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Rugby School 16+ Biology

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CONTENTS

RUGBY SCHOOL

Sixth Form Entrance Examination

Specimen paper

BIOLOGY

Time allowed: 1 hour

This paper is divided into two sections

Section A:	Multiple choice : 20 marks
Section B:	Structured questions : 30 marks

Equipment Required: Pen, pencil, ruler and calculator

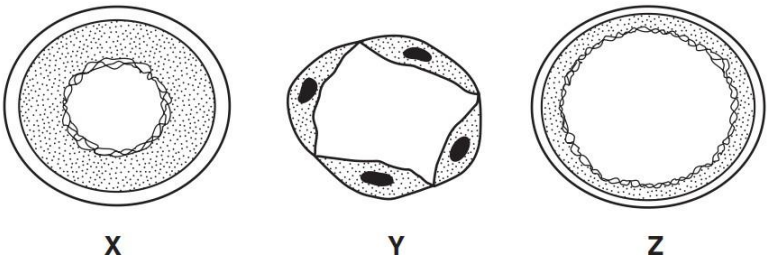
SECTION A

Use the attached 'Multiple Choice Answer Sheet' at the back of this booklet to give your answer to the following 20 multiple questions. You may detach the sheet but remember to write your name and school in the space provided.

Indicate your answer by circling your chosen letter using a dark (HB) pencil. Ensure you have only one clear answer for each question.

Q1

The diagram shows cross-sections of three types of blood vessel (not drawn to the same scale).

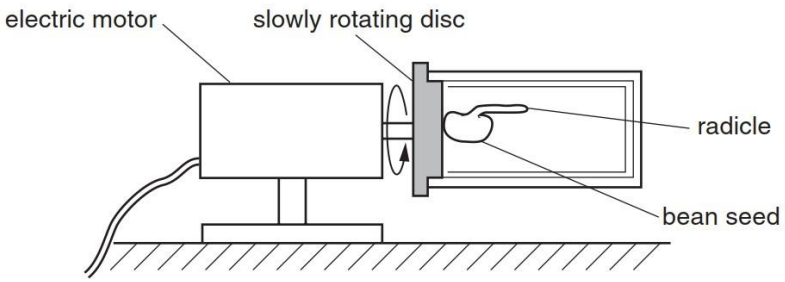


What is the identity of the three vessels?

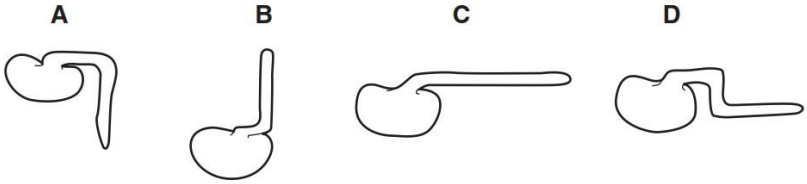
	artery	capillary	vein
A	X	Y	Z
B	Y	X	Z
C	X	Z	Y
D	Y	Z	X

Q2

The diagram shows a germinated bean seed with a horizontal radicle. This is placed on a slowly rotating disc and is left for three days.



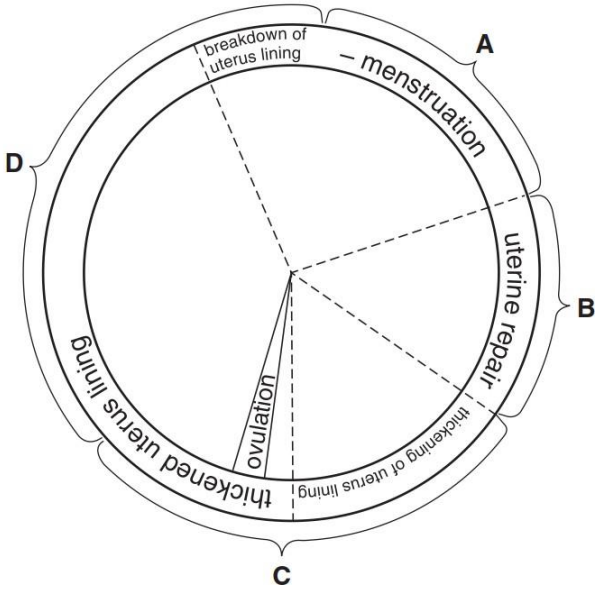
Which diagram shows the appearance of the radicle after three days?



Q3

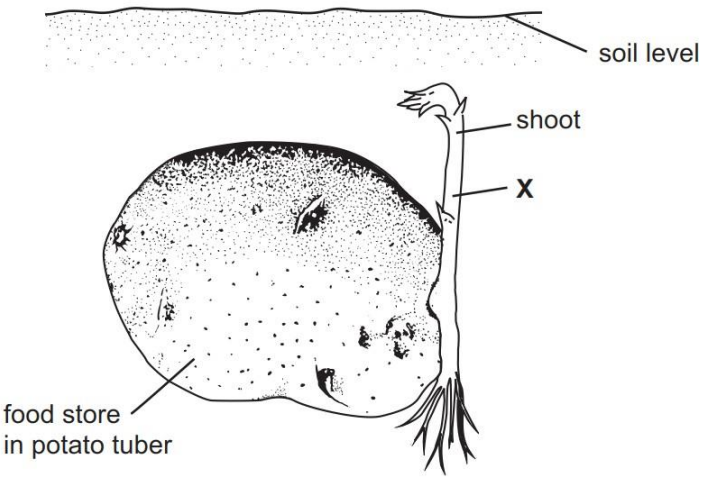
The diagram shows stages of a menstrual cycle.

During which stage is a woman most fertile?



Q4

The diagram shows a shoot growing from a potato tuber.



What is being transported in the phloem cells at **X**?

A starch downwards

B starch upwards

C sugars downwards

D sugars upwards

Q5

From which organ is most carbon dioxide excreted?

A kidney

B liver

C lung

D skin

Q6

Which substance normally passes from a fetus to its mother through the placenta?

A alcohol

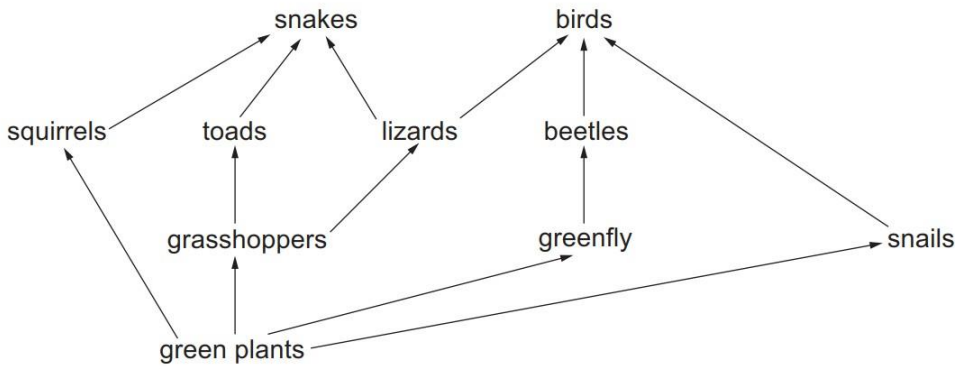
B glucose

C oxygen

D urea

Q7

The diagram shows a food web.



