Biology Units 1 & 2

Practice Examinations

Aboriginal and Torres Strait Islander content has been excluded as accuracy cannot be guaranteed, and it is better to be respectful than cover the entire curriculum inaccurately.

Significant effort has been made to ensure this content is legal. Please send any areas of concern to admin@vwx.au with appropriate document/legal references so errors can be verified and changes be made.

Contents

Exam 1 — Practice examination

Reading time: 15 minutes. Writing time: 2 hours 30 minutes. Section A: 40 questions, 40 marks. Section B: 9 questions, 80 marks. Total 120 marks. This examination covers Units 1 and 2. Answer all questions.

- *No calculator may be used.*
- *No formula sheet, data sheet, dictionary or notes may be used.*
- *Diagrams in this examination are not drawn to scale.*

Section A — Multiple choice

Every question in this section must be attempted. Select the response that is correct or that best answers the question. One mark is awarded for each correct response, and nothing is taken away where a response is wrong. Where two or more responses have been completed for the same question, no mark is awarded for it. No diagram in this section is drawn to scale.

Question 1

Which one of the following structures is found in a plant cell but not in a typical animal cell?

A. a cell wall

B. a nucleus

C. a plasma membrane

D. ribosomes

Question 2

A cell has no nucleus and no membrane-bound organelles. This cell is

A. a plant cell.

B. an animal cell.

C. a fungal cell.

D. a prokaryotic cell.

Question 3

The organelle that releases energy from glucose in a process that uses oxygen is the

A. nucleus.

B. ribosome.

C. mitochondrion.

D. chloroplast.

Question 4

The plasma membrane is built mainly from a double layer of

A. protein molecules.

B. phospholipid molecules.

C. carbohydrate chains.

D. cholesterol molecules.

Question 5

Oxygen crosses the plasma membrane from a higher to a lower concentration, without the cell using any energy. This movement is

A. active transport.

B. osmosis.

C. simple diffusion.

D. exocytosis.

Question 6

Moving a substance across the plasma membrane against its concentration gradient

A. requires energy from ATP.

B. can occur only in plant cells.

C. needs no membrane proteins.

D. is called osmosis.

Use the following information to answer Questions 7 and 8.

Four identical cylinders were cut from one potato and weighed. Each was then left for one hour in a different sucrose solution, and reweighed. The change in mass of each cylinder is shown in the table.

Sucrose solution (mol/L)	Change in mass of the cylinder (%)
0.1	+9
0.3	+3
0.5	−6
0.7	−13

Question 7

In which solution or solutions did water move out of the potato cylinder overall?

A. the 0.1 mol/L solution only

B. the 0.3 mol/L solution only

C. the 0.5 mol/L and 0.7 mol/L solutions

D. none of the solutions

Question 8

The movement of water into or out of the cylinders is an example of

A. active transport.

B. osmosis.

C. facilitated diffusion of sucrose.

D. exocytosis.

Question 9

The levels of organisation of a multicellular organism, listed from the simplest to the most complex, are

A. cell → tissue → organ → organ system

B. cell → organ → tissue → organ system

C. tissue → cell → organ → organ system

D. organ → organ system → tissue → cell

Question 10

Skeletal muscle, which contracts to move parts of the body, is an example of

A. epithelial tissue.

B. nervous tissue.

C. connective tissue.

D. muscle tissue.

Question 11

A gland that releases its product directly into the blood, without a duct, is

A. an exocrine gland.

B. an endocrine gland.

C. a salivary gland.

D. a sweat gland.

Question 12

Which one of the following waste products is removed from the body mainly by the lungs?

A. carbon dioxide

B. urea

C. undigested fibre

D. excess glucose

Question 13

In a plant, the water absorbed by the roots is carried up to the leaves through the

A. phloem.

B. stomata.

C. xylem.

D. epidermis.

Question 14

When the body becomes too hot, one response that helps to cool it is

A. shivering of the muscles.

B. sweating from the skin.

C. narrowing the blood vessels in the skin.

D. raising the metabolic rate.

Question 15

In a homeostatic control system, the part that detects a change in a condition is the

A. effector.

B. response.

C. stimulus.

D. receptor.

Question 16

Which one of the following statements is a hypothesis?

A. To find out whether fertiliser affects the growth of tomato plants.

B. Does fertiliser affect the growth of tomato plants?

C. If tomato plants are given fertiliser, they will grow taller than plants given none.

D. Fertiliser is expensive to buy.

Question 17

A student investigates how the amount of fertiliser given to a plant affects the number of flowers it produces. The dependent variable in this investigation is

A. the amount of fertiliser given.

B. the number of flowers produced.

C. the species of plant used.

D. the size of the pot.

Question 18

A student measures the same quantity five times and calculates the mean. Taking several measurements and averaging them mainly

A. removes any systematic error in the method.

B. changes the independent variable.

C. proves that the hypothesis is correct.

D. reduces the effect of random error on the mean.

Question 19

A student downloads ten years of rainfall figures from a weather bureau's website to use in her report. For this student, these figures are

A. primary data.

B. an anecdote.

C. secondary data.

D. a hypothesis.

Question 20

After finding that a new plant food increased the growth of her bean plants, a student writes: "Gardeners could use this plant food to grow bigger beans." This statement is

A. an implication of her finding.

B. the hypothesis of the investigation.

C. a systematic error.

D. the independent variable.

Question 21

Different versions of the same gene are called

A. chromosomes.

B. alleles.

C. gametes.

D. genomes.

Question 22

The two chromosomes of a homologous pair carry

A. the same genes, at the same positions (loci).

B. completely different genes.

C. only the genes that determine sex.

D. no genes at all.

Question 23

A human body cell contains 46 chromosomes. A human sperm cell contains

A. 46 chromosomes.

B. 92 chromosomes.

C. 23 chromosomes.

D. 12 chromosomes.

Question 24

The type of cell division that produces gametes and halves the chromosome number is

A. mitosis.

B. binary fission.

C. cytokinesis.

D. meiosis.

Question 25

All of the observable characteristics of an organism together make up its

A. genotype.

B. phenotype.

C. genome.

D. karyotype.

Question 26

In pea plants, tall (T) is dominant to short (t). A plant with the genotype Tt will be

A. tall.

B. short.

C. medium in height.

D. impossible to predict.

Question 27

In fruit flies, grey body (G) is dominant to black body (g). Two flies of genotype Gg are crossed. The ratio of offspring expected is

A. all grey.

B. 1 grey : 1 black.

C. 1 grey : 2 black.

D. 3 grey : 1 black.

Question 28

In humans, an individual whose sex chromosomes are XX is

A. always male.

B. female.

C. missing a chromosome.

D. unable to be determined.

Question 29

Which one of the following is a form of asexual reproduction?

A. an egg and a sperm fusing at fertilisation

B. pollen from one flower fertilising another flower

C. two parents producing genetically varied offspring

D. a strawberry plant producing new plants along its runners

Question 30

Compared with offspring produced by asexual reproduction, offspring produced by sexual reproduction are

A. genetically identical to one parent.

B. genetically varied.

C. always larger.

D. unable to reproduce themselves.

Question 31

A lizard warms itself by lying on a sun-facing rock early in the morning. This is best described as

A. a structural adaptation.

B. a physiological adaptation.

C. a behavioural adaptation.

D. an acquired characteristic.

Question 32

The thick, waxy layer on the leaves of a desert plant, which reduces water loss, is

A. a structural adaptation.

B. a behavioural adaptation.

C. an acquired characteristic.

D. a learned response.

Question 33

A population with high genetic diversity is more likely to survive if a new disease reaches it, because

A. all of its members are genetically identical.

B. it always contains fewer individuals.

C. it is unable to change over time.

D. some individuals are likely to carry resistance and survive.

Question 34

A bee feeds on a flower's nectar and, in doing so, carries pollen that fertilises the flower. Because both species benefit, this relationship is an example of

A. predation.

B. competition.

C. mutualism.

D. parasitism.

Question 35

All of the individuals of one species living in the same area at the same time are called

A. a community.

B. an ecosystem.

C. a keystone species.

D. a population.

Question 36

A team has developed a new medicine. Three of the questions below can be settled by scientific evidence. Which one cannot, because it is a bioethical (value) question?

A. Does the new medicine lower blood pressure?

B. What dose of the medicine works best?

C. How is the medicine broken down in the body?

D. Should the new medicine be tested on animals before it is tested on people?

Question 37

The ethical concept of avoiding or minimising harm — "do no harm" — is called

A. beneficence.

B. justice.

C. non-maleficence.

D. integrity.

Question 38

Using a set of results to estimate a value that lies outside the range that was actually measured is called

A. extrapolation.

B. peer review.

C. plagiarism.

D. referencing.

Question 39

A food-web diagram is a useful scientific model, but one limitation of it is that it

A. shows which organisms are eaten by which.

B. does not show how the number of each species changes over time.

C. uses arrows to show the direction of energy flow.

D. can be printed clearly on a poster.

Question 40

In a report, a fact taken from another author's published work must be

A. acknowledged by citing the source.

B. presented as the student's own idea.

C. left out of the report entirely.

D. reworded so that no one can trace it.

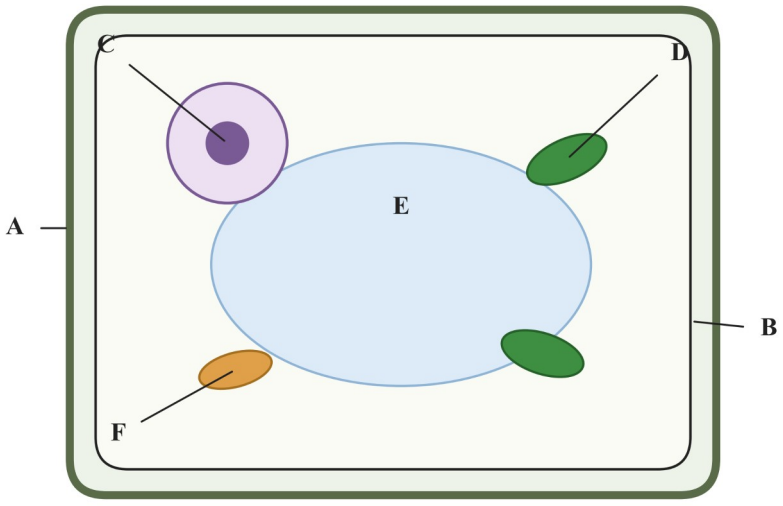
End of Section A

Section B — Short answer

Every question in this section must be attempted, in the spaces provided. For any question carrying two or more marks, a response earns full credit only if it reaches the depth that its command term and its mark allocation call for. No diagram in this section is drawn to scale.

Question 1 (8 marks)

The diagram below shows a plant cell. Six of its structures are labelled **A** to **F**.



A plant cell (diagram not drawn to scale)

a. Name the structure labelled **C**, and state one function it carries out for the cell. 2 marks

b. Identify, by its letter, and name the organelle that is the site of photosynthesis, and name the gas that photosynthesis releases. 2 marks

c. The organelle labelled **F** carries out aerobic cellular respiration. Name organelle **F**. 1 mark

d. Name two of the labelled structures that would not be found in a typical animal cell. 2 marks

e. Structure **A** is freely permeable to substances, whereas structure **B** controls what enters and leaves the cell. Name structures **A** and **B**. 1 mark

Question 2 (8 marks)

When a person grazes their skin, cells at the edge of the wound divide to replace the cells that were lost, and the wound gradually heals.

a. Name the type of nuclear division that produces the new skin cells, and state how the genetic makeup of the new cells compares with that of the cells they replace. 2 marks

b. Before a cell divides, it copies its DNA. Name the phase of the cell cycle during which the DNA is copied, and give one reason it is important that the copying is accurate. 2 marks

c. Cell division normally stops once the wound has healed. In cancer, this control is lost. State two ways in which cancer cells differ from normal body cells. 2 marks

d. After the nucleus of a dividing cell has split in two, the cytoplasm divides. Name this step, and state one way in which it differs between a plant cell and an animal cell. 2 marks

Question 3 (9 marks)

A person eats a meal of bread, which contains a large amount of the carbohydrate starch. The starch is digested and absorbed as the meal passes through the small intestine.

a. Name the small molecule that starch is digested into, and name the type of enzyme that digests starch. 2 marks

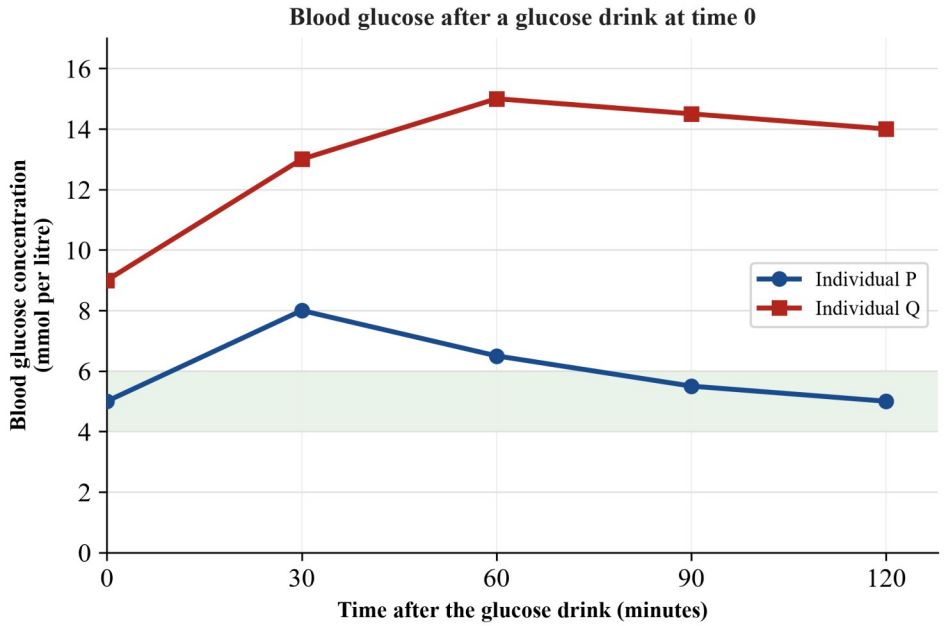
b. The lining of the small intestine is folded into many tiny villi. Each villus has a wall only one cell thick and a rich supply of blood capillaries. Explain how this lining increases the rate at which glucose is absorbed, referring to the surface area of the lining, the thickness of the villus wall and the blood supply to each villus. 3 marks

c. Once absorbed, the glucose is carried to the cells all around the body. Name the body system that transports the glucose, and, using the idea of interdependence, explain why the digestive system relies on this system. 2 marks

d. The liver converts some absorbed molecules into a nitrogen-containing waste called urea. Name the body system that removes urea from the blood, and name the main organ that does so. 2 marks

Question 4 (9 marks)

Two people, individual P and individual Q, each drank the same glucose drink at time 0. Their blood glucose concentration was then measured over the next two hours. Individual Q has untreated type 1 diabetes. The results are shown in the graph below.



a. State the blood glucose concentration of individual P at time 0, and state P's highest concentration and the time at which it occurred. 2 marks

b. After the drink, individual P's blood glucose returns to its starting level within two hours. Name the hormone that lowers blood glucose, name the gland that releases it, and describe what this hormone causes body cells and the liver to do. 3 marks

c. Individual Q has untreated type 1 diabetes. Explain, in terms of this hormone, why Q's blood glucose stays high. 2 marks

d. State whether the control of blood glucose is an example of negative or positive feedback, and give a reason for your answer. 2 marks

Question 5 (10 marks)

A student investigated whether practice improves how quickly a person's nervous system reacts to a stimulus. She used a "ruler-drop" reaction test: without warning, a ruler is released and the person tries to catch it as fast as they can, and the distance the ruler falls before it is caught (in cm) is recorded — a shorter distance means a faster reaction. The same person completed four rounds of practice, and at each round the test was repeated three times. Her results are shown in Table 1.

Table 1 Distance the ruler fell before it was caught (cm)

Round of practice	Trial 1	Trial 2	Trial 3
1	21	19	20
2	16	14	15
3	11	9	10
4	9	7	8

a. Identify the independent variable and the dependent variable in this investigation. 2 marks

b. State one variable that should be kept constant, and explain why it must be kept constant. 2 marks

c. Calculate the mean catch distance at round 1 and at round 3. Show your working. 2 marks

d. Calculate the percentage decrease in the mean catch distance from round 1 to round 3. Show your working. 2 marks

e. The student concludes: "The more the person practises, the faster their reaction becomes." State whether this conclusion is supported by her data, and state one limitation of her investigation. 2 marks

Question 6 (10 marks)

In chickens, a rose comb (allele **R**) is dominant to a single comb (allele **r**).

a. State what is meant by the term genotype, and what is meant by the term phenotype. 2 marks

b. A rose-combed chicken is crossed with a single-combed chicken. The chicks that hatch are five rose-combed and five single-combed. State the genotype of each parent, and explain how the ratio of the offspring shows that the rose-combed parent is heterozygous. 3 marks

c. Chicken gametes are produced by meiosis. State how many comb-shape alleles each gamete carries, and explain why, referring to what happens during meiosis. 2 marks

d. Construct a Punnett square for the cross in part **b**, and use it to state the expected ratio of rose-combed to single-combed offspring. 3 marks

Question 7 (9 marks)

The pot plant *Kalanchoe*, sometimes called "mother-of-thousands", grows tiny new plants along the edges of its leaves. Each one drops off and roots where it lands, so a single parent plant can fill a pot with new plants, none of them grown from a seed.

a. Name the type of reproduction that produces the new plants along the leaf edges, and name the type of cell division involved. 2 marks

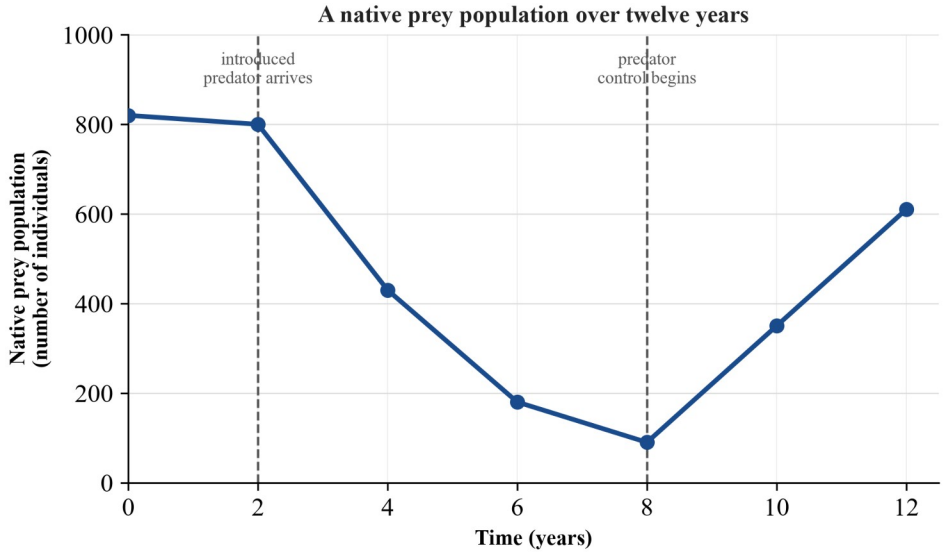
b. State the genetic relationship between one of these new plants and the parent plant, and give one advantage to the plant of reproducing in this way. 2 marks

c. One winter, an unusually severe frost strikes, and none of the plants in the pot can tolerate it. Explain why every plant in the pot is at risk, referring to genetic diversity. 2 marks

d. *Kalanchoe* can also reproduce sexually, producing flowers and seeds. Explain why sexual reproduction produces genetically varied offspring, and why this variation improves a species' chance of surviving a change in its environment. 3 marks

Question 8 (8 marks)

The graph below shows the size of a native prey population in an Australian reserve over twelve years. An introduced predator became established in the reserve early in year 2. A predator-control program began in year 8.



a. Using the graph, describe what happened to the native prey population between year 2 and year 8. Quote figures from the graph. 2 marks

b. Explain why the introduced predator caused this change, referring to the native prey having no defences against it and the predator having no natural enemies in the reserve. 2 marks

c. Describe what the graph shows about the prey population from year 8 to year 12, and explain how the predator-control program brought this about. 2 marks

d. Aboriginal and Torres Strait Islander ranger groups lead many programs that control introduced predators to protect native animals on Country. State one reason such programs are carried out in partnership with Aboriginal and Torres Strait Islander communities, and describe one way this partnership can make the predator-control program more effective. 2 marks

Question 9 (9 marks)

A community is deciding whether to release a genetically modified mosquito that could reduce the spread of a mosquito-borne disease. At a public meeting, people make several different arguments.

a. One person argues: "We should do this if the overall benefit — fewer people falling ill — is greater than the possible harms." Name the approach to bioethics this argument reflects, and justify your answer. 2 marks

b. Another person argues: "It is wrong to release an organism that might harm other wildlife, no matter what the benefit." Name a different approach to bioethics that this argument reflects. 1 mark

c. The proposal raises both scientific and bioethical questions. Write one scientific (empirical) question and one bioethical (value) question that it raises. 2 marks

d. Before deciding, the council reads several studies. Explain why a finding published in a peer-reviewed scientific journal is generally more trustworthy than a claim made in a company's advertisement. 2 marks

e. The council must explain its decision both to a panel of expert scientists and to the general public. State one way the communication prepared for the general public should differ from the one prepared for the experts. 2 marks

End of Section B

End of examination questions

Exam 1 — Answers and solutions

Section A — answers

Q	Ans	Q	Ans	Q	Ans	Q	Ans
1	A	11	B	21	B	31	C
2	D	12	A	22	A	32	A
3	C	13	C	23	C	33	D
4	B	14	B	24	D	34	C
5	C	15	D	25	B	35	D
6	A	16	C	26	A	36	D
7	C	17	B	27	D	37	C
8	B	18	D	28	B	38	A
9	A	19	C	29	D	39	B
10	D	20	A	30	B	40	A

Q1. A — a cell wall is found in plant cells but not in animal cells; a nucleus, a plasma membrane and ribosomes are all present in animal cells as well.

Q2. D — a cell with no nucleus and no membrane-bound organelles is a prokaryotic cell; plant, animal and fungal cells are all eukaryotic and have a nucleus.

Q3. C — the mitochondrion carries out aerobic cellular respiration, releasing energy from glucose using oxygen; the chloroplast is the site of photosynthesis, not respiration.

Q4. B — the membrane is a bilayer (double layer) of phospholipids; proteins, carbohydrates and cholesterol are embedded among them but do not form the bilayer.

Q5. C — a small, non-polar molecule moving down its concentration gradient without energy is crossing by simple diffusion; osmosis is the movement of water, and active transport and exocytosis both require energy.

Q6. A — moving a substance against its concentration gradient is active transport, which needs energy from ATP and a membrane protein; osmosis moves water down a gradient and requires no energy.

Q7. C — a fall in mass means water left the cylinder overall, which happened in the 0.5 mol/L (−6%) and 0.7 mol/L (−13%) solutions; in the two weaker solutions the mass rose, so water moved in.

Q8. B — the net movement of water across the membrane, from the dilute to the more concentrated side, is osmosis; sucrose itself did not cross.

Q9. A — the levels run cell → tissue → organ → organ system, each level being built from the one before it.

Q10. D — muscle that contracts to move the body is muscle tissue; epithelial, nervous and connective tissues have other roles.

Q11. B — a ductless gland that secretes its product straight into the blood is an endocrine gland; exocrine glands (such as salivary and sweat glands) release their products through a duct.

Q12. A — carbon dioxide, a waste of respiration, is removed by the lungs; urea is removed by the kidneys, and fibre and any un-absorbed food are egested, not excreted.

Q13. C — water taken up by the roots travels to the leaves through the xylem; the phloem carries sugars, and the stomata and epidermis are not transport tubes.

Q14. B — when the body overheats, sweating cools it as the sweat evaporates; shivering, narrowing the skin's vessels and raising the metabolic rate all warm the body.

Q15. D — the receptor detects the change in the condition; the effector produces the response, the stimulus is the change itself, and the response is the action taken.

Q16. C — a hypothesis is a testable statement that commits to a direction ("if … then … taller"). A is the aim, B is the research question, and D is an unrelated statement.

Q17. B — the dependent variable is what is measured in response, the number of flowers; the amount of fertiliser is the independent variable, and the species and pot size are controlled.

Q18. D — averaging repeated readings reduces the effect of random error on the mean; it cannot remove a systematic error, does not change the independent variable and does not prove a hypothesis.

Q19. C — figures obtained from someone else's published work are secondary data for this student; they would be primary data only for the people who first measured the rainfall.

Q20. A — a statement about how someone else might use the finding, beyond the conditions tested, is an implication; it is not the hypothesis, an error or a variable.

Q21. B — different versions of the same gene are alleles; chromosomes carry genes, gametes are sex cells, and the genome is the full set of an organism's DNA.

Q22. A — homologous chromosomes carry the same genes at the same loci (though they may carry different alleles of those genes); they are not made of different genes.

Q23. C — a gamete is haploid, carrying half the body-cell number: half of 46 is 23.

Q24. D — meiosis produces gametes and halves the chromosome number; mitosis keeps the number the same, binary fission is prokaryotic, and cytokinesis is the splitting of the cytoplasm.

Q25. B — the observable characteristics are the phenotype; the genotype is the set of alleles, the genome is the full DNA, and a karyotype is a picture of the chromosomes.

Q26. A — T is dominant, so a Tt plant shows the dominant trait and is tall; it is not medium (that would be incomplete dominance) or unpredictable.

Q27. D — Gg × Gg gives a 3 : 1 ratio of dominant to recessive, so 3 grey : 1 black.

Q28. B — in humans XX is female and XY is male; XX is a complete, normal pair, so nothing is missing and the sex can be determined.

Q29. D — a strawberry sending out runners that grow into new plants is asexual reproduction (one parent, identical offspring). Fertilisation, pollination and producing varied offspring are all sexual.

Q30. B — sexual reproduction combines alleles from two parents, so the offspring are genetically varied; asexual offspring are identical to the one parent.

Q31. C — basking on a warm rock is an action the animal performs, so it is a behavioural adaptation, not a body structure or an internal process.

Q32. A — a thick waxy leaf layer is a physical feature of the plant's body, so it is a structural adaptation; it is inherited, not acquired or learned.

Q33. D — with high genetic diversity a population holds a range of characteristics, so some individuals are likely to carry resistance and survive the disease; identical or unchanging populations would not.

Q34. C — where both species benefit — the bee is fed and the flower is pollinated — the relationship is mutualism.

Q35. D — all the individuals of one species in an area at one time make up a population; a community is all the species together, and an ecosystem includes the non-living surroundings as well.

Q36. D — "should …" asks what ought to be done, a value question that evidence alone cannot settle; the other three ask what is or what happens, which evidence can settle.

Q37. C — avoiding or minimising harm is the concept of non-maleficence; beneficence is doing good, justice is fairness, and integrity is honesty.

Q38. A — estimating a value beyond the range of the data actually collected is extrapolation; peer review, plagiarism and referencing all concern how other people's work is checked, misused or acknowledged, not how a graph is read.

Q39. B — a food web shows feeding links but not how the numbers of each species change over time, which is a genuine limitation; the other options describe what the model usefully does.

Q40. A — a fact taken from another author must be acknowledged by citing its source; presenting it as one's own, hiding it or disguising it would be dishonest.

Section B — solutions

Q1. (a) Structure **C** is the **nucleus**. Its function is to **control the activities of the cell** and to **contain (store) the cell's DNA / genetic material**, which carries the instructions for making the cell's proteins. *(1 mark: nucleus; 1 mark: a correct function — controls the cell and/or holds the genetic material.)*

(b) The site of photosynthesis is structure **D**, the **chloroplast**, and the gas that photosynthesis releases is **oxygen**. *(1 mark: **D**, named as the chloroplast — both the letter and the name are needed; 1 mark: oxygen.)*

(c) Organelle **F** is the **mitochondrion**. *(1 mark.)*

(d) Any **two** of the structures that a typical animal cell lacks: **A** the **cell wall**, **D** the **chloroplast**, or **E** the **large central vacuole**. *(1 mark each for two of these; naming the nucleus, plasma membrane or mitochondrion earns nothing, as animal cells have them too.)*

(e) Structure **A** is the **cell wall** (freely permeable) and structure **B** is the **plasma membrane** (which controls what enters and leaves the cell). *(1 mark: both correct — A cell wall and B plasma membrane.)*

Q2. (a) The new cells are produced by **mitosis**. The new cells are **genetically identical** to one another and to the cells they replace (each carries the same DNA). *(1 mark: mitosis; 1 mark: genetically identical.)*

(b) DNA is copied during the **S phase** (of interphase). It is important that the copying is accurate so that **each new cell receives a complete and correct copy of the DNA** — an error in the copy could stop the cell working properly, or, if it affected the control of cell division, could lead to cancer. *(1 mark: S phase; 1 mark: a valid reason accuracy matters.)*

(c) Any **two** ways cancer cells differ from normal body cells: they **divide in an uncontrolled way / do not stop dividing**; they **do not undergo apoptosis (programmed cell death) when they should**; they **fail to respond to the signals that normally stop division** (they keep dividing even when crowded); or they are **unspecialised** rather than doing a proper tissue job. *(1 mark for each of two valid differences.)*

(d) The step is **cytokinesis** (the division of the cytoplasm). One difference: in a **plant cell a new cell wall (cell plate) forms across the middle** to separate the two cells, whereas in an **animal cell the membrane pinches inwards (a cleavage furrow)** to divide the cell. *(1 mark: cytokinesis; 1 mark: a valid plant-vs-animal difference.)*

Q3. (a) Starch is digested into **glucose**, and the enzyme group that digests it is **carbohydrase (amylase)**. *(1 mark: glucose; 1 mark: carbohydrase / amylase.)*

(b) **Surface area:** the lining is folded into **many villi (and microvilli)**, which give a **very large surface area**, so that much more glucose can be absorbed at once than a flat lining would allow. **Wall thickness:** each villus wall is **only one cell thick**, giving the glucose a **short distance to cross**, so it passes into the blood quickly. **Blood supply:** the **rich network of capillaries carries the absorbed glucose away** as fast as it arrives, keeping the glucose concentration inside the villus low, so a **steep concentration gradient** into the villus is maintained. *(1 mark each: large surface area → more absorption at once; wall one cell thick → short diffusion distance; capillaries carry glucose away → gradient maintained. Naming a feature without saying how it speeds absorption earns nothing, as all three are given in the question.)*

(c) The glucose is transported by the **circulatory system (the blood)**. The digestive system **absorbs the glucose but relies on the circulatory system to carry it to the cells** all around the body; without the blood to distribute it, the absorbed glucose could not reach the cells that need it — the two systems are **interdependent**. *(1 mark: circulatory system; 1 mark: explains the dependence — the digestive system needs the blood to distribute the absorbed nutrients.)*

(d) Urea is removed by the **excretory (urinary) system**, and the main organ that does so is the **kidney**. *(1 mark: excretory / urinary system; 1 mark: the kidney.)*

Q4. (a) At time 0, individual P's blood glucose is **5.0 mmol/L**. P's **highest** concentration is **8.0 mmol/L**, which occurs at **30 minutes** after the drink. *(1 mark: 5.0 mmol/L at time 0; 1 mark: peak of 8.0 mmol/L at 30 minutes.)*

(b) The hormone that lowers blood glucose is **insulin**, released by the **pancreas**. Insulin makes the **body cells take up more glucose** from the blood, and makes the **liver take up glucose and store it as glycogen**; both of these remove glucose from the blood, so its concentration falls back to the set level. *(1 mark: insulin; 1 mark: the pancreas; 1 mark: describes the effect — cells take up glucose and/or the liver stores it as glycogen.)*

(c) In untreated type 1 diabetes the cells of the pancreas that make insulin have been destroyed, so **little or no insulin is released**. Without insulin, the **body cells do not take up the extra glucose and the liver does not store it**, so the glucose is not removed from the blood and its concentration **stays high**. *(1 mark: little or no insulin is produced; 1 mark: so glucose is not taken up / stored, and stays high.)*

(d) It is **negative feedback**. The response **opposes (reverses) the change that set it off**: when blood glucose rises above the set level, the response acts to **bring it back down** towards the set point, rather than pushing it further away. *(1 mark: negative feedback; 1 mark: the response opposes the change / returns the variable towards the set point.)*

Q5. (a) The **independent variable** is the **round of practice** (the number of the practice round). The **dependent variable** is the **distance the ruler fell before it was caught (cm)** — the measure of reaction time. *(1 mark: IV = round of practice; 1 mark: DV = catch distance / reaction time.)*

(b) Any **one** suitable variable, with a reason — for example the **same person**, the **same ruler**, the **same hand**, the **same starting gap between finger and thumb**, or **giving no warning** before the ruler is dropped. It must be kept constant so that it **does not also affect the catch distance**, which would make it impossible to tell that practice alone caused the change (the test stays fair / valid). *(1 mark: a valid controlled variable; 1 mark: because it must not also affect the dependent variable.)*

(c) **At round 1:** (21 + 19 + 20) ÷ 3 = 60 ÷ 3 = **20 cm**. **At round 3:** (11 + 9 + 10) ÷ 3 = 30 ÷ 3 = **10 cm**. *(1 mark: 20 cm at round 1, with working; 1 mark: 10 cm at round 3, with working.)*

(d) Percentage decrease = (initial − final) ÷ initial × 100 = (20 − 10) ÷ 20 × 100 = 10 ÷ 20 × 100 = **50%**. *(1 mark: correct method; 1 mark: 50%.)*

(e) The conclusion **is supported** by the data: as the person does more rounds of practice, the mean catch distance falls (from 20 cm at round 1 down to 8 cm at round 4), so the reaction gets faster, which is exactly the pattern the conclusion describes, within the rounds tested. Any **one** valid limitation: only **one person** was tested, so the result may not apply to others; only **four rounds** were carried out; only **three trials** were run at each round; or the **catch distance is only an indirect measure** of reaction time (and the person may improve partly through familiarity with the task rather than through a truly faster reaction). *(1 mark: the conclusion is supported / consistent with the data, within the range tested; 1 mark: one valid limitation.)*

