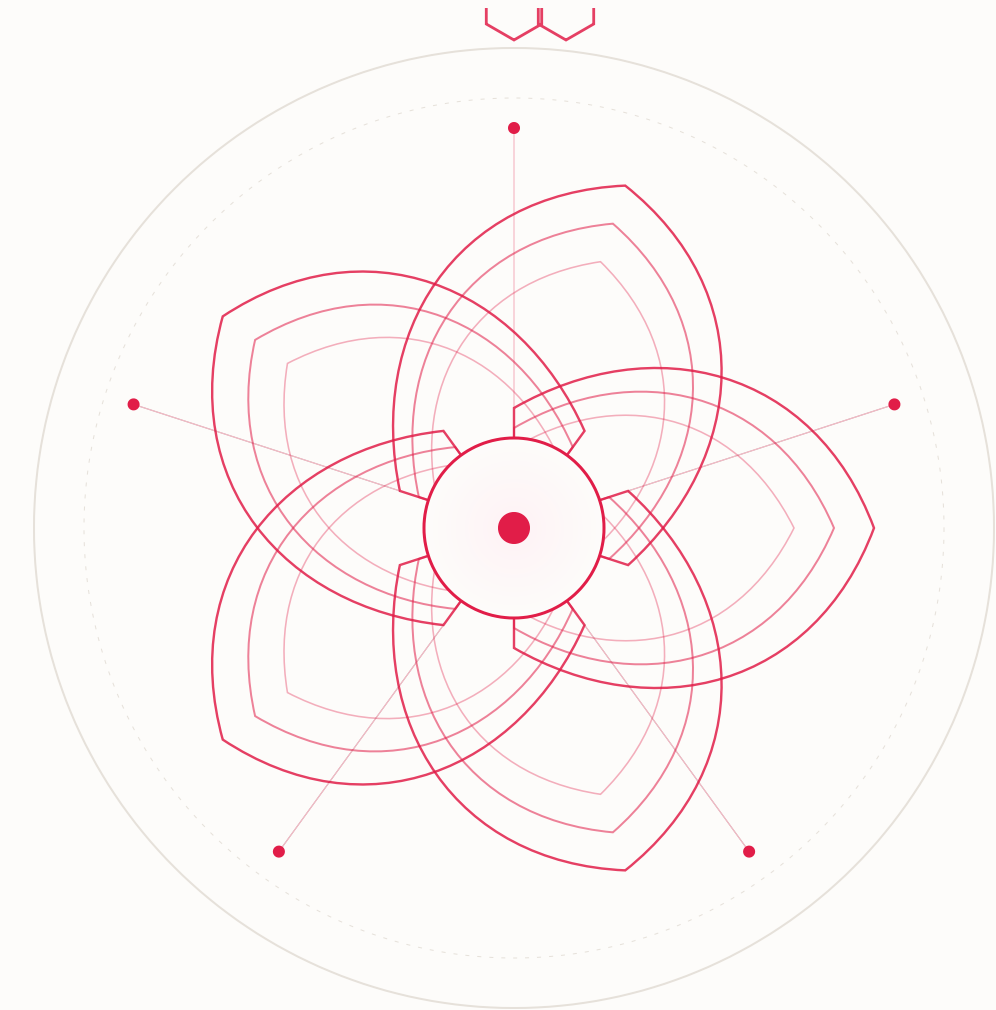


CHAPTER 00 · COVER

# Invertase: *The Enzyme* That Transforms *Sugar.*

A complete guide for AP Biology, IB Biology,  
A-Level & GCSE students.

invertase.bio / open science education



PRESS → TO BEGIN

CHAPTER 01 • DEFINITION

# What is invertase?

Invertase ( *$\beta$ -fructofuranosidase*, EC 3.2.1.26) is a hydrolase that cleaves **sucrose** into its monosaccharide components — **glucose** and **fructose** — by breaking the  $\alpha$ -1,2 glycosidic bond.