Which organisms will increase in number, if the number of snakes increases?

A birds

B grasshoppers

C lizards

D squirrels

Q8

The activity of decomposers returns substances to the atmosphere.

Which products of decomposition enter the atmosphere?

A carbon dioxide and nitrogen

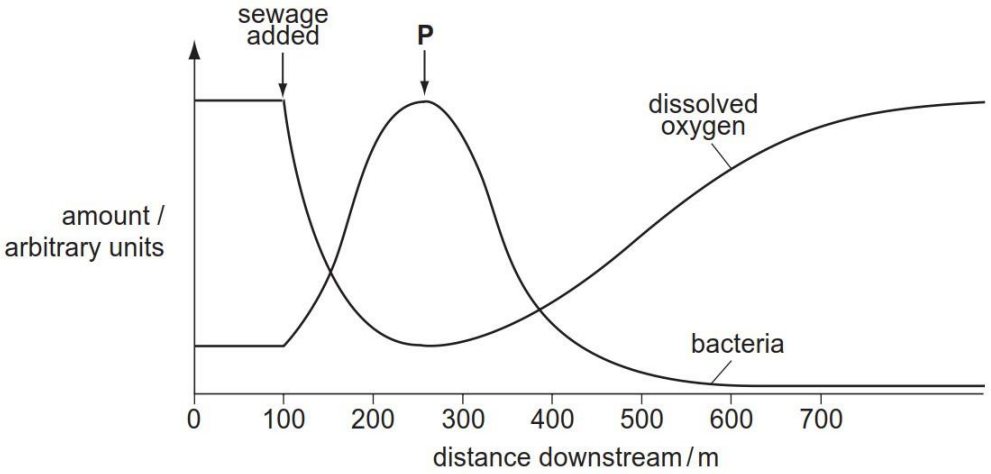
B carbon dioxide and water

C oxygen and nitrogen

D oxygen and water

Q9

The graph shows how oxygen concentration and numbers of bacteria change when sewage is added to a river.



What describes the oxygen concentration and the numbers of bacteria between the point at which sewage is added and point **P**?

A Oxygen concentration and numbers of bacteria stay the same.

B Oxygen concentration decreases and numbers of bacteria increase.

C Oxygen concentration increases and numbers of bacteria decrease.

D Oxygen concentration remains the same and numbers of bacteria increase.

Q10

Which word equation represents anaerobic respiration in human muscle?

A glucose → carbon dioxide + ethanol (alcohol)

B glucose → carbon dioxide + lactic acid

C glucose → ethanol (alcohol)

D glucose → lactic acid

Q11

Starch is digested by amylase in the mouth, but it is not digested in the stomach.

What is the reason for this?

A All starch digestion is completed in the mouth.

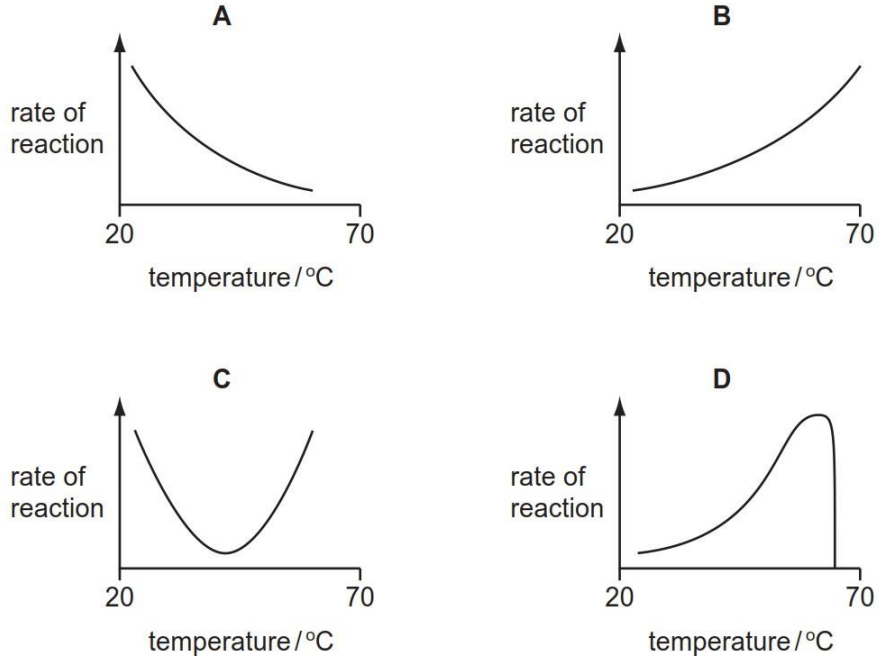
B The pH in the stomach is not suitable for the amylase to work.

C The starch does not stay in the stomach long enough to be digested.

D The temperature in the stomach is not suitable for the amylase to work.

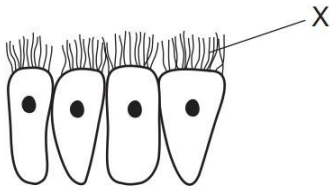
Q12

Which graph shows the effect of temperature on the activity of a human digestive enzyme?



Q13

The diagram shows some cells from the lining of the trachea (windpipe) in the respiratory tract.



What is the function of the structures labelled X?

A absorbing oxygen

B killing micro-organisms

C moving mucus

D trapping bacteria

Q14

Which cell type contains the **most** chloroplasts?

A palisade mesophyll

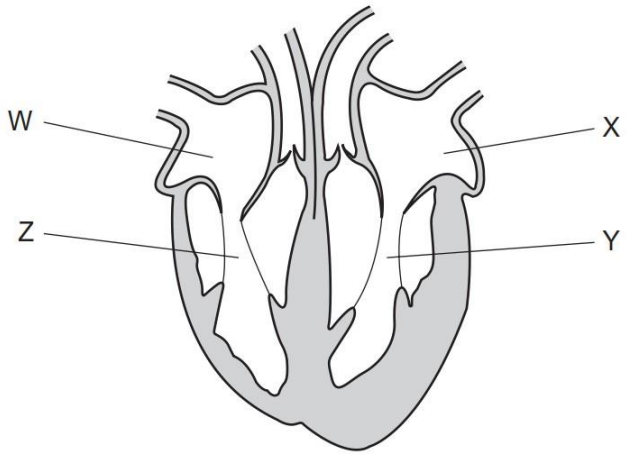
B phloem

C spongy mesophyll

D xylem

Q15

The diagram shows the human heart.

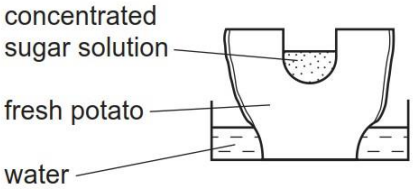


Which two chambers contract at the same time?

