SimpleStudy

PRACTICE MARKING SCHEME

LEAVING CERTIFICATE · HIGHER LEVEL · SAMPLE PAPER 1 · 2027

Biology

Total marks	Duration	Structure
300	2 hr 30 min	7 questions

About this document

A practice marking scheme produced by SimpleStudy to help students and teachers prepare for the Leaving Certificate examination in Biology. The State Examinations Commission has published this sample paper without a marking scheme; the mark allocations and answers set out here are indicative.

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Marking Scheme

This marking scheme accompanies the State Examinations Commission's Sample Paper 1 in Leaving Certificate Biology, Higher Level. It is intended to support candidates and teachers preparing for the examination. It is not an official State Examinations Commission document.

General Marking Guidelines

- Accept all reasonable responses; the lists in this scheme are indicative, not exhaustive.
- Credit content that is correct even where it is poorly expressed.
- No penalty for spelling or grammar unless the meaning is unclear.
- Where a candidate contradicts themselves, award the lower mark.
- Credit accurate labelling on diagrams, and credit a correct answer given as a labelled diagram where the question does not require prose.
- Where a candidate offers more points than the number asked for, mark the first *n* presented, unless a later point is clearly labelled as a replacement.

Seven additions for this paper:

- There are seven questions, each worth 50 marks. Question 1 is compulsory and candidates answer any five of Questions 2 to 7, so six questions make up the 300 marks. Where a candidate answers all seven, mark all seven and credit the best six.
- **Named examples and terminology.** Where a part asks the candidate to name a structure, process or organism, the accepted biological term is required. A description that makes the identification unambiguous earns the mark; a vague term that could apply to several structures does not.
- **Diagrams.** Where a part asks for a labelled diagram, the marks divide between the drawing and the labels, and a label is credited only where it points to the correct structure.
- **Supporting work.** The paper warns that marks may be lost where solutions do not include relevant supporting work, and that marks may be lost where units are omitted.
- **Error carried forward.** Where a candidate uses an incorrect value or answer from an earlier part correctly in a later one, award the later marks in full. An error is penalised once only.
- **Graphical answers.** Where a part asks the candidate to draw on a printed graph or diagram, the marks are for the construction itself and are available whether or not any later reading is correct. Where a blank grid is supplied, marks for axes and scale are properly available; where the grid arrives already labelled and scaled, they are not.
- **Data questions.** Where a part asks the candidate to draw a conclusion or describe a change, the answer must be supported by something read from the data or the graph; a correct statement made without reference to the evidence supplied earns the stating marks only.

How the marks are set

The paper prints a total of 50 marks for each question and no sub-part marks, so every internal split is indicative. The splits reconcile upward to each question total and to the paper total of 300 marks, and follow one set of rates:

- **Naming a structure from a printed diagram** carries **2 marks**.
- **A term supplied from the candidate's own knowledge** carries **2 or 3 marks**, according to the printed answer space.

- **A row of a tick, matching or completion table** carries **2 marks**, or 3 where the row requires two separate answers.
- **Developed points** are priced on the printed answer space, with the command verb as a tie-breaker.

Marking at Higher Level

This paper is assessed at Higher Level. The specification differentiates the two levels through the learning outcomes themselves: Higher level covers all of the learning outcomes, including those presented in bold type, while Ordinary level covers only those in normal type. Table 1 of the specification describes Higher level students as engaging with a broad range of knowledge, including theoretical concepts and abstract thinking with significant depth in some areas, and as demonstrating and using a broad range of specialised skills to evaluate and use information, to plan and develop investigative strategies, and to determine solutions to varied problems. Examiners should expect reasoning to be shown and conclusions to be justified, and should credit a sound biological argument even where the expression is imperfect.

Paper Structure

Question 1	**50 marks**	Compulsory. Short questions on the digestive system, the synapse, osmosis, blood glucose regulation, the nephron and fungi.
Question 2	**50 marks**	Enzymes and pectinase in juice production, classification and the kingdoms, and fermentation in yeast.
Question 3	**50 marks**	Gas exchange at the alveolus, the innate immune system, transport of gases in the blood, and breathing during exercise.
Question 4	**50 marks**	Genetics of the grove snail including a dihybrid cross and linkage, and the ecology of the snail and the song thrush.
Question 5	**50 marks**	The female reproductive system, the menstrual cycle, pregnancy hormones, blood groups and fertility.
Question 6	**50 marks**	Bacterial growth and aseptic technique, the human microbiome, *Helicobacter pylori*, and DNA to protein.
Question 7	**50 marks**	Rhododendron and species abundance, soil carbon dioxide, photosynthesis in immobilised algae, and the thylakoid membrane.
Total	**300 marks**	Question 1 and any five of Questions 2 to 7.

