

# Enzymes and metabolism

International Baccalaureate · IB Diploma · Biology · HL

## Scope and prerequisites

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This handout covers selected HL topics for the course first assessed in 2025; it is not the whole syllabus.

Prerequisites: read the stated quantities and units, and use arithmetic and the model conditions below.

The examples are original and fictional: they are not real measurements or real student investigations.

## Enzyme rate and controlled measurements

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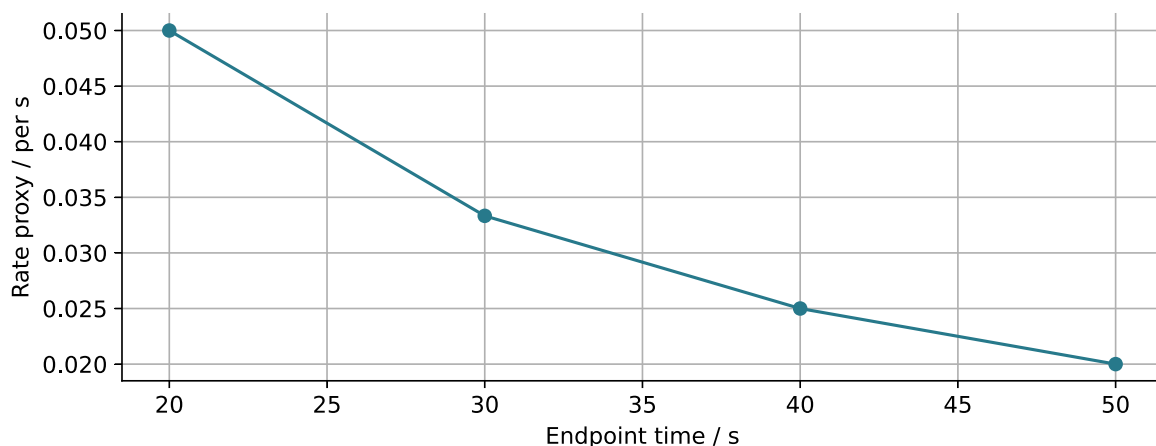
### ■ What would explain this observation?

- An **enzyme** works quickly at one temperature and slowly at another. Heating can increase successful collisions, but excessive heat can change the active site.

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### ■ Build the model

- An enzyme is a biological catalyst.
- The substrate binds at an active site whose shape and chemical properties support the reaction.
- A catalyst increases rate without being used up overall.
- enzyme: A biological catalyst.
- **denaturation** : A structural change that disrupts function.



*A longer time to the endpoint means a slower rate: rate is proportional to  $1/\text{time}$*

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### ■ Choose evidence that can test it

- Measure rate using product formed per unit time or a fixed endpoint.
- For an endpoint test,  $1/\text{time}$  is a rate proxy if the same amount of product or substrate change defines the endpoint each time.

**In the lab:** For starch digestion, equilibrate enzyme and starch in a water bath, control pH with buffer, mix measured volumes, and test samples with iodine at fixed intervals. Use a clean spot for each test. Do not put iodine into the reaction mixture.

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### ■ Work from known quantities

- Known: the endpoint is reached in 40 s.
- Use rate proxy =  $1/\text{time}$ .
- Rate proxy =  $1/40 = 0.025$  per second.
- At 20 s the proxy is 0.050 per second, twice as large.
- This comparison is valid only if the same endpoint and starting concentrations are used.

**Your turn:** A fixed endpoint takes 50 s. Calculate the rate proxy  $1/\text{time}$ .

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### ■ Check the conclusion and its limits

- An optimum is specific to the enzyme and conditions.
- Low temperature usually slows the reaction; it does not necessarily denature the enzyme.
- Endpoint intervals limit precision.

**Not true:** A low temperature always permanently denatures an enzyme. Low temperature usually only slows an enzyme because molecules collide less often; the active site is unchanged and warming restores activity. Denaturation is a structural change from excessive heat or extreme pH, not a guaranteed result of cooling.

### Key:

- An enzyme is a biological catalyst.
- Measure rate using product formed per unit time or a fixed endpoint.
- Watch for: an optimum is specific to the enzyme and conditions.

### ■ Write from a rate proxy of 0.0125 per second

- A fixed endpoint takes 80 s.
- Find the rate proxy  $1/\text{time}$ . The same endpoint must define every trial.