A W and X **B** W and Z **C** X and Z **D** X and Y

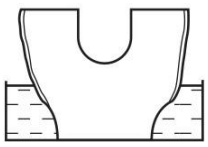
Q16

The diagram shows an experiment using a potato.

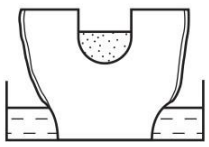


Which shows the result of the experiment after 24 hours?

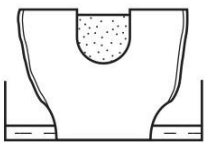
A



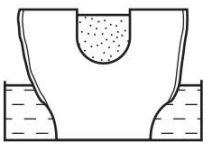
B



C



D



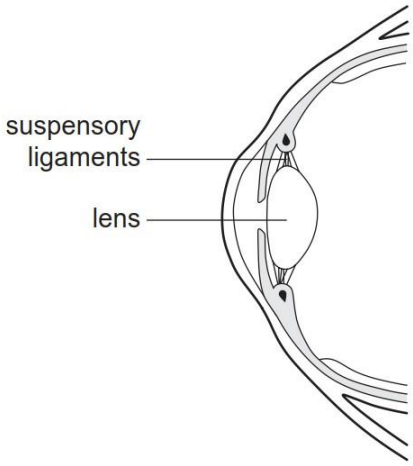
Q17

Which set of conditions will best enable seeds to germinate quickly?

	water	oxygen	temperature (°C)
A	absent	present	20
B	present	absent	20
C	present	present	20
D	present	present	0

Q18

The diagram shows a section through part of the human eye.



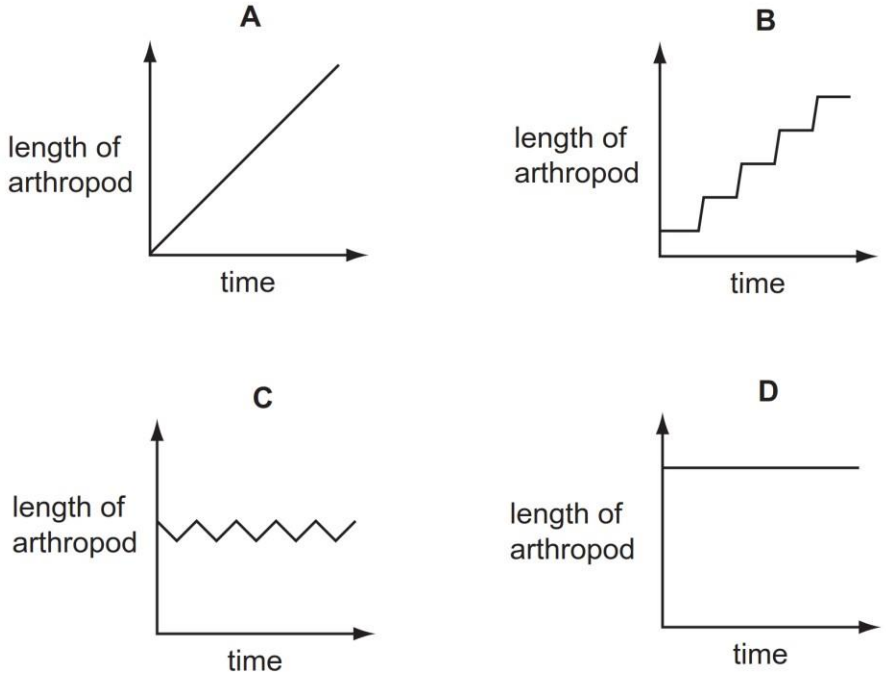
When a person looks at an object which is close to their eye, which of the following takes place?

	suspensory ligaments	lens
A	slacken	becomes fatter
B	slacken	becomes thinner
C	tighten	becomes fatter
D	tighten	becomes thinner

Q19

In arthropods, growth occurs only after the exoskeleton is shed and before the new one hardens.

Which graph shows a typical growth curve for an arthropod?



Q20

In the life cycle of a mammal, what describes the eggs or sperms and the cells of the embryo?

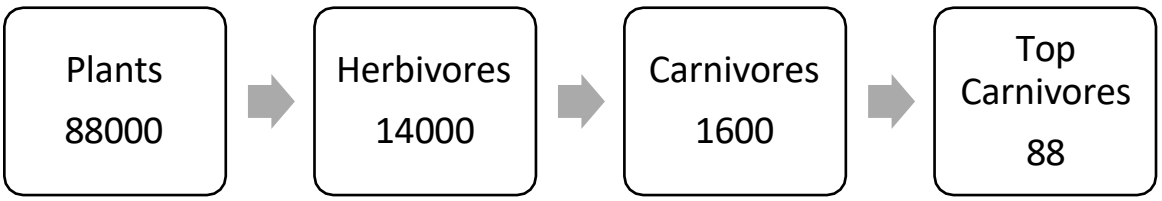
	eggs or sperms	cells of the embryo
A	diploid	diploid
B	diploid	haploid
C	haploid	diploid
D	haploid	haploid

The END of Section A

Section B

Q1

The diagram shows a food chain in a pond. The figures show the amounts of energy in each type of organism, in kilojoules per m^2 of pond per year



(a) Calculate the percentage of the energy in plants that is passed to the top carnivores. Show your working

……..%

[1]

(b) In the space below, draw a labelled pyramid of biomass for this food chain.

[2]

(c) If humans ate organisms from this food chain, it would be more efficient to eat plant that to eat herbivories. Why is this?

