Hold the enzyme, keep its action

An immobilised enzyme is retained on or within a support rather than freely dissolved. Here, lactase is trapped inside a porous calcium alginate gel.

1. FORM CALCIUM ALGINATE BEADS

A. MIX

Lactase solution
+ sodium alginate

→

B. ADD DROPS

Drop the mixture into calcium chloride

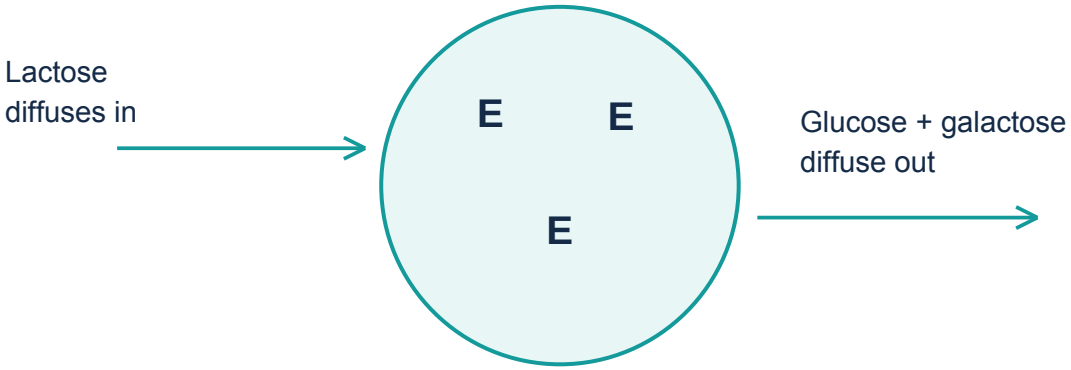
→

C. HARDEN

Allow beads to set; strain and rinse

Calcium ions cross-link alginate chains, forming a gel that retains the enzyme.

2. SMALL MOLECULES MOVE THROUGH THE GEL



E = lactase retained in gel

Schematic cross-section; not to scale.

3. LACTASE CATALYSES HYDROLYSIS

lactose + water —(lactase)→ **glucose + galactose**

Immobilised does not mean inactive. Alginate is the support, not the catalyst.

Practical basis: NCBE, University of Reading, Lactose-reduced milk.

Scope: Cambridge Biology 9700 syllabus, section 3.2, outcome 4, p. 20.

Compare activity fairly

Suggested investigation: compare glucose production by the same lactase preparation, either free in solution or immobilised in alginate. Use a lactose solution as substrate.

1. CHANGE ONLY THE ENZYME PREPARATION

Use equal enzyme doses from the same stock. Keep lactose concentration, total liquid volume, buffer pH, temperature and mixing the same. For beads, standardise diameter and the amount used. Equal bead mass alone does not guarantee equal enzyme loading.

2. MEASURE THE EARLY RATE

Measure glucose at time zero and short, regular intervals with a calibrated glucose assay. Calculate the initial gradient of glucose concentration against time. Include enzyme-free alginate beads and a no-enzyme solution as controls; repeat each treatment and compare mean rates.

3. WORKED EXAMPLE: FIRST TWO MINUTES

Illustrative values; both samples start at zero glucose.

Preparation	Glucose at 2 min	Mean rate over 0-2 min
Free lactase	1.20 mmol L^{-1}	0.60 mmol L^{-1} min^{-1}
Bead-trapped lactase	0.80 mmol L^{-1}	0.40 mmol L^{-1} min^{-1}

Rate = change in glucose concentration / time; e.g. 0.80 / 2 = 0.40.

These data show a lower measured rate for beads in this example, not a universal rule. Use more early time points to estimate the initial rate reliably. Account for enzyme lost during bead preparation before attributing differences solely to diffusion.

Practical safety: use teacher-approved methods and protective equipment. Avoid enzyme aerosols and skin/eye contact; never taste laboratory products.

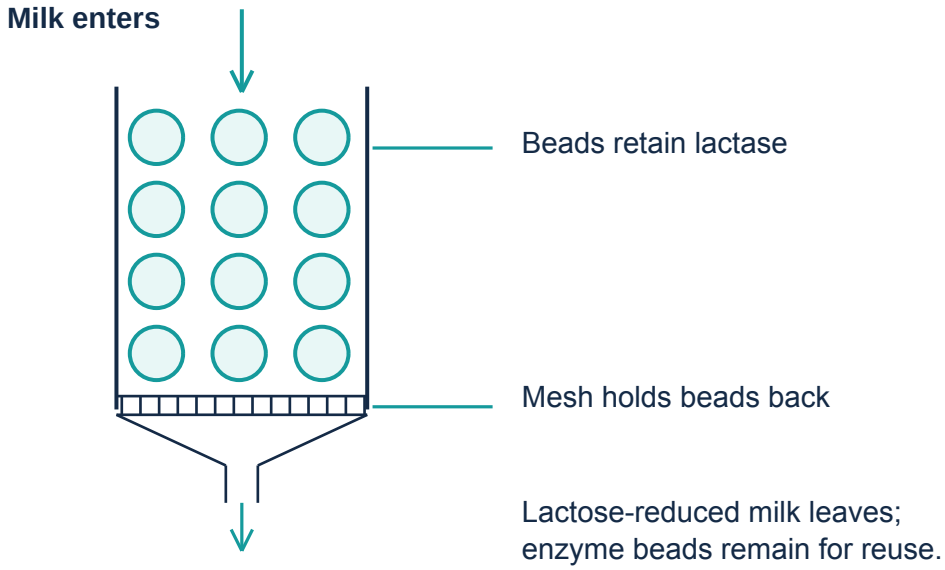
Investigation design follows Cambridge outcome 3.2.4; numbers are illustrative.
Lactase handling and glucose testing: NCBE, Lactose-reduced milk.

Scope: Cambridge Biology 9700 syllabus, section 3.2, outcome 4, p. 20.

Reuse the catalyst

A packed column retains enzyme-containing beads while liquid passes through. Immobilised lactase can be used to reduce the lactose content of milk.

1. A REUSABLE ENZYME COLUMN



2. ADVANTAGES: SEPARATION, REUSE, STABILITY

Retaining the enzyme makes product separation easier and reduces enzyme carry-over. Beads can be used repeatedly, reducing replacement costs and supporting continuous processing. Immobilisation may improve stability, depending on the enzyme and support; it does not make enzymes indestructible.

3. LIMITATIONS: DIFFUSION AND OPERATING CONDITIONS

Substrate must reach enzymes inside the gel, which can limit the measured rate. Smaller beads shorten diffusion paths but may be harder to retain. Flow must allow enough contact time. Bead damage or enzyme leakage can reduce reuse; assess performance over repeated runs.

Column application: NCBE, University of Reading, Lactose-reduced milk.
Supporting research: Peta et al. (2025), Scientific Reports, doi:10.1038/s41598-025-00172-6.

Scope: Cambridge Biology 9700 syllabus, section 3.2, outcome 4, p. 20.