$\Delta G \approx -7 \text{ kJ/mol}$  · spontaneous



ALSO CALLED

Sucrased (in human digestion) · saccharase ·  $\beta$ -D-fructofuranoside fructohydrolase

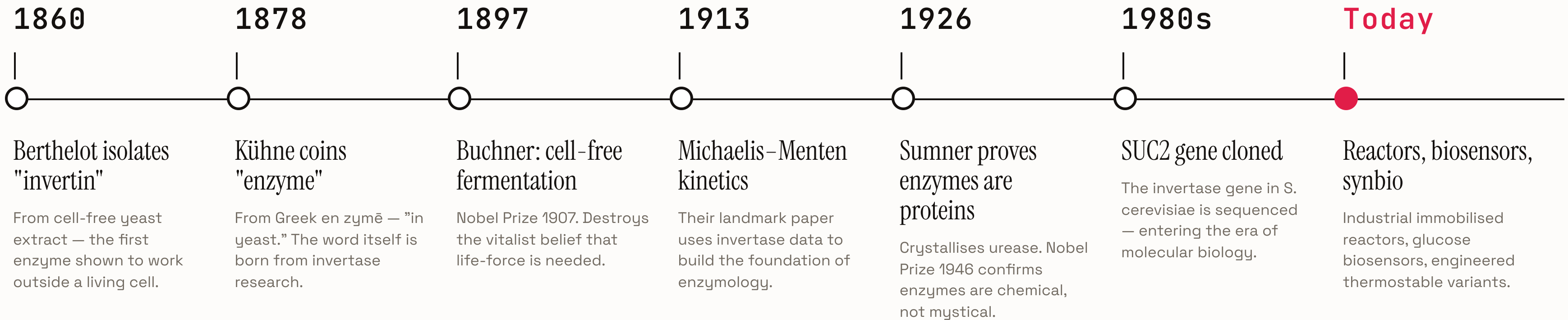
FOUND IN

Yeast (*S. cerevisiae*) · fungi (*A. niger*) · plants · honey bees

CHAPTER 02 • HISTORY

# 165 years of invertase.

Invertase is not just an enzyme — it is the *model organism* of biochemistry. Nearly every foundational idea in enzymology was first tested on it.

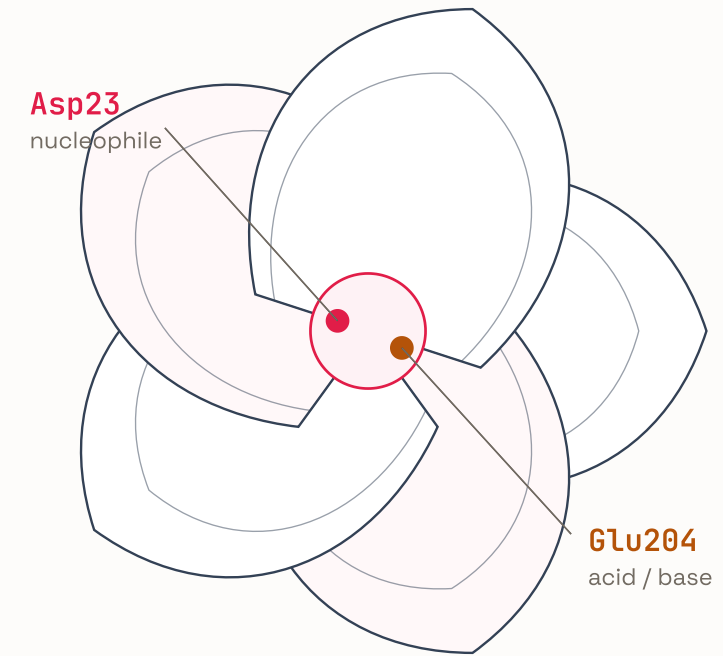


CHAPTER 03 • STRUCTURE

# Inside the active site.

Invertase belongs to glycoside hydrolase family **GH32**. Its fold is a five-bladed  $\beta$ -propeller — a disc of five wedge-shaped sheets arranged around a central cleft that holds the catalytic machinery.

5-BLADED  $\beta$ -PROPELLER



NUCLEOPHILE

## Asp 23

Attacks C2 of fructose

ACID / BASE

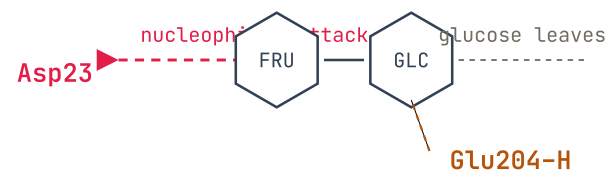
## Glu 204

Donates, then abstracts H<sup>+</sup>

The mechanism is *retaining double-displacement* — anomeric configuration at C2 is preserved through two inversions.

