

To provide an idea about what this book contains, only few pages taken randomly from the book are shown here.



ABOUT BIOLOGY KEY•POINTS

ABOUT
KEY SYMBOLS

i. TO UNLOCK THE CONTENTS IN THE OVERVIEW OF THE TOPIC.

OR

ii. TO SEARCH FOR NEXT SUBJECT.

BIOLOGY IS THE STUDY OF LIFE. It is derived from the Greek words “*bios*” (meaning life) and “*logos*” (meaning knowledge). It involves

— *Botany* – the study of plants

— *Zoology* – the study of animals

— *Ecology* – the study of early developmental stages of an organism

— *Genetics* – the study of genes and the principles of inheritance

— *Biotechnology* – the study of the application of scientific and engineering principles to develop a product beneficial for the society

BIOLOGY KEY•POINTS offers the student a complete guide to aid preparation for the upcoming GCE ‘O’ Level examinations.

Each chapter begins with EXPECTATIONS for the chapter. There is also a list of USEFUL WEBSITES for further research on the topic.

Next comes OVERVIEW OF THE TOPIC in tabular form. The book is geared towards tables as it helps to give the student the ability to analyse, interpret and draw conclusions from the study material.

An exercise consisting of QUESTIONS AND ANSWERS relating to the topic follows, reflecting the trend that is commonly found in the examination papers.

EXAMTIPS are available at the end of each question to point out the common mistakes, so that it can be avoided when the student sits for the examinations.

<i>no. 1 CELL STRUCTURE and ORGANISATION</i> _____	5
<i>no. 2 SPECIALISED CELLS, TISSUES and ORGANS</i> _____	14
<i>no. 3 DIFFUSION and OSMOSIS</i> _____	22
<i>no. 4 ENZYMES</i> _____	32
<i>no. 5 PLANT NUTRITION</i> _____	42
<i>no. 6 TRANSPORT in FLOWERING PLANTS</i> _____	59
<i>no. 7 FOOD and NUTRITION</i> _____	75
<i>no. 8 DIGESTION</i> _____	92
<i>no. 9 TRANSPORT in MAN</i> _____	115
<i>no. 10 RESPIRATION</i> _____	137
<i>no. 11 EXCRETION</i> _____	155
<i>no. 12 HOMEOSTASIS</i> _____	166
<i>no. 13 CO-ORDINATION and RESPONSE</i> _____	178
<i>no. 14 THE USE and ABUSE of DRUGS</i> _____	203
<i>no. 15 MICRO-ORGANISMS and BIOTECHNOLOGY</i> _____	213
<i>no. 16 ENERGY and THE ECOSYSTEM</i> _____	229
<i>no. 17 EFFECTS of MAN on THE ECOSYSTEM</i> _____	241
<i>no. 18 ASEXUAL REPRODUCTION and REPRODUCTION in PLANTS</i> _____	251
<i>no. 19 REPRODUCTION in MAN</i> _____	273
<i>no. 20 INHERITANCE</i> _____	292

TOPIC 4**ENZYMES**

LEARNING OBJECTIVES

Candidates should be able to:

1.	Define enzymes are proteins which function as biological catalysts.
2.	Investigate and describe the effect of temperature and of pH on enzyme activity.
3.	Describe the uses of enzymes in the germination of seeds.

USEFUL WEBSITES

1. www.chem.qmw.ac.uk/iupac/medchem/ah.html#e3
 2. www.chem.wsu.edu/Chem102/102-EnzInhibReg.html
(Enzyme inhibition and regulation)
 3. www.bartleby.com/65/en/enzyme.html
 4. www.people.virginia.edu/~rjh9u/enzychar.html
(Characteristics of enzymes)
-

OVERVIEW OF THE TOPIC

ENZYMES	1. INTRODUCTION	
	2. MODE OF FUNCTION	
	3. COENZYMES	
	4. USES OF ENZYMES	
	5. ENZYME ACTIVITY	•Temperature
		•pH
6. ENZYMES IN SEED GERMINATION		

INTRODUCTION

Enzymes

1. Are proteins that function as biocatalysts.
2. Has a unique shape that acts on specific substrates like a "lock and key".
3. Are produced in minute quantities by living cells.
4. Can be used over and over again, as it remains unchanged at the end of the reaction.
5. Are named by adding suffix 'ase' to the name of its substrate. E.g. sucrase acts on sucrose.

MODE OF FUNCTION

Mode of function	Inactivation (by changing the active site)
•Very specific in their substrate	•Heat (usually above 50°C)
•Binds to substrate on the active site	•pH changes
•Bonds are temporary	•By poisons
•Anabolic - produce complex molecules from simple molecules •Catabolic - split large molecules into smaller ones	•Heavy metals such as lead, arsenic, mercury

Table 1: Mode of function of enzymes

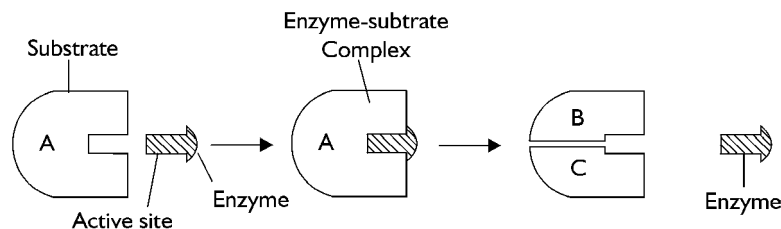


Fig. 1: Mode of action of enzymes

ExamTip

Enzymes that are found inside cells catalyse metabolic reactions. Those found outside cells are involved in digestion.