……

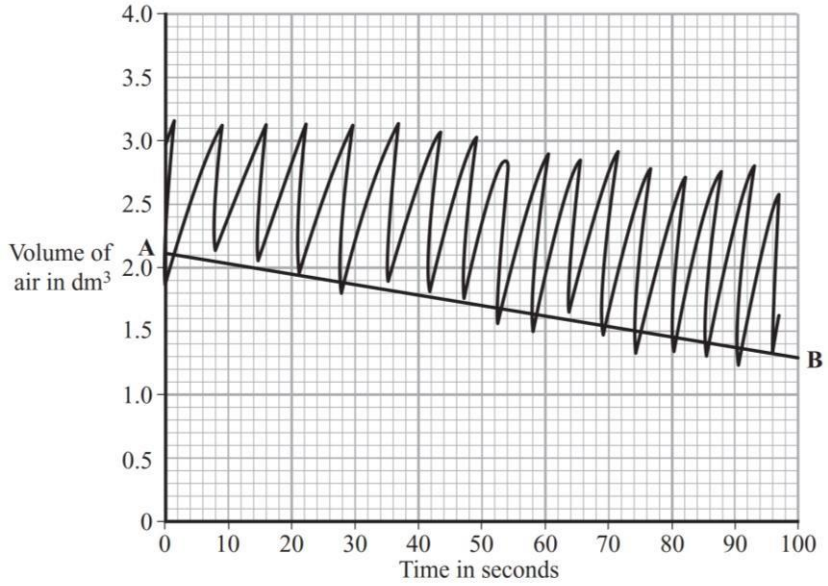
……

……

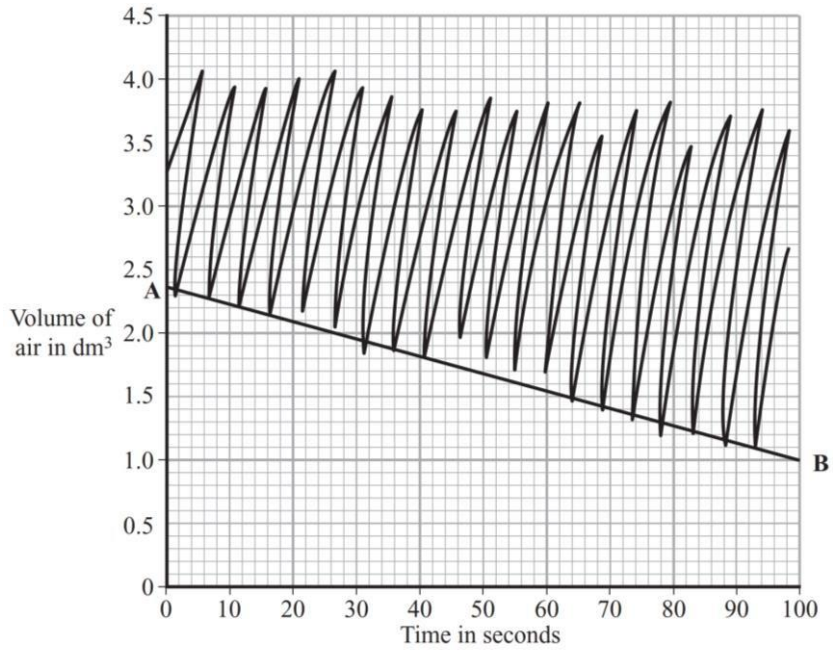
[1]

Q2 A student's breathing was monitored before and after vigorous exercise. The student breathed in and out through a special apparatus. The graphs show the changes in the volume of air inside the apparatus. Each time the student breathed in, the line on the graph dropped. Each time the student breathed out, the line went up.

Before Exercise



After Exercise



(a) How many times did the student breathe in per minute

Before exercise; ……

After exercise; ……...

[1]

(b) ON each graph, the line **A-B** shows how much oxygen was used. The rate of oxygen use before exercise was 0.5 dm^3 per minute?

Calculate the rate of oxygen use after exercise.

Rate of oxygen use after exercise =.....dm^3 per minute

[1]

(c) The breathing rate and amount of oxygen used were still higher after exercise, even though the student sat down to rest.

Why were they still higher?

……

……

……

……

……

……

……

……

[4]

(d) Apart from the temperature, state on other factor which must be kept constant throughout the experiment.

……

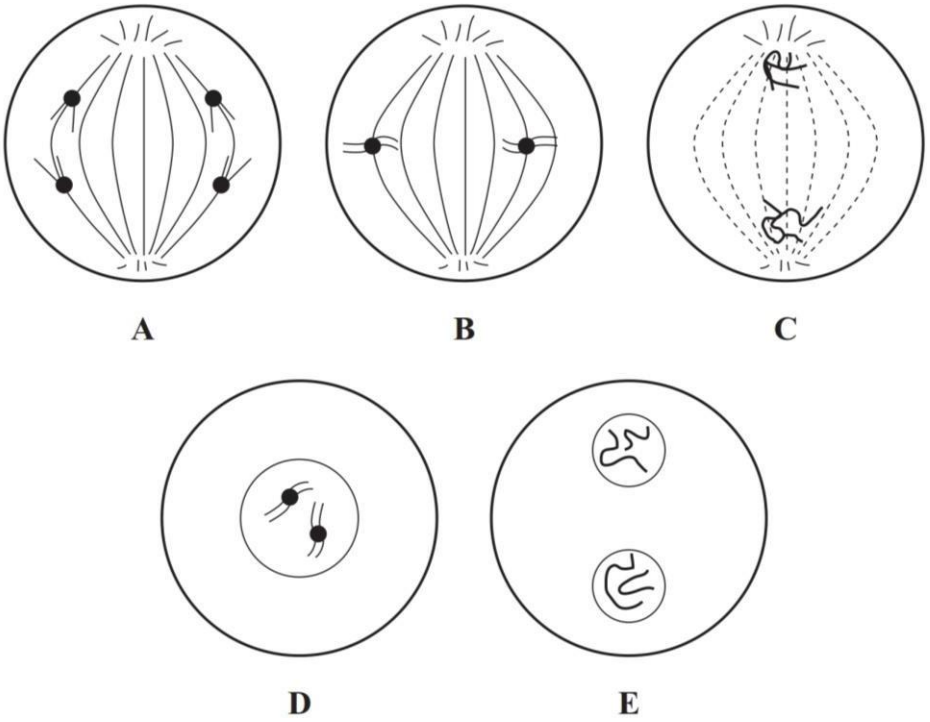
……

……

[1]

Q3

The diagram shows five stages in one type of cell division. The stages are not in the correct order. Cells produced by this type of cell division are genetically identical.



(a) Name the type of cell division shown in the diagram

……

[1]

(b) What is the correct order of stages A, B, C, D, E?

……

[1]

(c) Approximately one in every million cells produced by this types of cell division will be genetically different.

(i) What term do scientists use to describe a change in a gene?

……

[1]

(ii) The rate of genetic change can be increased by some environmental factors. Give one environmental factor that would cause an increase in the rate of genetic change.

……

[1]

Q4

(a) What is the name given to an enzyme which catalyses the breakdown of a protein?

.....

[1]

(b) What product is formed when protein is broken down by an enzyme?

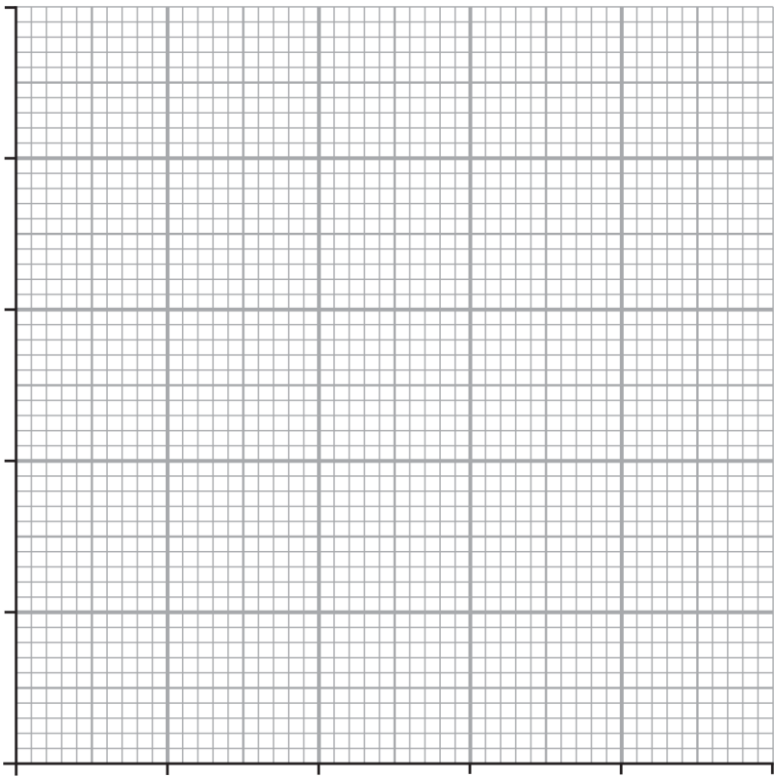
.....