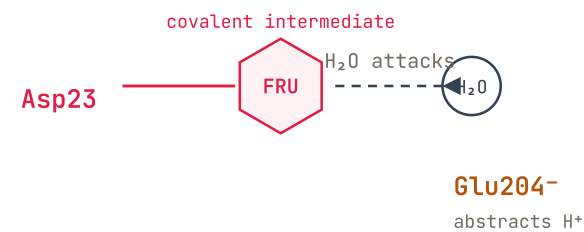
STEP 1

### Nucleophilic attack



STEP 2

### Fructosyl intermediate + H<sub>2</sub>O



STEP 3

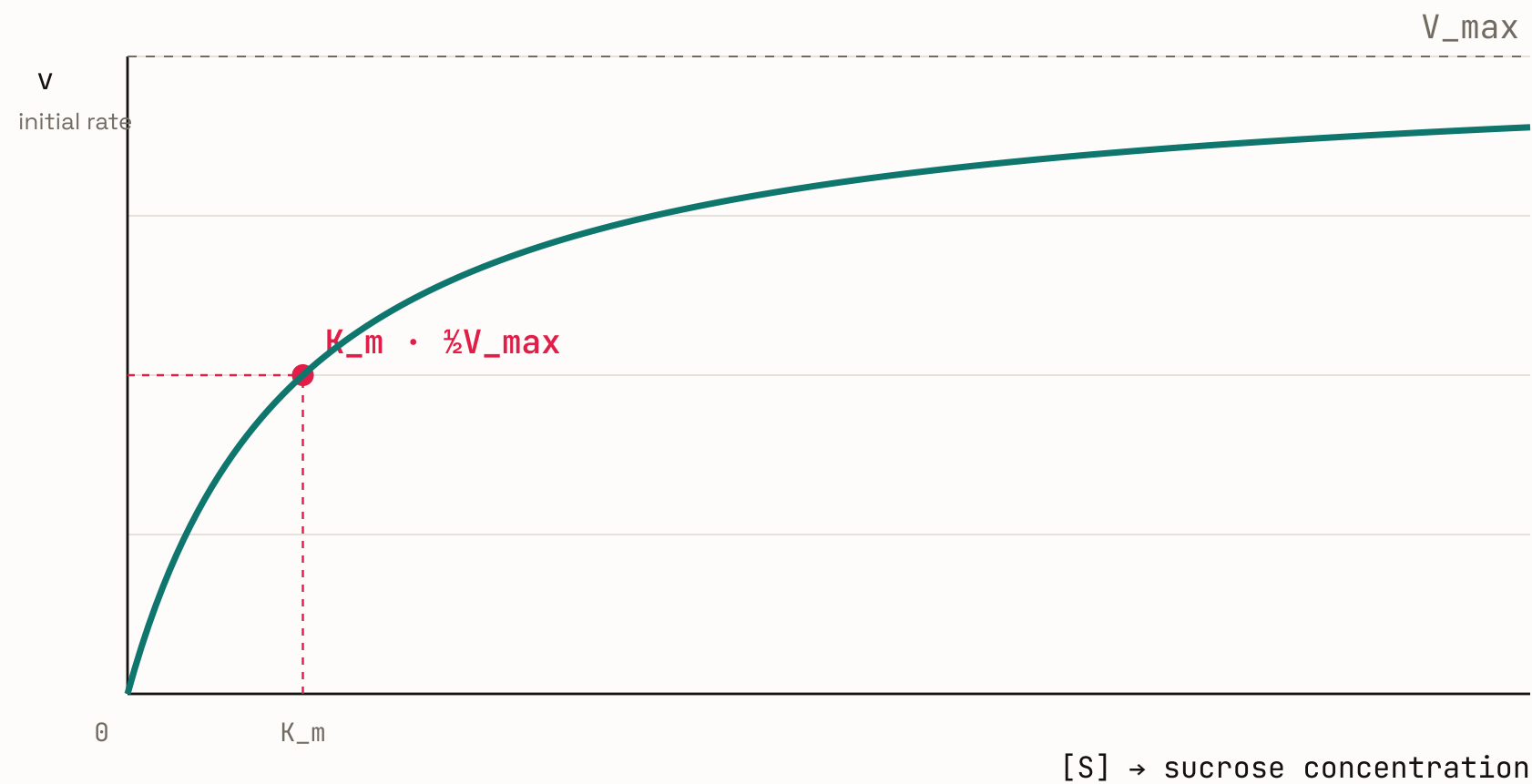
### Fructose release



CHAPTER 04 • KINETICS

# Michaelis–Menten, on invertase.

The 1913 paper that defined modern enzyme kinetics used invertase data to derive the rate law that still appears in every biology textbook.



