

Which sugars can yeast use?

Same yeast, same dough, five different sugars.

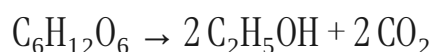
Which ones does yeast actually turn into gas?

Name _____ Group _____

Fill in the white columns as you work. Calculate the shaded columns using the formulas in the dashed boxes.

1 The big idea

Yeast respires sugar without oxygen (**fermentation**). The CO₂ it makes gets trapped as bubbles, so the dough rises.



Only a **monosaccharide** can enter **glycolysis**. A bigger sugar must first be split by an enzyme.

No enzyme, no fuel.

Substrate	Type	Built from	Enzyme needed to split it
Glucose	Monosaccharide	—	None
Sucrose	Disaccharide	Glucose + fructose	Invertase (sucrase)
Lactose	Disaccharide	Glucose + galactose	Lactase
Starch	Polysaccharide	Hundreds of glucose units, branched	Amylase
Control	No sugar added (just the flour)		

Mr Bradford says

Starch is a *storage* molecule. It is great for packing away energy, but the cell has to unpack it before it can be used. Keep that in mind when you predict.

2 Predict

P1 Rank the five doughs from most rise (1) to least rise (5).

- 1 (Glucose / Sucrose / Lactose / Starch / Control) 2 (Glucose / Sucrose / Lactose / Starch / Control) 3 (Glucose / Sucrose / Lactose / Starch / Control)
- 4 (Glucose / Sucrose / Lactose / Starch / Control) 5 (Glucose / Sucrose / Lactose / Starch / Control)

P2 Explain your ranking using the idea of enzymes.

Try: **I think ... will rise most because I think ... will rise least because yeast does not have**

...

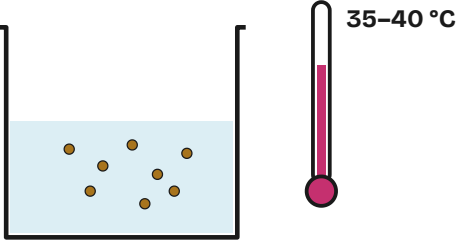
P3 Sucrose and lactose are both disaccharides. Will they give the same result?

3 Method

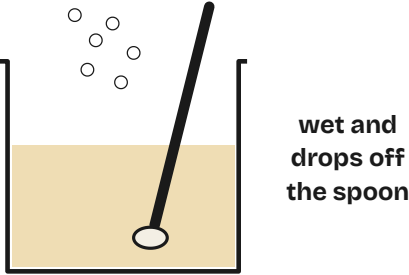
You will need (per group)

- | | | |
|---|-----------------------------------|---------------------------------|
| ■ 4 g dried yeast | ■ 75 mL warm water (35–40 °C) | ■ Plain flour (about 100 g) |
| ■ 1 g each: glucose, sucrose, lactose, starch | ■ 5 small beakers + 100 mL beaker | ■ 5 × 10 mL measuring cylinders |
| ■ Water bath at 35 °C, thermometer | ■ Spatulas, marker, stopwatch | |

4 g yeast + 75 mL warm water

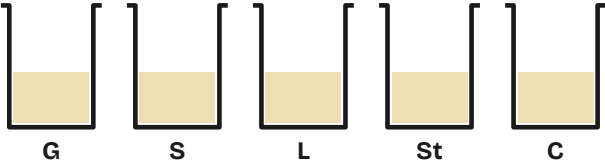


1 Make the yeast mix. Dissolve 4 g of dried yeast in 75 mL of warm water (35–40 °C) in a 100 mL beaker.



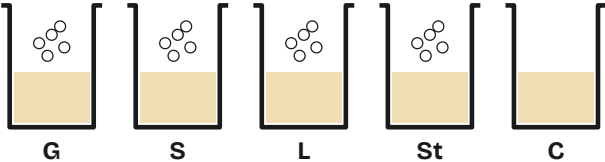
2 Add the flour. Stir in flour (about 20 spatulas) until you have a wet dough with a dropping consistency.