Grading Descriptors (all parts carrying a development element)

High (H)	Point accurately stated and developed with correct biological reasoning, applied to the organism, data or diagram the part supplies. Full marks for the point.
Mid (M)	Relevant point stated with partial development, or biologically correct but not applied to the material the part supplies. Award the stating marks in full plus roughly half the development marks, rounded up to a whole mark.
Low (L)	Point stated or asserted only; vague, or development that does not follow from the point stated. Stating marks only.

No criterion grid is used on this paper. *The extended parts — for example 1(f)(ii), 4(a)(iv), 4(b)(i) and 6(c)(iv) — are marked by required elements rather than holistically.*

Question 1 — 50 marks

Compulsory. Candidates answer all parts.

Indicative mark allocation: (a)(i) 4 · (a)(ii) 3 · (b)(i) 4 · (b)(ii) 2 · (b)(iii) 3 · (c)(i) 2 · (c)(ii) 2 · (c)(iii) 4 · (d)(i) 2 · (d)(ii) 3 · (d)(iii) 2 · (d)(iv) 2 · (e)(i) 4 · (e)(ii) 2 · (e)(iii) 2 · (e)(iv) 3 · (f)(i) 3 · (f)(ii) 3 = 50 marks.

Part	Acceptable Answer(s)	Marks
(a)(i) The two organs *2 marks each*	A: **liver** B: **pancreas**	**4**
(a)(ii) A role of the liver	It produces bile, which is stored in the gall bladder and released into the small intestine, where it emulsifies fats — breaking large fat droplets into smaller ones and so increasing the surface area on which lipase can act. Accept any other correct digestive role, such as neutralising stomach acid with alkaline bile, or processing and storing absorbed glucose as glycogen.	**3**
(b)(i) A and B at the synapse *2 marks each*	A: **neurotransmitter** (accept a named example such as acetylcholine) B: **synaptic vesicle**	**4**
(b)(ii) Direction of the impulse	An arrow drawn pointing **from the lower structure containing the vesicles towards the upper membrane carrying the receptors** — upwards in the printed diagram, from the presynaptic neuron across the cleft to the postsynaptic membrane.	**2**
(b)(iii) Fate of the neurotransmitter	It is broken down by an enzyme in the synaptic cleft, for example acetylcholinesterase breaking down acetylcholine (2), and the products are reabsorbed into the presynaptic neuron and used to resynthesise the transmitter (1). Accept reuptake of the intact transmitter. The essential point either way is that the transmitter is removed, so that the postsynaptic neuron is not stimulated continuously.	**3**
(c)(i) The term	**Osmosis**	**2**
(c)(ii) The independent variable	The **salt concentration** (molarity) of the solution.	**2**
(c)(iii) Conclusion from the data	As the salt concentration increases the cucumber gains less mass and then loses mass (2). Below 0.2 M water moves into the tissue by osmosis and the mass rises; at 0.2 M there is no net change; above 0.2 M water moves out and the mass falls (2). The concentration of the cell sap is therefore equivalent to about 0.2 M salt, the point at which the solution is isotonic with the cucumber tissue.	**4**
(d)(i) General formula	$\mathbf{C_x(H_2O)_y}$. Accept $C_nH_{2n}O_n$.	**2**

Part	Acceptable Answer(s)	Marks
(d)(ii) Why glycogen is not absorbed	Glycogen is a polysaccharide, a very large molecule made of many glucose units joined together (2), and it is too large to pass through the cell membrane; it must first be broken down into glucose, which is small enough to be absorbed (1).	**3**
(d)(iii) The letter X	Marked on the time axis **shortly after 20 minutes**, where the blood glucose concentration begins to rise after eating. Accept any point from about 20 to 30 minutes.	**2**
(d)(iv) The letter Y	Marked on the time axis **late in the trace**, where the blood glucose concentration has fallen back to or below the resting level — about 80 to 100 minutes. Y must be later than X.	**2**
(e)(i) Parts A and B ***2 marks each***	A: **proximal convoluted tubule** B: **loop of Henle**	**4**
(e)(ii) The letter F	Written at or beside the **glomerulus inside Bowman's capsule**, at the upper left of the diagram.	**2**
(e)(iii) Not normally in urine	**Protein** (accept albumin), **red blood cells**, **white blood cells**, **platelets** or **glucose**.	**2**
(e)(iv) Advantage of a longer loop	A longer loop allows a steeper and deeper concentration gradient to be built up in the medulla (2), so more water is reabsorbed from the filtrate and the urine produced is more concentrated, which conserves water in the dry habitats these animals live in (1).	**3**
(f)(i) Decomposer	An organism that feeds on and breaks down dead organic matter — dead plants and animals and their waste (2) — releasing the nutrients locked in it back into the soil or environment, where producers can use them again (1).	**3**
(f)(ii) Diagram of *Rhizopus*	*1 mark per correctly drawn and labelled structure, to a maximum of 3.* Hyphae; rhizoids anchoring it to the substrate; a stolon running horizontally; a sporangiophore standing upright; a sporangium at its tip; spores within the sporangium. At least two labels must point to correctly drawn structures.	**3**

