AMGEN® Biotech Experience

Scientific Discovery for the Classroom

Exploring Tools of the Biotechnology Lab

Yeast – The Living Tool

STUDENT SCIENCE NOTES

AMGEN® Foundation

Science Note 1.1

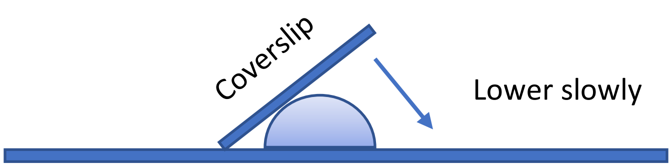
You know from the video you watched and your class discussion that yeast is used to make bread dough rise. But what is yeast? In this activity, you are going to examine yeast through a microscope to learn more about it.

MATERIALS

- Low-lint tissues
- 1 capped test tube containing yeast solution
- 1 plastic pipette
- 1 compound microscope, at least 400x
- 2 microscope slides and coverslips
- Paper towels

PROCEDURE

1. Clean your microscope slides carefully with a low-lint tissue. After cleaning, handle the slide by only its edges.
2. Open your test tube and mix the solution carefully with your pipette.
3. Draw a drop of the solution into your pipette.
4. Place one drop of solution onto the microscope slide.
5. Carefully cover with a coverslip as shown.



6. Repeat Steps 1–5 to make a second slide.
7. Turn the revolving nosepiece so the lowest objective lens is in position.
8. Place your slide on the stage of the microscope. Make sure it is held in place by the metal clips.
9. Use the stage adjustment knobs to move the slide left and right and up and down until the slide is centered over the light source.
10. Look into the eyepiece and then slowly rotate the coarse adjustment knob to focus. Make sure the slide does not touch the lens.
11. Rotate the condenser to maximize the light on your specimen. Adjust the light so you can see the specimen clearly.

12. Use the fine adjustment knob to focus on your specimen.

13. Give each team member a chance to examine the specimen. Discuss what you see.

14. Switch to the next power objective and refocus using the fine adjustment knob.

NOTE: Do not use the coarse adjustment knob when using the medium- or high-power objective because the lens is close to the slide, and large adjustments could cause the lens to crack the slide.

15. Give each team member a chance to examine the specimen. Discuss what you see.

16. Switch to the highest power objective and draw and describe what you see in the circle below.

Microscope power: ___________

Science Note 2.1

You know that yeast is a living thing. What does it eat? And what kind of food and what conditions make yeast grow and multiply most effectively? In this experiment, you will make sugar water solutions to feed yeast. Your class will explore four different kinds of sugar (fructose, glucose, lactose, and sucrose). Your team will be assigned one type of sugar. The sugar solutions will each have a different amount of sugar in them (will have different *concentrations* of sugar). Your job as a class is to figure out which kind of sugar is best for yeast and what concentration of sugar is best.

INGREDIENTS

- Access to a mass scale
- 1 stopwatch
- 1 laptop, Chromebook, smartphone, or video camera (recommended)
- 1 stirring rod
- 1 50-mL graduated cylinder
- 3 100-mL beakers (or plastic cups)
- 3 50-mL conical tubes
- 3 4-mL cupcake pipettes
- 6 washers
- ~300 mL tap (faucet) water warmed to 40°C
- 50 mL yeast solution (from your teacher)
- 20 g of your team's assigned sugar ______________________________
  name of sugar

PROCEDURE

1. Choose one team member to be the timer and assign each of the other team members to be observers—one will observe the 0% reaction, one the 10% reaction, and one the 20% reaction. Make sure that the timer has the stopwatch.
2. Label your 100-mL beakers "0%," "10%," and "20%."
3. Place the beaker labeled "10%" on the mass scale and push Tare, which removes the weight of the beaker. Make sure the scale is set to *grams*. The scale should read "0."
4. Add your sugar to the beaker until the display reads "5 g."
5. Using the beaker labeled "20%," repeat Step 2, and then add sugar to this beaker until the display reads "10 g" of sugar.
6. Using the graduated cylinder, measure and add 50 mL of warm water to each of the three beakers. Stir the beakers until the sugar dissolves—be sure to rinse and dry the stirring rod between beakers.
7. Label your three cupcake pipettes "0%," "10%," and "20%."
8. Label your three conical tubes "0%," "10%," and "20%."