MICHAELIS & MENTEN • 1913

THE EQUATION

$$v = \frac{V_{max} \cdot [S]}{K_m + [S]}$$

$K_m$  (SUCROSE)

5–10 mM

Moderate substrate affinity

$k_{cat}$

100–1000  $s^{-1}$

Turnovers per second per enzyme

$k_{cat} / K_m$

$\sim 10^5 M^{-1} s^{-1}$

Catalytic efficiency — well below diffusion limit

[invertase.bio/learn](http://invertase.bio/learn)

CHAPTER 05 • OPTIMAL CONDITIONS

# Every enzyme has a happy place.

MOLECULAR WEIGHT

## ~270 kDa

yeast external form • heavily glycosylated

### pH optimum

4.0 - 5.5 • peak 4.5

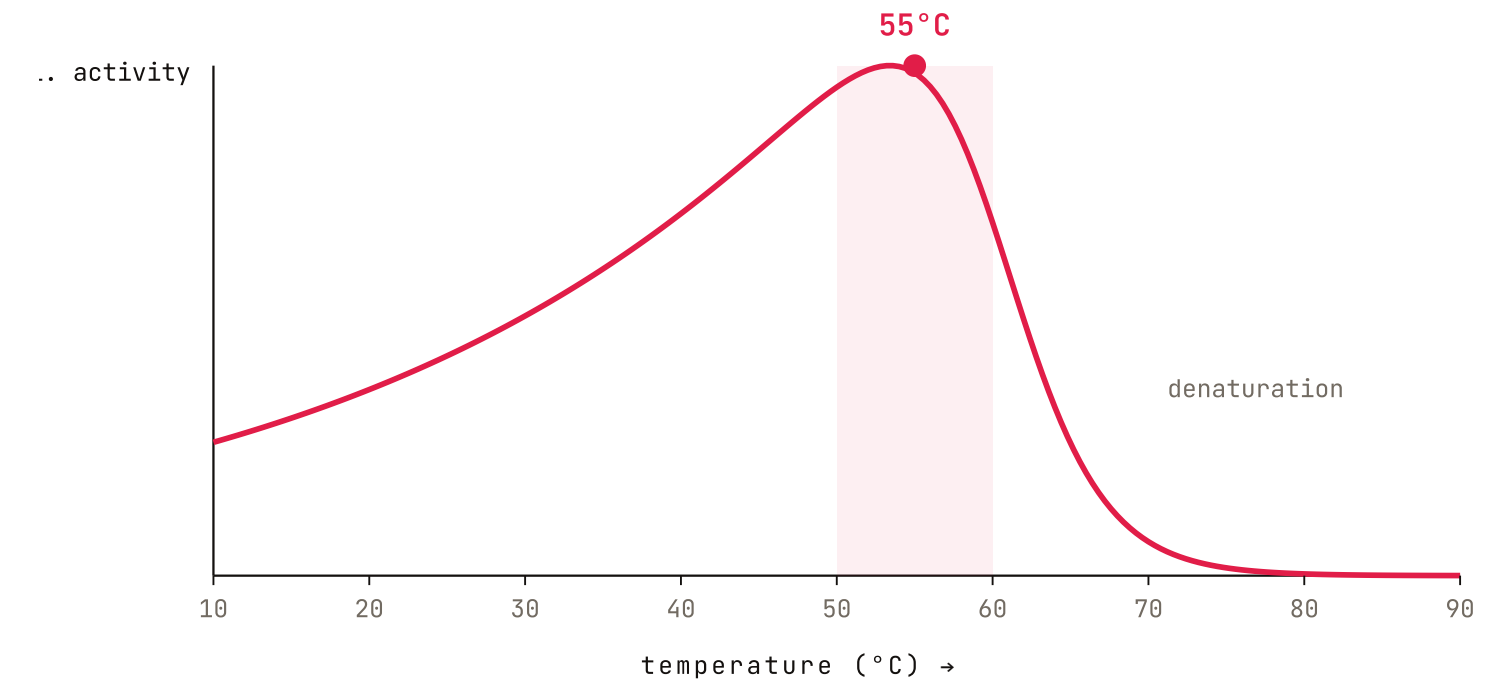
WHY

Below pH 4 the catalytic Glu204 becomes fully protonated and cannot act as a base; above pH 6 Asp23 deprotonates and loses nucleophilicity. The enzyme needs both residues in opposite ionisation states.