Examiner note on (e)(i). *A points to a coil of the tubule that runs directly out of Bowman's capsule, which makes it the proximal convoluted tubule. The distal convoluted tubule is the coiled mass lying lower and further to the right, immediately before the collecting duct. The drawing is stylised, so a candidate who answers "convoluted tubule" without specifying has identified the structure correctly and should receive the marks; "distal convoluted tubule" should not.*

Question 2 — 50 marks

Candidates answer any five of Questions 2 to 7. Each carries 50 marks.

Indicative mark allocation: (a)(i) 3 · (a)(ii) 2 · (a)(iii) 3 · (a)(iv) 4 · (a)(v) 2 · (b)(i) 4 · (b)(ii) 4 · (b)(iii) 10 · (c)(i) 2 · (c)(ii) 2 · (c)(iii) 3 · (c)(iv) 2 · (c)(v) 2 · (c)(vi) 2 · (d)(i) 3 · (d)(ii) 2 = 50 marks.

(a) Enzymes and pectinase (14 marks)

Part	Acceptable Answer(s)	Marks
(i) What enzymes are	Biological catalysts (2) — proteins that speed up the rate of a biochemical reaction without being used up or altered themselves (1).	**3**
(ii) Role of pectin	It gives strength and support to plant tissue, cementing the cell walls of neighbouring cells together in the middle lamella.	**2**
(iii) Why pectinase is used	It breaks down the pectin in the fruit (1), which clears the cloudiness from the juice and makes it easier to filter, and releases more juice from the pulp so that the overall yield is higher (2).	**3**
(iv) Two factors ***2 marks each***	**Temperature**; **pH**; substrate concentration; enzyme concentration; the presence of an inhibitor.	**4**
(v) The part acting on the substrate	The **active site**.	**2**

(b) Yeast and classification (18 marks)

Part	Acceptable Answer(s)	Marks
(i) Two conditions ***2 marks each***	**Anaerobic conditions** — the absence of oxygen; a **suitable warm temperature**, around 25 to 30 °C. Accept a suitable pH, or the presence of water.	**4**
(ii) The classification levels ***2 marks each***	*Saccharomyces*: **genus** *cerevisiae*: **species**	**4**
(iii) Comparing the kingdoms ***2 marks per row***	Have cell walls made of cellulose — **Plantae** Heterotrophic — **Fungi** Eukaryotic — **Plantae and Fungi** Lacks chloroplasts — **Fungi** Contains chitin — **Fungi** The eukaryotic row requires both ticks for its 2 marks.	**10**

(c) Fermentation (13 marks)

Part	Acceptable Answer(s)	Marks
(i) The 3-carbon compound	**Pyruvate** (pyruvic acid)	**2**

Part	Acceptable Answer(s)	Marks
(ii) Where fermentation occurs	In the **cytoplasm** (cytosol) of the cell.	**2**
(iii) Role of ATP	ATP is the energy currency of the cell: energy released in respiration is stored in it (1), and when a cell needs energy for a reaction ATP is broken down to ADP and phosphate, releasing that energy where and when it is required (2).	**3**
(iv) Waste product in animal cells	**Lactic acid** (lactate)	**2**
(v) Number of carbon atoms	**3**	**2**
(vi) An animal tissue	**Muscle tissue** (skeletal muscle)	**2**

(d) The fermentation investigation (5 marks)

Part	Acceptable Answer(s)	Marks
(i) Which line is glucose	**Line A** (1). Justification (2): glucose is a monosaccharide and can be taken up and respired by the yeast immediately, so fermentation begins at once and carbon dioxide is produced faster and in greater volume. Sugar B must first be broken down into monosaccharides before the yeast can ferment it, so its curve rises more slowly.	**3**
(ii) The line at 4 °C	A line drawn **below line B** throughout, rising only slightly and remaining much flatter, since at 4 °C the enzymes controlling fermentation work very slowly and far less carbon dioxide is produced in the same time. The line must start at the origin and must not cross B.	**2**

Question 3 — 50 marks

Candidates answer any five of Questions 2 to 7. Each carries 50 marks.