[1]

The table below shows the effect of pH on the activity of an enzyme which catalyses the breakdown of protein

pH	1.0	2.0	3.0	4.0	5.0
Rate of formation of product in mmol per minute	10.5	23.0	10.5	2.5	0.0

(c) Draw a graph of the data in the table



[5]

(d) Calculate how many times greater the enzyme rate is at pH 2.0 than pH 4.0.

.....

[1]

The enzyme is produced by the human digestive system.

(e) Suggest which part of the digestive system produces this enzyme.

.....

[1]

Q5

Describe an experiment to investigate the effect of light intensity on the rate of photosynthesis.

[6]

The END of Section B

Multiple Choice Answer Sheet

Please answer all 20 questions by circling the correct answer.

Take care not to go out of sequence as this will adversely affect your score.

	Question				
	1	A	B	C	D
	2	A	B	C	D
	3	A	B	C	D
	4	A	B	C	D
	5	A	B	C	D
	6	A	B	C	D
	7	A	B	C	D
	8	A	B	C	D
	9	A	B	C	D
	10	A	B	C	D
	11	A	B	C	D
	12	A	B	C	D
	13	A	B	C	D
	14	A	B	C	D
	15	A	B	C	D
	16	A	B	C	D
	17	A	B	C	D
	18	A	B	C	D
	19	A	B	C	D
	20	A	B	C	D

Paper Notes: 16+ Biology Specimen Paper (16+ Biology Specimen Paper)

Compiled by SATs-Papers.co.uk to help you get the most from this paper.

Overview

This is **Rugby School's Sixth Form Entrance Examination specimen paper for Biology**, designed for candidates seeking entry into Year 12. The paper is used by Rugby School as part of their 16+ selection process and gives applicants a clear sense of the expectations and academic standard required at this level.

The examination is divided into two sections: **Section A**, comprising 20 multiple-choice questions worth 20 marks, and **Section B**, consisting of structured questions worth 30 marks. The paper is time-limited to **one hour** and requires candidates to demonstrate a broad understanding of GCSE-level biology topics, alongside the ability to apply knowledge to unfamiliar scenarios and interpret data from graphs and diagrams.

This specimen paper is particularly valuable for students preparing for the Rugby School 16+ Biology exam or for those revising core biological principles at the upper GCSE or early A-level threshold. It tests recall, application, and analysis across topics including ecology, respiration, cell division, enzymes, and photosynthesis. The format balances quick-fire knowledge checks with more extended reasoning tasks.

How this paper is organised

The paper opens with **Section A**, which contains 20 multiple-choice questions. Candidates must mark their answers on a detachable answer sheet using an HB pencil, circling one clear answer per question. This section carries 20 marks and covers a range of topics including blood vessels, tropisms, the menstrual cycle, plant transport, excretion, ecology, respiration, digestion, enzymes, the respiratory system, photosynthesis, the circulatory system, osmosis, seed germination, vision, and arthropod growth. The questions are concise and fact-based, testing recognition and understanding of key biological concepts.

Section B follows with five structured questions (Q1 to Q5) totalling 30 marks. These questions require extended written responses, calculations, diagram drawing, and experimental design. Question 1 addresses energy flow in a food chain, Question 2 analyses breathing rate and oxygen consumption before and after exercise, Question 3 explores cell division (mitosis) and mutation, Question 4 examines enzyme activity at different pH levels, and Question 5 asks candidates to design a photosynthesis experiment.

Candidates are permitted to use a pen, pencil, ruler, and calculator throughout the examination. Time management is critical: approximately 20 minutes for Section A and 40 minutes for Section B is a sensible allocation.

Topics covered

- Structure and function of blood vessels (arteries, veins, capillaries) and their distinguishing cross-sectional features
- Plant tropisms, specifically gravitropism in germinating bean seeds and the expected growth response of radicles on a slowly rotating disc
- The menstrual cycle, including ovulation timing and the period of maximum fertility
- Translocation in plants, particularly the direction of sugar transport in phloem cells from food stores to growing shoots
- Excretion of carbon dioxide via the lungs as the primary organ of gaseous waste removal
- Placental exchange of substances between mother and fetus, distinguishing which molecules (oxygen, glucose, alcohol, urea) cross the placenta
- Food webs and predator-prey relationships, specifically how changes in predator populations affect organisms at different trophic levels
- Decomposition and nutrient cycling, identifying products (carbon dioxide and water) returned to the atmosphere by decomposers
- Effects of sewage pollution on river ecosystems, interpreting graphs of oxygen concentration and bacterial population changes downstream
- Anaerobic respiration in human muscle tissue, including the production of lactic acid and the word equation for the process
- Enzyme specificity and pH dependence, particularly amylase activity in the mouth versus the stomach and the role of stomach acidity
- Temperature effects on enzyme activity in human digestive enzymes, recognising the characteristic optimum and denaturation curve
- Structure and function of ciliated epithelial cells in the trachea, including the role of cilia in moving mucus
- Distribution of chloroplasts in leaf tissues, identifying palisade mesophyll as the cell type containing the most chloroplasts
- Structure and function of the human heart, including identification of the four chambers and understanding of coordinated contraction (atria and ventricles)
- Osmosis demonstrated through potato tissue experiments, predicting water movement between concentrated sugar solution and fresh potato cells
- Conditions for seed germination, identifying the essential requirements of water, oxygen, and a suitable temperature
- Accommodation in the human eye, describing changes in suspensory ligaments and lens shape when focusing on close objects

- Growth patterns in arthropods, recognising the stepped (discontinuous) growth curve caused by periodic moulting of the exoskeleton
- Diploid and haploid cells in mammalian life cycles, distinguishing gametes (haploid) from embryonic body cells (diploid)
- Energy flow through trophic levels in a pond food chain, calculating energy transfer efficiency and constructing pyramids of biomass
- Gas exchange during exercise, interpreting spirometer traces to calculate breathing rate and oxygen consumption before and after vigorous activity, and explaining the oxygen debt
- Cell division (mitosis), sequencing the stages of nuclear division, chromosome separation, and cytokinesis, and understanding that daughter cells are genetically identical
- Mutation as spontaneous genetic change and environmental factors (such as radiation or mutagenic chemicals) that increase mutation rate
- Enzyme action on proteins, naming proteases and amino acids as products, and interpreting pH-activity data to identify optimal conditions and suggest the site of enzyme secretion (stomach)
- Experimental design for investigating the effect of light intensity on the rate of photosynthesis, including control of variables, measurement of oxygen production or carbon dioxide uptake, and use of pondweed or similar aquatic plants