Q6. (a) The **genotype** is the **alleles an organism carries** for a characteristic (for example RR, Rr or rr). The **phenotype** is the **observable characteristic** the organism shows (for example a rose comb or a single comb). *(1 mark: genotype = the alleles carried; 1 mark: phenotype = the observable characteristic.)*

(b) The **single-combed parent** shows the recessive comb, so it must be **rr**. About **half of the chicks are single-combed (rr)**, and each single-combed chick must have received an **r allele from each parent** — so the rose-combed parent must also carry an **r** allele. Since that parent is rose-combed, its other allele is **R**, making its genotype **Rr (heterozygous)**. *(1 mark: single-combed parent rr; 1 mark: rose-combed parent Rr; 1 mark: explains that the single-combed chicks show the rose-combed parent must carry r, so it is heterozygous.)*

(c) Each gamete carries **one** comb-shape allele. During meiosis the **chromosome number is halved** — the **homologous chromosomes are separated**, so each gamete receives only **one chromosome of each pair**, and therefore only **one of the two alleles**. *(1 mark: one allele; 1 mark: because meiosis separates the homologous chromosomes / halves the number, so each gamete gets one allele.)*

(d) The cross is **Rr × rr**:

×	R	r
r	Rr	rr
r	Rr	rr

The offspring are **Rr, rr, Rr, rr** — that is **2 Rr : 2 rr**, or **1 rose comb : 1 single comb**. *(1 mark: correct Punnett square with the right gametes; 1 mark: offspring 2 Rr : 2 rr; 1 mark: phenotype ratio 1 rose : 1 single.)*

Q7. (a) The new plants along the leaf edges are produced by **asexual reproduction** (vegetative propagation), and the type of cell division involved is **mitosis**. *(1 mark: asexual reproduction; 1 mark: mitosis.)*

(b) Each new plant is **genetically identical to the parent plant (a clone)**. One advantage: a **single plant can produce many new plants quickly, with no need for a mate or for pollination**, so it can build up its numbers and spread rapidly. *(1 mark: genetically identical / a clone; 1 mark: a valid advantage of reproducing this way.)*

(c) Because every plant in the pot is **genetically identical**, they **all share the same characteristics — including the same inability to tolerate the severe frost**. A frost that can kill one plant can therefore kill **all of them**, and there are **no differing plants** with any frost tolerance to survive, so every plant is at risk. *(1 mark: the plants are all identical, so all share the same susceptibility; 1 mark: so there are no more-tolerant individuals and the whole pot could be lost.)*

(d) In sexual reproduction, **gametes are made by meiosis** and a gamete from **each of two parents** fuses at **fertilisation**, so each offspring receives a **new combination of alleles** and is genetically varied. This variation means the population contains a **range of inherited characteristics**, so if the environment changes (for example a severe frost or a new disease), **some individuals are likely to have characteristics that let them survive and reproduce**, allowing the species to persist. *(1 mark: meiosis and fertilisation combine alleles from two parents, giving varied offspring; 1 mark: variation means a range of inherited characteristics in the population; 1 mark: so some individuals are likely to survive an environmental change, and the species persists.)*

Q8. (a) Between year 2 and year 8 the native prey population **fell sharply (declined)**, from about **800 individuals down to about 90 individuals**. *(1 mark: describes the decline using directional language; 1 mark: quotes figures, roughly 800 falling to about 90.)*

(b) The native prey had **no defences against the introduced predator**, and the predator had **no natural enemies in the reserve** to keep its own numbers down, so the predator **killed prey faster than the prey population could replace them**, and the prey numbers fell. *(1 mark: with no defences, a high proportion of the prey that were hunted were caught and killed; 1 mark: with no natural enemies the predator's own numbers grew unchecked, so prey were killed faster than they could be replaced.)*

(c) After the control program began in year 8, the prey population **rose (recovered)**, from about **90 up to about 610 individuals** by year 12. Controlling the predator **reduced its numbers**, so **fewer prey were killed each year**; more prey therefore **survived to breed**, and the population climbed. The recovery is only partial — 610 is still well below the **820** present before the predator arrived — because the program **reduced the predator's numbers rather than eradicating it**, so some predation continued. *(1 mark: describes the recovery, quoting figures from the graph; 1 mark: explains it — the predator's numbers, and so the predation pressure, were reduced, allowing more prey to survive and reproduce.)*

(d) Any **one** valid reason for the partnership — for example, decisions about **caring for Country are properly made with the communities** whose Country it is, respecting their custodianship and their right to be involved. One way the partnership can make the program **more effective**: Aboriginal and Torres Strait Islander communities hold **detailed, long-standing knowledge of Country and of the native species, their behaviour and their interdependencies**, built up over a very long time, which can guide **where and how the introduced predators are best controlled**. *(1 mark: a valid reason for the partnership; 1 mark: a valid way the partnership / this knowledge makes the program more effective.)*

Q9. (a) This argument reflects the **consequences-based approach**. It judges the action by its **outcomes**, weighing the **benefit (fewer people falling ill)** against the **possible harms** and saying the release is right only if the benefit is the

greater — that is, deciding by consequences rather than by a rule or by character. *(1 mark: consequences-based approach; 1 mark: justification — it weighs the benefit against the harms / judges by outcomes.)*

(b) This argument reflects the **duty- and rule-based approach** — it appeals to the release being **wrong in itself, whatever the benefit**, that is, to a rule that must be followed **regardless of the consequences**, rather than to the outcomes. *(1 mark: duty- and/or rule-based. "Virtues-based" earns nothing: that approach judges the moral character of the person acting, and the argument says nothing about anyone's character.)*

(c) A **scientific (empirical) question**, for example: **"Does releasing the modified mosquito actually reduce the number of disease cases?"** — a question that evidence can answer. A **bioethical (value) question**, for example: **"Should we release the modified mosquito?"** — a question about what ought to be done, which evidence alone cannot settle. *(1 mark: a valid empirical question; 1 mark: a valid value question.)*

(d) A finding published in a peer-reviewed journal has been **independently checked by experts in the same field before publication**, so obvious faults are more likely to have been caught. A claim in a company's advertisement has **had no such independent check**, and the company **stands to gain from a favourable claim (a conflict of interest)**, so it may be biased. The peer-reviewed finding is therefore generally more trustworthy. *(1 mark: peer review = independent expert checking before publication; 1 mark: the advertisement is unchecked and/or biased by a conflict of interest.)*

(e) For the **general public**, the communication should **use plain, everyday language with little or no technical jargon, and lead with the key message and what it means for people**; the version for the experts can use the **full technical terminology and present the detailed data**. (The accuracy and balance of the message stay the same for both.) *(1 mark: identifies plain language / minimal jargon / key message first for the public; 1 mark: contrasts this with the technical detail appropriate for experts.)*

Exam 2 — Practice examination

Reading time: 15 minutes. Writing time: 2 hours 30 minutes. Section A: 40 questions, 40 marks. Section B: 9 questions, 80 marks. Total 120 marks. This examination covers Units 1 and 2. Answer all questions.

- *No calculator may be used.*
- *No formula sheet, data sheet, dictionary or notes may be used.*
- *Diagrams in this examination are not drawn to scale.*

Section A — Multiple choice

Every question in this section must be attempted. Select the response that is correct or that best answers the question. One mark is awarded for each correct response, and nothing is taken away where a response is wrong. Where two or more responses have been completed for the same question, no mark is awarded for it. No diagram in this section is drawn to scale.

Question 1

Which one of the following features distinguishes a eukaryotic cell from a prokaryotic cell?

A. the presence of a plasma membrane

B. the presence of ribosomes

C. the presence of DNA as its genetic material

D. the presence of membrane-bound organelles

Question 2

The phospholipids of a plasma membrane are arranged as a bilayer because each phospholipid molecule has

A. two hydrophilic (water-attracting) heads.

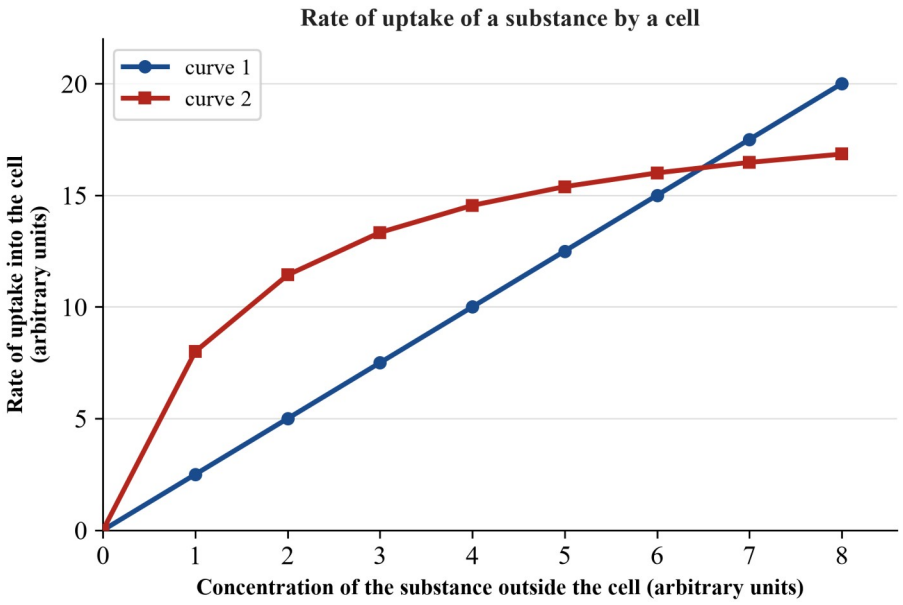
B. a hydrophobic head that faces the watery surroundings.

C. a hydrophilic head and two hydrophobic (water-repelling) tails.

D. a single tail that binds to a carbohydrate chain.

Use the following information to answer Questions 3 and 4.

The graph below shows how the rate at which a cell takes up a substance changes as the concentration of that substance outside the cell increases. Two different substances give the results shown as curve 1 and curve 2.



Question 3

Curve 1 is most likely to represent the uptake of a substance by

A. active transport, because energy from ATP is being used.

B. simple diffusion, because the rate stays in proportion to the outside concentration.

C. facilitated diffusion, because a carrier protein is being used.

D. osmosis, because only water molecules are moving.

Question 4

The rate of uptake shown by curve 2 stops increasing at high concentrations because

A. every transport protein is occupied and working at its maximum rate.

B. the cell has run out of ATP.

C. the concentration gradient has reversed direction.

D. the substance can no longer dissolve in the membrane.

Question 5

Red blood cells are placed in three different solutions. In solution X the cells swell and burst; in solution Y they stay the same size; in solution Z they shrink. Relative to the cells, solutions X, Y and Z are respectively

A. hypertonic, isotonic, hypotonic.

B. isotonic, hypotonic, hypertonic.

C. hypertonic, hypotonic, isotonic.

D. hypotonic, isotonic, hypertonic.

Question 6

A cube-shaped cell of side length 2 units has a surface area to volume ratio of 3 : 1. A cube-shaped cell of side length 4 units has a surface area to volume ratio of

A. 3 : 1

B. 6 : 1

C. 1.5 : 1

D. 12 : 1

Question 7

Which pair of organelles is directly responsible, respectively, for capturing light energy and for releasing energy from glucose?

A. the nucleus and the ribosome

B. the Golgi apparatus and the mitochondrion

C. the chloroplast and the ribosome

D. the chloroplast and the mitochondrion

Question 8

The two daughter cells produced by mitosis are

A. haploid and genetically identical to each other.

B. diploid and genetically identical to the parent cell.

C. haploid and genetically different from the parent cell.

D. diploid and genetically different from each other.

Question 9

A tumour is described as malignant, rather than benign, when its cells

A. divide only until they fill the space available.

B. stay together in a single mass.

C. break away and spread to form new tumours in other parts of the body.

D. undergo apoptosis as soon as their DNA is damaged.

Question 10

Which organ removes the nitrogen-containing waste urea from the blood and excretes it in the urine?

A. the lungs

B. the liver

C. the kidney

D. the large intestine

Question 11

The lining of the small intestine is folded into thousands of tiny finger-like villi. These villi increase the rate at which digested food is absorbed mainly because they

A. increase the surface area across which food is absorbed.

B. make the wall of the intestine thicker.

C. release additional digestive enzymes.

D. slow the movement of food through the intestine.

Question 12

The pancreas releases the hormone insulin, and it also releases digestive enzymes into the small intestine. The pancreas is therefore

A. an endocrine gland only.

B. an exocrine gland only.

C. both an endocrine gland and an exocrine gland.

D. neither an endocrine nor an exocrine gland.

Question 13

Glucose is filtered into a nephron of the kidney, yet healthy urine contains no glucose. This is because the glucose is

A. never filtered out of the blood.

B. broken down inside the kidney.

C. completely reabsorbed from the nephron back into the blood.

D. converted into urea before it leaves the body.

Question 14

The loss of water vapour from the leaves of a plant, which helps to draw water up through the xylem, is called

A. translocation.

B. transpiration.

C. reabsorption.

D. active transport.

Question 15

In the negative feedback control of a body variable, the response produced by the effector

A. increases the original change, moving the variable further from its set point.

B. opposes the original change, returning the variable towards its set point.

C. has no effect on the value of the variable.

D. permanently lowers the set point to a new value.

Question 16

Which one of the following correctly pairs a digestive enzyme with the food group it breaks down?

A. lipase — fats (lipids)

B. amylase — protein

C. protease — starch

D. amylase — fats (lipids)

Question 17

After a meal the hormone insulin is released. Insulin lowers the concentration of glucose in the blood by

A. causing the liver to break glycogen down into glucose.

B. reducing the absorption of glucose from the gut.

C. increasing the breakdown of body fat.

D. stimulating body cells to take up glucose and the liver to store it as glycogen.

Question 18

A student measures the height of one seedling in each of five identical pots and calculates the mean height. She uses five pots rather than one mainly to

A. reduce the effect of random variation on her mean, giving a more reliable result.

B. increase the number of levels of the independent variable.

C. remove any systematic error in her ruler.

D. change the dependent variable being measured.

Question 19

The same object is measured five times. A set of readings that is precise but not accurate is one in which the five readings are

A. close to one another and close to the true value.

B. widely spread but with a mean equal to the true value.

C. widely spread and far from the true value.

D. close to one another but all clearly different from the true value.

Question 20

Which one of the following is a systematic error?

A. slight differences in reaction time each time a stopwatch is started by hand

B. a measuring cylinder that reads 1 mL too high for every measurement

C. occasionally misreading the scale on a balance

D. small, unpredictable fluctuations in the reading of a temperature probe

Question 21

In a field of 250 wheat plants, 30 plants showed signs of a rust disease. The percentage of the plants showing the disease was

A. 12%.

B. 8.3%.

C. 30%.

D. 220%.

Question 22

A student found that adding a small amount of a mineral to pond water increased the growth of algae in the laboratory. She writes: “Adding this mineral to farm dams could help to grow algae to feed livestock.” This statement is best described as

A. the hypothesis of the investigation.

B. a controlled variable.

C. the conclusion of the investigation.

D. an implication of the finding.

Question 23

An allele is best described as

A. the place on a chromosome at which a particular gene sits.

B. one of the different forms of a particular gene.

C. the complete set of an organism's genetic material.

D. a chromosome that carries the genes for sex determination.

Question 24

Compared with mitosis, meiosis produces

A. two diploid cells that are genetically identical to the parent cell.

B. two haploid cells that are genetically identical to each other.

C. four diploid cells that are genetically identical to the parent cell.

D. four haploid cells that are genetically varied.

Question 25

An organism has a diploid number of 2n = 6. Ignoring crossing over, the number of genetically different gametes it can produce by independent assortment alone is

A. 3

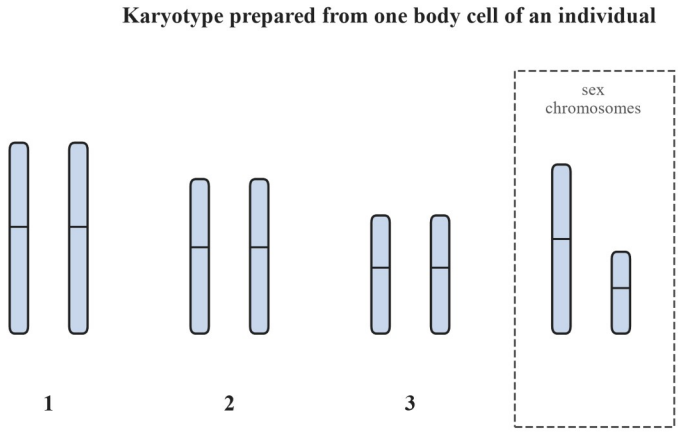
B. 6

C. 8

D. 64

Use the following information to answer Questions 26 and 27.

The diagram below is a karyotype prepared from a single body cell of an individual of a certain animal species.



Question 26

A normal gamete of this individual would contain

A. 4 chromosomes.

B. 8 chromosomes.

C. 16 chromosomes.

D. 2 chromosomes.

Question 27

The individual whose karyotype is shown is

A. male, because its two sex chromosomes are different (one X and one Y).

B. female, because it has two matching X chromosomes.

C. male, because it has an extra chromosome at one position.

D. female, because it has an even number of chromosomes.

Question 28

In pea plants, purple flower colour (P) is dominant to white flower colour (p). A pea plant with purple flowers

A. must be homozygous, PP.

B. must be heterozygous, Pp.

C. must be homozygous recessive, pp.

D. could be either PP or Pp.

Question 29

When a red-flowered plant is crossed with a white-flowered plant, all of the offspring have pink flowers. This pattern of inheritance is

A. complete dominance of red over white.

B. incomplete dominance.

C. codominance, with red and white patches on each flower.

D. sex-linkage.

Question 30

In tomato plants, tall (T) is dominant to short (t). A cross between a heterozygous tall plant and a short plant is expected to produce offspring in the ratio

A. 1 tall : 1 short

B. 3 tall : 1 short

C. all tall

D. all short

Question 31

In a species of mouse, an X-linked gene affects coat colour. The allele for a black coat (B) is dominant to the allele for a sandy coat (b). A black female that carries the sandy allele mates with a black male. Among their young,

A. all of the sons will have a sandy coat, and all of the daughters a black coat.

B. half of the daughters will have a sandy coat, and all of the sons a black coat.

C. all of the sons and all of the daughters will have a black coat.

D. half of the sons will have a sandy coat, and all of the daughters a black coat.

Question 32

One advantage of asexual reproduction over sexual reproduction is that asexual reproduction

A. allows a single organism to reproduce rapidly without needing a mate.

B. produces genetically varied offspring.

C. combines the alleles of two different parents.

D. always produces offspring that are better suited to a changing environment.

Question 33

A gardener grows many new strawberry plants from the runners (horizontal stems) of a single parent plant. The new plants are

A. genetically varied, because they grew from seeds.

B. genetically identical to the parent, because they were produced asexually.

C. genetically identical to one another but different from the parent.

D. produced by meiosis.

Question 34

The thick layer of blubber (fat) beneath the skin of a seal, which reduces heat loss in cold water, is an example of

A. a behavioural adaptation.

B. a physiological adaptation.

C. a structural adaptation.

D. an acquired characteristic.

Question 35

A farmer plants a large field with a single crop variety, so that all of the plants are genetically identical. Compared with a field planted with a genetically varied crop, this field is more at risk because

A. the identical plants are unable to photosynthesise.

B. a single pest or disease able to harm one plant could harm the whole crop.

C. the identical plants will grow more slowly than varied plants.

D. the plants will produce genetically varied seed.

Question 36

Removing a keystone species from a community is most likely to

A. leave the community unchanged, because keystone species are never abundant.

B. increase the total number of species present.

C. make every species in the community extinct immediately.

D. change the distribution, density and population size of many of the other species present.

Question 37

In a predator–prey relationship in which the two populations cycle, a sharp fall in the prey population is most likely to be followed by

A. a rise in the predator population.

B. a fall in the predator population, as food becomes scarce.

C. no change in the predator population.

D. a rise in both populations together.

Question 38

Which one of the following is the strongest form of scientific evidence about whether a treatment works?

A. a comment on social media from someone saying the treatment "worked for me"

B. a controlled study of 400 volunteers that compared a treatment group with a control group given no treatment

C. an advertisement describing the treatment as "clinically proven"

D. a well-known athlete's endorsement of the treatment

Question 39

A scientist argues that a research project must follow the rules set out in the institution's code of conduct, whatever its outcomes turn out to be. This reasoning reflects the

A. duty- and rule-based approach.

B. virtues-based approach.

C. consequences-based approach.

D. approach based on the concept of respect.

Question 40

A student takes ten repeated measurements. Nine of the readings lie close together, but the tenth lies a long way from the rest. Accepted scientific practice is that this tenth reading should be

A. deleted, because a reading far from the others is always a mistake.

B. replaced by the mean of the other nine readings.

C. recorded as an outlier, then further examined and accounted for.

D. ignored when the mean is calculated, but still written up in the logbook.

End of Section A

Section B — Short answer

Every question in this section must be attempted, in the spaces provided. For any question carrying two or more marks, a response earns full credit only if it reaches the depth that its command term and its mark allocation call for. No diagram in this section is drawn to scale.

Question 1 (8 marks)

A researcher examined cells taken from a healthy tissue and from a tumour that had grown in the same kind of tissue. She recorded the percentage of the cells that were in each stage of the cell cycle at the moment the samples were taken. Her results are shown in Table 1.

Table 1 Percentage of cells in each stage of the cell cycle

Stage	Healthy tissue (% of cells)	Tumour (% of cells)
interphase	90	60
mitosis	9	39
undergoing apoptosis	1	1

a. Name the stage of interphase during which a cell copies (replicates) its DNA, and name the stage of mitosis during which the sister chromatids separate and move to opposite poles of the cell. 2 marks

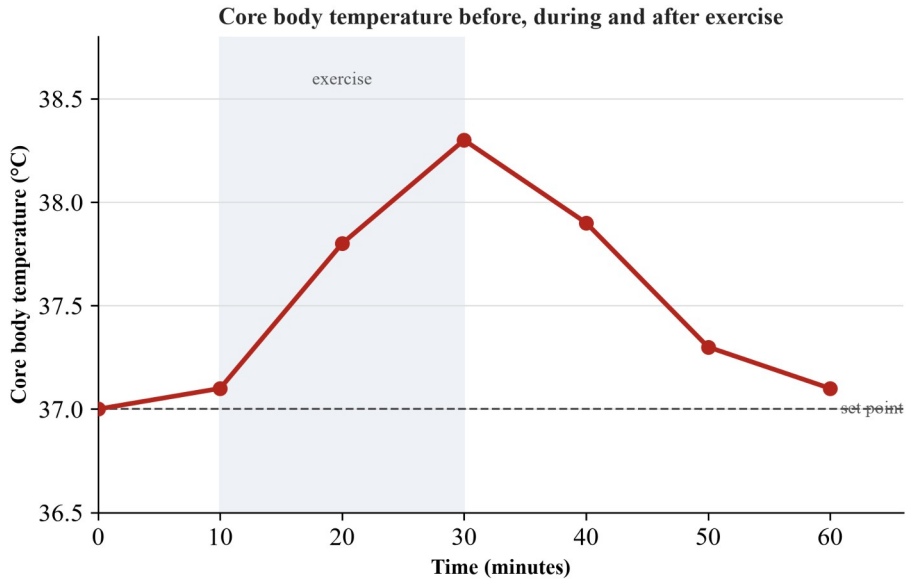
b. Using the data in Table 1, describe one difference between the tumour cells and the healthy cells, quoting figures. 2 marks

c. Cancer can arise when the genes that control the cell cycle are damaged. Explain how such damage can lead to the growth of a tumour. Refer to both cell division and apoptosis. 3 marks

d. State one role that apoptosis plays in a healthy tissue. 1 mark

Question 2 (9 marks)

A person's core body temperature was measured before, during and after a period of vigorous exercise on a warm day. The graph below shows how their core body temperature changed over 60 minutes. The person exercised during the shaded period (from 10 to 30 minutes). The dashed line shows the body's set-point temperature of about 37 °C.



a. Using the graph, describe how the person's core body temperature changed during the exercise and after it stopped. Quote figures from the graph. 2 marks

b. Explain why vigorous exercise causes the core body temperature to rise. 1 mark

c. Describe two responses the body uses to bring the raised temperature back down, and explain how each one helps to cool the body. 4 marks

d. At 60 minutes the core body temperature was still slightly above the set point. State one reason why a homeostatic mechanism does not hold a variable at exactly its set point. 1 mark

e. Name the part of the brain that acts as the control centre for body temperature. 1 mark

Question 3 (8 marks)

To investigate how light affects the rate at which a plant loses water, a student stood a leafy shoot in a tube of water and sealed the top of the tube so that water could be lost only from the shoot. She stood the whole set-up on an electronic balance and measured the mass of water lost by the shoot in 30 minutes at each of four light intensities, keeping everything else the same. Her results are shown in Table 2.

Table 2 Mass of water lost by the shoot in 30 minutes

Light intensity (arbitrary units)	Mass of water lost in 30 minutes (g)
0 (darkness)	0.10
20	0.30
40	0.50
60	0.70

a. Identify the independent variable and the dependent variable in this investigation. 2 marks

b. Using the data, describe the relationship between the light intensity and the mass of water lost, quoting figures. 2 marks

c. Explain, in terms of stomata and transpiration, why the shoot lost more water at higher light intensities. 2 marks

d. In darkness the shoot still lost a small amount of water (0.10 g). Suggest where this water was lost from. 1 mark

e. State one variable, other than the light intensity, that the student needed to keep the same throughout. 1 mark

Question 4 (7 marks)

A student investigated whether the concentration of an antibiotic affects how well it stops bacteria growing. She spread the same harmless species of bacteria evenly over identical agar plates, then placed a paper disc soaked in an antibiotic solution at the centre of each plate. After two days she measured the diameter of the clear zone (the ring around the disc where no bacteria had grown) on each plate. She tested three plates at each antibiotic concentration. Her results are shown in Table 3.

Table 3 Diameter of the clear zone around the disc (mm)

Antibiotic concentration (mg/mL)	Plate 1	Plate 2	Plate 3
2	9	12	9
4	14	13	18
6	19	22	19

a. Identify the independent variable and the dependent variable in this investigation. 2 marks

b. Calculate the mean diameter of the clear zone at each antibiotic concentration. Show your working. 2 marks

c. Calculate the percentage change in the mean clear-zone diameter from 2 mg/mL to 6 mg/mL. Show your working. 1 mark

d. Express, in its simplest form, the ratio of the mean clear-zone diameter at 2 mg/mL to the mean clear-zone diameter at 6 mg/mL. 1 mark

e. The student concluded: “A higher concentration of the antibiotic stops more bacteria growing.” State one limitation of her investigation. 1 mark

Question 5 (10 marks)

In humans, the MN blood group is controlled by a single gene that shows codominance. A person with two "M" alleles ($L^M L^M$) has blood group M, a person with two "N" alleles ($L^N L^N$) has blood group N, and a person with one of each ($L^M L^N$) has blood group MN, in which both the M form and the N form of the marker are produced together on the red blood cells.

a. State the genotype of a person with blood group MN, and explain, in terms of codominance, why they are group MN rather than group M. 2 marks

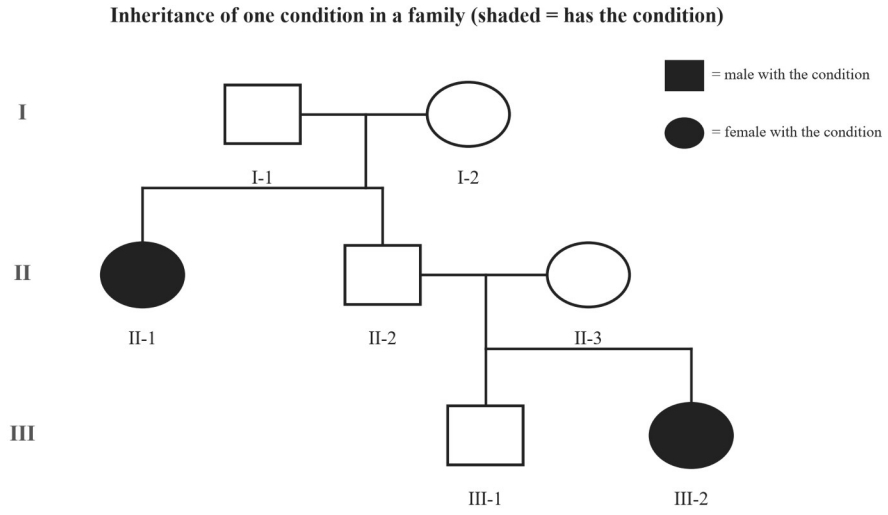
b. A group MN man has children with a group MN woman. Construct a Punnett square for this cross and state the ratio of blood groups expected among the children. 3 marks

c. A group MN man has children with a group N woman. Identify the genotypes that their children could have, and state the ratio of blood groups expected among the children. 2 marks

d. A second gene determines whether a person can taste the bitter chemical PTC: the tasting allele (T) is dominant to the non-tasting allele (t), and this gene assorts independently of the blood-group gene. A group MN man who can taste PTC, of genotype $L^M L^N T t$, has children with a group N woman who cannot taste PTC, of genotype $L^N L^N t t$. Calculate the probability that a child of this cross is both group MN and a taster. 3 marks

Question 6 (9 marks)

The pedigree below shows the inheritance of a single genetic condition in one family. Shaded symbols represent individuals who have the condition. Use the allele symbols A (the normal allele) and a (the allele causing the condition) where genotypes are required.



a. State whether the allele causing the condition is dominant or recessive, and give one reason from the pedigree. 2 marks

b. Explain how the pedigree shows that the condition is autosomal, rather than X-linked recessive. Refer to one specific individual. 2 marks

c. State the genotype of II-1, and the genotypes of I-1 and I-2. 2 marks

d. II-2 and II-3 are expecting another child. Both of them are carriers (Aa). Construct a Punnett square for this cross and use it to calculate the probability that the child has the condition. 2 marks

e. III-1 does not have the condition. Calculate the probability that III-1 is a carrier of the condition. 1 mark

Question 7 (8 marks)

In parts of arid Australia, native digging mammals such as bettongs dig many small pits in the soil as they forage for food. In a study, researchers fenced off some plots to exclude the digging mammals and left other, nearby plots open

to them. After three years they recorded, in each type of plot, the mean number of plant species and the mean depth of leaf litter and seed trapped in the soil. Their results are shown in Table 4.

Table 4 Effect of excluding digging mammals

Measurement	Plots with digging mammals	Plots with the mammals fenced out
mean number of plant species per plot	18	11
mean depth of leaf litter and seed trapped in the soil (mm)	24	4

a. Two inherited features of this digging mammal are its strong digging claws and its ability to produce very concentrated (almost dry) droppings that lose little water. Classify each of these two features as a structural, physiological or behavioural adaptation. 2 marks

b. Using the data, describe the effect that the digging mammals have on the number of plant species, and suggest how their digging brings this about. 3 marks

c. Surveys showed that these digging mammals were uncommon, making up only a small part of the total animal biomass in the open plots. Using the data in Table 4, explain whether the digging mammal could be described as a keystone species. 2 marks

d. Aboriginal and Torres Strait Islander peoples hold detailed knowledge of native digging mammals and of their role in Country. State one way this knowledge can contribute to understanding and managing these species. 1 mark

Question 8 (7 marks)

A company offers a genetic test that tells prospective parents whether they each carry a recessive allele for a serious inherited condition. If both parents are carriers, each of their children has a one-in-four chance of having the condition. Members of the public disagree about whether such testing should be widely encouraged.

a. Classify each of the following statements as an empirical (scientific) claim or a value (ethical) claim. Statement 1: "The test correctly identifies carriers in 99 out of 100 people tested." Statement 2: "Couples ought to be told whether they are carriers before they have children." 2 marks

b. A health official argues: "This testing should be offered only if the overall benefit to families outweighs the anxiety and the cost it causes." Name the approach to bioethics that this reasoning reflects, and justify your answer. 2 marks

c. Name one ethical concept relevant to this issue, and explain how it applies. 2 marks

d. A couple read the company's claim about the accuracy of its test in a brochure written by the company. State whether this information is primary data or secondary data for the couple. 1 mark

Question 9 (14 marks)

A native frog has become threatened after a fungal skin disease spread through its habitat. A wildlife park runs a program that breeds the frogs in captivity and releases young frogs back into the wild. A small number of the frogs carry an allele that gives resistance to the fungal disease.

a. In the breeding program the frogs reproduce sexually. Explain how meiosis and fertilisation together produce genetically varied offspring, and state why this variation is valuable for the program. 3 marks

b. Resistance to the fungal disease is due to a dominant allele R (the non-resistant allele is r). A resistant frog of genotype Rr is crossed with a non-resistant frog. Construct a Punnett square and state the proportion of the offspring expected to be resistant. 3 marks

c. The frog has thin, moist skin through which it exchanges gases and loses water, and it shelters under damp leaf litter during the day. Classify the thin, moist skin and the sheltering behaviour as adaptations, and explain how sheltering under damp litter by day helps the frog to survive. 3 marks

d. Before releasing frogs, the team reviews two sources of information about where the disease is worst: a study published in a peer-reviewed scientific journal, and a post on a personal blog. State which source provides the stronger evidence, and give one reason. 2 marks

e. The program raises a bioethical issue. Name one ethical concept that supports running the program, and state one consideration that could count against it. 2 marks

f. The released frogs come from only a few captive pairs. State one reason the released population may have lower genetic diversity than the original wild population. 1 mark

End of Section B

End of examination questions

Exam 2 — Answers and solutions

Section A — answers

Q	Ans	Q	Ans	Q	Ans	Q	Ans
1	D	11	A	21	A	31	D
2	C	12	C	22	D	32	A
3	B	13	C	23	B	33	B
4	A	14	B	24	D	34	C
5	D	15	B	25	C	35	B
6	C	16	A	26	A	36	D
7	D	17	D	27	A	37	B
8	B	18	A	28	D	38	B
9	C	19	D	29	B	39	A
10	C	20	B	30	A	40	C

Q1. D — every cell has a plasma membrane, ribosomes and DNA; only a eukaryotic cell also has membrane-bound organelles such as a nucleus and mitochondria, so that is the distinguishing feature.