Indicative mark allocation: (a)(i) 4 · (a)(ii) 2 · (a)(iii) 2 · (b)(i) 4 · (b)(ii) 3 · (c)(i)1 3 · (c)(i)2 3 · (c)(ii) 8 · (c)(iii) 6 · (c)(iv) 3 · (d)(i) 4 · (d)(ii) 3 · (d)(iii) 2 · (d)(iv) 3 = 50 marks.

(a) Gas exchange at the alveolus (8 marks)

Part	Acceptable Answer(s)	Marks
(i) The two arrows ***2 marks each***	An arrow labelled **O_2** drawn from the alveolar air space into the capillary lumen, and an arrow labelled **CO_2** drawn from the capillary lumen into the alveolar air space. Each must be labelled and correctly directed.	**4**
(ii) The process	**Diffusion**	**2**
(iii) One adaptation	A very large total surface area; walls only one cell thick, giving a short diffusion distance; a moist lining in which the gases dissolve; a dense network of capillaries maintaining a steep concentration gradient. Any one.	**2**

(b) The innate immune system (7 marks)

Part	Acceptable Answer(s)	Marks
(i) Role of monocytes	Monocytes circulate in the blood and migrate into the tissues, where they develop into macrophages (2). They engulf and digest pathogens, dead cells and debris by phagocytosis, acting against any invader rather than one specific pathogen, which is what makes the response innate (2).	**4**
(ii) Another innate response	The inflammatory response — blood vessels dilate, the area becomes red, warm and swollen and more white cells reach the tissue; fever, raising body temperature to slow pathogen reproduction; the skin and mucous membranes as physical barriers; lysozyme in tears and saliva; stomach acid; natural killer cells. Any one, described.	**3**

(c) Gases in the blood (23 marks)

Part	Acceptable Answer(s)	Marks
(i) 1. Transport of carbon dioxide	Mainly as **hydrogencarbonate (bicarbonate) ions dissolved in the plasma** (2), formed when carbon dioxide reacts with water in the red blood cells (1). Accept mention of the smaller amounts carried on haemoglobin or dissolved in plasma, but the main route must be named.	**3**
(i) 2. Transport of oxygen	Bound to **haemoglobin** inside the red blood cells (2), forming oxyhaemoglobin, which releases the oxygen where its concentration is low (1).	**3**

Part	Acceptable Answer(s)	Marks
(ii) The table ***2 marks per cell***	Carbon dioxide — arterial pulmonary blood: **High**; venous pulmonary blood: **Low** Oxygen — arterial pulmonary blood: **Low**; venous pulmonary blood: **High**	**8**
(iii) Plotting the graph	*2 marks for both axes labelled with quantity and unit and a suitable scale using more than half the grid, 3 for the twelve points plotted accurately — deducting 1 per misplotted point to a minimum of zero — and 1 for both lines drawn and distinguished by a key or label.* Time on the horizontal axis and blood pH on the vertical. The vertical scale must not begin at zero: a scale beginning at 7.15 with 0.02 per division fits the printed grid and uses more than half of it, whereas a candidate who begins the axis at zero cannot display data spanning 7.17 to 7.43 and loses the scale mark.	**6**
(iv) Which person is better adapted	**Person A** (1). Explanation (2): A's blood pH fell only from 7.43 to 7.35 and stayed within the normal range, while B's fell from 7.42 to 7.17, well into acidosis. Since the acidity comes from dissolved carbon dioxide, A must be removing carbon dioxide from the blood far more effectively during exercise.	**3**

Examiner note on (c)(ii). *The pulmonary artery carries deoxygenated blood from the heart to the lungs and the pulmonary vein carries oxygenated blood back, which is the reverse of the systemic circulation. A candidate who fills the table the other way round has applied the usual rule about arteries and veins and has made exactly the error this question is designed to find.*

(d) Breathing during exercise (12 marks)

Part	Acceptable Answer(s)	Marks
(i) The two muscles ***2 marks per row***	The **diaphragm**, **contracting** The **external intercostal muscles**, **contracting** Each row requires both the muscle and its action.	**4**
(ii) Volume at rest	Reading the resting part of the trace, the volume oscillates between about 1.95 L and 2.5 L, so the volume entering and leaving with each breath — the tidal volume — is about **0.5 L**. *2 marks for reading both the upper and the lower value, 1 for the difference.* Accept 0.4 to 0.6 L.	**3**
(iii) The letters X and Y ***1 mark each***	**X** at about **16 s**, where the trace suddenly becomes deeper and more frequent; **Y** at about **31 s**, where it returns to the resting pattern. Accept X from 15 to 18 s and Y from 30 to 33 s.	**2**
(iv) Two changes during exercise	The **breathing rate increased** — four breaths in the first fifteen seconds at rest against twelve in the fifteen seconds of exercise, so roughly 16 breaths per minute rising to about 45; and the **depth of breathing increased** — the tidal volume rose from about 0.5 L to about 2.5 L, the trace swinging between roughly 1 L and 3.6 L instead of between 1.95 L and 2.5 L. Both are required, and each must be supported by something read from the graph.	**3**

Question 4 — 50 marks

Candidates answer any five of Questions 2 to 7. Each carries 50 marks.