9. *(Optional)* Set up your video recording device so you can video-record all three conical tubes. (Make sure that the labels and the contents will be visible on the video.)
10. Fill each conical tube to the 50-mL mark with 40°C water.
11. Using the graduated cylinder, add 15 mL of yeast solution to each of the beakers and stir.
12. Squeeze the bulb of the cupcake pipette labeled "0%" and submerge it into the liquid in the beaker labeled "0%." Release the bulb and allow the yeast mixture to be drawn up into the bulb. If it doesn't fill completely, squeeze the bulb to push out the remaining air and allow more liquid to be drawn in.
13. Remove the pipette from the liquid and turn it so that the bulb side is toward the floor. Tap it on a hard surface to make sure that all the liquid is in the bulb; if there is any liquid left in the stem, carefully squeeze it out.
14. Place two washers over the stem of the pipette.
15. Repeat Steps 9–11 to fill each of the other pipettes with the 10% sugar and 20% sugar mixtures, respectively.
16. When all three pipettes are filled (try to ensure that each pipette has approximately the same volume of yeast solution in it), drop them into the appropriately labeled conical tubes at approximately the same time while the timer starts the video-recording and the stopwatch.
17. Wait 5 minutes. While you are waiting, observe the beakers and describe what happens in them. Can you measure anything that will help you distinguish between the three beakers?

An example of a completed setup, through Step 16.

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18. After 5 minutes, observers should start counting bubbles. They will count for 1 minute, then wait 1 minute, then count for 1 minute. The timer will say "Start" and "Stop" at the beginning and end of each minute, and the observers will count the bubbles produced during the 1-minute intervals.
19. Record the number of bubbles in the table on the following page.

20. *(Optional)* After you have completed your counting, watch the video-recording of the activity, and count the bubbles released by each cupcake pipette for the 1-minute intervals again. Correct any bubble counts in the table that were inaccurate.

Activity 2 Data Chart

		Number of CO_2 Bubbles		
Count #	**Min**	**0% sugar**	**10% sugar**	**20% sugar**
1	1–2			
2	2–3			
3	3–4			
4	4–5			
5	5–6			

Science Note 3.1

In the last activity, you performed a whole-class experiment in which you investigated how the type and amount of sugar affected the CO_2 production of yeast. In this activity, you design and carry out an experiment to determine what temperature allows yeast to grow best.

PROCEDURE

1. Design your experiment by filling out the graphic organizer on the next page.
2. After your team has completed the design of your experiment, share it with the class and determine a shared class experimental procedure.
3. Carry out the procedure and share your results as a class.

<table>
<tr><td colspan="2">What is your research question?</td></tr>
<tr><td rowspan="3">What do you think will happen?</td><td>What variable(s) will you change (independent variables)?</td></tr>
<tr><td>What parts of the experiment will you not change (constants)?</td></tr>
<tr><td>What are you going to measure (dependent variable)?</td></tr>
<tr><td colspan="2">What materials will you use?</td></tr>
</table>

What is your procedure? (What steps will you take to perform your experiment?)

Science Note 3.2

Examine this graphic organizer for the experiment in the previous activity to help you design your own experiment.