Q2. C — each phospholipid has one hydrophilic head and two hydrophobic tails, so in water the tails turn inward, away from the water, and two layers form a bilayer.

Q3. B — curve 1 is a straight line through the origin: the rate keeps rising in proportion to the outside concentration, with no ceiling. That is the signature of simple diffusion straight through the phospholipid bilayer, which needs no protein and no ATP. Both facilitated diffusion and active transport depend on a limited number of membrane proteins, so neither could give an unlimited straight line, and osmosis refers only to the movement of water.

Q4. A — the plateau is reached when all the transport proteins are occupied and working at their maximum rate (they are saturated), so supplying more of the substance cannot speed uptake. Facilitated diffusion uses no ATP, so B is wrong.

Q5. D — cells swell in a hypotonic solution (water enters), stay the same size in an isotonic solution (no net movement) and shrink in a hypertonic solution (water leaves).

Q6. C — a cube of side 4 has a surface area of $6 \times 4^2 = 96$ and a volume of $4^3 = 64$, so the ratio is 96 : 64 = 1.5 : 1; the ratio falls as the cell gets larger.

Q7. D — the chloroplast captures light energy in photosynthesis, and the mitochondrion releases energy from glucose in aerobic cellular respiration.

Q8. B — mitosis produces two diploid cells that are genetically identical to the parent cell (and to each other).

Q9. C — a malignant tumour is one whose cells break away and spread (metastasise) to form new tumours elsewhere in the body; a benign tumour stays as a single mass.

Q10. C — the kidney removes urea from the blood and excretes it in the urine; the lungs remove carbon dioxide, and the liver makes urea but does not excrete it from the body.

Q11. A — the villi greatly increase the surface area of the intestine lining, so more digested food can be absorbed in a given time; they do not thicken the wall or add enzymes.

Q12. C — the pancreas is both: it releases insulin straight into the blood (endocrine) and releases digestive enzymes through a duct into the small intestine (exocrine).

Q13. C — all of the filtered glucose is reabsorbed from the nephron back into the blood, so none is left to appear in the urine of a healthy person.

Q14. B — the loss of water vapour from the leaves is transpiration, and it helps to draw water up the xylem.

Q15. B — in negative feedback the response of the effector opposes the original change, returning the variable towards its set point.

Q16. A — lipase digests fats (lipids) into fatty acids and glycerol; amylase digests starch and protease digests protein, so the other pairings are wrong.

Q17. D — insulin lowers blood glucose by making body cells take up glucose and the liver store it as glycogen; A describes the action of glucagon.

Q18. A — repeating over five pots and averaging reduces the effect of random variation, giving a more reliable mean; averaging cannot remove a systematic error, and it changes neither variable.

Q19. D — readings that agree closely with one another are precise, but if they are all clearly off the true value they are not accurate; that one-sided offset is the mark of a systematic error.

Q20. B — a cylinder that reads 1 mL too high every single time shifts every reading in the same direction by a consistent amount, which is a systematic error. A and D are random errors: unpredictable variations that scatter the readings either side of the true value. C is different again — occasionally misreading a scale is a mistake, that is a **personal** error, not a measurement error at all; it should be eliminated by carrying out the measurement correctly next time and does not form part of an analysis of data quality.

Q21. A — percentage = (part ÷ whole) × 100 = (30 ÷ 250) × 100 = 12%.

Q22. D — a statement about how the finding might be used in the wider world (farm dams), beyond the laboratory conditions tested, is an implication; the conclusion is what the data themselves show.

Q23. B — an allele is one of the different forms a particular gene can take; the place on the chromosome where a gene sits is its locus, and the whole set of genetic material is the genome.

Q24. D — meiosis produces four haploid cells that are genetically varied, whereas mitosis produces two identical diploid cells.

Q25. C — n = 3 homologous pairs, and independent assortment alone gives $2^n = 2^3 = 8$ different gametes.

Q26. A — the karyotype shows 8 chromosomes (the diploid number), so a gamete, being haploid, carries half of that — 4 chromosomes.

Q27. A — the sex-chromosome pair is made of two **different** chromosomes, one long and one short, rather than a matched pair like the autosomes; two different sex chromosomes are an X and a Y, so the individual is male.

Q28. D — a purple-flowered plant carries at least one P allele, so it could be either PP or Pp; appearance alone cannot tell the two apart.

Q29. B — a red × white cross giving all-pink offspring (an intermediate, blended colour) is incomplete dominance; codominance would show red and white together, not a blend.

Q30. A — Tt × tt gives half Tt (tall) and half tt (short), a 1 tall : 1 short ratio.

Q31. D — the carrier mother is $X^B X^b$ and the black father is $X^B Y$. Every daughter receives her father's X^B, so she is either $X^B X^B$ or $X^B X^b$ and is black in both cases (black is dominant). Every son receives his single X from his mother, and that X is X^B or X^b with equal chance, so half the sons are $X^B Y$ (black) and half are $X^b Y$ (sandy). So half of the sons have a sandy coat while all of the daughters are black.

Q32. A — asexual reproduction needs only one parent, so a single organism can reproduce rapidly without finding a mate; producing varied offspring and combining two parents' alleles are features of sexual reproduction.

Q33. B — plants grown from runners are produced asexually, by mitosis, so they are genetically identical to the parent.

Q34. C — blubber is a physical feature of the body, so it is a structural adaptation.

Q35. B — because the plants are genetically identical they share the same susceptibilities, so a single pest or disease that can harm one could harm them all; a varied crop would be likely to include some resistant plants.

Q36. D — a keystone species helps to structure and maintain the community, so removing it shifts the distribution, density and population size of many of the species that depend on it. It does not leave the community untouched (A), and although some species may be lost, whole-community extinction (C) does not follow; the usual result is a fall, not a rise, in the number of species (B).

Q37. B — with fewer prey there is less food, so fewer predators can be supported and the predator population falls after the prey population has fallen.

Q38. B — a large controlled study that compares a treatment group with an untreated control group is far stronger evidence than an anecdote, an advertisement or a personal endorsement, because the comparison group is what allows the effect of the treatment itself to be judged.

Q39. A — following a set rule or duty "whatever its outcomes turn out to be" judges the action by the rule rather than by its results, which is the duty- and rule-based approach. Judging by outcomes would be the consequences-based approach, and judging the researcher's character would be the virtues-based approach. D names an ethical *concept*, not an approach.

Q40. C — a reading lying a long way from the others is an outlier, and an outlier must be recorded, then further examined and accounted for, rather than being automatically dismissed: it may be a genuine result that matters. Deleting it (A) or replacing it with the mean (B) discards real data, and a single outlier does not oblige the student to repeat the whole investigation (D).

Section B — solutions

Q1. (a) DNA is copied during the **S phase** of interphase, and the sister chromatids separate and move to opposite poles during **anaphase** of mitosis. *(1 mark: S phase; 1 mark: anaphase.)*

(b) Any one clear difference, with figures. The tumour has a **much greater percentage of its cells in mitosis** — **39%**, against only **9%** in the healthy tissue — so far more of the tumour cells are actively dividing at any moment. (Equally acceptable: the tumour has a smaller percentage of cells in interphase, 60% against 90%.) *(1 mark: states the difference — more tumour cells in mitosis / dividing; 1 mark: quotes the matching figures.)*

(c) Damage (a mutation) to the genes that control the cell cycle means the cycle is **no longer properly regulated** — the checkpoints that normally stop a faulty or over-dividing cell fail, so the cell **divides again and again in an uncontrolled way**. At the same time, cells that are damaged would normally be removed by **apoptosis**; if the genes controlling apoptosis are also damaged, these faulty cells are **not destroyed** and instead survive and keep dividing. The result is that a **growing mass of cells — a tumour — accumulates**. *(1 mark: damage to cell-cycle genes removes the normal control, so the cell divides uncontrollably; 1 mark: apoptosis fails, so damaged cells are not removed and survive; 1 mark: the cells therefore accumulate as a tumour.)*

(d) Any one: apoptosis **removes damaged, worn-out or excess cells in a controlled way** — for example, it destroys a cell whose DNA is too badly damaged to repair (before it can divide), or it **shapes developing structures** during development. *(1 mark.)*

Q2. (a) During the exercise (from 10 to 30 minutes) the core body temperature **rose**, from about **37.1 °C to a peak of 38.3 °C at 30 minutes**. After the exercise stopped it **fell** back towards the set point, reaching about **37.1 °C by 60 minutes**. *(1 mark: the rise during exercise, with figures; 1 mark: the fall back towards the set point after exercise, with figures.)*

(b) During vigorous exercise the **muscles contract and respire rapidly**, which **releases a large amount of heat**; the heat is produced faster than the body can lose it, so the core body temperature rises. *(1 mark.)*

(c) Any **two** cooling responses, each with an explanation of how it cools the body. **Sweating:** more sweat is released onto the skin, and as the **sweat evaporates it takes heat from the body**, cooling it. **Vasodilation of the skin arterioles:** the arterioles near the skin **widen, so more warm blood flows close to the skin surface**, and **more heat is lost from the blood to the surroundings**, cooling the body. *(1 mark: a valid cooling response named; 1 mark: how it cools the body — for each of two responses.)*

(d) Any one: the mechanism can only act **after the variable has already moved away from the set point** — the receptors must first detect a deviation, and the effectors' response then takes time to take effect, so the variable **fluctuates within a narrow range around the set point** rather than sitting exactly on it. *(1 mark.)*

(e) The **hypothalamus**. *(1 mark.)*

Q3. (a) The **independent variable** is the **light intensity** the shoot is exposed to. The **dependent variable** is the **mass of water lost by the shoot in 30 minutes**. *(1 mark: IV; 1 mark: DV.)*

(b) As the **light intensity increases**, the **mass of water lost increases** — it rises from **0.10 g in darkness to 0.70 g at intensity 60** (a positive relationship; each rise of 20 units adds about 0.20 g). *(1 mark: states the positive relationship; 1 mark: quotes the matching figures.)*

(c) Brighter light makes the **guard cells open the stomata** (so that carbon dioxide can enter the leaf for photosynthesis). With **more stomata open**, more **water vapour diffuses out of the leaf**, down the water-vapour gradient, so **transpiration increases** and the shoot loses more water. *(1 mark: brighter light opens more stomata; 1 mark: so more water vapour is lost by transpiration.)*

(d) Through the **waxy cuticle** of the leaves (and stem) — a small amount of water passes through the cuticle even when the stomata are closed in the dark. *(1 mark.)*

(e) Any one, for example: the **temperature**, **humidity** or **air movement** around the shoot; the **same shoot** (its size / leaf area); or the **length of time** (30 minutes). *(1 mark.)*

Q4. (a) The **independent variable** is the **concentration of the antibiotic**. The **dependent variable** is the **diameter of the clear zone** around the disc (the ring where no bacteria grew), in mm. *(1 mark: IV; 1 mark: DV.)*

(b) **2 mg/mL:** (9 + 12 + 9) ÷ 3 = 30 ÷ 3 = **10 mm**; **4 mg/mL:** (14 + 13 + 18) ÷ 3 = 45 ÷ 3 = **15 mm**; **6 mg/mL:** (19 + 22 + 19) ÷ 3 = 60 ÷ 3 = **20 mm**. *(1 mark: the 2 mg/mL and 4 mg/mL means; 1 mark: the 6 mg/mL mean — all with working.)*

(c) Percentage change = (final − initial) ÷ initial × 100 = (20 − 10) ÷ 10 × 100 = 10 ÷ 10 × 100 = **+100%** (a 100% increase). *(1 mark.)*

(d) The means are 10 mm and 20 mm, so the ratio is 10 : 20; dividing both by 10 gives **1 : 2**. *(1 mark.)*

(e) Any one valid limitation, for example: **only three plates** were tested at each concentration (a small sample); **only three concentrations** were tested; only **one antibiotic** and **one species of bacteria** were used; the zone was measured only **to the nearest millimetre**; or the plates were left for only **two days**. *(1 mark.)*

Q5. (a) A group MN person has the genotype $L^M L^N$. They are group MN rather than group M because the two alleles are **codominant** — **both are fully expressed together**, so both the M form and the N form appear on the red blood cells (giving group MN), instead of one allele masking the other. *(1 mark: genotype $L^M L^N$; 1 mark: both alleles are expressed together because they are codominant.)*

(b) The cross is $L^M L^N \times L^M L^N$:

×	L^M	L^N
L^M	$L^M L^M$	$L^M L^N$
L^N	$L^M L^N$	$L^N L^N$

The offspring are $L^M L^M$, $L^M L^N$, $L^M L^N$, $L^N L^N$ — a genotype ratio of 1 : 2 : 1 — so the blood-group ratio is **1 group M : 2 group MN : 1 group N**. *(1 mark: correct Punnett square; 1 mark: the four offspring identified; 1 mark: 1 M : 2 MN : 1 N.)*

(c) The cross is $L^M L^N \times L^N L^N$, so the children can only be $L^M L^N$ **(group MN) or** $L^N L^N$ **(group N)**, and these arise in equal numbers — a ratio of **1 group MN : 1 group N**. *(1 mark: the two possible genotypes, $L^M L^N$ and $L^N L^N$; 1 mark: 1 MN : 1 N.)*

(d) The two genes assort independently, so each can be treated separately. **Blood group:** $L^M L^N \times L^N L^N$ gives **1/2 group MN** ($L^M L^N$). **PTC tasting:** Tt × tt gives **1/2 tasters** (Tt). The probability of a child being **both**

group MN **and** a taster is 1/2 × 1/2 = **1/4 (one in four)**. *(1 mark: 1/2 group MN; 1 mark: 1/2 taster; 1 mark: 1/2 × 1/2 = 1/4.)*

Q6. (a) The allele is **recessive**. Two **unaffected** parents (I-1 and I-2) have an **affected** child (II-1); this can happen only if the allele is recessive and both parents carry it hidden in the heterozygous condition. *(1 mark: recessive; 1 mark: two unaffected parents have an affected child.)*

(b) II-1 is an **affected female**. If the condition were **X-linked recessive**, an affected female would be X^aX^a and would have had to receive an X^a from her father, so her father would also be affected (X^aY). But her father **I-1 is unaffected**, so the condition cannot be X-linked recessive — it must be **autosomal**. *(1 mark: refers to II-1, an affected female with an unaffected father I-1; 1 mark: an X-linked recessive affected female would need an affected father, so the gene is autosomal.)*

(c) II-1 has the condition, so she is **aa**. Because she received one **a** from each parent, and both parents are unaffected, **I-1 and I-2 must each be carriers, Aa**. *(1 mark: II-1 = aa; 1 mark: I-1 = Aa and I-2 = Aa.)*

(d) The cross is **Aa** × **Aa**:

×	A	a
A	AA	Aa
a	Aa	aa

The offspring are AA, Aa, Aa, aa (1 AA : 2 Aa : 1 aa). Only the **aa** child has the condition, so the probability that the child has the condition is **1/4 (one in four)**. *(1 mark: correct Punnett square; 1 mark: probability 1/4.)*

(e) III-1 does not have the condition, so he is **not aa**. Among the unaffected offspring of Aa × Aa, the genotypes AA and Aa occur in the ratio **1 : 2**, so the probability that an unaffected child is a **carrier (Aa) is 2/3 (two in three)**. *(1 mark: 2/3.)*

Q7. (a) The **strong digging claws** are a **structural** adaptation (a physical feature of the body). The ability to produce **very concentrated, almost dry droppings** is a **physiological** adaptation (an internal functional process). *(1 mark: claws — structural; 1 mark: concentrated droppings — physiological.)*

(b) The plots **with the digging mammals had more plant species** — a mean of **18 species**, against only **11** where the mammals were fenced out. Their digging creates **pits that trap far more leaf litter and seed** (a mean depth of **24 mm**, against **4 mm** in the fenced plots); these pits make **moist, sheltered, more fertile spots in which seeds lodge and germinate**, so a greater number of plant species can establish and grow. *(1 mark: describes the effect — more plant species where the mammals are present, with figures; 1 mark: the digging traps litter and seed / creates favourable sites, with figures; 1 mark: so more seeds germinate and more plant species establish.)*

(c) **Yes.** Although these mammals were **uncommon and made up only a small part of the animal biomass**, **removing them (fencing them out) caused a large change in the community** — the mean number of plant species fell from 18 to 11, and the trapping of litter and seed collapsed from 24 mm to 4 mm. An effect on the community this large, out of all proportion to the species' own abundance, is exactly what defines a **keystone species** (here acting as an "ecosystem engineer"). *(1 mark: yes — although the mammals are uncommon, their removal caused a large change in the community, out of proportion to their abundance; 1 mark: supported with the figures from Table 4.)*

(d) Any one: Aboriginal and Torres Strait Islander peoples hold **detailed, long-term observational knowledge** — built over many generations — of these mammals' **habits, distribution and role in the ecosystem** (for example, how their digging supports plants and other species), which can **inform how the species are conserved and how Country is managed**. *(1 mark.)*

Q8. (a) **Statement 1** ("the test correctly identifies carriers in 99 out of 100 people tested") is an **empirical (scientific) claim** — a statement of fact that evidence can check. **Statement 2** ("couples ought to be told whether they are carriers") is a **value (ethical) claim** — a statement about what should be done, which evidence alone cannot settle. *(1 mark: Statement 1 empirical; 1 mark: Statement 2 value/ethical.)*

(b) This reflects the **consequences-based approach**. It judges the action by weighing its **outcomes** — the **benefit to families against the anxiety and cost** it causes — and allows the testing only if the benefit is greater, rather than appealing to a rule, a duty or the character of the person. *(1 mark: consequences-based; 1 mark: justified — it weighs the benefits against the harms/costs.)*

(c) Any one relevant concept, named and applied. For example: **respect** — couples should be free to make their own **informed choice** about whether to be tested and what to do with the result; **non-maleficence** — the testing should **avoid causing harm**, such as unnecessary anxiety; **justice** — the test should be available **fairly** to all who want it, not only to those who can afford it; or **beneficence** — the test can **help** families make informed decisions. *(1 mark: a relevant concept named; 1 mark: how it applies here.)*

(d) It is **secondary data** for the couple: they did not generate it themselves, but are reading data that was collected and reported by someone else (the company). *(1 mark.)*

Q9. (a) Each parent produces **genetically varied gametes by meiosis** — the homologous chromosomes are shuffled by **independent assortment**, and segments are exchanged by **crossing over** — so no two gametes are alike. At **fertilisation** a gamete from each parent fuses **at random**, so each offspring receives a **new combination of alleles** and is genetically varied. This variation matters because it means **some offspring may inherit useful characteristics** (such as the disease-resistance allele), so the population is **more likely to include individuals that survive** and the program is more likely to succeed. *(1 mark: meiosis produces varied gametes — independent assortment / crossing over; 1 mark: random fertilisation combines them, so each offspring is genetically varied; 1 mark: the variation means some offspring may have useful features / resistance, helping the population survive.)*

(b) The cross is **Rr × rr**:

×	R	r
r	Rr	rr
r	Rr	rr

The offspring are Rr, Rr, rr, rr — half Rr (resistant, since R is dominant) and half rr (non-resistant). So **1/2 (50%) of the offspring are expected to be resistant**. *(1 mark: correct Punnett square; 1 mark: offspring are 1/2 Rr and 1/2 rr; 1 mark: 1/2 / 50% resistant.)*

(c) The **thin, moist skin** is a **structural** adaptation (a physical feature of the body), and **sheltering under damp leaf litter by day** is a **behavioural** adaptation (an inherited pattern of activity). Sheltering in a **cool, damp place during the day reduces the frog's water loss**: the frog's skin is thin and permeable and loses water easily, but in the **moist air of the damp litter the water-vapour gradient out of the skin is small**, so **less water evaporates/diffuses from the skin** and the frog is less likely to dry out (and it also stays out of the daytime heat). *(1 mark: thin moist skin — structural; 1 mark: sheltering — behavioural; 1 mark: the damp, cool litter reduces the frog's water loss / evaporation from its permeable skin.)*

(d) The **peer-reviewed journal study** provides the stronger evidence. It has been **independently checked by experts in the field before publication**, so it is more likely to be reliable, whereas a personal blog post has had **no such independent check** (it may be opinion, and its author's expertise and possible bias are unknown). *(1 mark: the peer-reviewed study; 1 mark: a valid reason — it has been independently checked by experts, unlike the blog.)*

(e) A concept **supporting** the program: **beneficence** — the program does good by **helping to save a threatened species from extinction**. A consideration **against**: for example, the **cost** of the program (which might instead protect habitat); **animal-welfare** concerns (non-maleficence — captive breeding and handling may harm individual frogs); or the risk that captive-bred frogs have **low genetic diversity**. *(1 mark: a supporting concept named and applied; 1 mark: a valid consideration against.)*

(f) Because the released frogs descend from **only a few captive pairs (founders)**, they carry only a **small sample of the alleles** present in the original wild population, so the released population has **lower genetic diversity**. *(1 mark.)*

Exam 3 — Practice examination

Reading time: 15 minutes. Writing time: 2 hours 30 minutes. Section A: 40 questions, 40 marks. Section B: 9 questions, 80 marks. Total 120 marks. This examination covers Units 1 and 2. Answer all questions.

- *No calculator may be used.*
- *No formula sheet, data sheet, dictionary or notes may be used.*
- *Diagrams in this examination are not drawn to scale.*

Section A — Multiple choice

Every question in this section must be attempted. Select the response that is correct or that best answers the question. One mark is awarded for each correct response, and nothing is taken away where a response is wrong. Where two or more responses have been completed for the same question, no mark is awarded for it. No diagram in this section is drawn to scale.

Question 1

A cell is found to have an extensive network of internal membranes, very many mitochondria and a large Golgi apparatus, but no chloroplasts and no cell wall. This cell is most likely

A. an animal cell that secretes large amounts of protein.

B. a bacterial cell.

C. a cell from the leaf of a plant.

D. a mature red blood cell.

Question 2

A single large spherical cell is compared with a cluster of many small cells that together have the same total volume. The cluster of small cells can exchange oxygen with its surroundings faster than the single large cell because

A. the single large cell has a higher surface-area-to-volume ratio.

B. the many small cells together have a smaller total volume.

C. small cells do not use oxygen.

D. the many small cells together have a larger total surface area for the same total volume, and so a higher surface-area-to-volume ratio.

Question 3

An animal cell, whose contents are equivalent to a 0.9% salt solution, is placed in a 3.0% salt solution. The cell will

A. take in water and swell.

B. lose water and shrink.

C. neither gain nor lose water.

D. take in water and burst.

Question 4

In a certain cell, the lysosomes can no longer function. The process most directly affected is

A. the synthesis of proteins for export.

B. the production of ATP.

C. the breakdown and recycling of worn-out materials within the cell.

D. the packaging of proteins into vesicles for export.

Question 5

A membrane protein moves glucose into a cell. When the cell's supply of ATP is blocked, the protein still moves glucose into the cell, but only while the glucose concentration outside the cell is higher than inside it. This protein is carrying out

A. active transport.

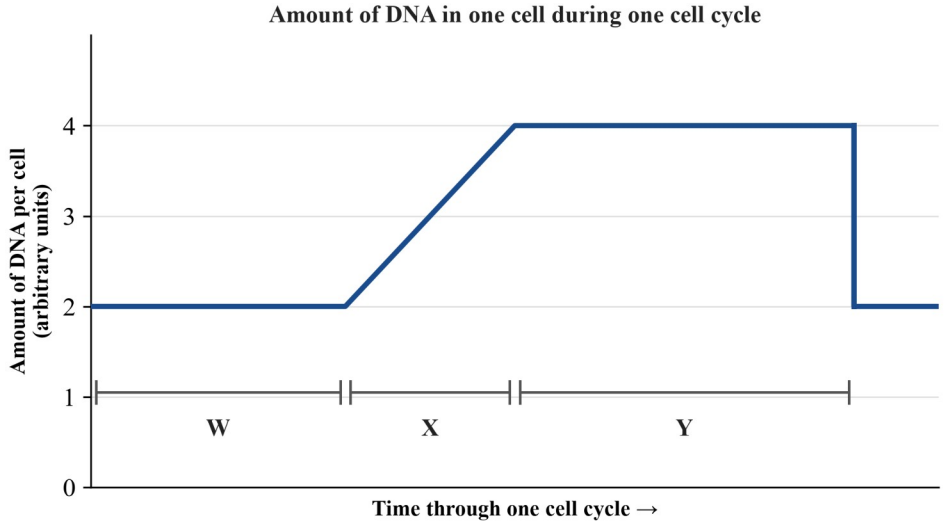
B. osmosis.

C. simple diffusion directly through the bilayer.

D. facilitated diffusion.

Use the following information to answer Questions 6 and 7.

The graph shows the amount of DNA in one cell over one complete cell cycle. Three intervals of the cycle are labelled W, X and Y.



Question 6

The amount of DNA per cell doubles during the interval labelled

A. X.

B. W.

C. Y.

D. none of the three intervals; it doubles only at the very end of the cycle.

Question 7

The sudden halving of the DNA amount at the end of the graph occurs because the cell

A. is copying its DNA.

B. divides into two daughter cells, each receiving half of the DNA.

C. is in the interval labelled W.

D. is undergoing programmed cell death (apoptosis).

Question 8

A fertilised egg divides to form an early embryo. A single cell taken from this very early embryo can, on its own, develop into a complete organism, including the placenta. This cell is best described as

A. multipotent.

B. pluripotent.

C. totipotent.

D. fully differentiated.

Question 9

The wall of the human trachea (windpipe) is built from a lining of cells that traps and moves dust, together with cartilage, muscle, nerves and blood vessels, all working together to carry air to the lungs. The trachea is best described as

A. an organ.

B. a single tissue.

C. a single cell.

D. an organ system.

Question 10

The enzyme that begins the digestion of starch is present in saliva. A person who produces no saliva at all would be least able to begin digesting the

A. protein in a piece of meat.

B. fat in a knob of butter.

C. vitamins in a salad.

D. starch in a slice of bread.

Question 11

After food has passed through the small intestine, the watery material that remains enters the large intestine. The main role of the large intestine is to

A. digest the protein that is left in the food.

B. add bile to the food.

C. absorb most of the remaining water, so that semi-solid faeces are formed.

D. absorb glucose into the blood.

Question 12

Water travels from the roots to the leaves at the top of a tall tree

A. up the phloem, as dissolved sugar.

B. up the xylem, as a continuous column drawn upward by the evaporation of water from the leaves.

C. up the phloem, pushed from the roots.

D. up the xylem, as water vapour.

Question 13

Which one of the following correctly gives the order of events in a homeostatic negative-feedback response?

A. stimulus → receptor → control centre → effector → response

B. response → stimulus → receptor → effector

C. receptor → stimulus → control centre → response

D. stimulus → effector → control centre → response

Question 14

On a cold day, which combination of responses would best help a person conserve body heat?

A. vasoconstriction of the skin arterioles, and shivering

B. vasodilation of the skin arterioles, and sweating

C. vasodilation of the skin arterioles, and shivering

D. vasoconstriction of the skin arterioles, and sweating

Question 15

Which one of the following is an example of positive feedback?

A. sweating when the body becomes too hot

B. the release of insulin when blood glucose rises after a meal

C. the formation of a blood clot, in which activated platelets release chemicals that activate still more platelets

D. shivering when the body becomes too cold

Question 16

Repeating a measurement many times and taking the mean will reduce the effect of

A. a systematic error, such as a wrongly calibrated instrument.

B. a random error, such as small unpredictable variations between readings.

C. a mistake in the design of the experiment.

D. a confounding variable.

Question 17

A study found that a fertiliser increased the yield of wheat in a trial plot. The statement "farmers could use this fertiliser to increase their own wheat harvests" is best described as

A. the aim of the investigation.

B. the hypothesis of the investigation.

C. a conclusion of the investigation.

D. an implication of the finding.

Question 18

A student compares plant growth in two different soils, but waters the pot of one soil with 50 mL a day and the pot of the other with 200 mL a day. Her comparison of the soils is not valid because

A. the amount of water was not kept constant, so the water rather than the soil could have caused any difference in growth.

B. only two pots were used.

C. plants should not be grown in pots.

D. plant growth cannot be measured accurately.

Question 19

A student investigates how the number of hours of light per day affects plant growth, using 2, 4, 6 and 8 hours of light per day. In this investigation, "2, 4, 6 and 8 hours" are

A. the dependent variables.

B. controlled variables.

C. the levels (values) of the independent variable.

D. hypotheses.

Question 20

In a diploid cell, one chromosome carries the allele for a rough coat, and its homologous partner carries, at the same position, the allele for a smooth coat. For coat type, this cell is

A. haploid.

B. homozygous.

C. heterozygous.

D. carrying two different genes at that position.

Question 21

A diploid body cell of a plant contains 24 chromosomes. A gamete of this plant, and a cell produced from the body cell by mitosis, contain respectively

A. 12 chromosomes and 24 chromosomes.

B. 24 chromosomes and 12 chromosomes.

C. 12 chromosomes and 12 chromosomes.

D. 24 chromosomes and 24 chromosomes.

Question 22

Human height varies smoothly across a whole range of values, from short to tall, rather than falling into a few distinct groups. This pattern of variation is

A. discontinuous, and controlled by a single gene.

B. discontinuous, and caused only by the environment.

C. continuous, and controlled by many genes together with the environment.

D. continuous, and controlled by a single gene with no environmental effect.

Question 23

In a plant, a red-flowered variety crossed with a white-flowered variety gives offspring that are all pink. When two of these pink plants are crossed, their offspring are red, pink and white in a 1 : 2 : 1 ratio. Flower colour in this plant shows

A. codominance.

B. complete dominance.

C. an environmental effect on flower colour.

D. incomplete dominance.

Question 24

Two genetically identical plants are grown, one in bright light and one in deep shade, and they reach different heights. Height in this plant is influenced by

A. its genotype only.

B. the environment only.

C. both its genotype and its environment.

D. neither its genotype nor its environment.

Question 25

In guinea pigs, a black coat (allele B) is dominant to a white coat (allele b). Two guinea pigs, each heterozygous, are crossed and have four offspring. The single most likely outcome is

A. four black offspring.

B. three black offspring and one white offspring.

C. two black offspring and two white offspring.

D. four white offspring.

Question 26

A pure-breeding tall pea plant is crossed with a short one, and all the F1 offspring are tall. When two F1 plants are crossed, some of their F2 offspring are short. The reappearance of short plants in the F2 shows that

A. the F1 plants were all short.

B. the allele for shortness was present, but hidden, in the tall F1 plants.

C. a new mutation for shortness occurred in the F2.

D. plant height is not inherited.

Question 27

In pea plants, a round seed (allele R) is dominant to a wrinkled seed (allele r), and a yellow seed (allele Y) is dominant to a green seed (allele y); the two genes assort independently. Two plants of genotype RrYy are crossed. The fraction of the offspring expected to have round, green seeds is

A. 9/16.

B. 3/16.

C. 1/16.

D. 6/16.

Question 28

A karyotype prepared from a person's cell shows 47 chromosomes, with three copies of one chromosome instead of the usual pair. This most likely happened because, during the formation of one of the gametes,

A. a pair of chromosomes (or the sister chromatids) failed to separate, so that gamete received an extra copy of the chromosome.

B. a single base in a gene was changed by a mutation.

C. crossing over exchanged segments between two chromosomes.

D. the DNA was not copied before the cell divided.

Question 29

A gardener wants every plant in a new hedge to have exactly the same leaf colour as one prized parent plant. The most reliable method is to grow the new plants

A. from seed produced by self-pollination of the parent.

B. from seed produced by cross-pollinating two parents.

C. from wind-blown seed collected nearby.

D. from cuttings taken from the parent plant.

Question 30

A student measures the same quantity five times, using the same method and the same equipment each time, and checks that the five readings agree closely with one another. Measuring in this way tests the

A. accuracy of the measurement, because the true value is now known.

B. validity of the experiment.

C. reproducibility of the measurement.

D. repeatability of the measurement.

Question 31

A desert cactus has its leaves reduced to spines and a thick, fleshy, water-storing stem. These two features are best classified as

A. behavioural adaptations.

B. structural adaptations.

C. physiological adaptations.

D. acquired characteristics.

Question 32

A kangaroo rat can survive in the desert without ever drinking, in part because its kidneys produce extremely concentrated urine, so that it loses very little water. This ability is best classified as

A. a structural adaptation.

B. a behavioural adaptation.

C. a physiological adaptation.

D. an acquired characteristic.

Question 33

Which one of the following is an inherited behavioural adaptation, rather than a characteristic acquired during an animal's life?

A. a bird building the nest typical of its species without having been taught to

B. a dog learning to sit on command

C. the calluses that form on a labourer's hands

D. the enlarged heart an athlete develops through years of training

Question 34

A fungus grows among the roots of a gum tree. The fungus receives sugars from the tree, and the tree takes up water and minerals more effectively because of the fungus. This relationship is best described as

A. predation.

B. competition.

C. parasitism.

D. mutualism.

Question 35

A population of 5000 native animals is reduced by a bushfire to only 30 survivors, which then breed and restore the population to about 4000. Compared with the original population, the restored population is most likely to have

A. more genetic diversity than the original population.

B. less genetic diversity, because the 30 survivors carried only some of the original alleles.

C. exactly the same alleles, at the same frequencies, as the original population.

D. no genetic variation at all.

Question 36

Ecologists find that a species of frog is present all along a creek, but is much more crowded near the ponds. "How crowded the frogs are near the ponds" is a measure of the population's

A. distribution.

B. biodiversity.

C. community.

D. density.

Question 37

A student measures the heights of 40 plants herself, and also uses height figures for the same species published by another researcher. For the student, these two sets of numbers are, respectively,

A. both primary data.

B. both secondary data.

C. primary data and secondary data.

D. secondary data and primary data.

Question 38

Which one of the following would most strengthen your confidence in a published claim that a food additive is safe?