equal amounts in each

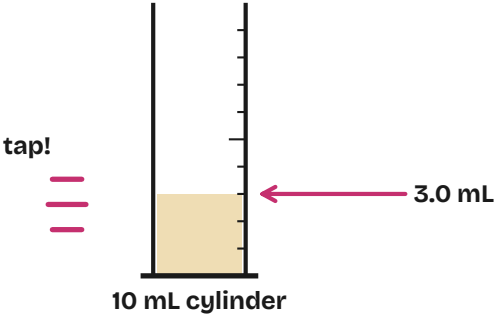


3 Split into five. Divide the dough equally between five small beakers labelled G, S, L, St and C.

1 g 1 g 1 g 1 g none

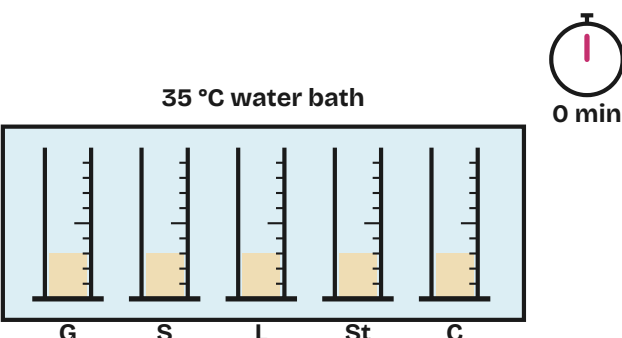


4 Add the sugars. Add 1 g of the matching sugar: glucose, sucrose, lactose, starch. Add nothing to C. Mix each with a clean spatula.



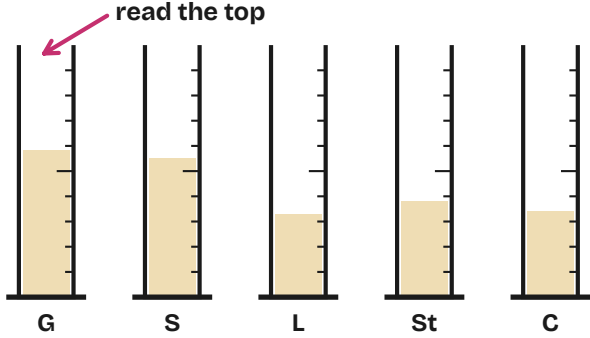
10 mL cylinder

5 **Fill to 3 mL.** Spoon each dough into a 10 mL measuring cylinder up to the 3.0 mL mark. Tap gently to remove air pockets.



35 °C water bath

6 **Into the water bath.** Stand all five cylinders in the 35 °C water bath. Record the starting level and start the stopwatch.



7 **Read every 5 minutes.** Read the level of the top of the dough every 5 minutes for 30 minutes and type it into your table.