<table>
<tr><td colspan="2">What is your research question?
How does the type and amount of sugar affect CO_2 production by yeast?</td></tr>
<tr><td rowspan="3">What do you think will happen?</td><td>What variable(s) will you change (independent variables)?
• The type of sugar
• The amount of sugar</td></tr>
<tr><td>What parts of the experiment you will not change (constants)?
• The volume of yeast solution
• The volume of sugar solution</td></tr>
<tr><td>What are you going to measure (the dependent variable)?
• The amount of CO_2 production</td></tr>
<tr><td colspan="2">What materials will you use?
• Access to a mass scale
• 1 stirring rod
• 1 50-mL graduated cylinder
• 3 100-mL beakers (or plastic cups)
• 3 50-mL conical tubes
• 3 4-mL cupcake pipettes
• 50 mL yeast solution (from your teacher)
• 20 g of sugar
• ~300 mL tap water
• 1 glass marking pen</td></tr>
<tr><td colspan="2">What is your procedure? (What steps will you take to perform your experiment?)
1. Choose one team member to be the timer and assign each of the other team members to be observers—one will observe the 0% reaction, one the 10% reaction, and one the 20% reaction. Make sure that the timer has the stopwatch.
2. Label your 100-mL beakers “0%,” “10%,” and “20%.”
3. Place the beaker labeled “10%” on the mass scale and push Tare, which removes the weight of the beaker. Make sure the scale is set to grams. The scale should read “0.”
4. Add your sugar to the beaker until the display reads “5 g.”
5. Using the beaker labeled “20%,” repeat Step 2, and then add sugar to this beaker until the display reads “10 g” of sugar.
6. Using the graduated cylinder, measure and add 50 mL of warm water to each of the three beakers. Stir the beakers until the sugar dissolves—be sure to rinse and dry the stirring rod between beakers.
7. Label your three cupcake pipettes “0%,” “10%,” and “20%.”
8. Label your three conical tubes “0%,” “10%,” and “20%.”
9. (Optional) Set up your video recording device so you can video-record all three conical tubes. (Make sure that the labels and the contents will be visible on the video.)</td></tr>
</table>

10. Fill each conical tube to the 50-mL mark with 40°C water.
11. Using the graduated cylinder, add 15 mL of yeast solution to each of the beakers and stir.
12. Squeeze the bulb of the cupcake pipette labeled “0%” and submerge it into the liquid in the beaker labeled “0%.” Release the bulb and allow the yeast mixture to be drawn up into the bulb. If it doesn’t fill completely, squeeze the bulb to push out the remaining air and allow more liquid to be drawn in.
13. Remove the pipette from the liquid and turn it so that the bulb side is toward the floor. Tap it on a hard surface to make sure that all the liquid is in the bulb; if there is any liquid left in the stem, carefully squeeze it out.
14. Place two washers over the stem of the pipette.
15. Repeat Steps 9–11 to fill each of the other pipettes with the 10% sugar and 20% sugar mixtures, respectively.
16. When all three pipettes are filled (try to ensure that each pipette has approximately the same volume of yeast solution in it), drop them into the appropriately labeled conical tubes (see example completed setup at right) at approximately the same time while the timer starts the video-recording and the stopwatch.
17. Wait 5 minutes. While you are waiting, observe the beakers and describe what happens in them.
18. After 5 minutes, observers should start counting bubbles. They will count for 1 minute, then wait 1 minute, then count for 1 minute. The timer will say “Start” and “Stop” at the beginning and end of each minute, and the observers will count the bubbles produced during the 1-minute intervals.
19. Record the number of bubbles in the table on the following page.
20. (Optional) After you have completed your counting, watch the video-recording of the activity, and count the bubbles released by each cupcake pipette for the 1-minute intervals again. Correct any bubble counts in the table that were inaccurate.

Science Note 3.3

You have spent the past few classes exploring the fungus yeast and learning how to be a good *yeast farmer*. People have been using yeast for a really long time, even before they fully understood what it was. One of the most common uses of yeast is in baking. When yeast is added to bread dough, it helps the dough rise and become fluffy. This happens because yeast eats sugar and makes carbon dioxide (CO_2) gas. The gas gets trapped in the dough, making it expand and giving bread its yummy texture.