A. the same result has been obtained by several independent, peer-reviewed studies

B. the claim appears on the website of the company that sells the additive

C. the claim is written in confident, technical language

D. many people online agree with the claim

Question 39

Before taking part in a study, each volunteer is told exactly what the study will involve and is free to agree to take part or to refuse. Honouring the volunteers' right to make this choice is an example of the ethical concept of

A. beneficence.

B. justice.

C. integrity.

D. respect.

Question 40

A student measures a length and reports the mean as "7.0 cm" rather than "7.03941 cm". Reporting the value to two significant figures is appropriate because

A. it looks tidier on the page.

B. the extra digits would imply a precision that the measurement does not have.

C. two significant figures is always the correct number to use.

D. the true value is known to be exactly 7.0 cm.

End of Section A

Section B — Short answer

Every question in this section must be attempted, in the spaces provided. For any question carrying two or more marks, a response earns full credit only if it reaches the depth that its command term and its mark allocation call for. No diagram in this section is drawn to scale.

Question 1 (8 marks)

Living cells were placed in a solution containing a substance, substance S. Over eight hours, the concentration of substance S was measured both inside the cells and in the surrounding solution. The results are shown in Table 1.

Table 1 Concentration of substance S inside the cells and in the surrounding solution

Time (hours)	Concentration inside the cells (units)	Concentration in the surrounding solution (units)
0	4	22
2	13	20
4	26	17
8	40	14

a. Using Table 1, describe how the concentration of substance S inside the cells changes over the eight hours, and compare it with the concentration in the surrounding solution. Quote figures from the table. 2 marks

b. By eight hours, substance S is far more concentrated inside the cells than in the solution, yet the cells have gone on taking it up. Name the transport process the cells must be using, and explain how the data rule out simple diffusion. 2 marks

c. Explain why this transport process depends on the cells being able to release energy from respiration. 2 marks

d. Predict what would happen to the uptake of substance S if the cells were cooled to near 0 °C, and explain your prediction. 2 marks

Question 2 (9 marks)

A variegated geranium leaf has **green areas** (which contain chlorophyll) and **white areas** (which contain no chlorophyll). A plant with such leaves was first kept in the dark for two days. Part of one leaf was then covered on both sides with black paper, and the plant was placed in bright light for six hours. The leaf was removed, decolourised by warming it in ethanol, rinsed in water, and tested with iodine solution, which turns **blue-black** where starch is present and stays **orange-brown** where there is no starch. The results are shown in Table 2.

Table 2 Result of the iodine test on three parts of the leaf

Part of the leaf	Chlorophyll present?	Received light?	Colour with iodine
green area, uncovered	yes	yes	blue-black
green area, covered with black paper	yes	no	orange-brown
white area, uncovered	no	yes	orange-brown

a. The blue-black colour shows that starch is present. Using the results in Table 2, state the two conditions a part of the leaf needed in order to make starch. 2 marks

b. Explain why the plant was kept in the dark for two days before the experiment began. 2 marks

c. The white area of the leaf received light but still made no starch. Explain why. 2 marks

d. State the gas that a photosynthesising green area of the leaf takes in, the gas it gives out, and the substance that the glucose it makes is stored as. 2 marks

e. Explain why the leaf had to be decolourised in ethanol before the iodine solution was added. 1 mark

Question 3 (9 marks)

During vigorous exercise, a person's leg-muscle cells greatly increase their rate of aerobic cellular respiration. The person becomes hot and sweats heavily.

a. Write the word equation for aerobic cellular respiration, and name the organelle in the muscle cell in which most of it takes place. 2 marks

b. During the exercise the muscle cells need far more oxygen and glucose and produce far more carbon dioxide. Explain how the increased breathing rate and heart rate meet these needs. In your answer, refer to the interdependence of the person's body systems. 3 marks

c. The heat released by the muscle cells raises the body temperature above its set point. Describe **two** responses that cool the body, explaining how each one lowers the body temperature, and state whether this is negative or positive feedback. 3 marks

d. Heavy sweating removes water from the blood, so the blood becomes too concentrated. Name the hormone released in response, and state its effect on the kidney. 1 mark

Question 4 (8 marks)

A student investigated how temperature affects the rate at which a coloured dye spreads (diffuses) through blocks of agar jelly. She cut an identical well in each block, added the same volume of dye to each well, and kept each block at a set temperature. After 30 minutes she measured the distance the dye had spread. At each temperature she used three blocks and calculated the mean distance. Her results are shown in Table 3.

Table 3 Distance the dye spread through the agar in 30 minutes

Temperature (°C)	Block 1 (mm)	Block 2 (mm)	Block 3 (mm)	Mean (mm)
10	4	5	6	5
20	8	9	10	9
30	13	14	15	14
40	18	19	20	?

a. Identify the independent variable and the dependent variable in this investigation. 2 marks

b. Calculate the mean distance the dye spread at 40 °C (the value marked "?"). Show your working. 1 mark

c. Describe the trend shown by the mean results, using directional language and quoting values from the table. 2 marks

d. Explain, in terms of the movement of the dye particles, why the dye spread further through the agar at the higher temperatures. 2 marks

e. State one variable, other than temperature, that had to be kept the same for every block. 1 mark

Question 5 (10 marks)

In a variety of maize (corn), a purple kernel (allele C) is dominant to a yellow kernel (allele c), and a smooth kernel (allele S) is dominant to a shrunken kernel (allele s). The two genes are on different chromosome pairs. A pure-breeding purple, smooth plant was crossed with a pure-breeding yellow, shrunken plant. All of the F1 plants had purple, smooth kernels. Two F1 plants were then crossed with each other.

a. State the genotype of the F1 plants, and list the four types of gamete an F1 plant can produce. 2 marks

b. State the phenotype ratio expected among the F2 offspring, and state the fraction of the F2 expected to have yellow, shrunken kernels. Show how you obtain that fraction. 3 marks

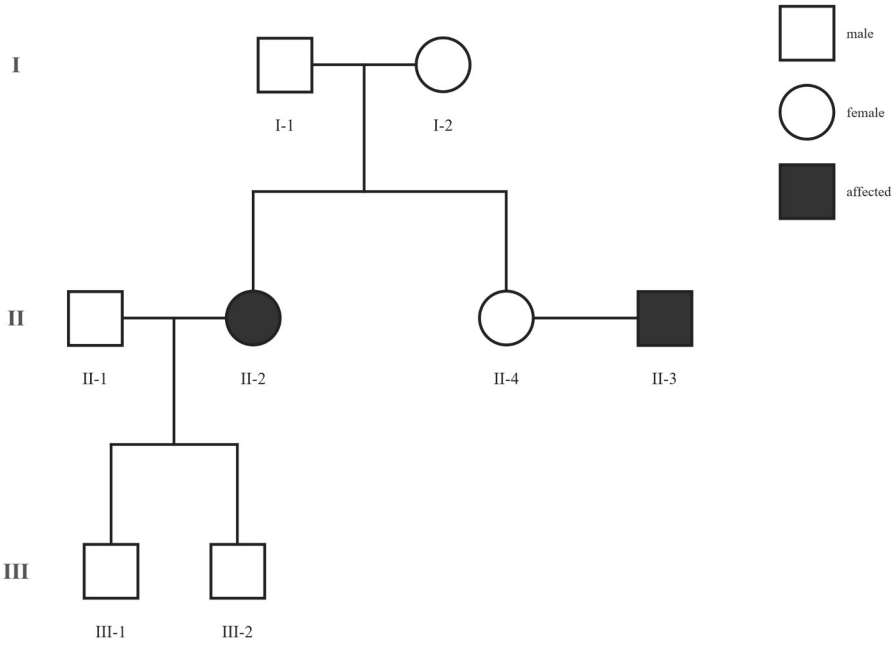
c. A large F2 contains 3200 plants. Calculate the number expected to have purple, smooth kernels. Show your working. 2 marks

d. One purple, smooth F2 plant is test-crossed. State the genotype of the test-cross partner, and state the phenotype ratio of the offspring if the F2 plant has the genotype CcSs. 2 marks

e. Name the event in meiosis that allows the C/c gene and the S/s gene to be passed on independently of each other. 1 mark

Question 6 (9 marks)

The pedigree below shows a single condition present in one family. Affected individuals are shaded. Use the allele **A** for the normal allele and **a** for the allele that causes the condition.



a. State whether the allele causing the condition is dominant or recessive, and give one reason from the pedigree. 2 marks

b. II-2 is affected and III-1 is her unaffected son. Explain how this shows that the gene is autosomal, rather than X-linked recessive. 2 marks

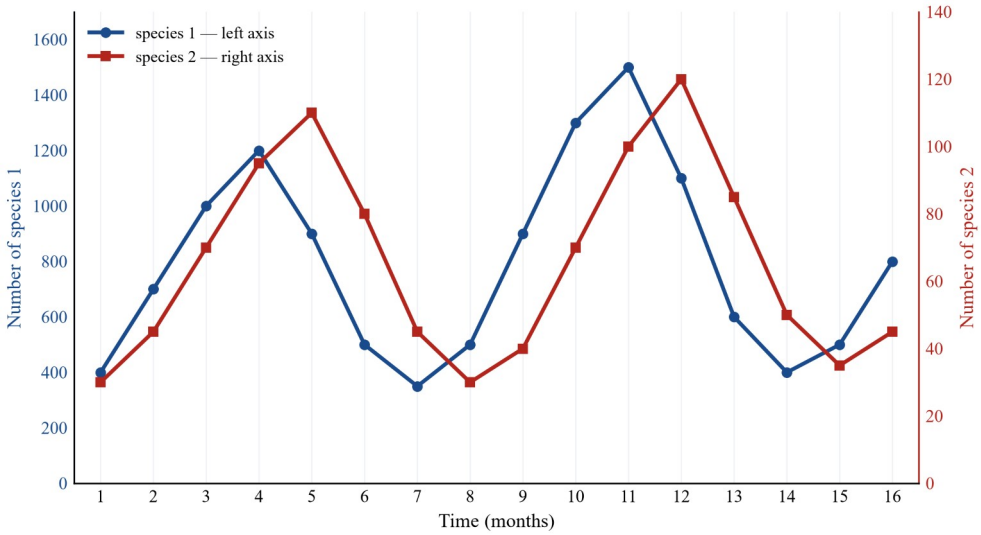
c. State the genotypes of I-1 and I-2, and explain how you know. 2 marks

d. II-4 is unaffected and her partner II-3 is affected. Calculate the probability that II-4 is a carrier, and hence the probability that their first child is affected. Show your reasoning. 2 marks

e. If the first child of II-3 and II-4 is unaffected, state the probability that it is a carrier, and explain your answer. 1 mark

Question 7 (9 marks)

The graph shows the numbers of two interacting animal species, species 1 and species 2, recorded in one area over 16 months. One species is a predator; the other is its prey. (The two species are plotted on different scales.)



Species 1 (left axis) and species 2 (right axis) are plotted on different scales.

a. State which species is the predator and which is the prey, and justify your answer using the graph. 2 marks

b. Explain how the interaction between the two species produces the repeating cycle shown in the graph. 3 marks

c. The predator is later found to be a keystone species in this community. Using the idea of a keystone species, explain what would be likely to happen to the variety of other species in the community if the predator were removed. 2 marks

d. The area contains open grassland and patches of dense shrub. The prey feeds in both, but the predator can hunt only in the open grassland. Explain how the presence of the predator would be expected to affect the distribution and the density of the prey within the area. 2 marks

Question 8 (8 marks)

A small native marsupial lives in cold alpine grassland. Three of its inherited features are:

- **feature (i):** a thick coat of dense fur;
- **feature (ii):** gathering with others into a shared nest on the coldest nights;
- **feature (iii):** entering torpor — a controlled fall in its body temperature and metabolic rate — to save energy when food is scarce in winter.

The marsupial feeds mainly on the seeds of one alpine plant, and shelters in the dense growth of a particular alpine shrub.

a. Classify each of features (i), (ii) and (iii) as a structural, physiological or behavioural adaptation. 3 marks

b. Distinguish between an adaptation and an acquired characteristic, using one example from this marsupial. 2 marks

c. Using the idea of interdependencies, explain why the survival of this marsupial depends on the alpine plant and the alpine shrub. 2 marks

d. The Aboriginal peoples of this alpine region hold detailed, long-standing knowledge of this marsupial and its seasonal behaviour. If scientists draw on this knowledge, state one thing they must do. 1 mark

Question 9 (10 marks)

A company proposes to produce a large herd of dairy cattle by cloning: every animal in the herd would be a genetically identical copy of one cow that was selected for its very high milk yield.

a. Write **one** scientific (empirical) question and **one** bioethical (value) question that this proposal raises. 2 marks

b. Using **two different** named approaches to ethics, give one argument in favour of the proposal and one argument against it. 2 marks

c. Name **two** ethical concepts relevant here — one that supports the proposal and one that counts against it — and briefly state how each applies. 2 marks

d. Using the idea of genetic diversity, explain one biological risk of a herd of genetically identical cloned cattle. 2 marks

e. The company's own website reports the cow's yield as "10.42 thousand litres per year", based on its own trial. An independent university study reports a mean yield of "10 thousand litres per year". State which source provides the stronger evidence and give one reason, and explain why quoting the yield as "10.42" may overstate how precisely it is known. 2 marks

End of Section B

End of examination questions

Exam 3 — Answers and solutions

Section A — answers

Q	Ans	Q	Ans	Q	Ans	Q	Ans
1	A	11	C	21	A	31	B
2	D	12	B	22	C	32	C
3	B	13	A	23	D	33	A
4	C	14	A	24	C	34	D
5	D	15	C	25	B	35	B
6	A	16	B	26	B	36	D
7	B	17	D	27	B	37	C
8	C	18	A	28	A	38	A
9	A	19	C	29	D	39	D
10	D	20	C	30	D	40	B

Q1. A — no chloroplasts and no cell wall rule out a plant cell (C) and a bacterium (B); a mature red blood cell has no mitochondria and no organelles (D). Many mitochondria, extensive internal membranes and a large Golgi apparatus fit an animal cell that makes and exports large amounts of protein.

Q2. D — dividing the same total volume into many small cells greatly increases the total membrane surface, giving a higher surface-area-to-volume ratio, so exchange is faster. A reverses the ratio, B is false (the total volume is the same) and C is false.

Q3. B — the 3.0% solution is more concentrated (hypertonic) than the cell, so water leaves the cell by osmosis and the cell shrinks. An animal cell has no wall, but it does not gain water or burst in a hypertonic solution.

Q4. C — lysosomes contain the enzymes that break down and recycle worn-out organelles and materials inside the cell, so it is this process that fails. Protein synthesis and export, ATP production and vesicle packaging are carried out by other organelles.

Q5. D — the protein still works without ATP, and only while the substance moves down its concentration gradient, which is facilitated diffusion; active transport would require ATP and could move glucose against its gradient. Osmosis is the movement of water, and simple diffusion needs no protein.

Q6. A — the amount of DNA doubles only where the trace rises, which is interval X (this is the S phase, in which the DNA is replicated). It is level in W and in Y.

Q7. B — the amount of DNA per cell halves at the moment the cell divides in two, when each daughter cell receives one full copy of the replicated DNA. Replication doubles the DNA (A), and apoptosis is not shown.

Q8. C — a cell that can, by itself, form a whole organism including the placenta is totipotent; a pluripotent cell forms all body cell types but not the placenta or a whole organism, and a multipotent cell forms only a limited range.

Q9. A — a structure built from several different tissues (epithelium, cartilage, muscle, nervous and vascular tissue) working together for one function is an organ. A group of organs working together would be an organ system.

Q10. D — the enzyme in saliva (amylase) begins the digestion of starch, so it is the starch in the bread whose digestion could not begin without saliva. Protein and fat digestion begin elsewhere, and vitamins are absorbed rather than digested.

Q11. C — by the time material reaches the large intestine, digestion is complete and the nutrients have already been absorbed in the small intestine; the large intestine's main job is to absorb most of the remaining water, so that semi-solid faeces are formed. It does not digest protein, add bile, or absorb glucose.

Q12. B — water travels up the dead, hollow xylem as a continuous liquid column, drawn upward by the evaporation of water (transpiration) from the leaves. Phloem carries dissolved sugar, and water does not travel up as vapour.

Q13. A — a homeostatic response runs stimulus → receptor → control centre → effector → response; the receptor detects the change and the effector carries out the response. The other sequences put the steps out of order.

Q14. A — in the cold the body conserves heat by narrowing the skin arterioles (vasoconstriction), so less heat is lost at the surface, and by shivering, which releases heat. Vasodilation and sweating are cooling responses.

Q15. C — in clotting, activated platelets trigger the activation of still more platelets, so the response reinforces the original change: this is positive feedback. Sweating, insulin release and shivering all oppose a change, so they are negative feedback.

Q16. B — averaging washes out the small unpredictable variations of random error, because they fall on either side of the true value. It cannot correct a systematic error, a design mistake or a confounding variable, which push results one way or bias the whole comparison.

Q17. D — the finding itself (that the fertiliser raised yield in the trial) is the conclusion; a statement about how the finding might be used more widely, beyond the conditions tested, is an implication.

Q18. A — the amount of water differs between the two pots as well as the soil, so water is an uncontrolled variable that changes with the groups being compared; any difference in growth could be due to the water rather than the soil, so the comparison is not valid.

Q19. C — the quantity deliberately changed is the independent variable (hours of light per day), and 2, 4, 6 and 8 hours are the particular values, or levels, chosen for it.

Q20. C — two different alleles of the same gene, at the same position on a homologous pair, make the cell heterozygous for that gene. Homozygous would mean two identical alleles, and the two chromosomes carry the same gene (not different genes) at that locus.

Q21. A — meiosis halves the chromosome number, so a gamete is haploid with 12 chromosomes; mitosis keeps the diploid number, so a mitotic daughter cell has 24.

Q22. C — a characteristic that varies smoothly across a whole range shows continuous variation, which occurs when it is controlled by many genes acting together and is also influenced by the environment. Control by a single gene gives a few distinct groups (discontinuous variation).

Q23. D — all-pink offspring, and a 1 : 2 : 1 (red : pink : white) result in the next generation, is incomplete dominance: the heterozygote is an intermediate blend. Codominance would show both colours together rather than a blend.

Q24. C — genetically identical plants that grow to different heights in different conditions show that height depends on the environment as well as the genotype; the phenotype is the product of both.

Q25. B — Bb × Bb gives each offspring a 3/4 chance of black and a 1/4 chance of white. Among four offspring, three black and one white is the single most likely split (its probability, about 0.42, is greater than that of four black, about 0.32, or two-and-two, about 0.21).

Q26. B — the tall F1 plants each carried a hidden (recessive) allele for shortness alongside the dominant tall allele; when two F1 plants were crossed, some offspring inherited two short alleles and were short. No new mutation is needed, and the trait is clearly inherited.

Q27. B — the genes assort independently, so round = 3/4 and green = 1/4, giving round and green = 3/4 × 1/4 = 3/16.

Q28. A — an extra whole chromosome (giving 47, a trisomy) arises when a homologous pair, or the sister chromatids, fail to separate during meiosis (non-disjunction), so one gamete receives two copies and the resulting individual has three. A single base-change mutation, crossing over, and a failure to copy the DNA do not add an extra whole chromosome.

Q29. D — cuttings reproduce the parent asexually, so every plant is a genetically identical clone with the same leaf colour. Seed (whether from selfing, cross-pollination or wind) is produced sexually and gives varied offspring.

Q30. D — taking repeated measurements of the same quantity with the same method and equipment tests repeatability. Reproducibility (C) requires the measurement to be repeated under changed conditions — a different

person or different equipment; accuracy (A) needs the true value to be known; and validity (B) is about whether the method measures what it is meant to.

Q31. B — spines and a fleshy stem are physical features of the body, so they are structural adaptations. They are not actions (behavioural) or internal functional processes (physiological), and they are inherited, not acquired.

Q32. C — producing very concentrated urine is an internal functional (biochemical) process of the body, so it is a physiological adaptation, not a body part (structural) or an action (behavioural).

Q33. A — building the species-typical nest without being taught is an inherited pattern of behaviour, so it is a behavioural adaptation. Learning to sit, forming calluses and developing an enlarged heart through training are all acquired during the animal's own life.

Q34. D — both partners benefit (the fungus gains sugars and the tree gains water and minerals), so the relationship is mutualism (+ / +). It is not predation, competition or parasitism.

Q35. B — the 30 survivors carry only a sample of the alleles present in the original 5000, and the alleles they lack cannot be restored by breeding, so the restored population has less genetic diversity even after the numbers recover (a bottleneck). The variation is reduced, not abolished (D).

Q36. D — how crowded a population is (the number of individuals per unit area) is its density. Distribution is where the species is found, biodiversity is the variety of species, and a community is all the species living together.

Q37. C — the student collected the plant heights first-hand, so they are her primary data; the published figures were collected by someone else and used by her, so they are secondary data.

Q38. A — a claim confirmed by several independent, peer-reviewed studies has been checked by experts and shown not to depend on one team's method or bias. A seller's own website is a conflict of interest, and confident language or popularity does not make a claim reliable.

Q39. D — allowing informed volunteers to choose freely whether to take part honours their autonomy, which is the concept of respect. Beneficence is maximising benefit, justice is fairness and integrity is honesty.

Q40. B — the measurement is not known to five decimal places, so quoting all those digits would imply a precision the instrument cannot deliver; reporting to two significant figures reflects how precisely the length is actually known.

Section B — solutions

Q1. (a) Inside the cells, the concentration of substance S **rises throughout**, from **4 units at the start to 40 units at eight hours**. Over the same time the concentration in the surrounding solution **falls, from 22 units to 14 units**. So the inside concentration begins **below** the outside (4 against 22) but ends **well above** it (40 against 14). *(1 mark: inside rises from 4 to 40, with figures; 1 mark: it begins below and ends above the outside concentration, which itself falls.)*

(b) The cells must be using **active transport**. By eight hours substance S is being taken up even though it is **more concentrated inside the cells (40 units) than in the solution (14 units)** — that is, it is being moved **from a lower to a higher concentration, against its concentration gradient**. **Simple diffusion can only move a substance down its gradient**, from a higher to a lower concentration, so it cannot account for this continued uptake; only active transport can move a substance against its gradient. *(1 mark: active transport; 1 mark: the substance is moved against its gradient — to a higher concentration inside — which simple diffusion cannot do.)*

(c) Moving a substance **against its concentration gradient requires energy**, which the cell supplies as **ATP**. The cell **releases this ATP by respiration**, and the **carrier (pump) proteins in the membrane use the ATP** to move substance S against its gradient. Without energy released by respiration the pumps could not do this work. *(1 mark: active transport needs energy (ATP) to move a substance against its gradient; 1 mark: the ATP is released by respiration and used by the carrier/pump proteins.)*

(d) The uptake would **slow down or stop**, and substance S would **no longer build up above the outside concentration**. Cooling the cells to near 0 °C **greatly slows respiration**, so **far less ATP is made**; without ATP the carrier proteins **cannot pump substance S against its gradient**, so active transport slows or stops. *(1*

mark: uptake slows/stops — no further accumulation against the gradient; 1 mark: because cold slows respiration, so little ATP is available for the pumps.)

Q2. (a) A part of the leaf needed **both chlorophyll (it had to be green) and light**. Only the **green area that was uncovered** (green + light) turned blue-black; the covered green area (green but no light) and the uncovered white area (light but no chlorophyll) made no starch. *(1 mark: chlorophyll / being green; 1 mark: light.)*

(b) Keeping the plant in the dark for two days **removes the starch already stored in the leaf (destarches it)** — with no light the leaf cannot photosynthesise, so its stored starch is used up or moved away. This means that any starch found at the end **must have been made during the experiment**, so the result is a fair test of the conditions being investigated. *(1 mark: it removes/uses up the starch already in the leaf; 1 mark: so any starch found at the end must have been made during the experiment.)*

(c) The white area contains **no chlorophyll**. **Chlorophyll is the pigment that absorbs the light energy** needed for photosynthesis, so without it the white area **cannot photosynthesise** — it cannot make glucose (and therefore no starch), even though light reached it. *(1 mark: the white area has no chlorophyll; 1 mark: chlorophyll is needed to absorb light for photosynthesis, so without it no glucose/starch can be made.)*

(d) A photosynthesising green area takes in **carbon dioxide** and gives out **oxygen**; the glucose it makes is stored as **starch**. *(1 mark: takes in carbon dioxide and gives out oxygen; 1 mark: the glucose is stored as starch.)*

(e) Warming the leaf in ethanol **removes the green chlorophyll** from it. Without that step the **green colour would mask the colour given by the iodine**, so the **blue-black (starch present)** and **orange-brown (no starch)** results **could not be told apart**. *(1 mark: the ethanol removes the chlorophyll / green colour, so the colour given by the iodine can be seen clearly.)*

Q3. (a) **glucose + oxygen → carbon dioxide + water (+ energy / ATP)**. Most of this aerobic respiration takes place in the **mitochondrion**. *(1 mark: correct word equation — glucose and oxygen in, carbon dioxide and water out; 1 mark: mitochondrion.)*

(b) The exercising muscle cells need more oxygen and glucose delivered and more carbon dioxide taken away. **Breathing faster and more deeply** takes **more oxygen into the blood at the lungs and removes more carbon dioxide** from it. The **heart beating faster** pumps this blood around the body more quickly, so it **delivers oxygen and glucose to the muscle cells and carries carbon dioxide away faster**. The respiratory system, the circulatory system and the muscles therefore **depend on one another** — the muscle cells cannot keep respiring at a high rate unless the other systems supply their needs. *(1 mark: faster breathing takes in more oxygen and removes more carbon dioxide at the lungs; 1 mark: the faster heart rate delivers oxygen and glucose to the muscles and carries carbon dioxide away more quickly; 1 mark: the systems are interdependent — the muscles rely on the respiratory and circulatory systems to supply them.)*

(c) Any **two** cooling responses, each explained. **Vasodilation of the skin arterioles** — the arterioles widen so **more warm blood flows close to the skin surface and more heat is lost** to the surroundings. **Sweating** — sweat **evaporates from the skin, taking heat with it** and cooling the body. This is **negative feedback**, because the responses **oppose the rise in temperature** and bring it back towards the set point. *(1 mark each for two valid cooling responses correctly explained; 1 mark: negative feedback.)*

(d) The hormone is **ADH (antidiuretic hormone)**. It makes the **kidney (its collecting ducts) reabsorb more water back into the blood**, so a smaller volume of more concentrated urine is produced and water is conserved. *(1 mark: ADH named and its effect — the kidney reabsorbs more water / produces less, more concentrated urine.)*

Q4. (a) The **independent variable** is the **temperature** of the agar block; the **dependent variable** is the **distance the dye spreads through the agar in 30 minutes**. *(1 mark: IV = temperature; 1 mark: DV = distance the dye spreads in 30 minutes.)*

(b) Mean at 40 °C = (18 + 19 + 20) ÷ 3 = 57 ÷ 3 = **19 mm**. *(1 mark.)*

(c) As the **temperature increases** from 10 °C to 40 °C, the **mean distance the dye spreads increases**, from **5 mm at 10 °C to 19 mm at 40 °C** — the higher the temperature, the further the dye diffuses in the 30 minutes. *(1 mark: the direction stated in directional language — distance increases as temperature increases; 1 mark: values quoted from the table to support it.)*

(d) The dye spreads through the agar by **diffusion** — the **random movement of its particles from where they are more concentrated (the well) to where they are less concentrated**. At a **higher temperature the dye particles have more kinetic energy and move faster**, so they **cross the agar more quickly** and travel a **greater distance in the same 30 minutes**. *(1 mark: at a higher temperature the dye particles have more kinetic energy / move faster; 1 mark: so they diffuse down the concentration gradient more quickly, spreading further in the fixed 30 minutes.)*

(e) Any **one** controlled variable, for example: the **volume of dye added to each well**; the **size and shape of the well**; the **type (concentration) of agar**; the **time allowed (30 minutes)**; the **same dye**. *(1 mark.)*

Q5. (a) The F1 plants have the genotype **CcSs**. Because the two genes are on different chromosome pairs, an F1 plant produces **four** gamete types in equal numbers: **CS, Cs, cS and cs**. *(1 mark: CcSs; 1 mark: the four gametes CS, Cs, cS, cs.)*

(b) Each gene gives a 3 : 1 ratio (purple : yellow, and smooth : shrunken), and because the genes assort independently the F2 phenotype ratio is **9 purple-smooth : 3 purple-shrunken : 3 yellow-smooth : 1 yellow-shrunken**. The **yellow, shrunken** plants are **ccss**: yellow (cc) = 1/4 and shrunken (ss) = 1/4, so yellow and shrunken = 1/4 × 1/4 = **1/16**. *(1 mark: 9 : 3 : 3 : 1 phenotype ratio; 1 mark: yellow-shrunken = 1/16; 1 mark: obtained as 1/4 × 1/4 / from the 1 in the 9 : 3 : 3 : 1 ratio.)*

(c) Purple, smooth plants are expected to be **9/16** of the F2 (the "9 purple-smooth" class). 9/16 × 3200: 3200 ÷ 16 = 200, and 200 × 9 = **1800 plants**. *(1 mark: purple-smooth = 9/16; 1 mark: 9/16 × 3200 = 1800, with working.)*

(d) A test cross uses a partner that is **homozygous recessive for both genes — ccss** (yellow, shrunken). If the F2 plant is **CcSs**, it makes the four gametes CS, Cs, cS, cs equally, and the ccss partner contributes only cs, so the offspring appear in a **1 purple-smooth : 1 purple-shrunken : 1 yellow-smooth : 1 yellow-shrunken** ratio (1 : 1 : 1 : 1). *(1 mark: partner ccss; 1 mark: 1 : 1 : 1 : 1 phenotype ratio.)*

(e) **Independent assortment** of the homologous chromosome pairs during **meiosis I**. *(1 mark: independent assortment.)*

Q6. (a) The allele is **recessive**. Two **unaffected** parents, **I-1 and I-2**, have an **affected** daughter (**II-2**): this happens only when each unaffected parent can carry the allele hidden and pass it on, so that a child who inherits it in a double dose is affected. *(1 mark: recessive; 1 mark: because two unaffected parents (I-1, I-2) have an affected child (II-2).)*

(b) **II-2 is an affected female**, so on the recessive explanation her genotype is **aa**. If the gene were **X-linked recessive**, II-2 would be $X^a X^a$ and would pass an X^a to **every one of her sons**, so **all of her sons would be affected**. But her son **III-1 is unaffected**, which could not happen if the gene were X-linked recessive; the gene must therefore be **autosomal**. *(1 mark: an X-linked recessive affected mother would pass the allele to all of her sons, so all her sons would be affected; 1 mark: III-1 is an unaffected son of the affected II-2, so the gene must be autosomal.)*

(c) **I-1 and I-2 are both Aa** (heterozygous carriers). Each is **unaffected**, so each carries at least one **A**; but together they produced an **affected (aa) daughter, II-2**, who received an **a from each parent**, so each parent must also carry an **a**. Carrying one A and one a, each is **Aa**. *(1 mark: both Aa; 1 mark: unaffected yet produced an aa child, so each carries both A and a.)*

(d) II-4 is an **unaffected child of I-1 × I-2 (Aa × Aa)**. That cross gives **1 AA : 2 Aa : 1 aa**; II-4 is not affected, so she is **not aa**, leaving **1 AA : 2 Aa** — so the probability that she is a carrier (**Aa**) is **2/3**. Her partner **II-3 is affected, so his genotype is aa**, and he passes an **a** to every child. The child is affected (**aa**) only if **II-4 also passes an a**, which requires her to be a carrier (probability **2/3**) and then to pass the a (probability **1/2**): P = 2/3 × 1/2 = **1/3**. *(1 mark: P(II-4 is a carrier) = 2/3; 1 mark: P(first child affected) = 2/3 × 1/2 = 1/3.)*

(e) The probability is **1 (certain)**. Because **II-3 is affected (aa), he passes an a to every child**; an **unaffected** child cannot be aa, so it must have received an **A from II-4** and is therefore **Aa — a carrier**. Every unaffected child of this couple is a carrier. *(1 mark: certain / probability 1, because the affected parent II-3 (aa) gives every child an a, so any unaffected child must be Aa.)*

Q7. (a) **Species 2 is the predator and species 1 is the prey.** On the graph, each **peak in species 2 comes a little after the matching peak in species 1** (for example, species 1 peaks at about month 4 and species 2 peaks at about month 5;

species 1 peaks again at about month 11 and species 2 at about month 12). A predator can build up only after its prey (its food) is already plentiful, so the predator's numbers lag behind the prey's. *(1 mark: species 2 = predator, species 1 = prey; 1 mark: justified — species 2's peaks come after species 1's peaks / the predator lags the prey.)*

(b) When the **prey (species 1) are plentiful**, the predators have abundant food, so **more predators survive and reproduce** and predator numbers **rise**. The larger number of predators then **eats more prey**, so the **prey numbers fall**. With **less food**, the **predators decline** in turn; and with **fewer predators**, the prey are eaten less often and their numbers **recover** — after which the whole cycle repeats. *(1 mark: plentiful prey allow the predators to increase; 1 mark: the increased predators eat more prey, so the prey fall and then the predators fall; 1 mark: with fewer predators the prey recover, so the cycle repeats.)*