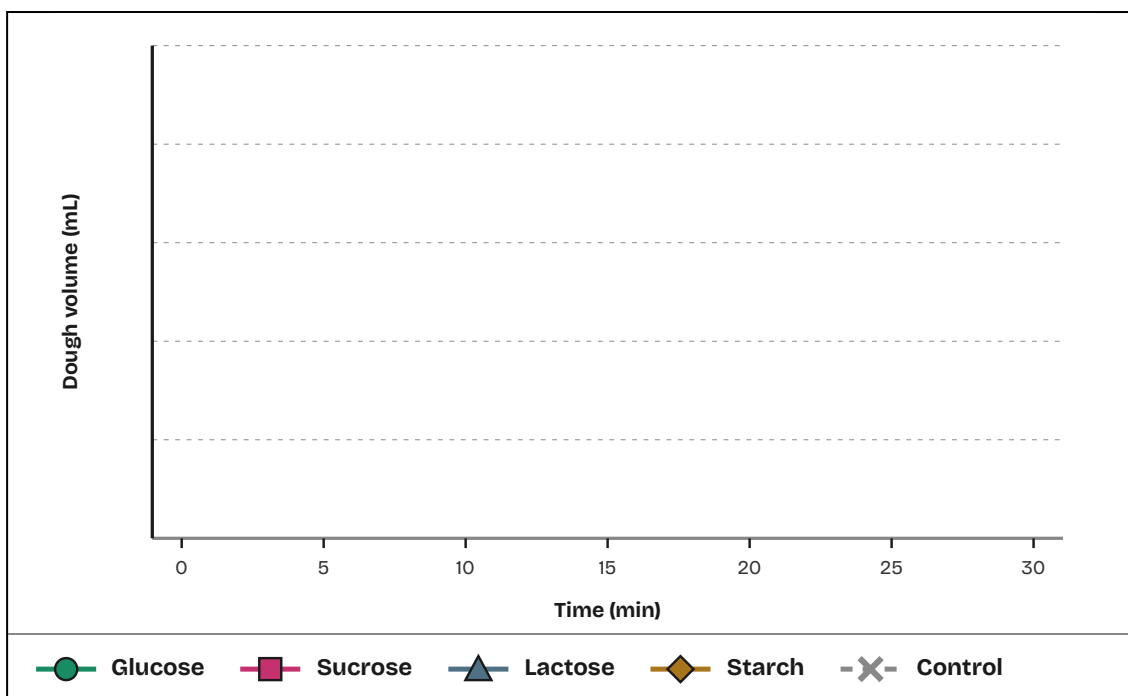
4 Your group's results

Time (min)	Glucose volume (mL $\pm$ 0.1)	Sucrose volume (mL $\pm$ 0.1)	Lactose volume (mL $\pm$ 0.1)	Starch volume (mL $\pm$ 0.1)	Control volume (mL $\pm$ 0.1)
0	_____	_____	_____	_____	_____
5	_____	_____	_____	_____	_____
10	_____	_____	_____	_____	_____
15	_____	_____	_____	_____	_____
20	_____	_____	_____	_____	_____
25	_____	_____	_____	_____	_____
30	_____	_____	_____	_____	_____
Change (mL)					

Change in volume: Δ = final volume – starting volume

Water bath temperature (°C) _____

Graph: dough volume over time



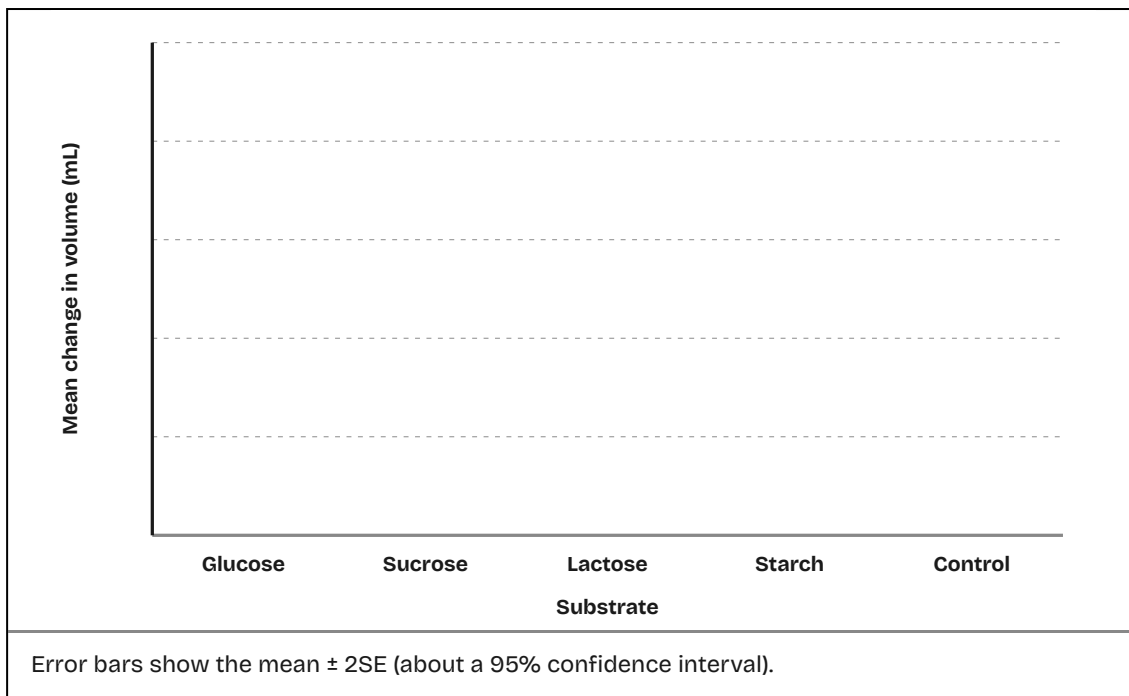
5 Class results

Change in volume after 30 minutes (mL) for every group. The pink columns calculate themselves. **Tap any value** to see how it was worked out.