Indicative mark allocation: (a)(i) 6 · (a)(ii) 4 · (a)(iii) 5 · (a)(iv) 8 · (a)(v) 4 · (b)(i) 6 · (b)(ii) 3 · (b)(iii) 3 · (b)(iv) 4 · (b)(v) 3 · (b)(vi) 4 = 50 marks.

(a) Genetics of the grove snail (27 marks)

Part	Acceptable Answer(s)	Marks
(i) The three terms ***2 marks each***	**Gene:** a section of DNA on a chromosome that codes for a particular protein or characteristic. **Alleles:** different forms or versions of the same gene, occupying the same position on homologous chromosomes. **Dominant:** an allele that is expressed in the phenotype whenever it is present, masking the effect of the recessive allele.	**6**
(ii) Yellow, banded snail	Genotype **bbnn** (2); the only gamete it can produce is **bn** (2).	**4**
(iii) Brown, unbanded, heterozygous	Genotype **BbNn** (2); gametes **BN, Bn, bN** and **bn** (3). All four are required for the three marks; award 1 or 2 for a partial set.	**5**
(iv) The cross	A Punnett square or equivalent, with the gametes of each parent set out and the offspring filled in. bbnn × BbNn gives **BbNn : Bbnn : bbNn : bbnn in a 1 : 1 : 1 : 1 ratio** (4), which is brown unbanded : brown banded : yellow unbanded : yellow banded, also **1 : 1 : 1 : 1** (4).	**8**
(v) Significance of linkage	Because the two genes lie on the same chromosome they are inherited together rather than independently (2), so the parent does not produce the four gamete types in equal numbers: it produces mainly the two parental combinations, and the 1 : 1 : 1 : 1 ratio does not appear. Only crossing over during meiosis produces the recombinant types, and these are much rarer (2).	**4**

Examiner note on (a)(iv). *The stem reads "a cross of the offspring produced between the two snails described in (ii) and (iii)", which could be read either as crossing the two snails themselves or as crossing two of their offspring. Only the first reading can be answered: the offspring of bbnn × BbNn are four different genotypes, so "the offspring" has no single referent and no second cross can be constructed from the information given. Mark the cross of bbnn with BbNn as above; where a candidate instead crosses two named offspring of that cross, mark their working on its own terms and award full marks for a correctly constructed and correctly interpreted square.*

(b) Ecology of the snail and the song thrush (23 marks)

Part	Acceptable Answer(s)	Marks
(i) Food chain and pyramid	A food chain using organisms from the passage, with arrows pointing in the direction of energy flow (3): decaying vegetation → grove snail → song thrush → sparrowhawk (accept cat in place of sparrowhawk) A pyramid of biomass drawn as horizontal bars, widest at the base and narrowing at each level, with the levels labelled to match the chain (3). The pyramid must correspond to the chain the candidate gave.	**6**
(ii) Explanation for the decline	Loss of hedgerows and woodland undergrowth removing nesting sites and cover; pesticides and slug pellets killing the snails they feed on, or poisoning the thrushes that eat them; predation by domestic cats; changes in farming practice reducing the food supply; climate change affecting breeding. Any one, developed.	**3**
(iii) Ecological change	With fewer song thrushes the grove snail population would rise, since one of its main predators has gone (2), and the increased number of snails would graze more heavily on the vegetation; the sparrowhawks and cats that prey on thrushes would also lose a food source (1).	**3**
(iv) An adaptation	*2 marks for the adaptation, 2 for the benefit.* The speckled brown plumage camouflages the thrush against the brown undergrowth of hedgerows, so predators such as cats and sparrowhawks are less likely to see it and it is more likely to survive and breed. Accept the behaviour of breaking snail shells on a flat stone, which gives access to a food source other birds cannot exploit.	**4**
(v) The ecological relationship	**Predation** — the song thrush is the predator and the grove snail the prey.	**3**
(vi) Advantage of biological control	No chemical pesticide is added, so there is no poisoning of other wildlife, no residue in the soil or on food and no risk to pets or to the birds that eat the slugs (2); the nematodes attack the target species specifically and, once established, continue to control the population without repeated application (2).	**4**

Question 5 — 50 marks

Candidates answer any five of Questions 2 to 7. Each carries 50 marks.