(c) A **keystone species** has an effect on its community far greater than its numbers alone would suggest. If this predator were **removed**, the species it preys on (and holds in check) would be expected to **increase greatly and crowd out or out-compete many other species**, so the **variety of other species in the community would fall**. Removing the keystone predator therefore causes a large change in the whole community. *(1 mark: a keystone species has an effect out of proportion to its numbers / holds its prey in check; 1 mark: removing it lets the prey increase and dominate, so the number of other species falls.)*

(d) Prey feeding in the **open grassland are caught far more often**, so **fewer of them survive there**, while those feeding in the **dense shrub are out of the predator's reach**. Over time the prey therefore come to be found **mainly in the shrub patches and only sparsely in the open grassland**: their **distribution across the area becomes patchy rather than even**, with a **much higher density in the shrub** than in the open. The predator therefore helps to set **where the prey live and how crowded they are**, not only how many there are altogether. *(1 mark: prey in the open are taken by the predator while those in the shrub are protected, so more survive in the shrub; 1 mark: so the prey are distributed mainly in the shrub patches, at a high density there and a low density in the open grassland.)*

Q8. (a) **Feature (i)** — a thick coat of dense fur — is a **structural** adaptation (a physical feature of the body). **Feature (ii)** — gathering into a shared nest on the coldest nights — is a **behavioural** adaptation (an inherited pattern of activity). **Feature (iii)** — entering torpor by lowering its body temperature and metabolic rate — is a **physiological** adaptation (an internal functional process). *(1 mark each for (i) structural, (ii) behavioural, (iii) physiological.)*

(b) An **adaptation** is an **inherited** feature that suits an organism to its environment and can be **passed on to its offspring**, whereas an **acquired characteristic** develops during the animal's **own life** and is **not inherited**. For example, the marsupial's **thick fur is an inherited adaptation**, but **extra body fat it puts on during a good season** is an acquired characteristic that it cannot pass on. *(1 mark: adaptation = inherited/heritable, acquired = develops during life and is not inherited; 1 mark: a correct example drawn from this marsupial.)*

(c) The marsupial is a **specialist**: it feeds **mainly on the seeds of the one alpine plant** and shelters **only in that one alpine shrub**, so it **cannot readily switch to another food or another kind of cover** if either becomes scarce. If either species **declined** — through fire, clearing or a run of poor seasons — the marsupial would **lose its food supply, or the cover that protects it from the weather and from predators**, and its own numbers would fall. Its survival is therefore **tied to the survival of those two species**, which is what interdependence between species means. *(1 mark: the marsupial is a specialist — it relies on that particular plant for food and that particular shrub for shelter and cannot readily replace either; 1 mark: so a decline in either species would take away its food or its shelter and its own numbers would fall.)*

(d) Any **one**: **acknowledge and attribute the knowledge to the particular Aboriginal community (or Traditional Owners) it belongs to**; **use it only with the community's consent and in keeping with cultural protocols**; **value it as a valid body of knowledge alongside Western science**; or **cite it as a source** rather than treating it as common knowledge. *(1 mark for any one valid point.)*

Q9. (a) A **scientific (empirical) question**, for example: **"Are cloned dairy cattle as healthy as, and do they yield as much milk as, the original cow?"** A **bioethical (value) question**, for example: **"Should we produce a whole herd of dairy cattle by cloning?"** *(1 mark: a valid empirical question that evidence could answer; 1 mark: a valid value question about what ought to be done.)*

(b) Two **different** approaches, one for and one against. For example, a **consequences-based** argument **in favour**: a herd cloned from a very high-yielding cow could **produce much more milk more cheaply**, a large benefit for producers and consumers, which could outweigh the costs. A **duty- and rule-based** (or **virtues-based**)

argument **against**: cloning can cause **health problems and suffering in the animals**, and we have a **duty to protect animal welfare** (or: a caring, responsible farmer would not accept that harm just to raise yields). *(1 mark: a valid for-argument tied to a named approach; 1 mark: a valid against-argument tied to a **different** named approach.)*

(c) Two concepts, one on each side (any valid pair). For example: **beneficence** — the **benefit of more, cheaper milk** for producers and consumers **supports** the proposal; **non-maleficence** — the **harm and suffering that cloning can cause the animals counts against** it. (Justice or respect, correctly applied, are also acceptable.) *(1 mark each: a relevant concept named and applied, one supporting and one counting against.)*

(d) Because the cloned cattle are **all genetically identical**, the herd has **very low genetic diversity**: every animal shares the **same characteristics, including the same susceptibility** to a disease or an environmental change. A **single new disease that one animal cannot resist could therefore affect the whole herd at once**, whereas a genetically varied herd would be likely to contain some resistant animals. *(1 mark: the identical cattle have very low genetic diversity / all share the same susceptibility; 1 mark: so one disease or change could affect the whole herd.)*

(e) The **independent university study** provides the **stronger evidence**. Any **one** reason: it is **independent of the company, so it has no conflict of interest** (the company stands to gain from a high figure); or it is **not funded by the seller** / is more likely to have been checked by other experts, whereas the company reports its **own** trial on its **own** website. On the significant figures: quoting the yield as **"10.42" implies four significant figures — a precision the data do not support**. It comes from a single company trial, and it is **more precise than the independent study's own figure (10, two significant figures)**, so it overstates how precisely the yield is actually known. *(1 mark: the independent study is stronger, with a valid reason — no conflict of interest / independent funding; 1 mark: "10.42" claims a precision (4 significant figures) the data cannot support / more than the other source gives.)*

Exam 4 — Practice examination

Reading time: 15 minutes. Writing time: 2 hours 30 minutes. Section A: 40 questions, 40 marks. Section B: 9 questions, 80 marks. Total 120 marks. This examination covers Units 1 and 2. Answer all questions.

- *No calculator may be used.*
- *No formula sheet, data sheet, dictionary or notes may be used.*
- *Diagrams in this examination are not drawn to scale.*

Section A — Multiple choice

Every question in this section must be attempted. Select the response that is correct or that best answers the question. One mark is awarded for each correct response, and nothing is taken away where a response is wrong. Where two or more responses have been completed for the same question, no mark is awarded for it. No diagram in this section is drawn to scale.

Question 1

The organelle in which light energy is captured and used to make glucose during photosynthesis is the

A. mitochondrion.

B. chloroplast.

C. ribosome.

D. Golgi apparatus.

Question 2

The organelle that modifies, packages and sorts proteins, ready for their release from the cell, is

A. the nucleus.

B. the mitochondrion.

C. the Golgi apparatus.

D. the chloroplast.

Question 3

A large, permanent, fluid-filled vacuole that stores cell sap is a typical feature of

A. plant cells.

B. animal cells.

C. bacterial cells.

D. red blood cells.

Question 4

A root hair cell is a cell of the outer layer of a root that grows out into the soil, where it takes in water and dissolved minerals. A cell whose structure suits it in this way to one particular job is called

A. a stem cell.

B. a gamete.

C. a cancer cell.

D. a specialised cell.

Question 5

Osmosis is best described as the movement of

A. water across a partially permeable membrane, from a higher to a lower water concentration.

B. any dissolved substance across a membrane.

C. water across a membrane using energy from ATP.

D. ions from a low to a high concentration.

Question 6

Very small cells, and cells that are long and thin, are able to exchange substances with their surroundings quickly because they have a

A. small surface area.

B. large surface-area-to-volume ratio.

C. thick cell wall.

D. large volume.

Question 7

The jelly-like fluid that fills a cell, in which the organelles are suspended and many of the cell's chemical reactions take place, is the

A. nucleus.

B. cell wall.

C. vacuole.

D. cytoplasm.

Question 8

After the nucleus of a cell has divided during mitosis, the cytoplasm itself divides to form two separate cells. This division of the cytoplasm is called

A. interphase.

B. differentiation.

C. cytokinesis.

D. fertilisation.

Question 9

Fat (adipose) tissue, which stores energy beneath the skin, and cartilage, which cushions the ends of the bones at a joint, are both examples of

A. muscle tissue.

B. nervous tissue.

C. connective tissue.

D. epithelial tissue.

Question 10

The breaking up of food into smaller pieces by the teeth, without changing it chemically, is an example of

A. chemical digestion.

B. absorption.

C. excretion.

D. mechanical (physical) digestion.

Question 11

Hormones released by an endocrine gland are carried to the parts of the body they affect by the

A. nerves.

B. blood.

C. air in the lungs.

D. lymph only.

Question 12

The removal from the body of the waste products of its own chemical reactions, such as carbon dioxide and urea, is called

A. excretion.

B. digestion.

C. respiration.

D. reproduction.

Question 13

Gases enter and leave a leaf, and water vapour escapes from it, mainly through small pores called

A. root hairs.

B. xylem vessels.

C. stomata.

D. phloem tubes.

Question 14

When a person becomes too hot, the small blood vessels (arterioles) in the skin widen. This response (vasodilation) helps to cool the body because it

A. brings more warm blood close to the skin surface, so more heat is lost.

B. keeps warm blood away from the skin surface.

C. makes the muscles shiver.

D. stops the person sweating.

Question 15

In a homeostatic control system, the change in the internal environment that is detected by a receptor is called the

A. response.

B. effector.

C. control centre.

D. stimulus.

Question 16

The statement "to investigate whether playing music in the milking shed affects how much milk dairy cows produce" is best described as the investigation's

A. hypothesis.

B. aim.

C. conclusion.

D. result.

Question 17

A student investigates whether the type of food offered changes the number of ants that come to a feeding station in a schoolyard. Which one of the following is a controlled variable in this investigation?

A. The type of food offered at the station.

B. The length of time the station is left out before the ants are counted.

C. The number of ants that come to the station.

D. The conclusion the student draws from the counts.

Question 18

In a survey, results based on a large sample of people are usually more reliable than results based on a very small sample, because a large sample

A. is more likely to represent the whole group and reduces the effect of chance.

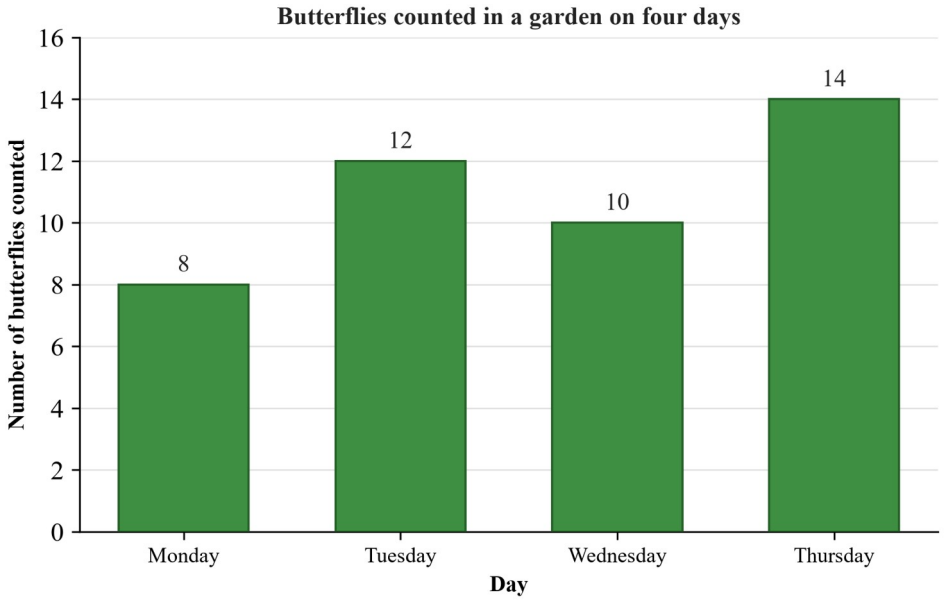
B. always gives the exact true value.

C. is quicker to collect.

D. removes any systematic error in the method.

Use the following information to answer Questions 19 and 20.

A student counted the number of butterflies visiting a garden on each of four days. The results are shown in the graph below.



Question 19

On which day were the most butterflies counted?

A. Monday

B. Tuesday

C. Wednesday

D. Thursday

Question 20

The mean (average) number of butterflies counted per day was

A. 8

B. 10

C. 11

D. 14

Question 21

A length of DNA that carries the instructions for a particular characteristic is called

A. a gene.

B. a chromosome.

C. a gamete.

D. a genome.

Question 22

The genetic make-up of an organism for a particular characteristic — the alleles it carries — is called its

A. phenotype.

B. genotype.

C. karyotype.

D. genome.

Question 23

A body cell that contains two complete sets of chromosomes is described as

A. haploid.

B. a gamete.

C. diploid.

D. a clone.

Question 24

A karyotype is

A. a picture of all of a cell's chromosomes, arranged in order.

B. the set of alleles an organism carries.

C. a type of gamete.

D. a section of DNA.

Question 25

An organism that carries two different alleles for a particular characteristic (for example, Bb) is described as

A. homozygous.

B. haploid.

C. a clone.

D. heterozygous.

Question 26

A long, thread-like structure, made of a molecule of DNA and carrying many genes in a fixed order, is

A. an allele.

B. a chromosome.

C. a gamete.

D. a ribosome.

Question 27

A sex cell, such as an egg or a sperm, which carries half the number of chromosomes of a body cell, is called

A. a zygote.

B. a clone.

C. a gamete.

D. a gene.

Question 28

In humans, whether a child is genetically male or female is determined by

A. the total number of chromosomes the child inherits.

B. the number of autosomes the child inherits.

C. whether the mother's egg carries a Y chromosome.

D. whether the sperm from the father carries an X or a Y chromosome.

Question 29

A flamingo's feathers are bright pink only when its food contains certain natural pigments; the same bird, fed food without them, grows pale feathers instead. This shows that a phenotype can be affected by

A. the genotype only.

B. the number of chromosomes.

C. neither the genotype nor the environment.

D. the environment as well as the genotype.

Question 30

The sharp spines that cover the body of an echidna and protect it from predators are an example of

A. a behavioural adaptation.

B. a structural adaptation.

C. a physiological adaptation.

D. an acquired characteristic.

Question 31

A brushtail possum rests in a tree hollow during the day and comes out to feed only at night. This night-time (nocturnal) activity is best classified as

A. a structural adaptation.

B. a physiological adaptation.

C. a behavioural adaptation.

D. an acquired characteristic.

Question 32

A brown snake's body makes a venom that it uses to overcome its prey. The making of this venom is best classified as

A. a physiological adaptation.

B. a structural adaptation.

C. a behavioural adaptation.

D. an acquired characteristic.

Question 33

A pelican catches and eats a fish. The relationship between the pelican and the fish is best described as

A. mutualism.

B. predation.

C. competition.

D. parasitism.

Question 34

A student records the colour of a solution as "dark green". Data like this, described in words rather than as numbers, are

A. quantitative data.

B. a controlled variable.

C. qualitative data.

D. a hypothesis.

Question 35

The variety of different species living in a particular area is called its

A. population.

B. density.

C. distribution.

D. biodiversity.

Question 36

Before a new medicine is given to patients, it is tested carefully to make sure that it will not harm them. This concern with avoiding harm reflects the ethical concept of

A. justice.

B. beneficence.

C. non-maleficence.

D. integrity.

Question 37

When choosing volunteers for a trial, a researcher makes sure that people from all backgrounds have a fair and equal chance to take part. This fairness reflects the ethical concept of

A. justice.

B. non-maleficence.

C. integrity.

D. beneficence.

Question 38

In a study, the researchers keep each volunteer's personal results private and do not share them without permission. Protecting the volunteers' privacy in this way reflects the ethical concept of

A. beneficence.

B. respect.

C. integrity.

D. justice.

Question 39

Which one of the following is a statement of opinion, rather than a scientific fact that can be tested?

A. Autumn is the most pleasant season of the year.

B. Water boils at 100 °C at sea level.

C. Green plants need light in order to photosynthesise.

D. A human body cell contains 46 chromosomes.

Question 40

A student copies several sentences from a website into her report and presents them as her own writing, without saying where they came from. This is

A. good referencing.

B. peer review.

C. collecting primary data.

D. plagiarism.

End of Section A

Section B — Short answer

Every question in this section must be attempted, in the spaces provided. For any question carrying two or more marks, a response earns full credit only if it reaches the depth that its command term and its mark allocation call for. No diagram in this section is drawn to scale.

Question 1 (8 marks)

Every cell must exchange substances, such as oxygen and wastes, with its surroundings across its surface. As a cell gets larger, its surface area and its volume do not increase at the same rate.

a. Name one substance a cell must take *in* across its surface, and one waste substance it must *remove*. 2 marks

b. State what happens to the surface-area-to-volume ratio of a cell as the cell gets larger. 1 mark

c. Explain why a very large cell may not be able to exchange substances fast enough to survive. 2 marks

d. In some lung diseases, the barrier between the air in the lungs and the blood becomes much thicker than normal. Explain why this would slow the rate at which oxygen enters the blood. 2 marks

e. Name the process by which oxygen moves from the air in the lungs into the blood, moving from a higher to a lower concentration. 1 mark

Question 2 (9 marks)

The tongue is an organ. Most of it is muscle tissue, which moves food around the mouth and pushes it to the back of the throat for swallowing. Its upper surface is covered by a sheet of epithelial tissue containing taste buds, and nervous tissue carries messages from the taste buds to the brain.

a. Using the tongue as an example, explain the difference between a *tissue* and an *organ*. 2 marks

b. Name the type of tissue that carries messages from the taste buds to the brain. 1 mark

c. Name the organ system that the tongue belongs to, and name one other organ of that same system. 2 marks

d. The muscle of the tongue works almost constantly and needs a great deal of energy. Name the process that releases this energy in the muscle cells, and name the organelle in which most of it occurs. 2 marks

e. Explain why the tongue could not do its job properly if it were made of muscle tissue alone. 2 marks

Question 3 (8 marks)

A student placed the cut stem of a white carnation flower in a jar of water coloured with blue food dye. After several hours, the edges of the white petals had turned blue.

a. Name the tissue that carried the blue dye up the stem, and state its normal function in the plant. 2 marks

b. State what this experiment shows about the direction in which water moves in this tissue. 1 mark

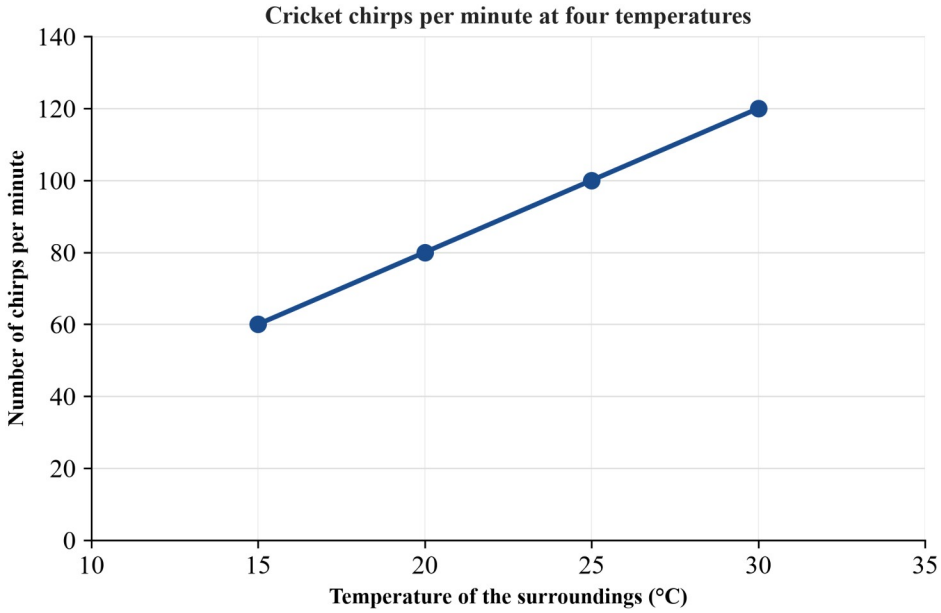
c. Water is drawn up the plant partly because water evaporates from the leaves and petals. Name this loss of water vapour from the plant. 1 mark

d. The student set up the same experiment again, with one flower in a warm, breezy place and one in a cool, still place. Predict in which flower the dye would reach the petals faster, and give a reason. 2 marks

e. Name the *other* transport tissue found in a plant, and state what it carries. 2 marks

Question 4 (8 marks)

A student investigated whether the temperature of its surroundings affects how often a cricket chirps. She used one cricket, which she kept in the same container and moved through four temperatures in turn. At each temperature she counted the number of chirps in one minute, repeated the count three times and worked out the mean. Her results are shown in the graph below.



a. Write a hypothesis for this investigation. 1 mark

b. Identify the independent variable and the dependent variable in this investigation. 2 marks

c. Using the graph, describe the trend shown by the results. Use directional language and quote figures from the graph. 2 marks

d. State one variable, other than the temperature, that the student should have kept the same, and give a reason why. 2 marks

e. The student says her results prove that a higher temperature *causes* the cricket to chirp more. State one reason she should be cautious about this claim. 1 mark

Question 5 (10 marks)

In budgerigars (a type of small parrot), a green body colour (allele G) is dominant to a blue body colour (allele g).

a. A green budgerigar is bred with a blue budgerigar, and all of their chicks are green. State the genotype of the blue parent, and give the most likely genotype of the green parent, with a reason. 2 marks

b. Two green budgerigars, each with the genotype Gg, are bred together. Construct a Punnett square for this cross. 2 marks

c. Using your Punnett square, state the expected ratio of green to blue chicks, and state the fraction of the chicks expected to be blue. 2 marks

d. Explain how two green (Gg) parents can produce a blue chick, even though neither parent is blue. 2 marks

e. State what is meant by the term *allele*. 1 mark

f. In part **a**, a bird showing the dominant colour was crossed with a blue (gg) bird in order to work out its genotype. Name this type of cross. 1 mark

Question 6 (8 marks)

The body cells of a certain plant each contain 20 chromosomes, arranged as 10 homologous pairs.

a. Explain what is meant by a *homologous pair* of chromosomes. 2 marks

b. State the number of chromosomes in one of this plant's gametes, and name the type of cell division that produces gametes. 2 marks

c. Meiosis produces gametes that are genetically varied. Name two events that occur during meiosis that create this variation. 2 marks

d. A body cell of this plant divides by mitosis. State the number of chromosomes in each cell produced, and state how the genetic make-up of these cells compares with the original cell. 2 marks

Question 7 (9 marks)

The red kangaroo lives in the hot, dry inland of Australia. It has powerful hind legs and a large, muscular tail, which it uses for fast and efficient hopping over long distances. During the hottest part of the day it rests in the shade, and it feeds in the cool of the early morning and evening.

a. Classify the kangaroo's powerful hind legs and tail as a structural or a behavioural adaptation, and classify its habit of resting in the shade by day as a structural or a behavioural adaptation. For each, explain how it helps the kangaroo survive in a hot, dry environment. 4 marks

b. State what is meant by the term *adaptation*. 1 mark

c. Red kangaroos feed on native grasses, and dingoes (a native predator) hunt and eat kangaroos. Using the idea of interdependence, explain how a drought that killed many of the native grasses could affect both the kangaroo and the dingo populations. 2 marks

d. Aboriginal and Torres Strait Islander peoples hold detailed, long-standing knowledge of the kangaroo and its seasonal behaviour on Country. State one way this knowledge could help scientists who are managing kangaroo populations, and state one thing scientists should do when they use this knowledge. 2 marks

Question 8 (10 marks)

Corals on the Great Barrier Reef reproduce in two ways. A coral colony grows larger as individual coral animals (polyps) divide to produce new, genetically identical polyps. Once a year, many corals also release eggs and sperm into the water at the same time (a "mass spawning"), producing tiny larvae that drift away, settle, and start new colonies.

a. Growing the colony by polyps dividing is a form of asexual reproduction. State what is meant by *asexual reproduction*, and name the type of cell division that produces the identical new polyps. 2 marks

b. State the genetic relationship between a new polyp and the polyp it grew from. 1 mark

c. State one advantage to the coral of being able to grow its colony asexually, and explain how this advantage helps the colony on the reef. 2 marks

d. The yearly mass spawning is sexual reproduction. Explain how sexual reproduction produces genetically varied larvae. 2 marks

e. Explain why producing genetically varied larvae is an advantage for the coral if the reef environment changes, for example if the water becomes warmer. 2 marks

f. State one disadvantage of a coral colony being made of genetically identical polyps if a disease reaches the colony. 1 mark

Question 9 (10 marks)

A company wants to clear an area of native bushland, which is home to several native plant and animal species, in order to build a new factory. The factory would create local jobs. A community meeting is held to discuss the proposal.

a. Explain the difference between a scientific (empirical) question and a bioethical (value) question, and write one example of each that this proposal raises. 3 marks

b. One person argues that the factory should be built because the benefit of the jobs outweighs the harm of losing the bushland. A second person argues that it is always wrong to destroy native habitat, whatever the benefit. Name the ethical approach that each person is using. 2 marks

c. Name one ethical concept that is relevant to protecting the bushland, and explain how it applies to this decision. 2 marks

d. The company publishes a report on its own website stating that "only a few common species live in the area". State one reason the community should be cautious about relying on this report. 1 mark

e. Explain why a survey of the bushland carried out by independent scientists and published in a peer-reviewed journal would provide more trustworthy evidence about the species present. 2 marks

End of Section B

End of examination questions

Exam 4 — Answers and solutions

Section A — answers

Q	Ans	Q	Ans	Q	Ans	Q	Ans
1	B	11	B	21	A	31	C
2	C	12	A	22	B	32	A
3	A	13	C	23	C	33	B
4	D	14	A	24	A	34	C
5	A	15	D	25	D	35	D
6	B	16	B	26	B	36	C
7	D	17	B	27	C	37	A
8	C	18	A	28	D	38	B
9	C	19	D	29	D	39	A
10	D	20	C	30	B	40	D

Q1. B — the chloroplast is the organelle in which photosynthesis captures light energy to make glucose. The mitochondrion releases energy in respiration, the ribosome makes proteins, and the Golgi apparatus packages them.

Q2. C — the Golgi apparatus modifies, packages and sorts proteins ready for release. The nucleus stores DNA, the mitochondrion releases energy, and the chloroplast carries out photosynthesis.

Q3. A — a large, permanent, fluid-filled vacuole storing cell sap is a feature of plant cells; animal cells have only small, temporary vacuoles, and bacterial and red blood cells do not have this structure.

Q4. D — a cell whose structure suits it to one particular job is a specialised cell (here a root hair cell, shaped for taking in water and minerals from the soil). A stem cell is unspecialised, a gamete is a sex cell, and a cancer cell is an abnormal, uncontrolled cell.

Q5. A — osmosis is the movement of water across a partially permeable membrane, from a region of higher water concentration to one of lower water concentration; it needs no energy and does not move dissolved solutes or ions.

Q6. B — a large surface-area-to-volume ratio means there is plenty of surface for exchange relative to the volume that must be served, so substances are exchanged quickly. A small surface area or a large volume would slow exchange.

Q7. D — the jelly-like fluid that fills the cell and holds the organelles, and in which many reactions take place, is the cytoplasm. The nucleus, cell wall and vacuole are particular structures, not this fluid.

Q8. C — the division of the cytoplasm to form two separate cells is cytokinesis. Interphase is the growth stage, differentiation is cells becoming specialised, and fertilisation is the fusion of gametes.

Q9. C — fat (adipose) tissue and cartilage are both connective tissues: in each, the cells lie spaced apart in a non-living matrix instead of being packed together. Muscle tissue contracts, nervous tissue carries messages, and epithelial tissue covers and lines surfaces.

Q10. D — breaking food into smaller pieces by the teeth, without changing it chemically, is mechanical (physical) digestion. Chemical digestion uses enzymes, absorption is the uptake of digested food, and excretion is the removal of wastes.

Q11. B — hormones are chemical messengers that are released into, and carried around the body by, the blood. The nerves carry electrical signals, not hormones.

Q12. A — the removal of the wastes made by the body's own chemical reactions, such as carbon dioxide and urea, is excretion. Digestion breaks down food, and respiration releases energy.

Q13. C — gases and water vapour pass through the stomata, small pores mostly on the underside of the leaf. The xylem and phloem are transport tubes, and root hairs are on the roots.

Q14. A — widening the skin arterioles brings more warm blood close to the surface, so more heat is lost to the surroundings and the body cools. Keeping blood away from the skin would conserve heat.

Q15. D — the change in the internal environment that is detected is the stimulus. The receptor detects it, the control centre coordinates the response, and the effector carries the response out.

Q16. B — a statement of the purpose of the investigation ("to investigate whether …") is the aim. A hypothesis would predict a direction, and a conclusion or result comes after the data are collected.

Q17. B — a controlled variable is one deliberately kept the same, so that it cannot affect the result: every food type must be left out for the same length of time. The type of food is the independent variable, the number of ants is the dependent variable, and a conclusion is not a variable at all.

Q18. A — a large sample is more likely to represent the whole group, and averaging over more individuals reduces the effect of chance, so the result is more reliable. A larger sample does not give the exact true value or remove a systematic error.

Q19. D — the tallest bar is Thursday, with 14 butterflies; Monday had 8, Tuesday 12 and Wednesday 10.

Q20. C — the mean = (8 + 12 + 10 + 14) ÷ 4 = 44 ÷ 4 = 11 butterflies per day.

Q21. A — a length of DNA carrying the instructions for a characteristic is a gene. A chromosome carries many genes, a gamete is a sex cell, and the genome is all of an organism's DNA.

Q22. B — the alleles an organism carries for a characteristic make up its genotype. The phenotype is the observable characteristic, the karyotype is a picture of the chromosomes, and the genome is all of the DNA.

Q23. C — a cell with two complete sets of chromosomes is diploid; a cell with one set (a gamete) is haploid.

Q24. A — a karyotype is a picture of all of a cell's chromosomes, arranged in order (usually by size and in pairs). It is not the alleles, a gamete or a section of DNA.

Q25. D — carrying two different alleles for a characteristic (for example Bb) makes an organism heterozygous for that characteristic; two identical alleles would make it homozygous.

Q26. B — a long, thread-like structure made of DNA and carrying many genes is a chromosome. An allele is a version of a single gene, a gamete is a sex cell, and a ribosome is the organelle that makes proteins.

Q27. C — a sex cell such as an egg or a sperm, carrying half the chromosome number, is a gamete. A zygote is the cell formed when two gametes join, a clone is a genetically identical copy, and a gene is a length of DNA.

Q28. D — the mother's egg always carries an X, so the sex of the child depends on whether the father's sperm carries an X (giving a female, XX) or a Y (giving a male, XY).

Q29. D — the same bird grows pink or pale feathers depending on what it eats, so the phenotype depends on the environment (here, the diet) as well as on the genotype.

Q30. B — the spines are a physical feature of the echidna's body, so they are a structural adaptation (here one used for defence). They are inherited, not acquired.

Q31. C — feeding at night is something the animal does — an action — so it is a behavioural adaptation, not a body structure or an internal process.

Q32. A — making a venom is an internal, functional (biochemical) process of the body, so it is a physiological adaptation. It is not a body part (structural) or an action (behavioural).

Q33. B — one animal catching and eating another is predation. In mutualism both benefit, in competition both contest a resource, and in parasitism one lives on or in a host and harms it.

Q34. C — data recorded in words, such as a colour, rather than as numbers, are qualitative data. Quantitative data are numerical; a controlled variable and a hypothesis are different things.

Q35. D — the variety of different species living in an area is its biodiversity. A population is one species, density is the number per unit area, and distribution is where a species is found.

Q36. C — acting to avoid causing harm is the concept of non-maleficence ("do no harm"). Justice is fairness, beneficence is doing good, and integrity is honesty.

Q37. A — giving people from all backgrounds a fair and equal chance to take part is fairness, which is the concept of justice. Non-maleficence is avoiding harm, integrity is honesty, and beneficence is doing good.

Q38. B — protecting a volunteer's privacy honours the person and their rights, which is the concept of respect. Beneficence is doing good, integrity is honesty, and justice is fairness.

Q39. A — "the most pleasant season" is a matter of opinion (a value judgement) that evidence cannot settle. The boiling point of water, plants needing light, and the human chromosome number are all facts that can be tested.

Q40. D — copying someone else's words and presenting them as your own, without acknowledging the source, is plagiarism. Good referencing would credit the source.