How to use this paper for revision

- Work through each multiple-choice question in Section A methodically, eliminating obviously incorrect answers first, then choosing the best remaining option based on your biological knowledge.
- For Section B calculations, show all working clearly, even if the final answer seems straightforward. Marks are often awarded for method as well as the correct numerical result.
- When drawing diagrams such as pyramids of biomass, use a ruler, label each trophic level clearly, and ensure the relative sizes of the bars reflect the data given in the question.
- In questions asking you to describe an experiment (such as Q5 on photosynthesis), structure your answer logically: state the independent variable, the dependent variable, the control variables, the method, and how you will measure the outcome.
- For graph-drawing tasks, plot points accurately, use a sharp pencil, draw a smooth curve or best-fit line as appropriate, and label both axes with units. Check the scale carefully before you begin.
- Revise the word equations for respiration (aerobic and anaerobic) and photosynthesis, as these are fundamental and often tested in multiple-choice or structured questions.
- Practise interpreting data from line graphs and bar charts, especially those showing changes over time or in response to environmental variables such as pH, temperature, or distance downstream in an ecosystem.

Common mistakes to avoid

- Confusing the structure of arteries and veins. Remember that arteries have thick, muscular walls and a narrow lumen to withstand high pressure, while veins have thinner walls, a wider lumen, and valves to prevent backflow.
- Misreading the direction of transport in phloem. Sugars are transported from sources (such as storage organs) to sinks (such as growing shoots), not the other way around.
- Stating that all substances cross the placenta. Urea and other waste products move from fetus to mother, not from mother to fetus; large molecules such as maternal antibodies may cross selectively, but not all solutes do so freely.
- Mixing up the products of aerobic and anaerobic respiration. Anaerobic respiration in muscle produces lactic acid, not ethanol (which is produced in yeast and plant cells).
- Forgetting to explain why oxygen consumption remains elevated after exercise. The oxygen debt must be repaid to oxidise the lactic acid accumulated during anaerobic respiration.
- Failing to sequence mitosis stages correctly. A common error is placing cytokinesis (cell division) before the separation of sister chromatids at the equator; remember that chromosomes align, separate, and then the cell divides.
- Confusing mutation with adaptation or evolution. A mutation is a change in the DNA sequence; it can be caused by environmental factors such as radiation, chemicals, or copying errors during cell division.
- Drawing pyramids of biomass upside down or with incorrect relative proportions. The base should represent producers (plants) and be the widest bar, with each successive trophic level narrower.
- Overlooking the need to state control variables in experimental design questions. For example, in a photosynthesis experiment, temperature, carbon dioxide concentration, and the species and size of plant must all be kept constant.

Exam technique

Begin with **Section A**, aiming to complete all 20 multiple-choice questions in roughly 20 minutes. Read each question carefully, paying close attention to diagrams and data provided. If you are unsure of an answer, eliminate clearly incorrect options and make an educated guess rather than leaving it blank. Mark your answers neatly on the detachable answer sheet, ensuring you do not skip a line by mistake.

Move on to **Section B** with around 40 minutes remaining. Allocate your time according to the marks available: a 1-mark question might need a single sentence or a brief

calculation, while a 6-mark question (such as the experimental design task) requires a structured, multi-part response. For questions asking you to calculate a percentage or a ratio, always show your working step by step. This allows you to earn partial credit even if your final answer is incorrect. When drawing graphs, use a ruler and a sharp pencil, plot points precisely, and ensure your axes are labelled with both the variable name and the unit.

Read the command words carefully. Calculate means you must perform a numerical operation and show your method. Describe asks you to state what you observe or what happens, without necessarily explaining why. Explain requires you to give reasons or mechanisms. Suggest indicates that the answer may not be directly from the specification, so apply your biological understanding to the context given. Leave a few minutes at the end to check your answers, particularly any calculations, and to ensure you have answered every part of every question.

What to revise alongside this paper

To prepare thoroughly for this paper, revise core GCSE topics in ecology, including food chains and webs, energy flow, and nutrient cycles. Make sure you understand how human activities such as sewage discharge and fertiliser runoff affect aquatic ecosystems. Review the structure and function of major organ systems, particularly the circulatory system (heart, blood vessels), the respiratory system (gas exchange, breathing), and the digestive system (enzymes, digestion, absorption).

Strengthen your understanding of **cell biology**, focusing on mitosis, the cell cycle, and the difference between diploid and haploid cells. Practise sequencing the stages of cell division and explaining how genetic information is passed to daughter cells. Also revise **plant biology**, including photosynthesis (factors affecting rate, limiting factors, practical investigations), transport in plants (xylem and phloem), and tropisms (phototropism and gravitropism).

If you are aiming for A-level Biology, extend your study to cover enzyme kinetics in more detail (Michaelis-Menten curves, competitive and non-competitive inhibition), gene expression and regulation, and more advanced ecological concepts such as succession, population dynamics, and the nitrogen cycle. Practising experimental design and data analysis questions from past A-level papers will also help you develop the skills needed for Section B-style tasks.

Key terms

Artery, **Vein**, **Capillary**, **Gravitropism**, **Radicle**, **Ovulation**, **Phloem**, **Translocation**, **Excretion**, **Placenta**, **Trophic level**, **Decomposer**, **Aerobic respiration**, **Anaerobic respiration**, **Lactic acid**, **Enzyme**, **Optimum pH**, **Denaturation**, **Amylase**, **Protease**, **Amino acid**, **Ciliated epithelial cell**, **Palisade mesophyll**, **Chloroplast**, **Atrium**, **Ventricle**, **Osmosis**, **Germination**, **Suspensory ligament**, **Accommodation**, **Exoskeleton**, **Moulting**, **Diploid**, **Haploid**, **Gamete**, **Mitosis**, **Chromosome**, **Mutation**, **Pyramid of biomass**, **Energy transfer**, **Oxygen debt**, **Independent variable**, **Dependent variable**, **Control variable**, **Rate of photosynthesis**

Rugby School

Biology

Sixth Form Examination

Mark Scheme

Sixth Form Entrance Examination

Specimen Paper Mark scheme

Section A

1 A	6 D	11 B	16 C
2 C	7 B	12 D	17 C
3 C	8 B	13 C	18 A
4 D	9 B	14 A	19 B
5 C	10 D	15 A	20 C

Section B

1.
   a. 0.1%;
   b. Correct shape; correctly labelled;
   c. Energy is lost between trophic levels/ Not all biomass at one trophic level is converted to biomass at the next;

2.
   a. 9-10 AND 12-13;
   b. 0.81 dm^3
   c. Anaerobic respiration during exercise;
      Produced lactic acid;
      Increased breathing rate increases delivery of oxygen;
      Required to break down lactic acid to water and carbon dioxide;
      Breathing rate also high to excrete the carbon dioxide produced during exercise;
      Correct reference to oxygen debt;
   d. Gas composition of air;

