic stage in which it occurs.

::
 Proteins into amino acids

::
 Polysaccharides into monosaccharides

::
 Lipids into fatty acids

::
 Pyruvate into acetyl-CoA

::
 Ammonium (NH₄⁺) into urea

:: ADP into ATP

Stage 1	Stage 2	Stage 3
1	2	3

Correct answers:

- 1 Proteins into amino acids Polysaccharides into monosaccharides
Lipids into fatty acids
- 2 Pyruvate into acetyl-CoA
- 3 Ammonium (NH₄⁺) into urea ADP into ATP

Match each term with the best description.

 An unfermented solution of simple carbohydrates	Mash		1
 A microorganism that converts sugar to ethanol and carbon dioxide	Wort		2
 The process to extract carbohydrates using hot water	Specific gravity		3
 The relative density of a solution compared to a pure liquid	Original gravity		4
 The initial density of a solution before fermentation	Yeast		5
 The density of a solution post fermentation	Final gravity		6

Correct answers:

- 1 The process to extract carbohydrates using hot water
- 2 An unfermented solution of simple carbohydrates
- 3 The relative density of a solution compared to a pure liquid
- 4 The initial density of a solution before fermentation

- 5 A microorganism that converts sugar to ethanol and carbon dioxide
- 6 The density of a solution post fermentation

Match each term with the best description.

 Oxygen-rich conditions for breaking down carbohydrates	Anaerobic	 1
 Oxygen-poor conditions for metabolizing carbohydrates	Aerobic	 2
 The conversion of sugars to ethanol and carbon dioxide by yeast	Fermentation	 3

Correct answers:

- 1 Oxygen-poor conditions for metabolizing carbohydrates
- 2 Oxygen-rich conditions for breaking down carbohydrates
- 3 The conversion of sugars to ethanol and carbon dioxide by yeast

Exploration

The breakdown of polysaccharides into monosaccharides takes place in ____ of catabolism.

- ☒ Stage 1
- ☐ Stage 2
- ☐ Stage 3
- ☐ All of the above



Metabolism is the breaking down of macromolecules into small molecules or the combining of small molecules to form macromolecules.

- ☒ True ✓
- ☐ False

Stage 3 of metabolism is ____.

- ☐ digestion and hydrolysis
- ☐ degradation into three-carbon sub-units
- ☒ where energy production is used to make ATP ✓
- ☐ All of the above

____ are the small molecules that are formed when ____ are broken down during metabolism.

- ☒ Metabolites; macromolecules ✓
- ☐ Salts; ionic compounds
- ☐ Proteins; amino acids
- ☐ Gases; starches

Yeasts convert pyruvate to ____ under anaerobic conditions.

- ☐ lactate
- ☐ acetyl-CoA
- ☒ ethanol and carbon dioxide ✓
- ☐ water
-

Aerobic conditions require an oxygen-rich environment to continue metabolizing pyruvate and enter the citric acid cycle.

- ☒ True ✓
- ☐ False

_____ is a boiled sugar solution produced from steeped grain.

- ☐ Ethanol
- ☐ The mash
- ☒ Wort ✓
- ☐ None of the above

The original gravity of a solution is its specific gravity of the solution before fermentation.

- ☒ True ✓
- ☐ False

Exercise 1

Did your malted barley solution contain starch? Use your results from Data Table 1 to explain your answer.

An IKI indicator will react when starch is present. The I-I⁻ ion has starch wrapped around it, which causes the color to be blue-black. Based on the results of the experiment, the student should have tested negative for starch, since the mashing process will have broken starch down into monosaccharides.

How would the extraction of carbohydrates from malted barley be affected if it was steeped at 23.0°C instead of 74.0°C? Explain your answer.

Temperature has a direct correlation to solubility. Typically, the higher the temperature, the better the solubility. The elevated temperature has two effects. First, alpha and beta amylase are the enzymes that digest starches into dextrins (such as maltose) and monosaccharides. At the mash temperature, the amylase is more active in digestion than at room temperature.

Second, at room temperature (23.0°C), starch is insoluble in water, which means that none of the starch can be in the solution to react with water. Without being in solution, it can't be hydrolyzed into smaller saccharides would lead to a very low extraction.

Data Table 1: Extraction of Polysaccharides
(SAMPLE ANSWER BELOW)

	Data Collected	Positive or Negative
Mass of Malted Barley	20.0 g	
Mash Temperature	70.0°C	
Color of IKI Indicator of mash	Brown	Negative
Color of IKI Indicator with starch	Black	Positive
Color of IKI Indicator with water	Orange	Negative

Exercise 2

Did you observe evidence of fermentation occurring in the fermenter? Which product of fermentation is observable during fermentation?