Section B — solutions

Q1. (a) A cell must take in, for example, **oxygen** (or glucose or water), and must remove a waste such as **carbon dioxide** (or urea/other wastes). *(1 mark: a valid substance taken in; 1 mark: a valid waste removed.)*

(b) As the cell gets larger, its surface-area-to-volume ratio **decreases (gets smaller)**. *(1 mark.)*

(c) As a cell grows, its **volume increases faster than its surface area**, so its surface area becomes too small compared with the volume it must serve. The **surface cannot take in enough substances, or remove enough wastes, fast enough** to supply the whole of the large volume, so a very large cell cannot survive. *(1 mark: volume grows faster than surface area / the ratio becomes too small; 1 mark: so exchange across the surface is too slow to supply the whole volume.)*

(d) A thicker barrier means the oxygen has a **greater distance to diffuse** to get from the air to the blood. Diffusion across a **longer distance is slower**, so **less oxygen reaches the blood each minute** and the rate of gas exchange falls. *(1 mark: the distance the oxygen must diffuse is greater; 1 mark: diffusion over a longer distance is slower, so less oxygen enters the blood in a given time.)*

(e) **Diffusion** (simple diffusion). *(1 mark.)*

Q2. (a) A **tissue** is a group of **similar cells that work together to carry out one job** (for example, the muscle tissue that makes up most of the tongue). An **organ** is made of **several different tissues working together** to carry out a function — the tongue is an organ because its muscle, epithelial and nervous tissue all work together to handle food in the mouth. *(1 mark: tissue = similar cells with one job; 1 mark: organ = several different tissues working together, e.g. the tongue.)*

(b) **Nervous tissue.** *(1 mark.)*

(c) The tongue belongs to the **digestive system**, and another organ of that system is, for example, the **stomach** (or the oesophagus, small intestine, large intestine or liver). *(1 mark: digestive system; 1 mark: any valid organ of the digestive system.)*

(d) The energy is released by **aerobic (cellular) respiration**, and most of it takes place in the **mitochondrion (mitochondria)**. *(1 mark: aerobic cellular respiration; 1 mark: mitochondrion.)*

(e) Muscle tissue alone could still **move the food**, but the tongue would have **no epithelial covering to protect its surface and hold the taste buds, and no nervous tissue to carry messages to the brain**, so the food could not be tasted. An organ works only because its **different tissues each do a job the others cannot**, all for the one function. *(1 mark: names something the missing tissue(s) do — protection/taste buds, or carrying messages; 1 mark: an organ needs several different tissues working together, each doing what the others cannot.)*

Q3. (a) The tissue is the **xylem**. Its normal function is to **carry water and dissolved minerals up from the roots to the leaves** (and the rest of the plant). *(1 mark: xylem; 1 mark: carries water and minerals up from the roots.)*

(b) It shows that water moves **upward**, from the base of the cut stem up towards the petals and leaves. *(1 mark.)*

(c) The loss of water vapour from the plant is **transpiration**. *(1 mark.)*

(d) The dye would reach the petals faster in the **warm, breezy** flower. Warmth and moving air **increase the rate of evaporation (transpiration) from the leaves and petals**, which draws water (and the dye) up the xylem more quickly. *(1 mark: the warm, breezy flower; 1 mark: because warmth and moving air speed up transpiration, drawing water up faster.)*

(e) The other transport tissue is the **phloem**, which carries **sugars (food) made in the leaves** to the rest of the plant. *(1 mark: phloem; 1 mark: it carries sugars/food made in the leaves.)*

Q4. (a) A suitable hypothesis, for example: **"If the temperature of the surroundings is increased, then the cricket will chirp more often (make more chirps per minute)."** *(1 mark: a testable, directional statement linking temperature to the chirp rate.)*

(b) The **independent variable** is the **temperature of the surroundings**; the **dependent variable** is the **number of chirps per minute**. *(1 mark: IV = temperature; 1 mark: DV = number of chirps per minute.)*

(c) As the **temperature increases** (from 15 °C to 30 °C), the **number of chirps per minute increases**, from **60 chirps per minute at 15 °C to 120 chirps per minute at 30 °C**. *(1 mark: the direction stated in directional language — chirps increase as temperature increases; 1 mark: figures quoted from the graph, e.g. 60 rising to 120.)*

(d) Any **one** suitable controlled variable, with a reason — for example the **same length of counting time (one minute)**, the **time of day**, or the amount of light, food or noise. It must be kept the same so that it **does not also affect the number of chirps**, which would make it impossible to tell that the temperature alone caused the change (keeping the test fair/valid). *(1 mark: a valid controlled variable; 1 mark: because it must not also affect the number of chirps / to keep the test fair.)*

(e) Any **one**: only **one cricket** was tested (a small sample), so the result may not apply to other crickets; only **four temperatures** were tested; the counts might be affected by another factor that changed with temperature; or a link between two things does not, on its own, prove that one **causes** the other. *(1 mark.)*

Q5. (a) The blue parent is **gg** (blue is the recessive colour). The green parent is most likely **GG (homozygous)**, because a cross with a blue (gg) bird produced **no blue chicks** — if the green parent had been Gg, about half the chicks would have been expected to be blue. *(1 mark: blue parent gg; 1 mark: green parent most likely GG, because no blue chicks appeared.)*

(b) The cross is **Gg × Gg**:

×	G	g
G	GG	Gg
g	Gg	gg

(1 mark: correct gametes G and g for each parent; 1 mark: the four offspring GG, Gg, Gg, gg correctly placed.)

(c) The offspring are 1 GG : 2 Gg : 1 gg. GG and Gg are green (G is dominant) and gg is blue, so the ratio is **3 green : 1 blue**, and the fraction expected to be blue is **1/4 (one quarter)**. *(1 mark: 3 green : 1 blue; 1 mark: 1/4 blue.)*

(d) Each green parent has the genotype **Gg**, so each one **carries a hidden g allele** as well as the G allele. Each parent can **pass on either G or g** to a chick. A chick that receives a **g from both parents** is **gg**, and so is blue — even though both parents show green, because in them the g allele is masked by the dominant G. *(1 mark: each Gg parent carries and can pass on a g allele; 1 mark: a chick receiving g from both parents is gg / blue.)*

(e) An **allele** is **one of the different forms (versions) of a gene** — here, G (green) and g (blue) are two alleles of the body-colour gene. *(1 mark.)*

(f) A **test cross** (a cross with a homozygous recessive individual). *(1 mark.)*

Q6. (a) A **homologous pair** is **two chromosomes of the same size and shape that carry the same genes at the same positions (loci)** — one inherited from each parent. (They may carry different alleles of those genes.) *(1 mark: same size/shape carrying the same genes at the same loci; 1 mark: one from each parent.)*

(b) A gamete contains **10 chromosomes** (half of 20), and gametes are produced by **meiosis**. *(1 mark: 10; 1 mark: meiosis.)*

(c) Any **two** of: **crossing over** (exchange of segments between homologous chromosomes) and **independent assortment** (the random way the homologous pairs are shared into the gametes). *(1 mark each for two correct events; "random fertilisation" is not part of meiosis itself.)*

(d) Each cell produced by mitosis contains **20 chromosomes** (the full number), and these cells are **genetically identical** to one another and to the original cell. *(1 mark: 20 chromosomes; 1 mark: genetically identical.)*

Q7. (a) The **powerful hind legs and muscular tail** are a **structural** adaptation: they let the kangaroo **hop fast and efficiently over long distances**, so it can **reach food and water that are scattered far apart** in a dry environment. **Resting in the shade by day** (and feeding when it is cool) is a **behavioural** adaptation: by **avoiding the greatest heat of the day**, the kangaroo **reduces heat gain and water loss**, helping it to survive in the heat. *(1 mark: legs and tail structural; 1 mark: how it helps — efficient travel to reach scattered resources; 1 mark: resting in shade behavioural; 1 mark: how it helps — avoiding the heat reduces heat stress / water loss.)*

(b) An **adaptation** is an **inherited feature that helps an organism to survive and reproduce in its environment**. *(1 mark.)*

(c) The kangaroo **depends on the native grasses for its food**, and the dingo **depends on the kangaroo as its prey (food)**. If a drought killed many of the grasses, the kangaroos would have **less food, so their numbers would fall**; with fewer kangaroos to eat, the **dingoes would then have less food, so their numbers would fall too**. Because the species are linked through what they feed on, they are **interdependent**. *(1 mark: fewer grasses means less food for the kangaroos, so their numbers fall; 1 mark: fewer kangaroos means less food for the dingoes, so their numbers fall too — the species depend on one another.)*

(d) Any **one** way plus **one** thing to do. The knowledge provides **detailed, long-term observations of the kangaroo's behaviour, movements, breeding and numbers**, which can **make the management more effective**. When they use it, scientists should **acknowledge and attribute it to the community it belongs to, and use it only with the community's consent and respect** (working in partnership). *(1 mark: a valid way the knowledge helps; 1 mark: a valid thing scientists should do — acknowledge/attribute / seek consent / work respectfully in partnership.)*

Q8. (a) **Asexual reproduction** is reproduction from a **single parent, producing offspring that are genetically identical to the parent**. The identical new polyps are produced by **mitosis**. *(1 mark: asexual = one parent, genetically identical offspring; 1 mark: mitosis.)*

(b) A new polyp is **genetically identical to the polyp it grew from (a clone)**. *(1 mark.)*

(c) One advantage is that a coral can reproduce **without needing to find a mate**, so a single polyp on its own can go on producing new polyps. This lets the colony **grow and spread over the reef quickly whenever conditions are good**, taking up space and light before slower-growing neighbours can, and letting a damaged colony rebuild itself. *(1 mark: a valid advantage — no mate/partner needed, or new polyps produced continuously from one individual; 1 mark: how that helps the colony — it enlarges and covers reef space quickly, or regrows after damage.)*

(d) In sexual reproduction, **eggs and sperm (gametes) from different corals join at fertilisation**. Because the gametes are made by **meiosis** and combine at random, each larva receives a **new combination of alleles from two parents**, so the larvae are genetically varied. *(1 mark: gametes from two corals combine at fertilisation; 1 mark: so each larva gets a new combination of alleles / is genetically varied.)*

(e) Because the larvae are **genetically varied**, they have a **range of inherited characteristics**, so it is **likely that some will have features that let them survive the changed conditions** (for example, tolerating warmer water). Those survivors can **reproduce**, so the population is more likely to persist. *(1 mark: variation means a range of characteristics among the larvae; 1 mark: so some are likely to survive the change, and the population persists.)*

(f) Because the polyps are **all genetically identical**, they **all share the same weaknesses**: a disease that can kill one polyp **can kill them all**, as there are **no genetically different polyps that might resist it**. *(1 mark.)*

Q9. (a) A **scientific (empirical) question** can be **answered by observation, measurement or experiment** — using evidence. A **bioethical (value) question** is about **what ought to be done**, and **cannot be settled by evidence alone**. For this proposal: an empirical question is, for example, **"How many native species live in the bushland?"**; a value question is, for example, **"Should the bushland be cleared to build the factory?"** *(1 mark: empirical = answerable by evidence; 1 mark: value = about what ought to be done / not settled by evidence; 1 mark: a valid example of each.)*

(b) The first person (weighing the benefit of the jobs against the harm) is using the **consequences-based approach**. The second person (it is wrong to destroy native habitat, whatever the benefit) is using the **duty- and rule-based approach**. *(1 mark: consequences-based; 1 mark: duty- and rule-based.)*

(c) Any **one** relevant concept, named and applied. For example: **non-maleficence** — the decision should **avoid causing harm to the native species and their habitat**; **respect** — the community whose area it is should be **involved in the decision**; or **justice** — it would be unfair to future generations, or to the wider community, to destroy the habitat for one company's benefit. *(1 mark: a relevant concept named; 1 mark: how it applies to protecting the bushland.)*

(d) The company **stands to gain if the factory is approved (a conflict of interest)**, so its own report may be **biased**, and it has **not been independently checked** — so the community should not rely on it alone. *(1 mark.)*

(e) A survey by **independent scientists** has **no interest in the outcome (no conflict of interest)**, and being **published in a peer-reviewed journal** means it has been **checked by other experts before publication**. It is therefore **more likely to be reliable and unbiased** than the company's own report. *(1 mark: independent / no conflict of interest; 1 mark: peer review = checked by experts before publication, so more reliable.)*

Exam 5 — Practice examination

Reading time: 15 minutes. Writing time: 2 hours 30 minutes. Section A: 40 questions, 40 marks. Section B: 9 questions, 80 marks. Total 120 marks. This examination covers Units 1 and 2. Answer all questions.

- *No calculator may be used.*
- *No formula sheet, data sheet, dictionary or notes may be used.*
- *Diagrams in this examination are not drawn to scale.*

Section A — Multiple choice

Every question in this section must be attempted. Select the response that is correct or that best answers the question. One mark is awarded for each correct response, and nothing is taken away where a response is wrong. Where two or more responses have been completed for the same question, no mark is awarded for it. No diagram in this section is drawn to scale.

Question 1

Which one of the following is found in both a bacterial cell and an animal cell?

A. a nucleus

B. a chloroplast

C. ribosomes

D. mitochondria

Question 2

A bacterial cell copies its single circular chromosome, grows, and then divides into two cells of about equal size, each receiving one copy of the chromosome. In a bacterium, this form of cell division is

A. binary fission.

B. mitosis.

C. meiosis.

D. apoptosis.

Question 3

A plant cell is placed in pure water. Water moves into the cell by osmosis, but the cell does not burst. This is because

A. water cannot cross the plasma membrane.

B. the plant cell has no plasma membrane.

C. the cell pumps the water straight back out using energy.

D. the cell wall resists the cell’s expansion once it is full.

Question 4

Root hair cells take up magnesium ions from the soil even when the concentration of magnesium ions is already higher inside the cell than in the soil water. This uptake

A. occurs by simple diffusion, down the concentration gradient.

B. requires energy from ATP, because the ions move against their concentration gradient.

C. occurs by osmosis.

D. requires no membrane proteins.

Question 5

A cell that produces and secretes large amounts of a protein hormone is likely to contain especially large numbers of

A. chloroplasts.

B. cell walls.

C. ribosomes.

D. large permanent vacuoles.

Question 6

During mitosis, the sister chromatids of each chromosome are pulled apart and move to opposite ends of the cell. This happens during

A. prophase.

B. metaphase.

C. telophase.

D. anaphase.

Question 7

As a human embryo develops, the cells in the webbing between the developing fingers die in a controlled, programmed way, so that separate fingers form. This programmed cell death is

A. apoptosis.

B. mitosis.

C. cytokinesis.

D. differentiation.

Question 8

In a body cell, the controls that normally halt the cell cycle when a cell is damaged fail, and the cell and its descendants go on dividing when they should not. The growing mass of cells that results is

A. an area of apoptosis.

B. a tumour.

C. a repaired, healthy tissue.

D. a group of cells held in interphase.

Question 9

In a leaf, palisade cells, guard cells, and xylem and phloem tissues all work together to carry out photosynthesis and to transport substances. A whole leaf is best described as

A. a single cell.

B. a single tissue.

C. an organ.

D. an organ system.

Question 10

When the protein in a meal is digested, it is broken down into

A. glucose.

B. amino acids.

C. fatty acids.

D. glycerol.

Question 11

The main role of the kidney in homeostasis is to

A. produce bile that digests fats.

B. produce the hormone insulin.

C. pump blood around the body.

D. regulate the water and solute balance of the blood and remove nitrogenous waste.

Question 12

On a hot, dry, windy day the guard cells in a plant's leaves close the stomata. The main benefit of this response to the plant is that

A. less water vapour is lost from the leaves.

B. more water vapour is lost from the leaves.

C. sugars are carried away from the leaves more quickly.

D. the roots stop taking up water from the soil.

Question 13

When body temperature falls below its set point, the skeletal muscles contract rapidly to release heat (shivering). In this response, the skeletal muscles act as the

A. receptor.

B. stimulus.

C. control centre.

D. effector.

Question 14

Between meals, the blood glucose concentration begins to fall. The response that raises it back towards the set point is

A. the pancreas releasing insulin, so that cells take up more glucose.

B. the pancreas releasing glucagon, so that the liver breaks glycogen down into glucose.

C. the kidney reabsorbing more water into the blood.

D. the skin arterioles widening to release heat.

Question 15

In the control of body temperature, the part of the body that receives information about the temperature and coordinates the response is the

A. sweat glands.

B. skin arterioles.

C. brain (the hypothalamus).

D. skeletal muscles.

Question 16

A student wants to find out whether the amount of sleep a person had the night before affects their score on a memory test. The independent variable is

A. the amount of sleep the person had.

B. the memory test score.

C. the difficulty of the memory test.

D. the time of day the test is taken.

Question 17

A student tests whether a sports drink improves how far people can run. For the comparison between the sports-drink group and the no-drink group to be valid, the two groups should be

A. made up of people of very different fitness levels.

B. tested on different days in different weather.

C. allowed to run for different lengths of time.

D. as alike as possible in every way except whether they are given the sports drink.

Question 18

Two research teams, in different laboratories and using their own equipment, carry out the same experiment and obtain very similar results. This adds confidence in the results because it shows they are

A. precise but not accurate.

B. reproducible.

C. based on secondary data.

D. the result of a systematic error.

Question 19

During an experiment a student records temperature readings herself with a thermometer, and also copies average rainfall figures from a government website. The temperature readings she recorded herself are

A. primary data.

B. secondary data.

C. an implication.

D. a hypothesis.

Question 20

In a survey of 80 students, 20 said they were left-handed. The percentage of the students surveyed who were left-handed was

A. 20%.

B. 4%.

C. 25%.

D. 60%.

Question 21

The complete set of an organism's genetic material (its DNA) is called its

A. allele.

B. genome.

C. phenotype.

D. gamete.

Question 22

In humans, 22 of the 23 pairs of chromosomes are alike in both males and females; only the remaining pair differs between the sexes. The 22 pairs that are alike in both sexes are the

A. gametes.

B. alleles.

C. sex chromosomes.

D. autosomes.

Question 23

During meiosis, sections of genetic material are exchanged between the two chromosomes of a homologous pair. This process is

A. crossing over, and it increases genetic variation.

B. independent assortment, and it reduces genetic variation.

C. fertilisation, and it halves the chromosome number.

D. binary fission, and it produces identical cells.

Question 24

A body cell of a certain frog contains 26 chromosomes. After meiosis, each of the gametes produced contains

A. 26 chromosomes.

B. 52 chromosomes.

C. 13 chromosomes.

D. 6 chromosomes.

Use the following information to answer Questions 25 and 26.

In hamsters, coat colour is controlled by a single gene. A pure-breeding golden hamster was crossed with a pure-breeding white hamster, and all of the offspring (the F1) were golden. Two of these F1 hamsters were then crossed, and their offspring (the F2) were counted.

F2 coat colour	Number of hamsters
golden	148
white	52

Question 25

From these results, the allele for golden coat colour is

A. recessive to the allele for white.

B. dominant to the allele for white.

C. codominant with the allele for white.

D. carried only on the sex chromosomes.

Question 26

The ratio of golden to white hamsters in the F2 is closest to

A. 1 : 1

B. 9 : 7

C. 2 : 1

D. 3 : 1

Question 27

In cats, a certain coat feature is caused by an X-linked recessive allele. Male cats show this feature more often than female cats because

A. male cats inherit two copies of every X-linked allele.

B. X-linked alleles are found only in male cats.

C. a male cat has only one X chromosome, so a single copy of the recessive allele is enough for the feature to show.

D. male cats cannot inherit the dominant allele.

Question 28

In some organisms, an environmental factor can switch a gene on or off without changing the DNA base sequence, and this change can sometimes be passed on to the next generation. This kind of influence on the phenotype is described as

A. a mutation.

B. an epigenetic effect.

C. crossing over.

D. codominance.

Question 29

A tick attaches to a wallaby, feeds on its blood, and harms the wallaby while benefiting itself. The relationship between the tick and the wallaby is best described as

A. parasitism.

B. mutualism.

C. competition.

D. predation.

Question 30

An animal produced by reproductive cloning (for example, by placing the nucleus of a body cell from one adult into an egg) is

A. a genetically varied mix of two parents.

B. produced by meiosis.

C. genetically identical to the egg donor only.

D. genetically identical to the adult that supplied the body-cell nucleus.

Question 31

During the hot part of the day, a camel allows its core body temperature to rise by several degrees instead of holding it steady. The main survival advantage of this to the camel is that

A. its cells no longer need oxygen while its temperature is high.

B. it can grow more quickly in hot conditions.

C. it does not need to sweat to stay cool, so it loses far less water.

D. the extra heat is stored as food energy for later use.

Question 32

Each spring, bogong moths fly hundreds of kilometres from the inland plains to cool caves high in the Australian Alps, where they rest through the hottest months before returning in autumn. This inherited migration is best classified as

A. a structural adaptation.

B. a behavioural adaptation.

C. a physiological adaptation.

D. an acquired characteristic.

Question 33

On a rocky seashore, sea otters feed on sea urchins, which graze on kelp. When the sea otters are removed, the sea urchins increase greatly and destroy most of the kelp, and many other species disappear. The sea otter is best described as

A. a keystone species.

B. a producer.

C. a parasite of the sea urchins.

D. an introduced species.

Question 34

Two species of birds living in the same woodland both feed on the seeds of one type of plant, and the supply of these seeds is limited. One of the two species is better at finding and taking the seeds. Over time, the most likely effect on the other bird species is that

A. its population size will rise, because the seeds it needs will be found for it.

B. its population size will be unaffected, because only members of the same species affect one another.

C. both bird species will increase in number, because they eat the same food.

D. its population size will fall, because it obtains less of the limited supply of seeds.

Question 35

Ecologists survey a beetle species in a forest and find it is common in the damp gullies but rare on the dry ridges. This description of where the beetles are found across the forest is a measure of the population's

A. density.

B. distribution.

C. genetic diversity.

D. biomass.

Question 36

A researcher makes sure she reports all of her results truthfully and does not leave out the data that do not suit her hypothesis. This behaviour is an example of the ethical concept of

A. non-maleficence.

B. justice.

C. integrity.

D. beneficence.

Question 37

A researcher deciding how to treat the animals in her study asks herself what an honest, careful and compassionate scientist would do in her position. This reasoning best reflects

A. the virtues-based approach.

B. the consequences-based approach.

C. the duty- and rule-based approach.

D. no ethical reasoning at all.

Question 38

A new medical treatment is very expensive. A committee argues that it should be made available fairly to everyone who needs it, not only to those who can afford it. This argument is based mainly on the ethical concept of

A. non-maleficence.

B. integrity.

C. beneficence.

D. justice.

Question 39

A website that sells a herbal supplement claims it "boosts the immune system", citing only the company's own tests. A reader should treat this claim with caution mainly because

A. the seller stands to profit from a favourable result, so it has a conflict of interest.

B. herbal supplements can never have any effect on the body.

C. the claim is written using scientific words.

D. the website is easy to read.

Question 40

Before a team may capture and release native animals during a field study, it must hold a permit issued under state wildlife law. In a bioethical investigation of this study, the permit requirement is best described as

A. an ethical concept.

B. an economic factor.

C. a legal factor.

D. a scientific hypothesis.

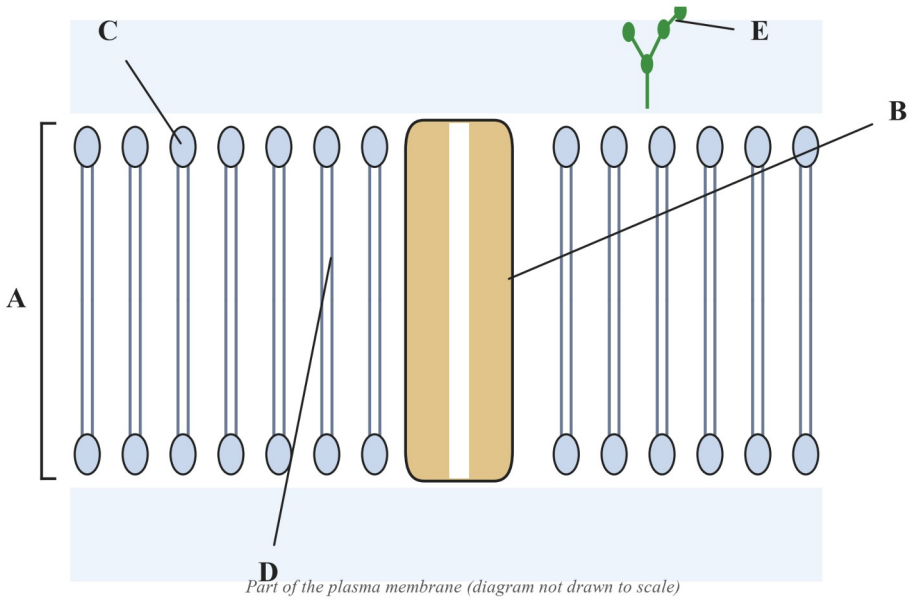
End of Section A

Section B — Short answer

Every question in this section must be attempted, in the spaces provided. For any question carrying two or more marks, a response earns full credit only if it reaches the depth that its command term and its mark allocation call for. No diagram in this section is drawn to scale.

Question 1 (8 marks)

The diagram below shows a cross-section of part of a plasma membrane. Five features are labelled **A** to **E**.



Part of the plasma membrane (diagram not drawn to scale)

a. Name the structure labelled **A**, and name the type of molecule that makes it up. 1 mark

b. Region **C** represents the "heads" of these molecules and region **D** represents their "tails". State whether the heads (**C**) are attracted to water or repelled by water, and explain why the tails (**D**) point towards the middle of the membrane. 2 marks

c. Structure **B** is a protein that spans the membrane. Explain how a large, water-soluble molecule such as glucose crosses the membrane, referring to structure **B**, and contrast this with how a small molecule such as oxygen crosses. 3 marks

d. State one function of the carbohydrate chain labelled **E**, and explain how the position of **E** on the membrane suits it to that function. 2 marks

Question 2 (8 marks)

A human begins life as a single fertilised egg cell. This cell divides many times to form an embryo, and the cells then become specialised into the many different cell types of the body, such as muscle cells, nerve cells and red blood cells.

a. Name the type of nuclear division by which the fertilised egg divides to form the many cells of the embryo, and state how the genetic make-up of these cells compares with that of the original fertilised egg. 2 marks

b. Name the sub-phase of interphase in which the DNA is copied before each division, and explain why it is important that each new cell receives an identical copy of the DNA. 2 marks

c. A muscle cell and a nerve cell contain the same genes but have very different structures. Name the process by which the unspecialised embryonic cells become specialised, and explain how two cells with the same genes can become so different. 2 marks

d. A stem cell taken from an embryo a few days after fertilisation can develop into any type of body cell in the organism, but cannot on its own form the placenta or a whole new organism. State the term that describes a cell with this ability, and distinguish it from a cell that can form only a limited range of related cell types. 2 marks

Question 3 (9 marks)

Two people were tested on a hot day. Person A had been resting in the shade and drinking normally. Person B had been exercising in the heat for two hours without drinking. Some measurements taken from each person are shown in Table 1. Hormone Z controls the amount of water reabsorbed by the kidney.

Table 1 Measurements from the two people

Measurement	Person A (well hydrated)	Person B (dehydrated)
solute concentration of the blood	normal	high
level of hormone Z in the blood	low	high
volume of urine produced per hour	large	small
concentration of the urine	dilute	concentrated

a. Name hormone Z, and name the organ that acts as the effector in this response. 2 marks

b. In Person B the solute concentration of the blood has risen above its set point. Describe the negative-feedback response that brings the blood solute concentration back towards its set point. In your answer, refer to the receptor, hormone Z and the effect on the kidney. 4 marks

c. Explain why this control system is described as negative feedback. 1 mark

d. Using the data in Table 1, explain the difference between Person A and Person B in the volume and concentration of the urine each produces. 2 marks

Question 4 (7 marks)

A student removed a complete ring of the outer bark from around the trunk of a young tree. The outer bark contains the phloem; the inner wood, which was left in place, contains the xylem. Several weeks later the bark had swollen just above the ring, and the leaves above the ring were still healthy, but the trunk below the ring had begun to die back.

a. Name the tissue that transports water and dissolved minerals from the roots to the leaves, and name the tissue that transports the sugars made in the leaves to the rest of the plant. 2 marks

b. Explain why the leaves above the ring stayed healthy for several weeks, even though the ring of bark had been removed. 2 marks

c. Sugars built up in the swollen bark just above the ring. Explain what this shows about the direction in which the phloem was transporting the sugars. 2 marks

d. State why the trunk below the ring eventually began to die back. 1 mark

Question 5 (10 marks)

Beetroot cells contain a red pigment that leaks out only when the plasma membrane is damaged. A student investigated how the concentration of ethanol (alcohol) affects the membranes of beetroot cells. She cut identical discs of beetroot, rinsed them, and placed the same number of discs in a solution of a different ethanol concentration for 20 minutes. She then measured the amount of red pigment that had leaked into each solution using a colour scale from 0 (no colour) to 10 (deep red). She used three tubes at each ethanol concentration. Her results are shown in Table 2.

Table 2 Colour score of the solution after 20 minutes

Ethanol concentration (%)	Tube 1	Tube 2	Tube 3	Mean colour score
0	1	1	1	1
20	3	4	5	4
40	6	7	8	7
60	8	10	9	?

a. Identify the independent variable and the dependent variable in this investigation. 2 marks

b. Calculate the mean colour score at 60% ethanol (the value marked "?"). Show your working. 1 mark

c. Calculate the percentage increase in the mean colour score from 20% ethanol to 60% ethanol. Show your working. 2 marks

d. Explain, in terms of the plasma membrane, why more red pigment leaked out at higher ethanol concentrations. 2 marks

e. The colour of each solution was judged by eye. State one way this could reduce the reliability of the results, and state one improvement the student could make. 2 marks

f. State one variable, other than the ethanol concentration, that the student needed to keep the same for every tube. 1 mark

Question 6 (10 marks)

In a certain breed of goat, ear length is controlled by a single gene that shows incomplete dominance. A goat with two "long" alleles ($E^L E^L$) has long ears, a goat with two "short" alleles ($E^S E^S$) has short ears, and a goat with one of each ($E^L E^S$) has ears of medium length.

a. State the genotype of a medium-eared goat, and explain, in terms of incomplete dominance, why its ears are medium rather than long. 2 marks

b. Two medium-eared goats are crossed. Construct a Punnett square for this cross and state the ratio of ear lengths expected among the offspring. 3 marks

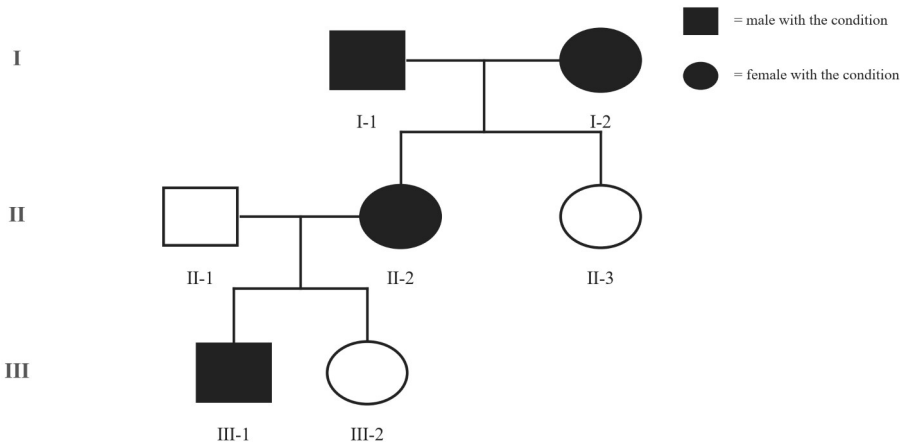
c. A medium-eared goat is crossed with a short-eared goat. Show the cross, and state the ratio of ear lengths expected among the offspring. 2 marks

d. A breeder wants a herd in which every goat has medium-length ears. Explain why this cannot be achieved by breeding medium-eared goats together, no matter which two medium-eared goats are chosen as parents. 3 marks

Question 7 (9 marks)

The diagram below is a pedigree for one inherited condition, followed across three generations of a family. Any individual drawn with a shaded symbol has the condition. Where a genotype is asked for, use **A** for the allele that causes the condition and **a** for the normal allele.

Inheritance of one condition in a family (shaded = has the condition)



a. State whether the allele causing the condition is dominant or recessive, and give one reason from the pedigree. 2 marks

b. Explain how the pedigree shows that the condition is autosomal, rather than X-linked dominant. Refer to one specific individual. 2 marks

c. State the genotypes of I-1, II-2 and II-1. 3 marks

d. II-1 and II-2 plan to have another child. Calculate the probability that this child has the condition. Show your reasoning. 2 marks

Question 8 (7 marks)

The grey mangrove is a tree that grows in the soft, waterlogged mud of coastal estuaries in Australia. Two of its inherited features are: (i) special roots, called pneumatophores, that grow upward out of the mud into the air; and (ii) the excretion of excess salt from the plant, which it carries out through special glands in its leaves. Many young fish and crabs shelter and feed among the mangrove's roots.

a. Classify each of the two features, the pneumatophores and the excretion of excess salt through the leaves, as a structural, physiological or behavioural adaptation. 2 marks

b. The mud in which the mangrove grows is waterlogged and contains very little oxygen. Explain how the pneumatophores are an adaptation to these conditions. 2 marks

c. Using the idea of interdependence, explain why a loss of the mangroves could reduce the numbers of the young fish that live among their roots. 2 marks

d. Aboriginal and Torres Strait Islander peoples hold detailed, long-standing knowledge of mangrove and estuary Country. State one way this knowledge can contribute to the management of these ecosystems. 1 mark

Question 9 (12 marks)

Conservation managers are considering a proposal to establish a new "insurance" population of an endangered native animal. They would move 20 individuals from a threatened mainland population to a predator-free offshore island, where a new population could grow. At a public meeting, people put forward several different arguments.

a. Write one scientific (empirical) question and one bioethical (value) question that this proposal raises. 2 marks

b. One manager argues that the move should go ahead because the likely benefit — saving the species from extinction — outweighs the likely harms and costs. Name the ethical approach this reflects, and name a different approach that a person opposing the move, on the grounds that it is wrong to disturb the island's existing ecosystem, might be using. 2 marks

c. Name one ethical concept that supports the proposal and one that could count against it, and briefly state how each applies. 2 marks

d. Only 20 individuals will be moved to start the new population. Using the idea of genetic diversity, explain one biological risk to the new island population of starting from so few individuals. 2 marks

e. Before deciding, the managers compare two sources of information about the island: a report published in a peer-reviewed scientific journal, and a claim posted on a social-media page by a member of the public. State which source provides the stronger evidence, and give one reason. 2 marks

f. The managers must explain their decision both to a scientific committee and to the general public. Contrast the explanation prepared for the general public with the one prepared for the scientific committee. 2 marks

End of Section B

End of examination questions

Exam 5 — Answers and solutions

Section A — answers

Q	Ans	Q	Ans	Q	Ans	Q	Ans
1	C	11	D	21	B	31	C
2	A	12	A	22	D	32	B
3	D	13	D	23	A	33	A
4	B	14	B	24	C	34	D
5	C	15	C	25	B	35	B
6	D	16	A	26	D	36	C
7	A	17	D	27	C	37	A
8	B	18	B	28	B	38	D
9	C	19	A	29	A	39	A
10	B	20	C	30	D	40	C

Q1. C — ribosomes are found in all cells, including bacteria and animal cells. A nucleus, mitochondria and chloroplasts are all membrane-bound structures that a bacterial cell lacks.