YEAST INVERTASE • EXTERNAL (SECRETED) FORM

### Temperature optimum

50 - 60°C • denatures > 65°C



WHY

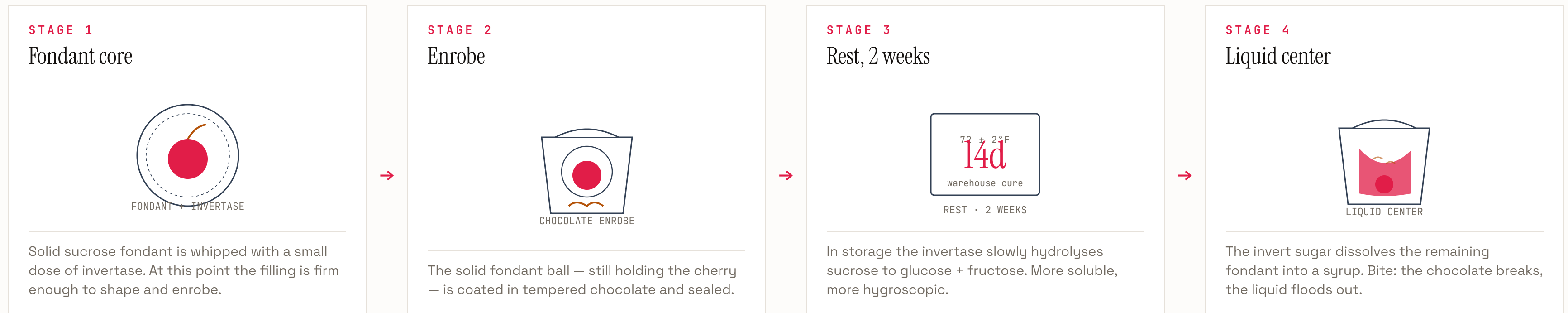
Rate rises with temperature (Arrhenius), but above ~60°C the folded  $\beta$ -propeller unravels faster than new substrate binds. The peak is the balance point between the two.

[invertase.bio/learn](http://invertase.bio/learn)

CHAPTER 06 · FOOD SCIENCE

# Invertase on your plate.

The same enzyme that taught us Michaelis–Menten kinetics is the reason the inside of a chocolate-covered cherry is liquid.



<b>HONEY</b>	Bee-made invert sugar	A honey bee secretes invertase into nectar as she carries it. By the time it ripens in the comb the sucrose has been hydrolysed — honey is mostly glucose + fructose.
<b>BAKING</b>	Moister cakes, longer shelf life	Invert sugar is more hygroscopic than sucrose and resists crystallisation, so fondants, cakes and fillings stay soft for weeks instead of days.
<b>BREWING</b>	Priming sucrose adjuncts	<i>S. cerevisiae</i> 's own invertase cleaves any sucrose in the wort before the yeast can ferment glucose and fructose. No invertase step, no beer.