3.
   a. Mitosis
   b. DBACE
   c. Mutation
   d. Radiation/X-rays/UV/chemicals e.g. carcinogens

4.

a. Protease
b. Amino acids/peptides
c. Linear scale covering at least 50% of plat area;
   Points joined point to point with ruler;
   Axis the correct way round and labelled;
   Units added to the axes;
   Plotted accurately;
d. 9.2x;
e. Stomach

5.

a. Change: Method outlines to alter light intensity e.g. distance from lamp, different bulbs etc
   Organism: same species, age, size, surface area of plant
   Measure 1: Method to measure photosynthesis e.g. capturing gas/counting bubbles etc.
   Measure 2: Over a stated period of time, measurement over time for rate
   Repeat: Minimum of three repeats at each light intensity
   Same 1&2: Temperature; PH; CO_2 concentration; wavelengths of light

Answer-Key Notes: 16+ Biology Mark Scheme (16+ Biology Mark Scheme)

Compiled by SATs-Papers.co.uk to help you mark this paper and learn from each answer.

How to use this answer key

This mark scheme provides the official answers for Rugby School's Sixth Form Biology entrance examination. When marking, award points strictly as specified: Section A awards one mark per correct multiple-choice answer, while Section B awards marks for each credited element shown in the scheme (e.g. Q2c lists six possible points). Distinguish between careless slips (misreading a question, arithmetic errors) and genuine gaps in understanding (not knowing what anaerobic respiration produces, or how to construct a pyramid of biomass).

If a student loses marks on multiple questions within the same topic, consult the worked examples below to understand the reasoning behind the correct answers. For instance, if Q2c on respiration or Q3 on mitosis prove difficult, the explanations reveal the biological principles that the examiners expected candidates to recall.

Record the total score out of 50 (20 from Section A, 30 from Section B) and use the score-interpretation guidance to judge readiness for Sixth Form Biology. Even strong candidates may benefit from reviewing one or two worked examples where the reasoning was less obvious.

Score interpretation

This paper awards 50 marks in total: 20 from the multiple-choice section and 30 from structured questions on ecology, respiration, cell division, enzymes and photosynthesis. A score of 40 or above suggests secure GCSE knowledge and readiness for A-level content; such candidates will benefit from broader reading on topics like energy transfer in ecosystems and enzyme kinetics. Scores between 30 and 39 indicate good foundational understanding but reveal specific gaps (often in explaining mechanisms, such as oxygen debt, or in graph-drawing conventions) that revision and past-paper practice will address.

Scores below 30 suggest that key GCSE topics require consolidation before Sixth Form begins. Focus first on the sections where most marks were lost: if Section A multiple-choice questions on plant and animal systems proved difficult, revisit those chapters in a GCSE textbook; if Section B structured answers were incomplete, practise writing explanations in full sentences and drawing labelled diagrams under timed conditions.

Remember that this is an entrance examination designed to stretch candidates beyond typical GCSE papers. A mark in the high twenties is not a poor result, but it does signal that summer preparation (reading ahead, attempting extension questions, reviewing practical techniques) will make the transition to A-level smoother.

Worked examples

Section A: Multiple choice, Q1–20

Each question awards one mark for the correct letter and no partial credit. Markers reward recall of definitions, structures and processes at GCSE level, together with the ability to interpret diagrams and graphs. Students lose easy marks by misreading labels (e.g. confusing artery and vein wall layers in Q1) or by rushing through graphs without checking units and trends (Q9, Q12). Work methodically: eliminate obviously wrong options, then choose between the remaining pair by referring to precise biological knowledge rather than guessing.

> **Q3** : `C`
>
> The question asks when a woman is **most fertile** during the menstrual cycle. Ovulation (stage C) occurs roughly mid-cycle, releasing an egg that can be fertilised; this is the only time conception is possible. Stage A (menstruation) involves breakdown of the uterus lining, stage B follows ovulation, and stage D represents the late luteal phase when the lining thickens but no egg remains. Only C corresponds to peak fertility.

> **Q7** : `B`
>
> The food web shows that snakes eat toads, lizards and squirrels. If snake numbers increase, predation on those three groups intensifies. **Grasshoppers** (option B) are eaten by toads; fewer toads means less predation on grasshoppers, so grasshopper numbers will rise. Birds, lizards and squirrels all face higher predation from the extra snakes, so their populations decline. Always trace the arrows both up and down the web.

> **Q10** : `D`
>
> Anaerobic respiration in human muscle converts **glucose into lactic acid** when oxygen supply is insufficient during intense exercise. Option A incorrectly includes ethanol (produced by yeast, not human muscle); option B adds carbon dioxide, which is a product of aerobic respiration; option C suggests glucose becomes ethanol. Only D correctly names lactic acid as the sole product of anaerobic respiration in muscle tissue.

Q12 : `D`

Human digestive enzymes (protease, amylase, lipase) are adapted to body temperature, roughly 37 °C. Graph D shows rate of reaction rising to a peak near 37 °C then falling sharply as the enzyme denatures above that temperature. Graphs A and C show steady decline or a trough, which is biologically implausible; graph B shows rate increasing indefinitely, ignoring denaturation. **Graph D alone** matches the characteristic optimum-temperature curve for enzymes.

Section B, Q1: Energy transfer and pyramids of biomass

Question 1a tests percentage calculation (one mark); 1b awards two marks for a correctly drawn and labelled pyramid (shape must be widest at the base, each tier labelled with the trophic level); 1c awards one mark for explaining energy loss. Students often draw pyramids of number by mistake or omit labels. Remember that biomass pyramids represent the mass of living tissue at each level, so the width of each bar reflects relative biomass, not the count of organisms.

Q1a : `0.1%`

The top carnivores contain 88 kJ and the plants contain 88 000 kJ. The percentage transferred is (88 ÷ 88 000) × 100 = 0.1 %. This calculation shows that **only a tiny fraction** of the energy captured by producers reaches the highest trophic level, illustrating why food chains rarely exceed four or five levels.

Q1c : `Energy is lost between trophic levels / Not all biomass at one trophic level is converted to biomass at the next`

Eating plants directly is more efficient because **each trophic transfer loses roughly 90 % of energy** as heat (respiration), movement, and egested waste. By consuming herbivores instead of plants, humans add an extra transfer step, wasting energy that could have been obtained by eating the plants themselves. This principle underpins arguments for plant-based diets from an energy-efficiency perspective.

Section B, Q2: Gas exchange and respiration during exercise

Question 2a awards one mark for identifying both time intervals when breathing rate was highest (9–10 s and 12–13 s on the graph). Part 2b requires calculating oxygen use from a line on the graph (one mark). Part 2c offers up to four marks from a list of six possible points about anaerobic respiration, lactic acid, oxygen debt and carbon dioxide excretion; examiners credit any four. Students lose marks by giving vague answers (e.g. 'the body needs oxygen' without explaining why) or by misreading the graph scale in part b. Always

show working for calculations and write explanations in full sentences that link cause and effect.