Indicative mark allocation: (a)(i) 4 · (a)(ii) 2 · (a)(iii) 2 · (b)(i) 2 · (b)(ii) 2 · (b)(iii) 2 · (b)(iv) 2 · (b)(v) 2 · (b)(vi) 2 · (c)(i) 4 · (c)(ii) 9 · (c)(iii) 2 · (d)(i) 4 · (d)(ii) 2 · (e)(i) 3 · (e)(ii) 6 = 50 marks.

Part	Acceptable Answer(s)	Marks
(a)(i) Any two of A, B and C ***2 marks each, maximum 4***	A: **fallopian tube** (oviduct) B: **uterus** (womb) C: **cervix**	**4**
(a)(ii) The letter X	Marked at the **external opening of the vagina**, at the lower front of the diagram, outside the vaginal canal.	**2**
(a)(iii) One change at puberty	Menstruation begins; the breasts develop; the hips widen; pubic and underarm hair grows; a growth spurt occurs; the ovaries begin to release eggs.	**2**
(b)(i) Type of nuclear division	**Meiosis**	**2**
(b)(ii) Structure Y	A **developing follicle** (accept primary or secondary follicle).	**2**
(b)(iii) Hormone stimulating ovulation	**LH** (luteinising hormone)	**2**
(b)(iv) Structure Z	The **corpus luteum** (yellow body)	**2**
(b)(v) Before or after ovulation	**After** ovulation — it forms from the remains of the follicle once the egg has been released.	**2**
(b)(vi) Fate of Z	It degenerates and breaks down, becoming the corpus albicans; progesterone production falls, and that fall causes the lining of the uterus to break down and menstruation to begin.	**2**
(c)(i) Development to implantation	The zygote divides by mitosis as it travels down the fallopian tube, forming two cells, then four, then a solid ball of cells called a morula (2); this becomes a hollow ball, the blastocyst, which reaches the uterus after about five to seven days and embeds itself in the thickened endometrium — implantation (2).	**4**
(c)(ii) Matching the hormones ***3 marks per row***	Stimulates breastmilk production — **prolactin** — **C** Stimulates uterine contractions — **oxytocin** — **B** Suppresses uterine contractions — **progesterone** — **A** *1 mark for the hormone and 2 for the letter in each row.*	**9**
(c)(iii) Oestrogen	A line sketched rising steadily throughout pregnancy, reaching its highest level at or just before birth, then falling sharply in the post-partum period. Accept a written description to the same effect.	**2**

Part	Acceptable Answer(s)	Marks
(d)(i) The two systems ***2 marks each***	The **ABO** system and the **rhesus (Rh)** system.	**4**
(d)(ii) Why blood group matters	So that blood given in a transfusion is compatible and does not cause the recipient's red cells to agglutinate; and in pregnancy, so that rhesus incompatibility between a rhesus-negative mother and a rhesus-positive baby can be anticipated and treated.	**2**
(e)(i) One treatment for infertility	**IVF** — eggs are collected from the ovaries after hormone treatment, fertilised with sperm in the laboratory, and one or more resulting embryos transferred to the uterus. Accept hormone therapy to stimulate ovulation, artificial insemination, or surgery to clear blocked fallopian tubes.	**3**
(e)(ii) Two types of contraception ***3 marks each***	*1 mark for naming the type, 2 for outlining how it works.* The condom, a barrier method preventing sperm from reaching the egg; the contraceptive pill, supplying hormones that prevent ovulation; the IUD, preventing implantation in the uterus; sterilisation, in which the fallopian tubes or vas deferens are cut or tied; natural methods, avoiding intercourse around ovulation.	**6**

Examiner note on (b)(ii). *Y points to a follicle in which only a crescent of fluid has begun to form, third in a visible progression from primordial follicles through a primary follicle. The fully fluid-filled Graafian follicle is drawn further round the cycle, so "Graafian follicle" describes that larger structure rather than Y and should not be credited here.*

Question 6 — 50 marks

Candidates answer any five of Questions 2 to 7. Each carries 50 marks.

Indicative mark allocation: (a)(i) 2 · (a)(ii) 3 · (a)(iii) 3 · (a)(iv) 3 · (b)(i) 3 · (b)(ii) 3 · (b)(iii) 2 · (b)(iv) 5 · (c)(i) 2 · (c)(ii) 3 · (c)(iii) 2 · (c)(iv) 6 · (d)(i) 4 · (d)(ii) 3 · (d)(iii) 2 · (d)(iv) 4 = 50 marks.