Mean: $\bar{x} = \sum x \div n$ · **Standard deviation:** $s = \sqrt{[\sum (x - \bar{x})^2 \div (n - 1)]}$ · **Standard error:** $SE = s \div \sqrt{n}$ · **Error bars:** $\bar{x} \pm 2SE$

Substrate	Gp 1	Gp 2	Gp 3	Gp 4	Gp 5	Gp 6	Mean	SD	SE	Mean $\pm$ 2SE
Glucose										
Sucrose										
Lactose										
Starch										
Control										

Graph: mean change in volume with $\pm 2SE$ error bars



6 Why does AP use standard error?

Standard deviation and standard error answer **different** questions.

Standard deviation (SD)

How spread out are the individual results?

It describes the data. Collecting more groups does not make it smaller. It just gets a better estimate of the real spread.

Standard error (SE)

How sure are we about the mean?

$SE = SD \div \sqrt{n}$. More groups $\rightarrow$ smaller SE. It describes how precise the mean is.

In this lab you want to **compare means**: is glucose really better than sucrose? That is a question about the means, so AP uses error bars of **$\pm 2SE$** . That range is about a 95% confidence interval for the mean.

The rule of thumb: if the $\pm 2SE$ error bars of two groups **do not overlap**, the difference is probably real (statistically significant). If they **overlap**, you cannot claim a difference.

7 Analyse

A1 Which substrate gave the largest mean rise?

(Glucose / Sucrose / Lactose / Starch / Control)

A2 Do the $\pm 2SE$ error bars for glucose and sucrose overlap?

(Yes, they overlap / No, they don't overlap)

So can you say glucose is better than sucrose? Explain.

A3 Is starch clearly different from the control?

(Yes, the error bars don't overlap / No, the error bars overlap)

A4 Yeast has the enzyme invertase but not lactase. Use this to explain your sucrose and lactose results.

Try: **Sucrose rose by ... mL because ...** . **Lactose only rose by ... mL because ...**

A5 The control dough still rose a little. Where did that sugar come from?

A6 Baker's yeast cannot digest starch, but flour contains its own amylase. Who is breaking down the starch in your dough? Why does starch rise only a little more than the control?

A7 Why is starch a good storage molecule but a slow fuel?

Think about: **branched** · **compact** · **insoluble** · **must be hydrolysed first**

8 Conclude

Step 1: build the science

Yeast produced the most CO₂ with (glucose and sucrose / lactose and starch / the control).
Sucrose works because yeast has (lactase / invertase / amylase), which splits it into glucose and fructose. Lactose rose about the same as the control because yeast (lacks lactase / lacks invertase / cannot respire glucose). Starch must be (condensed / phosphorylated / hydrolysed) before yeast can use it, so it is a slow fuel.

Step 2: which statements does your evidence support?

Tick only the ones your data and the science actually back up. Watch out for claims that go too far.

- ☐ Glucose and sucrose gave the largest mean rise.
- ☐ Yeast can always use any sugar if you give it enough time.
- ☐ If the $\pm 2SE$ bars for glucose and sucrose overlap, we cannot say one is really better.
- ☐ Our results prove that starch is useless as food for all organisms.
- ☐ Lactose gave little rise because yeast lacks the enzyme to split it.
- ☐ Some of the control's rise came from sugars already in the flour.

Step 3: write your conclusion (Claim, Evidence, Reasoning)

Claim Answer the question: which sugars can yeast use?

Evidence Quote class means with $\pm 2SE$. Say which error bars overlap.

Try: Glucose had a mean rise of ... $\pm$... mL, compared with ...

Reasoning Explain using enzymes, monosaccharides and glycolysis.

9 Evaluate

Don't just name a problem. Say **what it did to your results** and **exactly how to fix it**.

Weakness in method	Effect on results	Specific improvement

Ideas to think about: **dough consistency** · **air pockets** · **domed surface** · **water bath temperature** · **reading time**

E1 Your reading uncertainty is about ± 0.1 mL, but class results varied much more. What causes the extra variation?

E2 Suggest a method that measures CO_2 more directly than dough height.

✓ Before you hand in

- ☐ My table has my own results, not the practice numbers
- ☐ I have quoted means with $\pm 2\text{SE}$ in my evidence
- ☐ I said whether error bars overlap, and what that means
- ☐ My reasoning uses the words enzyme, monosaccharide and glycolysis
- ☐ Each weakness has an effect and a specific improvement