

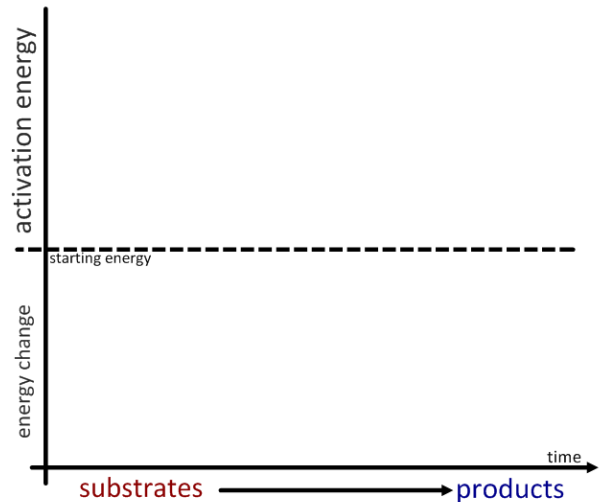
Topic 8.1 Metabolism

8.1.U1 Metabolic pathways consist of chains and cycles of enzyme-catalysed reactions.

1. Define metabolism.
2. Describe what a metabolic pathway is and state how each step in the pathway is controlled.
3. Give an example of a linear metabolic pathway.
4. Give an example of a metabolic pathway that is a cycle.

8.1.U2 Enzymes lower the activation energy of the chemical reactions that they catalyse.

5. Define activation energy?
6. How do enzymes lower the activation energy of a reaction?
7. Complete the sketch graph to show how enzymes reduce the activation energy required for a reaction to occur.
8. Enzymes benefit organisms by speeding up the rate at which reactions occur. Typically by what factor are the reactions increased by?



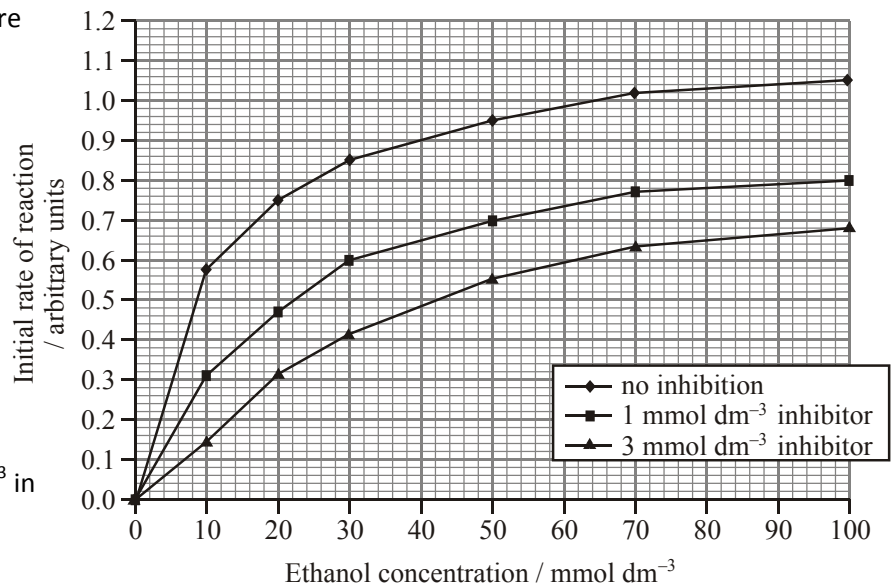
8.1.U3 Enzyme inhibitors can be competitive or non-competitive.

9. Define an inhibitor.
10. Using diagrams, explain the difference between competitive and non-competitive methods of inhibition.
11. Outline one example of a competitive inhibitor.
12. Outline one example of one non-competitive inhibitor.

8.1.S2 Distinguishing different types of inhibition from graphs at specified substrate concentration.

13. Sketch a graph to compare the effects of competitive and non-competitive inhibitors on the rate of enzyme activity at different substrate concentrations. Add annotations to explain the different effects the different types of inhibitor have upon the rate of enzyme activity.
14. Three experiments were carried out to measure the effect of inhibitor concentration upon an enzymes rate of reaction. The results for each experiment are shown in the graph below.