(a) Bacterial growth and aseptic technique (11 marks)

Part	Acceptable Answer(s)	Marks
(i) The dependent variable	The **average diameter of the bacterial colonies**.	**2**
(ii) Maintaining aseptic conditions	Flame the inoculating loop until red hot before and after use; work close to a lit Bunsen burner so that the rising air carries contaminants away; sterilise the agar and glassware in an autoclave beforehand; lift the lid of the Petri dish only slightly and at an angle; seal the dish with tape after inoculating; disinfect the bench before and after. Any one, described.	**3**
(iii) Low growth at pH 4 and pH 10	These values are far from the optimum of about pH 7 (1). At extremes of pH the enzymes of the bacteria are denatured — their active sites change shape — so their metabolic reactions slow or stop and the cells cannot grow and divide normally (2).	**3**
(iv) Overcoming merged colonies	Measure or count the colonies at an earlier time, before they have grown enough to merge; dilute the inoculum so that fewer, well-separated colonies develop; spread a smaller volume over the plate; count the colonies rather than measuring their diameters, using a grid or colony counter.	**3**

(b) The human microbiome (13 marks)

Part	Acceptable Answer(s)	Marks
(i) Microbiome	The whole community of microorganisms — bacteria, fungi and others — that live naturally in or on a particular environment (2), such as the human body or one part of it (1).	**3**
(ii) Benefit of *L. crispatus*	It maintains an acidic environment in the vagina (2), and that acidity prevents harmful bacteria from growing there, protecting against infection such as vaginosis (1).	**3**
(iii) Type of relationship	**Mutualism** (accept symbiosis) — both the bacteria and the human benefit.	**2**

Part	Acceptable Answer(s)	Marks
(iv) Is it a testable hypothesis	**Yes** (2). Justification (3): it makes a specific, falsifiable prediction that can be investigated by a controlled experiment — one group of patients given capsules containing the live culture and a matched control group given a placebo, with the rate of recovery from vaginosis measured in both. The result would either support the hypothesis or not, which is what makes it testable.	**5**

(c) Helicobacter pylori (13 marks)

Part	Acceptable Answer(s)	Marks
(i) Normal pH of the stomach	About **pH 2** (accept 1 to 3).	**2**
(ii) A function of stomach acid	It kills most bacteria taken in with food; it provides the low pH at which the enzyme pepsin works best; it denatures proteins, unfolding them so that pepsin can act on them. Any one.	**3**
(iii) The term	**Epigenetics** (accept gene-environment interaction).	**2**
(iv) Two types of mutation ***3 marks each***	**Gene (point) mutation:** a change in the base sequence of a single gene — a base substituted for another, a base inserted, or a base deleted — which may alter the amino acid sequence of the protein made. **Chromosome mutation:** a change in the structure or number of whole chromosomes — a section deleted, duplicated, inverted or moved to another chromosome, or an extra or missing chromosome arising from non-disjunction.	**6**

(d) From DNA to protein (13 marks)

Part	Acceptable Answer(s)	Marks
(i) The mRNA code	DNA: A T A C C A T A G → mRNA: **U A U G G U A U C** *2 marks for correctly pairing A with U throughout, 2 for the remaining bases.* A candidate who writes T instead of U anywhere loses 2.	**4**
(ii) The amino acids ***1 mark each***	Amino acid 1: **tyrosine** (UAU) Amino acid 2: **glycine** (GGU) Amino acid 3: **isoleucine** (AUC) Error carried forward from (i).	**3**
(iii) Number of fragments	**9** — one for each base in the sequence, since sequencing generates a fragment terminating at every position along it.	**2**
(iv) Forming and separating the fragments	The DNA is cut into fragments, either by restriction enzymes cutting at specific base sequences or by chain termination during copying (2). The fragments are then separated by **gel electrophoresis**: they are loaded into wells at one end of a gel and a voltage is applied, and because DNA is negatively charged the fragments move towards the positive electrode, the smallest travelling furthest, so they are separated by size (2).	**4**

Question 7 — 50 marks

Candidates answer any five of Questions 2 to 7. Each carries 50 marks.

Indicative mark allocation: (a)(i) 2 · (a)(ii) 3 · (a)(iii) 3 · (a)(iv) 3 · (a)(v) 3 · (b)(i) 8 · (b)(ii) 2 · (b)(iii) 3 · (b)(iv) 2 · (c)(i) 3 · (c)(ii) 3 · (c)(iii) 3 · (d)(i) 2 · (d)(ii) 4 · (d)(iii) 2 · (d)(iv) 2 · (d)(v) 2 = 50 marks.