It took about 24 hours before bubbling started. The bubbles are the byproduct of fermentation, which is carbon dioxide gas. The bubbling was small at the top of the solution and subsided after a day.

What effect did fermentation have on the specific gravity of the solution? Explain your answer referencing Data Table 2.

The gravity of the solution decreases as the fermentation proceeds. It decreases because ethanol is produced, and ethanol is less dense than water. The production of ethanol then decreases the density of the solution which in turn decreases the gravity.

Describe the pathway of the carbohydrates from the malted barley through fermentation in reference to metabolism.

Malted barley is rich in starch, which is a type of polysaccharide (polymer) made of glucose monomers. When it is mixed with hot water, enzymes in the malted barley break down starch into dextrins and glucose. These are further broken down into glucose by boiling them. The glucose is fed to the yeast under anaerobic conditions and the yeast breaks it down into ethanol and carbon dioxide gas.

Data Table 2: Fermentation Data
(SAMPLE ANSWER BELOW)

	Data
Pipet volume in distilled water (mL)	7 mL
Pipet volume in Wort (mL)	8.6 mL
Original Gravity	1.022
Pipet volume in distilled water after fermentation (mL)	5.75 mL
Pipet volume of solution after fermentation (mL)	6.1 mL
Final gravity	1.006
Alcohol by volume (%)	2.1 %

Data Table 3: Observation of yeast
(SAMPLE ANSWER BELOW)

	Observations
Yeast mixed with wort	The solution is cloudy and vigorous bubbling occurred.
Fermentation after 24 hours	Small bubbles could be observed at the top of the solution. Solution is cloudy with yeast floating at the bottom. The solution became clear over time.

Photo 1: Set up
(SAMPLE ANSWER BELOW)





Competency Review

The breakdown of starch to glucose is what stage of catabolism?

- ☒ Stage 1
- ☐ Stage 2
- ☐ Stage 3

✓

Anaerobic fermentation only occurs in oxygen-rich environments.

- ☐ True
 - ☒ False
- ✓

Yeast converts monosaccharides into carbon dioxide and ethanol during anaerobic fermentation.

- ☒ True
 - ☐ False
- ✓

Water breaks polysaccharides down into dextrins and monosaccharides in a ___ reaction.

- ☐ dehydration
 - ☒ hydration
 - ☐ hydrogenation
 - ☐ polymerization
- ✓

Carbohydrates are ___ molecules that are soluble in ___.

- ☒ polar, water
 - ☐ nonpolar, water
 - ☐ polar, hexanes (a nonpolar organic solvent)
 - ☐ nonpolar, hexanes (a nonpolar organic solvent)
- ✓

The density of the solution decreases during fermentation.

- ☒ True
 - ☐ False
- ✓

The conversion of ethanal (CH_3CHO) to ethanol ($\text{CH}_3\text{CH}_2\text{OH}$) is a(n) ____ reaction

- ☐ oxidation
- ☒ reduction ✓
- ☐ hydration
- ☐ dehydration

Muscle cells convert pyruvate into lactate/lactic acid during anaerobic fermentation.

- ☒ True ✓
- ☐ False

IKI indicator tests for the presence of ____ in solution.

- ☐ glucose
- ☒ starch ✓
- ☐ ethanol
- ☐ water

Given a solution with an original gravity of 1.044 and a final gravity of 1.011, what is the alcohol by volume using the equation below?

Alcohol by volume = (Original Gravity - Final Gravity) * 131.25

- ☐ 10 %
- ☐ 1.0%
- ☐ 2.2%
- ☒ 4.3 % ✓

In the brewing process, extracting carbohydrates from malted barley is called ____.

- ☐ wort
- ☐ strike temperature
- ☐ fermentation
- ☒ mashing



Extension Questions

In addition to brewery usage, yeast is also used in baking of bread. Bread, however, does not contain ethanol. Research and describe the metabolic pathways used in making yeast breads compared to brewery products. (SAMPLE ANSWER BELOW)

Yeast can undergo both anaerobic and aerobic reactions but the products will be different. As seen in this experiment anaerobic fermentation produces CO₂ and ethanol. For making a yeast starter for bread, the conditions are aerobic, meaning oxygen-rich. To make a starter yeast, water and flour are mixed together. The flour provides carbohydrates for the yeast. The yeast will break down any simple sugars that are in the flour and convert them to pyruvate. Since the conditions are aerobic, it will continue to make CO₂ and ATP and not ethanol. The yeast will continue to grow until all of the simple sugars have been consumed. If more sugar were added to the yeast, this process would continue.