From IB Biology past papers [Source: R Taber, Biochemical Education, (1998) 26, pages 239-242]

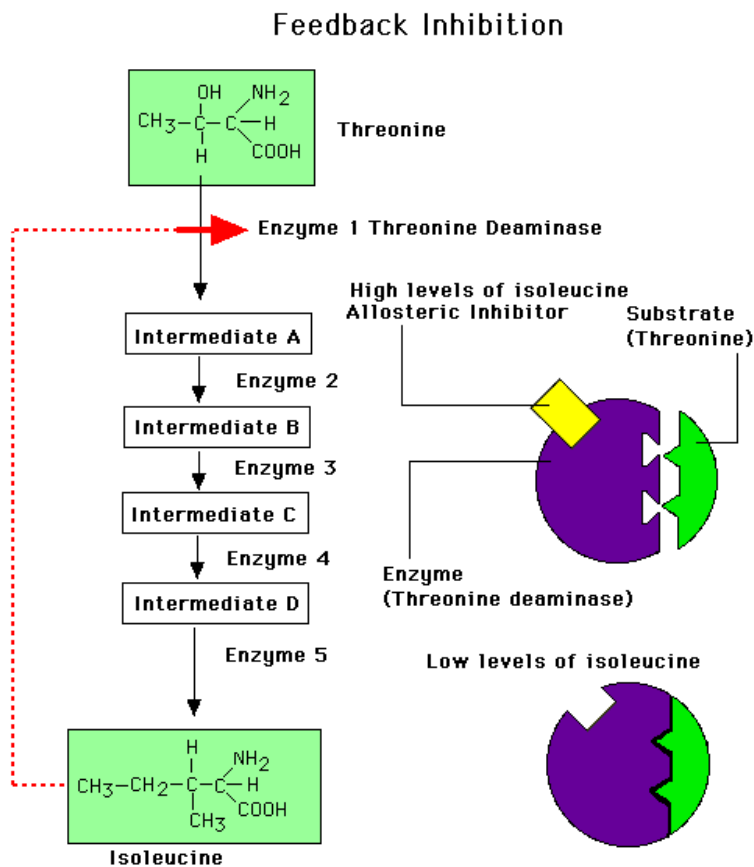


- Outline the effect of increasing the substrate concentration on the control reaction (no inhibition).
- State the initial rate of reaction at an ethanol concentration of 50 mmol dm^{-3} in the presence of the inhibitor at the following concentrations.
 - 1 mmol dm^{-3} :
 - 3 mmol dm^{-3} :
- State the effect of increasing the concentration of inhibitor on the initial rate of reaction.
- Deduce what type of inhibitor is in use. Give reasons for your decision.

8.1.U4 Metabolic pathways can be controlled by end-product inhibition.

15. Explain the role of end-product inhibition as a method of controlling metabolic pathways. Include the role of allosteric sites.

8.1.A1 End-product inhibition of the pathway that converts threonine to isoleucine.



- Isoleucine is an essential amino acid
- Bacteria synthesize isoleucine from threonine in a series of five enzyme-catalysed steps
- As the concentration of isoleucine increases, some of it binds to the allosteric site of threonine deaminase
- Isoleucine acts as a non-competitive inhibitor to threonine deaminase
- The pathway is then turned off, regulating isoleucine production.
- If the concentration of isoleucine later falls (as a result of its use) then the allosteric sites of threonine deaminase are emptied and the enzymes recommences the conversion of threonine to isoleucine takes place.

<http://www.uic.edu/classes/bios/bios100/lecturesf04am/feedback-inh.gif>

8.1.S1 Calculating and plotting rates of reaction from raw experimental results.

The rate of reaction can be calculated using the formula:

$$\text{Rate of reaction (s}^{-1}\text{)} = 1 / \text{time taken (s)}$$

Time taken in enzyme experiments this is commonly the time to reach a measurable end point or when a standard event, caused by the enzyme reaction, has come to pass. This is usually measured by the effects of the accumulation of product, but can as easily be measured by the disappearance of substrates.

You will carry out several labs, which will give you the opportunity to collect data from which you can calculate the rate of reaction.