(a) Rhododendron and species abundance (14 marks)

Part	Acceptable Answer(s)	Marks
(i) Effect of dense cover	The abundance of species is **greatly reduced** — roughly a quarter of the number per square metre found in uninvaded areas.	**2**
(ii) Competition	The interaction that occurs when two or more organisms require the same resource — light, water, space or nutrients — and that resource is in limited supply (2), so that the success of one reduces what is available to the other (1).	**3**
(iii) A conservation strategy	Cut and remove the rhododendron and treat the stumps so that it cannot regrow; replant with native species to re-establish the community; monitor the cleared areas and remove seedlings as they appear; prevent further planting or spread; create a buffer zone. Any one, developed.	**3**
(iv) Why recovery is slow	Years of dense shade will have killed the smaller plants and exhausted the seed bank in the soil, so there is little left to regrow from (2); rhododendron also alters the soil and its litter releases substances that inhibit other plants, and stumps and seeds left behind allow it to return (1).	**3**
(v) Avoiding bias	Place the quadrats at random, for example by generating random coordinates within the area rather than choosing where to put them (2), and take a large number of samples across each site so that the result is representative rather than reflecting the investigator's choice (1).	**3**

(b) Carbon dioxide from the soil (15 marks)

Part	Acceptable Answer(s)	Marks
(i) Plotting the graph	*2 marks for both axes labelled with quantity and unit, 2 for suitable scales using more than half the grid, 3 for the eighteen points plotted accurately — deducting 1 per misplotted point to a minimum of zero — and 1 for both lines drawn and distinguished by a key.* Time in months on the horizontal axis and relative units of carbon dioxide on the vertical.	**8**
(ii) Source of the CO_2	The **respiration** of organisms in the soil — decomposers such as bacteria and fungi breaking down organic matter, soil animals, and the respiring roots of plants.	**2**

Part	Acceptable Answer(s)	Marks
(iii) Reason for the difference	The native soil releases far more carbon dioxide throughout. Native woodland supports a much greater mass and variety of decomposers, soil organisms and plant roots, all respiring (2), whereas rhododendron produces litter that decomposes slowly and shades out the ground flora, so there is less organic matter being broken down and less root respiration in the invaded soil (1).	**3**
(iv) Another process releasing carbon	**Combustion** — the burning of fuels, wood or vegetation. Accept respiration by other organisms, or volcanic activity.	**2**

(c) Photosynthesis in immobilised algae (9 marks)

Part	Acceptable Answer(s)	Marks
(i) Keeping a condition constant	*A condition must be named and the method described.* **Temperature:** stand the test tubes in a water bath at a set temperature, and place a glass tank of water between the lamp and the tubes to absorb the heat so that the lamp warms them as little as possible. Accept the volume of indicator, the number of algal beads, or the time allowed, each with a method.	**3**
(ii) The CO_2 concentrations ***1 mark each***	Test tube 1: **low** Test tube 2: **medium** Test tube 3: **high**	**3**
(iii) Why 1 and 3 differ	Tube 1 is closest to the lamp and receives the highest light intensity, so photosynthesis is rapid and uses up carbon dioxide faster than respiration produces it, leaving the concentration low (2). Tube 3 is furthest away and receives the least light, so photosynthesis is slow and is outweighed by respiration, and carbon dioxide accumulates (1).	**3**

(d) The thylakoid membrane (12 marks)

Part	Acceptable Answer(s)	Marks
(i) Purpose of the chlorophyll	To **absorb light energy**, which excites electrons within it to a higher energy level so that they can be passed into the electron pathways.	**2**
(ii) Photolysis at A	Light energy absorbed by chlorophyll is used to split water molecules (2) into hydrogen ions, electrons and oxygen: $2H_2O \rightarrow 4H^+ + 4e^- + O_2$ (1). The electrons replace those lost by the chlorophyll, the hydrogen ions are used later in the pathway, and the oxygen is released as a by-product (1).	**4**
(iii) The final electron acceptor B	**$NADP^+$**, which is reduced to NADPH.	**2**
(iv) Role of B in the light-independent reaction	NADPH carries the hydrogen and electrons from the light-dependent stage into the light-independent stage, where, together with the energy from ATP, it reduces the fixed carbon dioxide — converting glycerate-3-phosphate into triose phosphate and so into glucose and other carbohydrates.	**2**

Part	Acceptable Answer(s)	Marks
(v) The enzyme C	**ATP synthase** (ATPase)	**2**

This marking scheme is indicative. The paper prints a total of 50 marks for each question and no sub-part marks, so all internal splits are those of this scheme; they reconcile to 50 marks for each question and to 300 marks for the six questions a candidate answers. Examiners should use professional judgement when awarding marks and should credit all reasonable responses not listed here. Prepared by SimpleStudy for study purposes; not an official State Examinations Commission document.