> **Q2b** : `0.81 dm³`
>
> The 'after exercise' graph shows that line A–B drops by 0.81 dm³ over 60 seconds (from roughly 2.5 dm³ to 1.69 dm³). Because the question states that the rate before exercise was 0.5 dm³ per minute, candidates must read the **after-exercise graph carefully** to see that the drop is larger. The correct figure is 0.81 dm³ per minute, reflecting increased oxygen consumption as the body repays oxygen debt.

> **Q2c** : `Anaerobic respiration during exercise; produced lactic acid; increased breathing rate increases delivery of oxygen; required to break down lactic acid to water and carbon dioxide; breathing rate also high to excrete the carbon dioxide produced during exercise; correct reference to oxygen debt`
>
> This question rewards understanding of the **oxygen-debt mechanism**. During vigorous exercise, muscles respire anaerobically, producing lactic acid. After exercise stops, breathing rate remains high to deliver extra oxygen that oxidises lactic acid back to carbon dioxide and water (repaying the debt) and to expel the carbon dioxide produced. Any four of these linked points earn the marks; vague statements like 'to get more oxygen' without explaining the fate of lactic acid score zero.

Section B, Q3: Mitosis and mutation

Question 3a and 3c each award one mark for naming mitosis and mutation respectively. Part 3b awards one mark for the correct sequence (DBACE). Part 3d awards one mark for any environmental mutagen. Marks are lost when candidates confuse mitosis with meiosis (which produces genetically different gametes) or when they write 'change' instead of the technical term 'mutation'. Learn the standard stages of mitosis (prophase, metaphase, anaphase, telophase, cytokinesis) and practise ordering diagrams.

> **Q3b** : `DBACE`
>
> The correct order is D (interphase: chromosomes replicate), B (prophase: chromosomes condense and become visible), A (metaphase: chromosomes align at the cell equator), C (anaphase: chromatids separate and move to poles), E (telophase and cytokinesis: two daughter cells form). **Diagram D must come first** because DNA replication precedes division, and E must come last because it shows two separate cells. Recognising these bookends helps you order the middle stages.

Q3d : `Radiation / X-rays / UV / chemicals e.g. carcinogens`

The question asks for an **environmental factor** that increases mutation rate. Ionising radiation (X-rays, gamma rays), ultraviolet light and chemical mutagens (tar in tobacco, certain pesticides) can all damage DNA. Candidates who write only 'radiation' or 'UV' score the mark; those who add an example (e.g. 'X-rays') demonstrate broader knowledge but the mark scheme accepts any one correct factor.

Section B, Q4: Enzyme activity and pH

Questions 4a and 4b each award one mark for naming protease and its product (amino acids or peptides). Part 4c awards five marks for graph construction (scale, labelling, plotting, joining points with ruled lines). Part 4d awards one mark for the calculated ratio; part 4e awards one mark for identifying the stomach. Graph marks are often lost through careless errors: forgetting units on axes, plotting points inaccurately, or joining points freehand instead of with a ruler. Use the full grid, check each plotted point against the table, and label every axis with quantity and unit.

Q4d : `9.2×`

At pH 2.0 the rate is 23.0 mmol/min; at pH 4.0 the rate is 2.5 mmol/min. The ratio is 23.0 ÷ 2.5 = **9.2**. Examiners accept 9.2 or 9.2× but will not award the mark for an answer like '9' (insufficiently precise) or for writing '23.0 – 2.5' (subtraction instead of division). Always show your working so that method marks can be awarded if the final answer contains an arithmetic slip.

Q4e : `Stomach`

The enzyme's optimum pH is 2.0, which matches the **strongly acidic environment of the stomach** (pH 1.5–2.5). Protease enzymes in the small intestine operate at neutral or slightly alkaline pH; those in the mouth work at neutral pH. Only the stomach provides the low pH that this enzyme requires, making it identifiable as pepsin or a similar gastric protease.

Section B, Q5: Investigating photosynthesis (extended response)

Question 5 awards six marks for describing an experiment to investigate the effect of light intensity on photosynthesis rate. The mark scheme lists six criteria (how to change light intensity, organism details, two measurement points, repeats, control variables). Each credited element scores one mark. Students lose marks by writing vague methods ('use a plant and see what happens') or by omitting repeats and control variables. Structure your answer as a step-by-step protocol: state what you will change, what you will measure, how you will measure it, and what you will keep constant.

Q5a (Change) : `Method outlines to alter light intensity e.g. distance from lamp, different bulbs etc`

To investigate light intensity as the **independent variable**, you must describe a practical way to vary it, such as moving a lamp closer or further from the plant (inverse-square law) or using bulbs of different wattage. Stating 'change the light' without explaining how earns no credit. The mark scheme rewards any clear method that produces measurable differences in intensity.

Q5a (Measure 1 & 2) : `Method to measure photosynthesis e.g. capturing gas/ counting bubbles etc. Over a stated period of time, measurement over time for rate`

Photosynthesis produces oxygen, so counting bubbles from an aquatic plant (e.g. *Elodea*) or collecting gas in an inverted tube provides a measure of rate. You must specify a time period (e.g. 'count bubbles per minute') to convert raw counts into a rate. Answers that say 'measure photosynthesis' without stating what or how to measure score zero. **Two separate measurement points** (what you observe and the time dimension) are required for both marks.

Q5a (Same 1 & 2) : `Temperature; pH; CO₂ concentration; wavelengths of light`

Any two control variables from this list earn the two marks. Temperature affects enzyme activity; CO_2 concentration affects the rate of the light-independent reaction; pH influences enzyme function; wavelength of light affects absorption by chlorophyll. Candidates who write 'keep everything else the same' without naming specific variables score zero. **Identify at least two factors** by name and, if possible, state how you will control them (e.g. 'use a water bath to maintain 20 °C').

Next steps

Once you have marked the paper and recorded the score out of 50, review every incorrect or incomplete answer with the candidate. For multiple-choice errors, ask the candidate to explain why they chose their answer and then work through the correct reasoning together (the worked examples above will help). For Section B, compare the candidate's written responses against the mark-scheme points: if key scientific terms (anaerobic respiration, lactic acid, mutation, oxygen debt) are missing, add them to a revision list and revisit the relevant GCSE topics before attempting another past paper.

If the score is below 30, prioritise consolidation over new material: use a GCSE revision guide to fill knowledge gaps, practise drawing and labelling diagrams (pyramids of biomass, heart structure, enzyme-activity graphs), and rehearse calculation skills

(percentages, ratios, rate from a graph). If the score is 40 or above, extend learning by reading introductory A-level chapters on the topics covered (ecology, respiration, cell cycle, enzymes, photosynthesis) and by tackling more challenging past papers. In either case, aim to reattempt a similar entrance paper in four to six weeks to measure progress; consistent practice under timed conditions builds both knowledge and exam technique.