Another way that humans use yeast is in brewing, which is how we make beer and other alcoholic drinks. Yeast is added to wort (a mixture of water, malt, and hops) to start the fermentation process, which turns the sugars in the wort into alcohol and CO_2.

Yeast is also used in science for a variety of purposes. One of the most common uses of yeast in science is as a model organism. A model organism is a living organism used by scientists to study biological processes in the lab. Scientists use yeast in this way because it is easy to grow and experiment with and because we already know a lot about its genes. By studying yeast, scientists can learn about important processes like how cells grow and divide, how DNA is copied, and how genes are controlled. This knowledge helps them understand similar processes in more-complex organisms, like humans.

Yeast is pretty amazing! It helps bread rise, turns sugar into alcohol, helps scientists understand biology, and even helps make important medicines. It's a tiny fungus with a big impact!

Science Note 3.4

Create a presentation using presentation software, such as PowerPoint, Google Slides, or Prezi, that explains how humans use yeast. Research one way that humans use yeast and then develop a presentation for your classmates. The following rubric will be used to score your presentation.

RUBRIC FOR SCORING PRESENTATION

	4	3	2	1
Content: Purpose	My presentation describes an important and meaningful use of yeast. All parts of my presentation relate to this use of yeast in a meaningful way.	My presentation describes an important and meaningful use of yeast. All parts of my presentation make an important statement about my topic.	My presentation describes an important and meaningful use of yeast. Most parts of my presentation make an important statement about that use, but some parts may be off topic.	My presentation describes a somewhat important use of yeast, but many parts are off topic.
Content: Conclusions	I add my own experiences and knowledge to the research to draw important and meaningful conclusions.	I add my own experiences and knowledge to the research to research to draw conclusions.	I try to use my knowledge and research to draw conclusions, but some of my ideas are not logical or based on credible evidence.	I rarely draw conclusions, and when I do, they are not logical.
Content: Key Points	I organize my presentation around a few important points related to this use of yeast based on the most important information I have discovered and the conclusions I have drawn.	I organize my presentation around a few points about this use of yeast.	I include some main points in my presentation, but they may be wordy or missing information.	I do not identify the main points in my presentation.

	4	3	2	1
Multimedia Features	I use graphics, video, sound, and other multimedia features effectively to communicate the information I found and create interest. I follow all copyright laws when I use multimedia features.	I use some graphics, video, sound, and other multimedia features to enhance and support my key points.	I use graphics, video, sound, and other multimedia features, but some features don't help me make my key points.	I do not use graphics, video, sound, or other multimedia features, or the ones I use don't help me make my key points.
Creativity	My presentation uses unique features to communicate meaningful, fresh insights and perspectives in unusual and surprising ways.	My presentation communicates insights in unusual and surprising ways.	I try to communicate fresh insights in unusual and surprising ways, but some of my methods distract from rather than support my presentation's theme.	My presentation is predictable.
Organization	My presentation begins with a slide that builds curiosity and interest in the use of yeast, organizes information in a logical order, and leaves the audience with an important idea about the use of yeast.	My presentation begins with an introduction that describes the use of yeast in an interesting way, organizes information in order, and concludes with a summary of the most important points.	My presentation has an introduction and a conclusion, but they may not engage the audience in thinking about my use of yeast. The order of the information may not help me communicate the theme.	My presentation is missing an introduction or a conclusion and is organized in a way that confuses the audience.
Oral Presentation	I have rehearsed my presentation. I speak clearly and smoothly in an engaging way. I show poise and confidence, interact appropriately with my audience, and handle unexpected problems effectively.	I have rehearsed my presentation. I speak clearly and smoothly. I show poise and audience awareness.	I could have rehearsed my presentation more carefully. Sometimes my audience loses interest or has difficulty understanding me.	My audience has difficulty following my presentation and understanding me. I did not practice enough.