Q2. A — a prokaryote divides by binary fission: the single circular chromosome is copied and the cell splits into two, each with one copy. Mitosis and meiosis are the nuclear divisions of eukaryotic cells, which bacteria do not have, and apoptosis is programmed cell death, not cell division.

Q3. D — water enters the plant cell by osmosis, but the strong cell wall resists further expansion, so the cell becomes firm (turgid) rather than bursting. An animal cell, with no wall, would burst.

Q4. B — the ions are moving against their concentration gradient (from lower to higher concentration), which is active transport and requires energy from ATP and a membrane protein.

Q5. C — proteins are assembled at ribosomes, so a cell that makes and secretes large amounts of a protein has especially many ribosomes (and rough endoplasmic reticulum). Chloroplasts, cell walls and large vacuoles are features of plant cells and are not involved in secreting protein.

Q6. D — the sister chromatids separate and move to opposite poles during anaphase. In metaphase they line up at the equator, and in telophase the nuclei re-form.

Q7. A — the controlled, programmed death of the cells between the fingers is apoptosis. Mitosis and cytokinesis are parts of cell division, and differentiation is cells becoming specialised.

Q8. B — when regulation of the cell cycle breaks down, the affected cells keep dividing when they should have been stopped or removed, and they accumulate as a tumour. Apoptosis is the opposite (the controlled removal of a cell), the tissue is not repaired, and interphase is simply the part of the cell cycle between divisions.

Q9. C — a leaf is made of several tissues (for example palisade, epidermis, xylem and phloem) working together for a function, which makes it an organ. An organ system is a group of organs.

Q10. B — proteins are digested into amino acids. Starch is digested into glucose, and fats into fatty acids and glycerol.

Q11. D — the kidney regulates the water and solute balance of the blood and removes nitrogenous waste (urea) in the urine. It does not make bile or insulin, and it does not pump blood.

Q12. A — the stomata are the main openings through which water vapour escapes from a leaf, so closing them slows transpiration and conserves water on a hot, dry, windy day. (The cost is that less carbon dioxide can enter for photosynthesis.) Closing the stomata does not increase water loss, does not move sugars, and does not stop uptake by the roots.

Q13. D — the muscles are the effector: they carry out the response (shivering) ordered by the control centre. The receptor detects the change, and the stimulus is the fall in temperature itself.

Q14. B — when blood glucose falls, the pancreas releases glucagon, which makes the liver break glycogen down into glucose and release it, raising the blood glucose. Insulin (A) lowers blood glucose.

Q15. C — the control centre that receives the temperature information and coordinates the response is the brain (the hypothalamus). The sweat glands, skin arterioles and skeletal muscles are effectors that carry out the response, not the control centre.

Q16. A — the independent variable is the factor deliberately changed and thought to have an effect: the amount of sleep. The memory score is the dependent variable, and the other two are controlled variables.

Q17. D — for the comparison to be valid the two groups must be alike in every way except the one variable being tested (whether they get the sports drink), so that any difference can be put down to the drink alone.

Q18. B — obtaining the same result in a different laboratory, with different equipment and a different team, shows the result is reproducible. Precision and accuracy concern a single set of readings, not different investigators.

Q19. A — data a student collects first-hand are primary data. The rainfall figures copied from a website were collected by someone else, so for this student they are secondary data.

Q20. C — percentage = (part ÷ whole) × 100 = (20 ÷ 80) × 100 = 25%.

Q21. B — the complete set of an organism's DNA is its genome. An allele is one form of a gene, the phenotype is the observable characteristics, and a gamete is a sex cell.

Q22. D — the 22 pairs that are alike in both males and females are the autosomes; the remaining pair are the sex chromosomes, which differ between the sexes.

Q23. A — the exchange of segments between homologous chromosomes is crossing over, and it produces new combinations of alleles, increasing genetic variation.

Q24. C — meiosis halves the chromosome number, so each gamete is haploid, carrying half of 26, which is 13 chromosomes.

Q25. B — the two pure-breeding parents differ, yet all the F1 are golden; the allele that shows in the F1 (golden) is the dominant one. (White reappears in the F2, showing it was the hidden recessive.)

Q26. D — 148 golden to 52 white is close to 3 : 1 (148 ÷ 52 ≈ 2.85), the ratio expected in the F2 of a monohybrid cross with complete dominance.

Q27. C — a male has only one X chromosome, so a single copy of an X-linked recessive allele is enough for the feature to show; a female would need the recessive allele on both of her X chromosomes.

Q28. B — a change that switches a gene on or off without altering the DNA base sequence, and that can be inherited, is an epigenetic effect. A mutation changes the base sequence itself.

Q29. A — the tick benefits while the wallaby (its host) is harmed, and it lives on and feeds from the host over time; this is parasitism. In mutualism both species benefit, in competition both are disadvantaged by contesting a resource, and a predator kills and eats its prey.

Q30. D — the clone develops from the body-cell nucleus of one adult, so it is genetically identical to that adult. It is not a mix of two parents and is not made by meiosis.

Q31. C — sweating cools the body but costs water. By letting its core temperature drift upward through the heat of the day, the camel avoids sweating and so conserves water where water is scarce; the stored heat is then given off to the cool night air. Cells always need oxygen, the camel does not grow faster when hot, and heat cannot be stored as food energy.

Q32. B — the migration is something the moth *does* — an inherited pattern of behaviour that takes it to a cooler place for the hottest months — so it is a behavioural adaptation. A structural adaptation is a physical feature of the body and a physiological adaptation is an internal functional process; the migration is inherited, not learned during the moth's life.

Q33. A — the sea otter has an effect on its community far greater than its own numbers would suggest: removing it lets the urchins destroy the kelp and many species disappear. That is a keystone species.

Q34. D — the two species contest the same limited resource, so the poorer competitor obtains less food and its population size falls (it may also be pushed into parts of the woodland where it competes less directly). Its numbers cannot rise while it is losing the contest, competition occurs between species as well as within a species, and neither bird becomes the other's food or partner.

Q35. B — where a species is found across an area (here, in the gullies but not the ridges) is its distribution. Density is the number per unit area, not where it occurs.

Q36. C — reporting all results truthfully, without leaving out inconvenient data, is honesty, which is the ethical concept of integrity. Non-maleficence is avoiding harm, justice is fairness, and beneficence is doing good.

Q37. A — the researcher is asking what sort of person she should be, judging the action by the moral character of the one performing it; that is the virtues-based approach. The consequences-based approach weighs the outcomes of the action, and the duty- and rule-based approach appeals to a duty or a rule that must be followed whatever the outcome.

Q38. D — sharing a limited, expensive resource fairly among all who need it is an appeal to justice. Non-maleficence is avoiding harm, beneficence is doing good, and integrity is honesty.

Q39. A — the company profits from selling the supplement, so it has a direct interest in the result of its own tests: that is a conflict of interest and a well-recognised source of bias. Herbal supplements can have real effects, and scientific-sounding words or an easy-to-read page do not make a claim reliable.

Q40. C — a requirement imposed by legislation is a legal factor bearing on the investigation. An economic factor concerns costs and money, an ethical concept (such as justice or respect) is a value used in judging what ought to be done, and a hypothesis is a testable prediction.

Section B — solutions

Q1. (a) Structure **A** is the (phospholipid) **bilayer** — the double layer that forms the membrane — and it is made of **phospholipid** molecules. *(1 mark: the phospholipid bilayer, made of phospholipids.)*

(b) The heads (**C**) are **attracted to water** (they are hydrophilic). The tails (**D**) are **repelled by water** (hydrophobic), so in the watery surroundings on both sides of the membrane the tails **turn inward, away from the water, towards the middle of the membrane**, where they are shielded from it. *(1 mark: the heads are attracted to water / hydrophilic; 1 mark: the tails are water-repelling, so they point inward, away from the water.)*

(c) A large, water-soluble molecule such as glucose **cannot pass through the water-repelling tail region in the middle of the membrane**, so it crosses **through a transport protein (structure B)**, which provides a route across the membrane (facilitated diffusion). A small molecule such as oxygen is able to **pass directly between the phospholipids, straight through the bilayer**, without needing a transport protein. *(1 mark: glucose is large/water-soluble and cannot cross the bilayer directly; 1 mark: so it crosses through the transport protein B; 1 mark: oxygen is small and passes directly through the bilayer without a protein.)*

(d) The carbohydrate chain (**E**) acts as a **marker that lets cells recognise one another** (cell recognition / identification). It is attached to the **outer face of the membrane** and **projects out into the cell's surroundings**, which is where other cells make contact with it — so it can be **reached and recognised from outside the cell**. A marker buried inside the membrane, or facing the cytoplasm, could not be detected by another cell. *(1 mark: a valid function — cell recognition / identification; 1 mark: **E** projects from the outer surface into the surroundings, where other cells can contact and recognise it.)*

Q2. (a) The fertilised egg divides by **mitosis**. The many cells produced are **genetically identical** to one another and to the original fertilised egg (each carries the same DNA). *(1 mark: mitosis; 1 mark: genetically identical.)*

(b) The DNA is copied during the **S phase** of interphase. It is important that each new cell receives an **identical, complete copy of the DNA** so that every cell has the **full, correct set of instructions** it needs to work properly; an error in the copy could stop the cell functioning correctly. *(1 mark: S phase; 1 mark: so each cell has a complete, correct copy of the genetic instructions.)*

(c) The process is **differentiation**. Although the two cells contain the **same genes**, **different genes are switched on (expressed) in each cell type**, so each cell makes different proteins and develops a different structure and function. *(1 mark: differentiation; 1 mark: different genes are expressed in each cell type, even though the genes present are the same.)*

(d) A cell that can develop into **any type of body cell**, but not the placenta and not a whole organism, is **pluripotent** (an embryonic stem cell). This differs from a cell that can form only a **limited range of related cell types**, which is **multipotent** — for example, a bone-marrow stem cell that forms only the various blood cells. (A cell that could also form the placenta and a complete organism, such as the zygote, would be **totipotent**.) *(1 mark: pluripotent; 1 mark: distinguishes it from a cell of the narrower kind, either by naming it multipotent or by stating that such a cell can form only the related cell types of one tissue.)*

Q3. (a) Hormone Z is **ADH (antidiuretic hormone)**, and the organ that acts as the effector is the **kidney**. *(1 mark: ADH; 1 mark: kidney.)*

(b) The rise in the blood's solute concentration is **detected by receptors (osmoreceptors) in the brain**. In response, **more ADH (hormone Z) is released** into the blood. The ADH makes the **kidney reabsorb more water from the filtrate back into the blood**, so a **smaller volume of more concentrated urine** is produced and **water is conserved**; this **returns the blood's solute concentration back down towards its set point**. *(1 mark: receptors detect the rise in solute concentration; 1 mark: more ADH is released; 1 mark: the kidney reabsorbs more water / produces less, more concentrated urine; 1 mark: so the blood solute concentration falls back towards the set point.)*

(c) It is negative feedback because the **response opposes (reverses) the original change** — it brings the raised solute concentration back down towards the set point, rather than pushing it further away. *(1 mark.)*

(d) Person B is **dehydrated**, so has a **high level of ADH**; the kidney therefore **reabsorbs more water**, producing a **small volume of concentrated urine** to conserve water. Person A is **well hydrated**, so has a **low level of ADH**; less water is reabsorbed, so a **large volume of dilute urine** is produced to remove the excess water. *(1 mark: Person B — high ADH → small volume of concentrated urine, linked to conserving water; 1 mark: Person A — low ADH → large volume of dilute urine, linked to removing excess water.)*

Q4. (a) Water and dissolved minerals are transported from the roots to the leaves by the **xylem**, and the sugars made in the leaves are transported to the rest of the plant by the **phloem**. *(1 mark: xylem; 1 mark: phloem.)*

(b) The **xylem is in the inner wood**, which was **left in place** when only the outer bark was removed. Water and minerals could therefore **still travel up the xylem to the leaves**, so the leaves remained supplied and stayed healthy. *(1 mark: the xylem (inner wood) was not removed; 1 mark: so water and minerals still reached the leaves.)*

(c) The sugars are made in the leaves and are normally carried **downward** through the phloem towards the roots. Removing the ring of bark **cut the phloem**, so the downward-moving sugars **could not pass the cut and built up just above it**. This shows the phloem was transporting the sugars **away from the leaves, downward towards the roots**. *(1 mark: the phloem transports sugars downward / away from the leaves; 1 mark: the sugars built up above the cut because the downward path was blocked.)*

(d) Below the ring, the cells (and roots) **no longer received sugars from the leaves** (the phloem was cut), so they were starved of nutrients and began to die back. *(1 mark.)*

Q5. (a) The **independent variable** is the **concentration of ethanol** in the solution; the **dependent variable** is the **amount of red pigment that leaked out** (the colour score of the solution). *(1 mark: IV = ethanol concentration; 1 mark: DV = amount of pigment leaked / colour score.)*

(b) Mean at 60% ethanol = (8 + 10 + 9) ÷ 3 = 27 ÷ 3 = **9**. *(1 mark.)*

(c) Percentage increase = (final − initial) ÷ initial × 100 = (9 − 4) ÷ 4 × 100 = 5 ÷ 4 × 100 = **125%**. *(1 mark: correct method; 1 mark: 125%.)*

(d) Ethanol **damages (dissolves/disrupts) the phospholipid membrane**, making it **more permeable** (or breaking it down), so the red pigment can **leak out** of the cells. The **higher the ethanol concentration, the more the membrane is damaged**, so more pigment leaks out. *(1 mark: ethanol damages/breaks down the*

membrane, making it more permeable; 1 mark: more damage at higher concentration, so more pigment leaks out.)

(e) Judging the colour **by eye is subjective** and different people (or the same person on different tubes) may **score the same colour differently**, so the results are **less reliable/consistent**. An improvement: **measure the colour with a colorimeter (or light sensor)**, which gives an **objective, consistent measurement**. *(1 mark: judging by eye is subjective / inconsistent; 1 mark: a valid improvement, e.g. use a colorimeter.)*

(f) Any **one** valid controlled variable, for example: the **number (and size) of beetroot discs**; the **temperature**; the **volume of solution**; the **time left (20 minutes)**; or the **same type of beetroot**. *(1 mark.)*

Q6. (a) A medium-eared goat has the genotype $E^L E^S$. Its ears are medium rather than long because the two alleles show **incomplete dominance** — **neither allele is completely dominant**, so the heterozygote shows an **intermediate (in-between) ear length**, between long and short, rather than the long-eared phenotype. *(1 mark: $E^L E^S$; 1 mark: neither allele is completely dominant, so the heterozygote is intermediate.)*

(b) The cross is $E^L E^S \times E^L E^S$:

×	E^L	E^S
E^L	$E^L E^L$	$E^L E^S$
E^S	$E^L E^S$	$E^S E^S$

The offspring are $E^L E^L$, $E^L E^S$, $E^L E^S$, $E^S E^S$ — a genotype ratio of 1 : 2 : 1 — so the ear-length ratio is **1 long : 2 medium : 1 short**. *(1 mark: correct Punnett square with the right gametes; 1 mark: the four offspring identified; 1 mark: 1 long : 2 medium : 1 short.)*

(c) The cross is $E^L E^S \times E^S E^S$, which gives offspring $E^L E^S$ (medium) and $E^S E^S$ (short) in equal numbers — a ratio of **1 medium : 1 short**. *(1 mark: the cross $E^L E^S \times E^S E^S$ shown correctly, by a Punnett square or by gametes; 1 mark: 1 medium : 1 short.)*

(d) A medium-eared goat is **heterozygous ($E^L E^S$)**. Crossing two medium-eared goats is therefore always $E^L E^S \times E^L E^S$, which (from part **b**) always gives a **1 : 2 : 1 ratio** — so **one quarter of the offspring have long ears and one quarter have short ears** every time. It is impossible to remove the long- and short-eared offspring by choosing different medium-eared parents, because every medium-eared goat has the same heterozygous genotype. (An all-medium herd could only be produced by crossing a long-eared goat with a short-eared goat, $E^L E^L \times E^S E^S$.) *(1 mark: medium is heterozygous $E^L E^S$; 1 mark: medium × medium always gives 1 : 2 : 1, so ¼ long and ¼ short always appear; 1 mark: so a herd of only medium-eared goats cannot be bred from medium-eared parents.)*

Q7. (a) The allele is **dominant**. **I-1 and I-2 are both affected, yet their daughter II-3 is unaffected.** If the allele causing the condition were recessive, two affected parents would each carry **two copies of it** and could pass on **nothing else**, so **every one of their children would be affected**. An unaffected child is only possible if each affected parent also carries a normal allele that is **masked** — that is, if the condition-causing allele is **dominant**. *(1 mark: dominant; 1 mark: the two affected parents I-1 and I-2 have an unaffected daughter, II-3, which could not happen if the allele were recessive.)*

(b) **I-1 is an affected male, and his daughter II-3 is unaffected.** If the condition were **X-linked dominant**, I-1 would pass his single X chromosome — the one carrying the condition-causing allele — to **every one of his daughters**, so **all of his daughters would be affected**. Because I-1 has an **unaffected daughter (II-3)**, the condition **cannot be X-linked dominant**. Part **a** has already shown that the allele is **dominant**, and the only two possibilities for a dominant allele are X-linked dominant and autosomal dominant, so the condition must be **autosomal dominant**. *(1 mark: refers to I-1 (affected male) having an unaffected daughter, II-3; 1 mark: an X-linked dominant affected father would pass the allele to all of his daughters, so all would be affected — since II-3 is not, the allele cannot be X-linked, and as it is dominant it must be autosomal.)*

(c) **I-1 = Aa**, **II-2 = Aa**, **II-1 = aa**. (I-1 is affected, so he carries at least one **A**; but his daughter II-3 is unaffected (**aa**), so she must have received an **a** from him — I-1 is therefore **Aa**. II-2 is affected, so she carries at least one **A**; her daughter III-2 is unaffected (**aa**), so she must have received an **a** from II-2 — II-2 is therefore **Aa**.

II-1 is unaffected, and because the condition is dominant an unaffected person cannot carry **A** at all, so II-1 is **aa**.) *(1 mark each: I-1 = Aa; II-2 = Aa; II-1 = aa.)*

(d) The cross is **Aa (II-2) × aa (II-1)**:

×	A	a
a	Aa	aa
a	Aa	aa

The offspring are **1 Aa (affected) : 1 aa (unaffected)**, so the probability that the child has the condition is **½ (1 in 2)**. *(1 mark: cross Aa × aa set up correctly; 1 mark: probability = ½.)*

Q8. (a) The **pneumatophores** (special roots) are a **structural** adaptation — a physical feature of the plant's body. The **excretion of excess salt through the leaves** is a **physiological** adaptation — a functional process that the plant's cells carry out. *(1 mark: pneumatophores — structural; 1 mark: salt excretion — physiological.)*

(b) The mud is **waterlogged and low in oxygen**, so the roots buried in it **cannot obtain enough oxygen** for their cells to respire. The **pneumatophores grow up out of the mud into the air**, where they can **take in oxygen** and supply it to the root cells, allowing the mangrove to survive in the low-oxygen mud. *(1 mark: the mud is waterlogged / low in oxygen, so the buried roots cannot get enough oxygen; 1 mark: the pneumatophores reach up into the air and take in oxygen for the roots.)*

(c) The young fish **depend on the mangroves for shelter and food** — the roots protect them from larger predators and provide feeding sites. If the mangroves were **lost**, the fish would **lose this shelter and food**, so **more would be eaten or would starve** and their numbers would fall. The two are **interdependent** — the fish rely on the mangroves to survive. *(1 mark: the fish depend on the mangroves for shelter/food; 1 mark: so losing the mangroves would reduce the fish's survival / numbers.)*

(d) Any **one**: Aboriginal and Torres Strait Islander peoples hold **detailed, long-standing observational knowledge** of the estuary species, their seasons and their sustainable use, which can **inform effective and respectful management of the ecosystem (caring for Country)**; and management should be **carried out in partnership with, and with the consent of, the communities** whose Country it is. *(1 mark for one valid point.)*

Q9. (a) A **scientific (empirical) question**, for example: **"Can the island's food supply support a growing population of this animal?"** (or "How many of the 20 animals will survive on the island?"). A **bioethical (value) question**, for example: **"Should we move these animals to the island?"** — a question about what ought to be done. *(1 mark: a valid empirical question that evidence could answer; 1 mark: a valid value question about what ought to be done.)*

(b) Weighing the benefit against the harms and costs is the **consequences-based approach**. A person opposing the move because it is **wrong to disturb the island's existing ecosystem, whatever the benefit**, is using the **duty- and rule-based approach** (a virtues-based answer, correctly explained, is also acceptable). *(1 mark: consequences-based; 1 mark: a different named approach — duty/rule-based or virtues-based.)*

(c) Any valid pair, one on each side. For example: **beneficence** — the move **does good by helping to save a species from extinction** (supports the proposal); **non-maleficence** — the move could **harm the animals moved, or the island's existing wildlife** (counts against it). (Justice or respect, correctly applied, are also acceptable.) *(1 mark: a supporting concept named and applied; 1 mark: a concept counting against, named and applied.)*

(d) The 20 individuals that are moved carry only a **small sample of the alleles** present in the whole source population, so the new island population starts with **low genetic diversity**. With little variation, the population is **less able to adapt to a new disease or environmental change** — it is unlikely to contain individuals with the characteristics needed to survive such a change — so it is at **greater risk of dying out**. *(1 mark: so few individuals carry only a small sample of the alleles → low genetic diversity; 1 mark: so the population is less able to survive a new disease / environmental change, e.g. no resistant individuals.)*

(e) The **peer-reviewed journal report** provides the stronger evidence. It has been **independently checked by experts in the field before publication**, so it is more likely to be reliable, whereas a social-media post by a member of the public has had **no such independent check** (its author's expertise and possible bias are

unknown, and it may be only opinion). *(1 mark: the peer-reviewed report; 1 mark: a valid reason — it has been independently checked by experts, unlike the social-media post.)*

(f) For the **general public**, the explanation should **use plain, everyday language with little or no technical jargon, and lead with the main message and what it means**, whereas the version for the scientific committee can use the **full technical terminology and present the detailed data and methods**. (The accuracy of the message stays the same for both audiences.) *(1 mark: the public version — plain, everyday language / little or no jargon / leads with the main message; 1 mark: the committee version — full technical terminology with the detailed data and methods.)*

Exam 6 — Practice examination

Reading time: 15 minutes. Writing time: 2 hours 30 minutes. Section A: 40 questions, 40 marks. Section B: 9 questions, 80 marks. Total 120 marks. This examination covers Units 1 and 2. Answer all questions.

- *No calculator may be used.*
- *No formula sheet, data sheet, dictionary or notes may be used.*
- *Diagrams in this examination are not drawn to scale.*

Section A — Multiple choice

Every question in this section must be attempted. Select the response that is correct or that best answers the question. One mark is awarded for each correct response, and nothing is taken away where a response is wrong. Where two or more responses have been completed for the same question, no mark is awarded for it. No diagram in this section is drawn to scale.

Question 1

A bacterial cell can be distinguished from an animal cell by the bacterial cell's lack of

A. ribosomes.

B. a cell membrane.

C. cytoplasm.

D. a nucleus.

Question 2

A nerve cell has a very long, thin fibre extending from its cell body. This structure suits the nerve cell to

A. absorbing sunlight for photosynthesis.

B. carrying electrical messages over long distances.

C. storing large amounts of starch.

D. dividing very rapidly to replace itself.

Question 3

When a cell carries out an activity that needs energy, the molecule that acts as the cell's immediate source of that energy is

A. ATP.

B. DNA.

C. water.

D. oxygen.

Question 4

A cell that uses a great deal of energy, such as an actively contracting muscle cell, would be expected to contain especially many

A. mitochondria.

B. chloroplasts.

C. cell walls.

D. large permanent vacuoles.

Question 5

A cell is surrounded by a solution containing water, glucose, sodium ions and a large protein. Water crosses the cell's plasma membrane freely; glucose and sodium ions cross only with the help of membrane proteins; and the large protein does not cross at all. This shows that the plasma membrane is

A. freely permeable to every substance.

B. impermeable to all substances.

C. made entirely of protein.

D. differentially (selectively) permeable.

Question 6

A muscle cell is respiring quickly and takes in oxygen from the blood. The oxygen crosses the plasma membrane

A. by simple diffusion, because respiration keeps the oxygen concentration inside the cell lower than the concentration outside.

B. by active transport, because the cell is using ATP.

C. by osmosis, because oxygen is dissolved in water.

D. by facilitated diffusion, because oxygen is too large to cross without a carrier protein.

Question 7

The plasma membrane is often described as a fluid mosaic. In this description, the term fluid refers to the fact that

A. the membrane is made mostly of liquid water.

B. the phospholipid molecules are not fixed in place and can move about within their layer.

C. every substance can flow freely across the membrane.

D. the membrane dissolves in the cytoplasm of the cell.

Question 8

A cell has acquired mutations so that it ignores the signals that normally stop cell division, and it no longer undergoes apoptosis. This cell is most likely to

A. differentiate into a specialised cell.

B. be removed at a cell-cycle checkpoint.

C. stop dividing once it is surrounded by other cells.

D. divide again and again, forming a growing mass of cells.

Question 9

Which one of the following gives the correct order of the stages in the cell cycle of a body cell?

A. mitosis → interphase → cytokinesis

B. cytokinesis → mitosis → interphase

C. interphase → mitosis → cytokinesis

D. mitosis → cytokinesis → interphase

Question 10

A layer of cells that lines the inside of the small intestine and absorbs digested food is an example of

A. epithelial tissue.

B. muscle tissue.

C. nervous tissue.

D. an organ system.

Question 11

The keeping of a relatively constant internal environment in the body, despite changes in the surroundings, is called

A. digestion.

B. homeostasis.

C. reproduction.

D. excretion.

Question 12

On a hot, dry, windy day, a well-watered plant may still wilt. This is because the plant

A. is carrying out too much photosynthesis.

B. is taking up too much water through its roots.

C. stops respiring in the heat.

D. loses water by transpiration faster than its roots can take it up.

Question 13

A group of different organs that work together to carry out a major function in the body is called

A. a tissue.

B. a single cell.

C. an organ.

D. an organ system.

Question 14

When a person's blood becomes too concentrated (it contains too little water), the body conserves water, and the blood returns towards its normal concentration. This return towards the set point is an example of

A. negative feedback.

B. positive feedback.

C. an acquired characteristic.

D. a systematic error.

Question 15

In a person with untreated type 1 diabetes, the blood glucose concentration stays high after a meal. This is because the person's body

A. produces far too much insulin.

B. cannot absorb any glucose from food.

C. produces little or no insulin.

D. breaks glucose down too quickly.

Question 16

Large, active animals need specialised transport systems (such as a blood system) because

A. their cells do not respire.

B. they have a very high surface-area-to-volume ratio.

C. diffusion alone is too slow to supply every cell deep inside a large body.

D. they do not need to exchange materials with their surroundings.

Question 17

A student investigates how the amount of fertiliser affects the growth of tomato plants. To make the comparison fair, which one of the following should be kept the same for every plant?

A. the amount of fertiliser given to each plant

B. the final height each plant reaches

C. the type and size of the pot used for each plant

D. the number of plants that die

Question 18

A digital balance has not been set to zero, so it adds 0.4 g to every mass it records. This is

A. a random error.

B. an error that averaging many readings will remove.

C. an outlier.

D. a systematic error.

Question 19

Five measurements of the same object are all very close to one another, and all very close to the true value. These readings are best described as

A. precise but not accurate.

B. accurate and precise.

C. accurate but not precise.

D. neither accurate nor precise.

Question 20

An experiment includes a control group that is treated in exactly the same way as the test group, except for the one factor being investigated. The main purpose of the control group is to

A. increase the number of participants.

B. make the experiment take longer.

C. provide a comparison, so that any effect can be attributed to the factor being tested.

D. remove the need to repeat the experiment.

Question 21

In a set of eight readings, seven lie between 20 and 24 and the eighth is 61. The logbook records nothing unusual about the eighth measurement. The best action is to

A. report the reading, and give the mean both with and without it.

B. delete the reading of 61 without comment.

C. replace the reading of 61 with the mean of the other seven readings.

D. report only the mean of all eight readings, without mentioning the unusual value.

Question 22

The particular position that a gene occupies on a chromosome is called its

A. allele.

B. locus.

C. genome.

D. gamete.

Question 23

An organism that is heterozygous for a gene shows the dominant phenotype. This is because

A. it carries two copies of the recessive allele.

B. the recessive allele has been lost from the cell.

C. the two alleles blend together to give the phenotype.

D. the dominant allele is expressed and masks the effect of the recessive allele.

Question 24

Meiosis of a single diploid cell produces

A. two diploid cells that are genetically identical to the parent cell.

B. two haploid cells that are genetically identical to each other.

C. four haploid cells that are genetically varied.

D. four diploid cells that are genetically identical to the parent cell.

Question 25

In a species of beetle, a dark body (D) is dominant to a pale body (d). Two dark beetles, each of genotype Dd, are crossed. The probability that the first two of their offspring are both dark is

A. 3/4

B. 1/2

C. 9/16

D. 3/16

Question 26

In mice, black coat (G) is dominant to grey coat (g). A black mouse is crossed with a grey mouse, and the litter includes some grey pups. The genotype of the black parent must be

A. GG.

B. gg.

C. impossible to determine from this information.

D. Gg.

Question 27

In a certain plant, crossing a red-flowered plant with a white-flowered plant produces offspring whose flowers each carry both red and white patches (rather than a single blended colour). This pattern of inheritance is

A. incomplete dominance.

B. codominance.

C. complete dominance of red over white.

D. sex-linkage.

Question 28

Identical twins have the same genotype. One twin trains as a distance runner for several years and develops far greater endurance than the other, who does not train. This difference in phenotype is best explained by

A. the effect of the environment on the expression of the same genotype.

B. a mutation that has occurred in one of the twins.

C. the twins carrying different alleles for endurance.

D. codominance of two alleles.

Question 29

In one plant species, the gene for flower colour and the gene for leaf shape lie close together on the same chromosome. Compared with two genes carried on different chromosome pairs, these two genes are

A. equally likely to be inherited independently of each other.

B. more likely to be inherited together, because they are usually passed into a gamete on the same chromosome.

C. unable to be passed on to the offspring at all.

D. always carried on the sex chromosomes.

Question 30

A segment breaks off one chromosome and becomes attached to a different, non-homologous chromosome. This change in chromosome structure is called

A. a deletion.

B. a duplication.

C. an inversion.

D. a translocation.

Question 31

Which one of the following produces offspring that are genetically identical to the single parent?

A. an egg being fertilised by a sperm

B. pollen from one flower fertilising the ovule of another flower

C. two fish producing a batch of genetically varied young

D. a bud growing on a hydra and then separating to form a new individual

Question 32

The deep root system of a mulga, an arid-zone Australian tree, which reaches water held well below the dry surface soil, is best classified as

A. a behavioural adaptation.

B. a structural adaptation.

C. a physiological adaptation.

D. an acquired characteristic.

Question 33

Each autumn, a species of migratory bird flies thousands of kilometres to a warmer region where food is available, and returns in spring. This inherited migration is best classified as

A. a physiological adaptation.

B. a structural adaptation.

C. a behavioural adaptation.

D. an acquired characteristic.

Question 34

A species of ant lives on a native tree, feeding on the tree's sugary nectar and, in return, attacking insects that try to eat the tree's leaves. Both the ant and the tree benefit. This relationship is best described as

A. mutualism.

B. predation.

C. competition.

D. parasitism.

Use the following information to answer Questions 35 and 36.

A native animal was used to start new populations in two reserves. The two populations were each started from a different number of individuals. Some years later, researchers counted how many different alleles were present at one gene in each population. The results are shown in the table.

Reserve	Number of individuals used to start it	Number of different alleles found at one gene
Reserve P	8	4
Reserve Q	60	11

Question 35

These data best illustrate that a population started from

A. more individuals tends to have lower genetic diversity.

B. fewer individuals tends to have lower genetic diversity.

C. fewer individuals always becomes extinct.

D. any number of individuals has the same genetic diversity.

Question 36

A new disease now reaches both reserves. The population more likely to include at least some individuals that carry an allele giving resistance to the disease is

A. Reserve P, because it was started from fewer individuals.

B. neither, because genetic diversity does not affect disease resistance.

C. Reserve Q, because its greater genetic diversity makes it more likely to contain a resistance allele.

D. both equally, because the disease is the same.

Question 37

A scientist develops a treatment specifically in order to reduce the suffering caused by a disease. Acting to bring about good in this way reflects the ethical concept of

A. beneficence.

B. non-maleficence.

C. justice.

D. integrity.

Question 38

A person argues: “A truly honest scientist would never leave out results that disagreed with their idea, because that is simply not the kind of person a good scientist chooses to be.” This reasoning best reflects

A. the consequences-based approach.

B. the duty- and rule-based approach.

C. the virtues-based approach.

D. no ethical reasoning at all.

Question 39

A student claims that a memory technique works, offering as the only evidence that it seemed to help one friend. This is weak evidence mainly because it is

A. a single, uncontrolled personal story (anecdote), rather than a result from a controlled study.

B. written in scientific-sounding language.

C. based on secondary data.

D. an example of a systematic error.

Question 40

A well-supported explanation for a wide range of observations, which has been tested many times and not shown to be wrong, is best described as a scientific

A. hypothesis.

B. theory.

C. opinion.

D. anecdote.

End of Section A

Section B — Short answer

Every question in this section must be attempted, in the spaces provided. For any question carrying two or more marks, a response earns full credit only if it reaches the depth that its command term and its mark allocation call for. No diagram in this section is drawn to scale.

Question 1 (8 marks)

A student sealed equal sprigs of a green water plant into three tubes of pond water, each fitted with an oxygen sensor. She kept one tube in bright light, one in dim light and one in darkness, all at the same temperature, and measured the net change in the oxygen in each tube over one hour. Her results are shown in Table 1. A positive value means oxygen was released into the water; a negative value means oxygen was taken up from the water.