COENZYME

1. Non-protein molecules e.g. Vitamin B.
2. Joins enzymes temporarily during a reaction.
3. Remains unchanged at the end of a reaction.
4. Without the coenzyme, these reactions will not occur.
E.g. lack of Vitamin B leads to stunted growth, paralysis and loss of appetite.

USES OF ENZYMES

Enzyme	Usage type	Effect
Protease	•Industrial use	•Skinning fish, removing hair
Amylase	•Industrial use	•Production of chocolate, syrup
Cellulase	•Industrial use	•Softening vegetable, removing seed coats
Protease	•Everyday	•Added to washing powder to remove protein stains
Lipase	•Digestion	•Converts fats to fatty acids and glycerol
Amylase	•Digestion	•Converts starch to glucose

Table 2: Uses of enzymes

ENZYME ACTIVITY

Temperature	pH
<ul style="list-style-type: none"> • (↑) Temperature, (↑) activity 	
<ul style="list-style-type: none"> • (↑) 10°C leads to the activity doubling 	<ul style="list-style-type: none"> • Specific pH for every enzyme
<ul style="list-style-type: none"> • Optimal temperature around 45°C 	<ul style="list-style-type: none"> • Works best at optimal pH
<ul style="list-style-type: none"> • Temperatures above 50°C will denature the enzyme 	<ul style="list-style-type: none"> • Changes in acidity and alkalinity will denature the enzyme
<ul style="list-style-type: none"> • Temperature damage not reversible 	<ul style="list-style-type: none"> • Damage is reversible by changing pH

Table 3: Effects of temperature and pH on enzymes

ExamTip

A change in pH results in a change in concentration of hydroxyl ions and hydrogen ions. An excess of either of these ions will destabilise the enzyme by changing the shape of its active site.

SEED GERMINATION



1. Seed germination takes place in the presence of water, oxygen and a suitable temperature.
2. During germination, water enters the seed, causing the seed to swell; rupturing the testa.
3. Water serves to soften the testa, making it more permeable to oxygen and carbon dioxide.
4. Water enters the cotyledons, activates the secretion of enzymes to digest the insoluble starch and protein present in the cotyledon.
E.g. amylase to convert starch to glucose
protease to convert protein to amino acids
5. These products of 'digestion' are sent to the plumule and radicle for growth.
6. Glucose is used during respiration to provide energy for cell growth.
7. Amino acids are used in the formation of new cell proteins.

SAMPLE QUESTIONS

1. Which molecules are produced by the digestion of starch and protein? (N99/PI/Q9)

	Starch	Protein
A	Glycerol	Amino acids
B	Glycerol	Fatty acids
C	Sugar	Amino acids
D	Sugar	Fatty acids

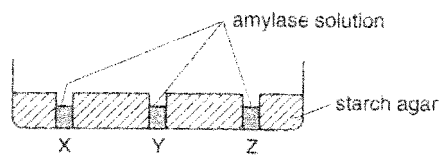
2. Under which conditions does amylase act on starch most quickly? (N99/PI/Q5)

	pH	Temperature
A	Acidic	30°C
B	Acidic	60°C
C	Neutral	30°C
D	Neutral	60°C

3. A shallow dish holds agar jelly containing starch. Three similar wells, X, Y and Z are cut into the jelly. Three different amylase solutions are prepared as follows.

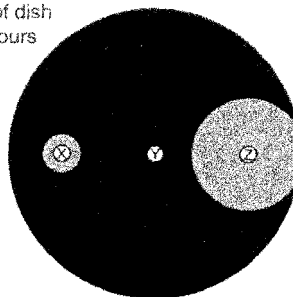
1. amylase solution
2. boiled amylase solution
3. amylase solution + dilute hydrochloric acid

Each well has a different amylase solution added to it.



Twenty-four hours later the jelly is covered with iodine solution.

top view of dish
after 24 hours



key

□ jelly stained light brown

■ jelly stained blue-black

- Which amylase solution was placed in each well? (J99/PI/Q5)

SOLUTIONS AND EXPLANATIONS

1. **C** Starch is converted to sugars and proteins are broken down to form amino acids.

Exam Tip 

Starch is a polysaccharide, or complex sugar. During digestion, it would be broken to form simpler forms of sugar. Proteins are formed by groups of amino acids. Therefore, digestion would convert a complex protein into simpler amino acids.

2. **C** Amylase works best under neutral pH at about 30°C.

Exam Tip 

Amylase is found in plants. Plants take in water. This water is at a neutral pH. Acid rain would have a detrimental effect on plants. At 30°C, the plant is under normal temperature settings in this tropical climate. However, at 60°C, the weather would be considered too warm and the plant tends to dehydrate. This is not an optimal temperature for plants.

3. **D** The jelly with the amylase solution should be able to digest the starch around it. It should produce the greatest effect on the agar as compared to the other solutions.

Exam Tip 

When the amylase solution is boiled, the high temperature will destroy the effects of the enzyme. It would result in irreversible damage to it. There should not be any reaction from this solution with the agar. When hydrochloric acid is added to the amylase solution, this would result in a change in pH for the enzyme. It would denature it as well, by changing its active sites. However this damage is reversible, as compared to heat damage.

4. **B** Enzyme activity increases steadily till the optimum range of temperatures. After that, there will be a sharp decrease in enzyme activity as the high temperature will denature the enzyme.

Exam Tip 

Graph A show that the enzyme activity will stabilize after a certain temperature. Graph C indicates a constant increase in enzyme activity as temperature rises. And in graph D, the enzyme activity increases to a point and then steadily decreases. Although this may be true, candidates should study the graphs well and note that for this graph, the optimal temperature has yet to be reached.