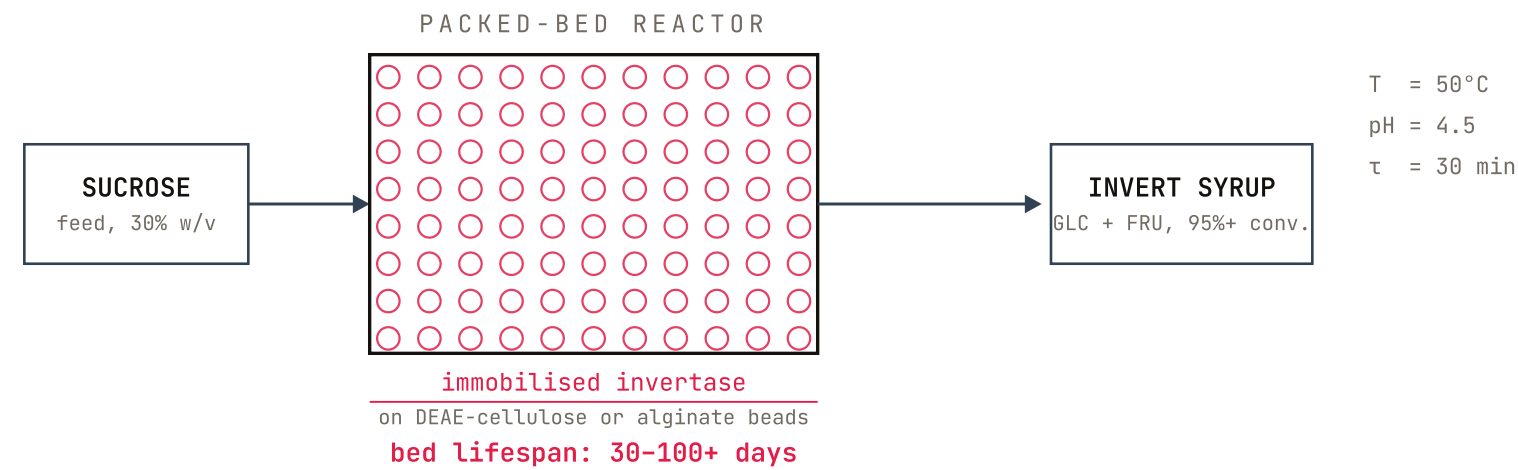
CHAPTER 07 · INDUSTRY & RESEARCH

# From reactor to biosensor.

Globally, confectionery is still the biggest buyer of invertase — but modern uses span pharma, bioethanol and analytical chemistry.

FLAGSHIP PROCESS

## Immobilised-enzyme reactor



CONFECTIONERY

### Largest market

Invert syrup and cordial fillings — the historical anchor of invertase demand.

PHARMA

### Sucraid (sacrosidase)

FDA-approved yeast invertase replacement for patients with congenital sucrase-isomaltase deficiency (CSID).

BIOSENSORS

### Invertase + GOx cascade

Sucrose → glucose → H<sub>2</sub>O<sub>2</sub> → amperometric signal. Used for sucrose QC in beverages and honey.

BIOETHANOL

### Brazilian sugarcane

Yeast's native invertase releases fermentable monosaccharides from cane-sucrose feedstock at industrial scale.

IMMOBILIZATION REUSABILITY CONTINUOUS FLOW

invertase 1990/learn

## CHAPTER 08 • CURRICULUM

# Where invertase fits in the syllabus.

US • GRADES 11-12

## AP Biology

- > Big Idea 2 — free energy & enzyme function
- > Big Idea 3 — information storage and transmission
- > Enzyme kinetics FRQ practice
- > Cellular respiration — links to glycolysis substrates

INTERNATIONAL • SL &amp; HL

## IB Biology

- > Topic 2.5 — Enzymes (active site, specificity)
- > Option D — Evolution and biodiversity
- > IA: measure  $K_m$  of yeast invertase
- > HL extension — intermediate metabolism

UK • 16-18

## A-Level

- > AQA / Edexcel / OCR core content
- > Enzyme kinetics and competitive inhibition
- > Industrial enzymes & immobilisation
- > Required practical — enzyme rate experiments

UK • 14-16

## GCSE

- > Biological catalysts — lock-and-key model
- > Industrial uses of enzymes
- > Digestive enzymes (including sucrase)
- > Effect of pH & temperature on activity

## LAB TIP

Cheap, safe,  
valid.

Invertase activity can be measured with a **glucose test strip** or **Benedict's reagent** — no exotic equipment needed. It is a curriculum-valid IA / coursework topic that lets students derive  $K_m$  from real data using kitchen-grade materials.

## CHAPTER 09 • CONTINUE

# Explore the full interactive guide at *invertase.bio/learn*

SIX ARTICLES • OPEN ACCESS

- |    |                   |   |
|----|-------------------|---|
| 01 | What Is Invertase | A plain-language introduction suitable for first-year biology students. |
| 02 | How It Works      | Active site, mechanism, and structural context of the GH32 family.      |
| 03 | Food Science      | Cordial cherries, honey, baking, brewing — with process walk-throughs.  |
| 04 | Applications      | Industrial reactors, Sucraid, biosensors, bioethanol, and beyond.       |
| 05 | For Students      | Exam-aligned notes, past-paper questions, downloadable diagrams.        |
| 06 | History           | From Berthelot's extract to modern synthetic-biology variants.          |

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## CONTACT

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