Table 1 Net change in the oxygen of the water in one hour

Light level	Net change in oxygen (units per hour)
bright light	+18
dim light	0
darkness	−6

a. Name the organelle in the plant's cells that carries out photosynthesis, and the organelle that carries out aerobic cellular respiration. 2 marks

b. In darkness the oxygen in the tube fell (−6 units). Explain why, referring to the processes occurring in the plant's cells. 2 marks

c. In bright light the oxygen rose (+18 units). Explain why more oxygen was released than was taken up. 2 marks

d. In dim light the net change was zero. State what this indicates about the rates of photosynthesis and of respiration at this light level, and explain why the plant still needs its mitochondria even in bright light. 2 marks

Question 2 (9 marks)

A person walked out of a warm building into very cold, windy air and stayed outside for 20 minutes. Some measurements taken from the person are shown in Table 2.

Table 2 Measurements before and during cold exposure

Measurement	In the warm building	After 20 minutes in the cold
blood flow through the skin	high	low
shivering	none	vigorous
core body temperature	37.0 °C	36.8 °C

a. Using the data, describe what happened to the person's core body temperature, and state what this shows about the body's control of temperature. 2 marks

b. Describe two responses shown in the table that help the body in the cold, and for each response explain how it helps. 4 marks

c. Name the part of the brain that acts as the control centre for body temperature. 1 mark

d. Explain why this control of body temperature is described as negative feedback, and state what would happen to the core body temperature if these responses failed in extreme cold. 2 marks

Question 3 (9 marks)

A student investigated how the level of physical activity affects a person's heart rate. For one person, she measured the pulse rate (in beats per minute) while resting, immediately after one minute of walking on the spot, and immediately after one minute of jogging on the spot. She measured the pulse rate three times for each level of activity. Her results are shown in Table 3.

Table 3 Pulse rate (beats per minute) at three levels of activity

Level of activity	Trial 1	Trial 2	Trial 3
resting	58	62	60
walking	88	92	90
jogging	118	122	120

a. Identify the independent variable and the dependent variable in this investigation. 2 marks

b. State one variable, other than the level of activity, that the student needed to keep the same, and explain why. 2 marks

c. Calculate the mean pulse rate at rest and the mean pulse rate when jogging. Show your working. 2 marks

d. Calculate the percentage increase in the mean pulse rate from resting to jogging. Show your working. 2 marks

e. The student measured only one person. State one improvement that would make her conclusion more reliable. 1 mark

Question 4 (10 marks)

In a species of aquarium fish, long tail (allele **L**) is dominant to short tail (allele **l**), and blue body (allele **B**) is dominant to silver body (allele **b**). The two genes are carried on different chromosome pairs. A breeder crossed two long-tailed, blue fish with each other. Among their offspring were:

- 89 long-tailed, blue fish
- 31 long-tailed, silver fish
- 28 short-tailed, blue fish
- 9 short-tailed, silver fish

a. These four classes are close to a 9 : 3 : 3 : 1 ratio. State the genotype of each of the two parent fish, and list the four types of gamete that each parent can produce. 2 marks

b. State the fraction of the offspring expected to be short-tailed and silver, and show how you obtain it. State also the fraction expected to be short-tailed (whatever their colour). 3 marks

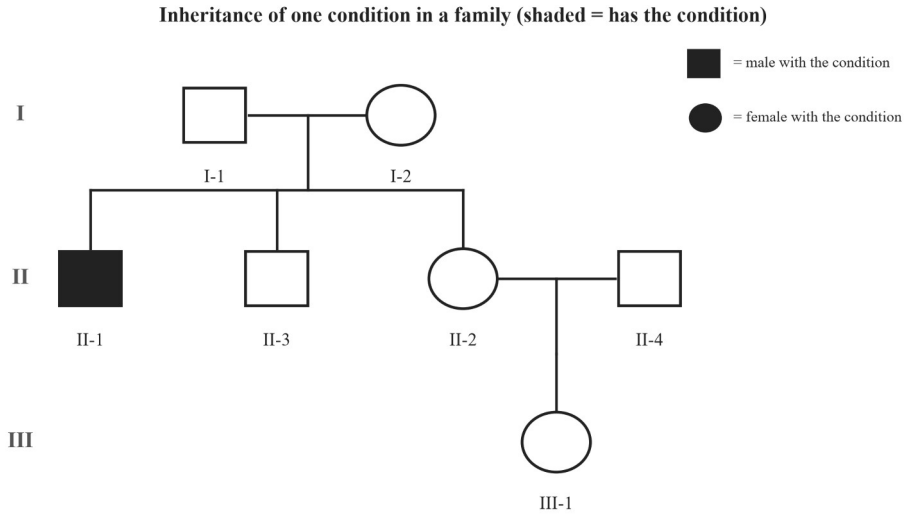
c. In a much larger batch of 4000 offspring from the same type of cross, calculate the number expected to be short-tailed and blue. Show your working. 2 marks

d. One of the long-tailed, blue offspring is test-crossed. State the genotype of the test-cross partner, and state the ratio of offspring phenotypes that would result if this fish has the genotype **BbLl**. 2 marks

e. Name the event in meiosis that allows the tail-length gene and the body-colour gene to be passed on independently of each other. 1 mark

Question 5 (10 marks)

The chart below records the members of a family across three generations, and shows which of them have a certain inherited condition (a shaded symbol) and which do not.



a. State whether the allele causing the condition is dominant or recessive, and give one reason from the chart. 2 marks

b. II-1 is the only member of this family who has the condition, and he is male. A student concludes from the chart that the condition must be X-linked recessive rather than autosomal recessive. Explain why the chart does not support that conclusion, and state one observation in a family chart that would give genuine support to X-linked recessive inheritance. 3 marks

c. Testing of the family later showed that the condition is in fact caused by a recessive allele carried on the X chromosome. Using X^A for the normal allele and X^a for the allele responsible for the condition, state the genotype of I-2 and the genotype of II-1, and explain how you know each one. 2 marks

d. II-2 and her partner II-4 plan to have another child. Calculate the probability that this child is a boy who has the condition. Show your reasoning. 3 marks

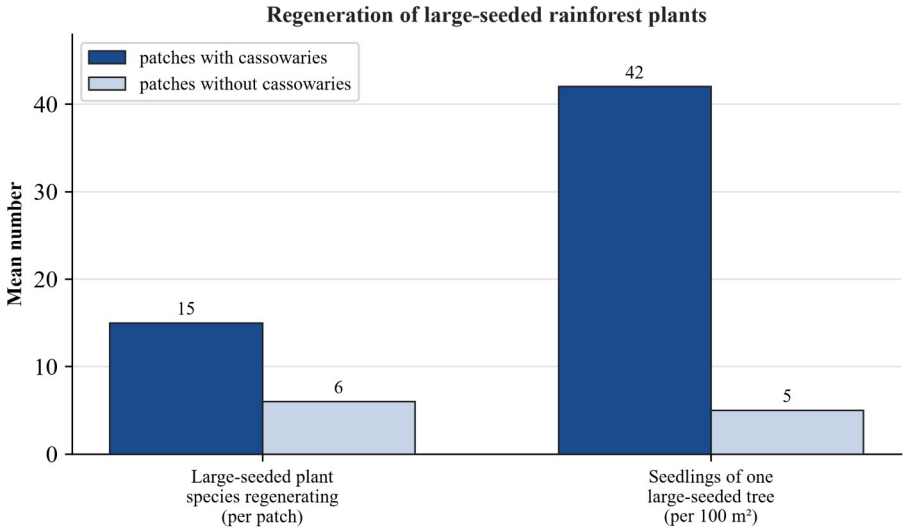
Question 6 (9 marks)

The cassowary is a large, flightless rainforest bird of far north Queensland. It swallows the fleshy fruits of many rainforest plants whole, and later deposits the large seeds, unharmed, in its droppings far from the parent plant. Researchers compared rainforest patches where cassowaries are still present with nearby patches where cassowaries have disappeared. Their results are shown in Table 4.

Table 4 Regeneration of large-seeded rainforest plants

Measurement	Patches with cassowaries	Patches without cassowaries
mean number of large-seeded plant species regenerating (as seedlings) per patch	15	6

Measurement	Patches with cassowaries	Patches without cassowaries
mean number of seedlings of one large-seeded rainforest tree per 100 m²	42	5



a. Using the data, describe the effect that the presence of cassowaries has on the regeneration of large-seeded plants. Quote figures in your answer. 2 marks

b. The cassowary and these plants depend on one another. Explain this interdependence, referring to what each partner gains. 3 marks

c. The cassowary is described as a keystone species in this rainforest. Using this idea, explain what is likely to happen to the variety of species in a patch if the cassowaries are lost. 3 marks

d. Programs to conserve the cassowary and its rainforest are developed in partnership with Aboriginal and Torres Strait Islander communities. State one reason for this. 1 mark

Question 7 (9 marks)

A green turtle is a large marine reptile that breathes air but feeds underwater, holding its breath during long dives. During a dive its muscle cells keep respiring, drawing on the oxygen already stored in its blood and body. A team measured the concentration of oxygen in the blood of turtles immediately after dives of different lengths. Their results are shown in Table 5.

Table 5 Blood oxygen after dives of different lengths

Length of dive (minutes)	Blood oxygen (arbitrary units)
5	14
20	10
40	5
60	1

a. While oxygen is available, the turtle's muscle cells carry out aerobic cellular respiration. Name the gas the cells take in and the waste gas they produce, and name the food molecule that must also be supplied to the cells as the fuel for this process. 2 marks

b. At the surface, and during the dive, the turtle's respiratory and circulatory systems supply its muscle cells with oxygen. Explain how these two systems work together (are interdependent) to do this. 2 marks

c. Using the data, describe how the blood oxygen changes as dives become longer, and explain, in terms of cellular respiration, why this happens. 2 marks

d. Three inherited features help the turtle to dive: (i) a streamlined shell and limbs shaped like flippers; (ii) slowing its heart rate during a dive, so that its store of oxygen lasts longer; (iii) returning to the surface to breathe between dives. Classify each of these three features as a structural, physiological or behavioural adaptation. 3 marks

Question 8 (8 marks)

Large numbers of feral (wild) horses live in an alpine national park. Studies report that the horses are damaging fragile alpine wetlands and streams that many native species depend on. Park managers propose to reduce the number of horses. Some people strongly support the proposal; others strongly oppose it, valuing the horses for their long history in the area.

a. Write one scientific (empirical) question and one bioethical (value) question raised by the proposal to reduce the number of horses. 2 marks

b. Using two different named approaches to ethics, give one argument in favour of reducing the horse numbers and one argument against it. 2 marks

c. Name one ethical concept that supports reducing the horse numbers and one ethical concept that counts against it, and briefly state how each applies. 2 marks

d. Before deciding, the managers read two sources: a study of the horses' effect on the wetlands published in a peer-reviewed scientific journal, and a media release from a group opposed to any reduction. State which source provides the stronger evidence and give one reason; and state one way in which the managers' explanation prepared for the general public should differ from the one prepared for a panel of expert ecologists. 2 marks

Question 9 (8 marks)

Researchers grew animal cells in two identical dishes. To one dish (the treated culture) they added a drug that stops cells from copying (replicating) their DNA; the other dish (the untreated culture) received no drug. They counted the number of cells in each dish once a day for three days. Their results are shown in Table 6.

Table 6 Number of cells in each culture (thousands)

Day	Untreated culture (thousands)	Treated culture (thousands)
0	10	10
1	20	11
2	40	10
3	80	11

a. Name the stage of the cell cycle during which a cell copies its DNA, and name the stage of mitosis during which the sister chromatids are pulled to opposite poles of the cell. 2 marks

b. Using the data, describe how the number of cells in each culture changed over the three days. Quote figures from the table. 2 marks

c. Explain why a drug that stops cells from copying their DNA prevents those cells from dividing. 2 marks

d. Cancer is a disease of uncontrolled cell division. Suggest why a drug like this one might be used to treat a cancer. 1 mark

e. The drug also acts on healthy tissues in which the cells divide frequently, such as the lining of the gut. Suggest why treatment with this drug can damage such a tissue. 1 mark

End of Section B

End of examination questions

Exam 6 — Answers and solutions

Section A — answers

Q	Ans	Q	Ans	Q	Ans	Q	Ans
1	D	11	B	21	A	31	D
2	B	12	D	22	B	32	B
3	A	13	D	23	D	33	C
4	A	14	A	24	C	34	A
5	D	15	C	25	C	35	B
6	A	16	C	26	D	36	C
7	B	17	C	27	B	37	A
8	D	18	D	28	A	38	C
9	C	19	B	29	B	39	A
10	A	20	C	30	D	40	B

Q1. D — a bacterial (prokaryotic) cell has no nucleus, whereas an animal cell does. Ribosomes, a cell membrane and cytoplasm are found in both.

Q2. B — a long, thin fibre suits a nerve cell to carrying electrical messages (impulses) over long distances; nerve cells do not photosynthesise, store starch, or divide rapidly.

Q3. A — ATP is the molecule a cell uses as its immediate source of energy; DNA carries genetic information, and water and oxygen are not energy-supplying molecules.

Q4. A — mitochondria carry out aerobic respiration to release energy (ATP), so a cell that uses a great deal of energy has especially many of them. Chloroplasts, cell walls and vacuoles are features of plant cells and do not release energy for the cell.

Q5. D — the membrane treats the four substances quite differently: water crosses freely, glucose and sodium ions need membrane proteins, and the large protein cannot cross at all. A membrane that lets some substances through much more readily than others is differentially (selectively) permeable — it is neither freely permeable nor impermeable, and it is not made entirely of protein.

Q6. A — oxygen is a small, non-polar molecule that diffuses freely through the membrane; because respiration constantly uses oxygen, its concentration stays lower inside the cell than outside, so it keeps diffusing in without energy or a carrier protein.

Q7. B — in the fluid-mosaic description, fluid refers to the phospholipid molecules not being fixed in place: they can move about within their own layer, so the membrane behaves like a flexible sheet rather than a rigid one. The membrane is not liquid water, it is not freely permeable to everything, and it does not dissolve in the cytoplasm.

Q8. D — a cell that ignores the signals to stop dividing and does not undergo apoptosis divides uncontrollably, building up into a tumour; it does not differentiate, stop, or get removed.

Q9. C — the cell cycle runs interphase (the cell grows and copies its DNA) → mitosis (the nucleus divides) → cytokinesis (the cytoplasm divides). The other sequences put the stages out of order.

Q10. A — a sheet of cells that lines a surface and absorbs material is epithelial tissue; muscle and nervous tissue have other roles, and a single tissue is not an organ system.

Q11. B — keeping the internal environment relatively constant is homeostasis; digestion, reproduction and excretion are other processes.

Q12. D — on a hot, dry, windy day water evaporates rapidly from the leaves (transpiration), and if this loss is faster than the roots can replace the water, the plant wilts. It is not caused by too much photosynthesis or water uptake, and the plant does not stop respiring.

Q13. D — a group of different organs working together for a major function is an organ system. A tissue is a group of similar cells, and an organ is made of several tissues.

Q14. A — the response (conserving water) opposes the original change (blood too concentrated) and returns the variable towards its set point, which is negative feedback.

Q15. C — in untreated type 1 diabetes the cells that make insulin have been destroyed, so little or no insulin is produced; without insulin the body cells do not take up glucose and the liver does not store it, so blood glucose stays high.

Q16. C — in a large animal, many cells are far from the body surface, and diffusion is too slow over such distances, so a transport system is needed to carry materials to and from every cell. Large animals have a low (not high) surface-area-to-volume ratio, and their cells do respire and must exchange materials.

Q17. C — to make the comparison fair, the controlled variables — such as the type and size of the pot — must be kept the same. The fertiliser amount is the independent variable, and the height reached and the number that die are outcomes (dependent variables), not things kept constant.

Q18. D — an error that shifts every reading the same way (here, +0.4 g each time) is a systematic error; averaging cannot remove it, and it is not random or an outlier.

Q19. B — readings that agree closely with one another are precise, and readings that lie close to the true value are accurate; readings that are both are accurate and precise.

Q20. C — the control group provides a comparison identical in every way except the factor being tested, so that any difference in the result can be attributed to that factor. It does not increase numbers, lengthen the experiment or remove the need to repeat.

Q21. A — with nothing in the logbook to justify discarding it, the unusual value should be reported and the mean given both with and without it; deleting, replacing or hiding a reading is not honest practice.

Q22. B — the position a gene occupies on a chromosome is its locus; an allele is a form of the gene, the genome is the full set of DNA, and a gamete is a sex cell.

Q23. D — in a heterozygote the dominant allele is expressed and masks the effect of the recessive allele, so the dominant phenotype is shown. The recessive allele is still present (not lost), and the alleles do not blend under complete dominance.

Q24. C — meiosis produces four haploid cells that are genetically varied; two identical diploid cells would be the product of mitosis.

Q25. C — each offspring has a 3/4 chance of being dark (Dd × Dd gives 3 dark : 1 pale), so the chance that the first two are both dark is $3/4 \times 3/4 = 9/16$.

Q26. D — because a grey (recessive, gg) pup appears, the black parent must carry a hidden g allele; being black, its other allele is G, so it is Gg (heterozygous).

Q27. B — when both alleles are fully expressed together, so both red and white appear in the same flower, the inheritance is codominance; incomplete dominance would give a single blended colour, such as pink.

Q28. A — identical twins have exactly the same alleles, so the difference in endurance cannot come from their genes; the same genotype has produced two different phenotypes because the environment (years of training) acted on one twin and not the other. A mutation or different alleles would contradict the twins being identical, and codominance concerns two alleles within one individual.

Q29. B — two genes that lie close together on the same chromosome are usually carried into a gamete together, so they tend to be inherited together (they are linked) rather than assorting independently. They are still inherited, and being linked has nothing to do with the sex chromosomes.

Q30. D — a segment moved to a different, non-homologous chromosome is a translocation; a deletion loses a segment, a duplication repeats one, and an inversion reverses one in place.

Q31. D — a bud that grows on a hydra and separates to form a new individual is asexual reproduction, giving offspring genetically identical to the one parent. The other options all involve fertilisation (two parents) and genetically varied offspring.

Q32. B — a deep root system is a physical feature of the plant's body, so it is a structural adaptation; it is inherited, not an action (behavioural) or an internal process (physiological).

Q33. C — migrating to a warmer region is an inherited pattern of activity, so it is a behavioural adaptation. It is not a body part (structural) or an internal process (physiological), and it is inherited, not acquired.

Q34. A — when both species benefit — the ant is fed and the tree is protected — the relationship is mutualism (+ / +).

Q35. B — Reserve Q, started from more individuals (60), has more different alleles (11) than Reserve P, started from fewer (8 individuals, 4 alleles): a population begun from fewer individuals carries only a small sample of the species' alleles, so it has lower genetic diversity. C and D are not supported by the data.

Q36. C — Reserve Q has the greater genetic diversity (more different alleles), so it is more likely to contain at least one individual carrying an allele that gives resistance to the new disease.

Q37. A — acting to bring about good (here, to reduce suffering) is the concept of beneficence. Non-maleficence is avoiding harm, justice is fairness, and integrity is honesty.

Q38. C — appealing to the kind of person a good scientist chooses to be (their character) is the virtues-based approach. Weighing outcomes would be consequences-based, and appealing to a rule would be duty-based.

Q39. A — a single personal story is an uncontrolled anecdote: the technique was not compared with a control, only one person was involved, and the improvement could have had another cause, so it is weak evidence. Scientific-sounding language does not make it stronger.

Q40. B — a well-supported explanation for a wide range of observations, tested many times, is a scientific theory. A hypothesis is a testable prediction, and an opinion or anecdote is not tested evidence.

Section B — solutions

Q1. (a) Photosynthesis takes place in the **chloroplast**, and aerobic cellular respiration takes place in the **mitochondrion**. *(1 mark: chloroplast; 1 mark: mitochondrion.)*

(b) In darkness there is **no light, so photosynthesis stops** and no oxygen is made. The plant's cells **continue to respire (day and night)**, and respiration **takes in oxygen** (and releases carbon dioxide), so the oxygen in the tube falls. *(1 mark: no light means no photosynthesis; 1 mark: the cells still respire, taking up oxygen, so the oxygen falls.)*

(c) In bright light the plant's cells carry out **both photosynthesis and respiration**. Photosynthesis **produces oxygen faster than respiration uses it up**, so there is a **net release of oxygen** into the water. *(1 mark: both photosynthesis and respiration occur in the light; 1 mark: photosynthesis makes oxygen faster than respiration uses it, giving a net release.)*

(d) A net change of zero indicates that **photosynthesis and respiration are occurring at the same rate** — the oxygen made by photosynthesis exactly equals the oxygen used by respiration, so there is no net change. The plant still needs its mitochondria even in bright light because **respiration releases the energy (ATP) from glucose** that the cells need to carry out their activities; photosynthesis stores energy in glucose, but the cell must respire to release it. *(1 mark: photosynthesis and respiration are occurring at the same rate; 1 mark: mitochondria/respiration are needed at all times to release usable energy (ATP) from glucose.)*

Q2. (a) The core body temperature **fell only slightly, from 37.0 °C to 36.8 °C**, even though the surroundings were very cold. This shows that the body **largely maintained (regulated) its core temperature** — it kept it close to the set point despite the cold (homeostasis). *(1 mark: describes the small fall, quoting 37.0 → 36.8 °C; 1 mark: so the body kept the temperature close to constant / regulated it.)*

(b) Any **two** responses from the table, each explained. **Reduced skin blood flow (vasoconstriction):** the arterioles supplying the skin **narrow, so less warm blood flows near the skin surface**, and **less heat is lost** to the cold surroundings. **Shivering:** the skeletal muscles **contract rapidly and repeatedly**, and this muscle

activity **releases (generates) extra heat**, which warms the body. *(1 mark: each response identified; 1 mark: each explanation of how it conserves or generates heat — for two responses, giving 4 marks.)*

(c) The **hypothalamus** (in the brain). *(1 mark.)*

(d) It is negative feedback because the **responses oppose the change** — they act against the fall in temperature, working to **raise it back towards the set point** rather than letting it fall further. If these responses **failed** in extreme cold, the **core body temperature would keep falling further and further below the set point** (the person would become dangerously cold — hypothermia). *(1 mark: the responses oppose the change / return the temperature towards the set point; 1 mark: if they failed, the core temperature would keep falling.)*

Q3. (a) The **independent variable** is the **level of physical activity** (resting, walking, jogging). The **dependent variable** is the **pulse (heart) rate**, in beats per minute. *(1 mark: IV = level of activity; 1 mark: DV = pulse rate.)*

(b) Any **one** suitable controlled variable with a reason — for example the **same person**, the **same length of activity (one minute)**, the **time left before the pulse was taken**, or the **surrounding conditions (such as temperature)**. It must be kept the same so that it **does not itself affect the pulse rate**; otherwise the change in pulse rate could be due to that variable rather than the level of activity, and the comparison would not be valid. *(1 mark: a valid controlled variable; 1 mark: so that it does not also affect the pulse rate / to keep the test valid.)*

(c) **At rest:** (58 + 62 + 60) ÷ 3 = 180 ÷ 3 = **60 beats per minute**. **When jogging:** (118 + 122 + 120) ÷ 3 = 360 ÷ 3 = **120 beats per minute**. *(1 mark: 60 at rest, with working; 1 mark: 120 jogging, with working.)*

(d) Percentage increase = (final − initial) ÷ initial × 100 = (120 − 60) ÷ 60 × 100 = 60 ÷ 60 × 100 = **100%**. *(1 mark: correct method; 1 mark: 100%.)*

(e) Any **one** valid improvement — for example, **measure the pulse rate of several different people** (rather than only one) and average the results, so the conclusion does not depend on a single individual; or repeat the whole investigation on more occasions. *(1 mark.)*

Q4. (a) Both parents are long-tailed and blue, and a 9 : 3 : 3 : 1 ratio in the offspring can only come from two parents that are each **heterozygous for both genes**, so each parent is **BbLl**. Each BbLl parent can produce **four types of gamete**: **BL, Bl, bL and bl**. *(1 mark: each parent is BbLl; 1 mark: the four gametes BL, Bl, bL, bl.)*

(b) The genes assort independently, so each can be treated separately. **Short-tailed** = ll = 1/4, and **silver** = bb = 1/4, so **short-tailed and silver** = 1/4 × 1/4 = **1/16** (this is the "1" in the 9 : 3 : 3 : 1 ratio). The fraction that are **short-tailed** (whatever their colour) is just ll = **1/4** (that is, the 3 + 1 = 4 short-tailed classes out of every 16). *(1 mark: short-tailed and silver = 1/16; 1 mark: obtained as 1/4 × 1/4 / from the 1 in 16; 1 mark: short-tailed = 1/4.)*

(c) Short-tailed and blue is the "3" class of the 9 : 3 : 3 : 1 ratio, so it is expected to be **3/16** of the offspring. 3/16 × 4000 = 12000 ÷ 16 = **750** fish. *(1 mark: short-tailed, blue = 3/16; 1 mark: 3/16 × 4000 = 750, with working.)*

(d) A test cross uses a partner that is **homozygous recessive for both genes — bbll** (short-tailed, silver). If the long-tailed, blue fish is **BbLl**, it makes the four gametes BL, Bl, bL, bl equally, and the bbll partner contributes only bl, so the offspring appear in the ratio **1 long blue : 1 long silver : 1 short blue : 1 short silver** (1 : 1 : 1 : 1). *(1 mark: partner bbll; 1 mark: 1 : 1 : 1 : 1 phenotype ratio.)*

(e) **Independent assortment** of the homologous chromosome pairs during meiosis (meiosis I). *(1 mark: independent assortment.)*

Q5. (a) The allele is **recessive**. Two **unaffected** parents (I-1 and I-2) have an **affected** child (II-1); this can happen only if the allele is recessive and is carried, hidden, by an unaffected parent. *(1 mark: recessive; 1 mark: two unaffected parents (I-1, I-2) have an affected child (II-1).)*

(b) The chart does **not** support that conclusion. **Only one person in the whole family has the condition (II-1)**, and a single affected individual cannot show a sex bias — one affected child is just as likely to be a boy as a girl whichever chromosome carries the allele. **Autosomal recessive inheritance fits every symbol on the chart equally well**: if I-1 and I-2 were both unaffected carriers, about one child in four of theirs would inherit two copies of the allele and be affected, and II-1 could be that child. The absence of **father-to-son**

transmission is no help either, because **no father anywhere in the chart is affected**, so there was never an opportunity for it to be seen. Genuine support for X-linked recessive inheritance would need an observation such as **several affected males and no affected females**, with those **affected males related to one another through unaffected females**. *(1 mark: a single affected individual cannot establish a sex bias — an affected male is equally expected under either pattern; 1 mark: autosomal recessive fits the chart exactly, two unaffected carrier parents giving the affected son II-1, and the absence of father-to-son transmission is meaningless because no father in the chart is affected; 1 mark: states a genuinely discriminating observation, such as several affected males and no affected females, linked through unaffected females.)*

(c) **I-2 is** $X^A X^a$ (a carrier): she is unaffected, so she carries a normal X^A, but she has an **affected son (II-1,** $X^a Y$**) who received his single X chromosome from her**, so she must also carry X^a. **II-1 is** $X^a Y$: he is an affected male, and a male has only one X, which must carry the recessive allele (his Y came from his father I-1). *(1 mark: I-2 =* $X^A X^a$*, justified by her affected son; 1 mark: II-1 =* $X^a Y$*, an affected male with a single X.)*

(d) First find the chance that **II-2 is a carrier**. Her parents are **I-1 (**$X^A Y$**) and I-2 (**$X^A X^a$**)**, so their daughters are $X^A X^A$ or $X^A X^a$ in equal numbers; II-2 is one of those daughters, so she has a **probability of 1/2 of being a carrier (**$X^A X^a$**)**. (Her existing daughter III-1 adds nothing to this: every daughter of II-2 and II-4 is unaffected whether or not II-2 is a carrier.) **If** II-2 is a carrier, then with II-4 ($X^A Y$) the cross $X^A X^a \times X^A Y$ gives the four equally likely children $X^A X^A$, $X^A X^a$, $X^A Y$ and $X^a Y$, so **1/4 of the children would be a boy with the condition (**$X^a Y$**)**. Combining the two steps, the probability that their next child is a boy who has the condition is 1/2 × 1/4 = **1/8 (one in eight)**. *(1 mark: P(II-2 is a carrier) = 1/2, from I-2 =* $X^A X^a$*; 1 mark: if II-2 is a carrier, P(affected boy) = 1/4; 1 mark: 1/2 × 1/4 = 1/8.)*

Q6. (a) Where cassowaries are **present**, **more large-seeded plants regenerate**: a mean of **15 large-seeded plant species** regenerate per patch, against only **6** where cassowaries are absent, and there are **42 seedlings** of the large-seeded tree per 100 m², against only **5** where cassowaries are absent. *(1 mark: states that regeneration of large-seeded plants is greater where cassowaries are present; 1 mark: quotes the matching figures — 15 vs 6 species and/or 42 vs 5 seedlings.)*

(b) The cassowary and the plants are **interdependent (a mutualism — both benefit)**. The **cassowary gains food**, eating the plants' fleshy fruit. The **plants gain seed dispersal**: the bird carries the **large seeds well away from the parent plant** and deposits them, unharmed, in its droppings, where they can germinate away from competition with the parent. The plants **depend on the cassowary** because their seeds are **too large for smaller animals to swallow and move**, so without the bird the seeds would not be spread. *(1 mark: the cassowary gains food from the fruit; 1 mark: the plants gain dispersal of their large seeds away from the parent; 1 mark: the plants depend on the cassowary because few other animals can disperse such large seeds — a mutual dependence.)*

(c) A **keystone species** is one whose effect on its community is **far larger than its own numbers would suggest**. If the cassowaries are lost, the **large-seeded plants would no longer be dispersed and would regenerate poorly**, so **those plant species would decline**. As those plants become scarcer, the **animals that depend on them for food or shelter would also decline**, so the **overall variety of species in the patch (its biodiversity) would fall**. This large, community-wide change from the loss of one bird is exactly why the cassowary is called a keystone species. *(1 mark: a keystone species has an effect out of proportion to its abundance; 1 mark: losing the cassowary means the large-seeded plants are not dispersed and decline; 1 mark: so other species that depend on those plants also decline and the variety of species falls.)*

(d) Any **one** valid reason: Aboriginal and Torres Strait Islander communities hold **detailed, long-standing knowledge of the rainforest (Country) and of the cassowary and its role**, which helps make conservation effective; and decisions about **caring for Country are properly made together with the communities** whose Country it is, respecting their custodianship. *(1 mark for one valid reason.)*

Q7. (a) The muscle cells take in **oxygen** and produce the waste gas **carbon dioxide**, and the food molecule supplied to them as the fuel for aerobic respiration is **glucose**. *(1 mark: oxygen in and carbon dioxide out; 1 mark: glucose.)*

(b) At the surface, the **respiratory system takes oxygen into the blood at the lungs** (and removes carbon dioxide). The **circulatory system then carries that oxygen-rich blood to the muscle cells** (and carries carbon dioxide back). The two systems are **interdependent**: the muscles can only keep respiring aerobically if

the respiratory system supplies the oxygen and the circulatory system delivers it. *(1 mark: the lungs/respiratory system load oxygen into the blood; 1 mark: the circulatory system delivers it to the muscles — the two systems depend on each other.)*

(c) As the dives become **longer, the blood oxygen falls** — from **14 units after a 5-minute dive to only 1 unit after a 60-minute dive**. While the turtle is submerged it **cannot breathe, so no new oxygen is added to its blood**, yet its muscle cells **continue aerobic cellular respiration, which uses oxygen up**; the longer the dive lasts, the more of the stored oxygen has been consumed. *(1 mark: blood oxygen falls as dives get longer, referring to the data; 1 mark: no oxygen can be taken in while the turtle is submerged, but respiration keeps using it, so the store is steadily depleted.)*

(d) **(i)** a streamlined shell and flipper-shaped limbs — **structural** (a physical feature of the body); **(ii)** slowing the heart rate during a dive — **physiological** (an internal functional process); **(iii)** returning to the surface to breathe — **behavioural** (an inherited pattern of activity). *(1 mark each: (i) structural, (ii) physiological, (iii) behavioural.)*

Q8. (a) A **scientific (empirical) question**, for example: **"How much damage are the horses causing to the alpine wetlands and the native species that live in them?"** — a question evidence can answer. A **bioethical (value) question**, for example: **"Should the number of horses be reduced?"** — a question about what ought to be done, which evidence alone cannot settle. *(1 mark: a valid empirical question; 1 mark: a valid value question.)*

(b) Two **different** approaches, one for and one against. For example, a **consequences-based** argument **in favour**: reducing the horses would **protect the alpine wetlands and the many native species** that depend on them, a greater overall benefit than the harm of reducing the horses. A **duty- or rule-based** (or **virtues-based**) argument **against**: it is **wrong to harm the horses** (or a caring, responsible manager should not), whatever the benefit, because we have a duty to their welfare and they have a long history in the area. *(1 mark: a valid for-argument tied to a named approach; 1 mark: a valid against-argument tied to a **different** named approach.)*

(c) Two concepts, one on each side (any valid pair). For example: **beneficence** — reducing the horses **does good by protecting the native species and their habitat** — **supports** the proposal; **non-maleficence** — reducing the horses **causes harm to the horses**, which **counts against** it. (Respect or justice, correctly applied, are also acceptable.) *(1 mark: a relevant supporting concept named and applied; 1 mark: a relevant opposing concept named and applied.)*

(d) The **peer-reviewed journal study** provides the **stronger evidence**, because it has been **independently checked by experts in the field before publication**, whereas the media release comes from a **group with a strong position (a conflict of interest)** and has had no such independent check. For the **general public**, the managers' explanation should use **plain, everyday language with little technical jargon and lead with the key message**, whereas the version for **expert ecologists** can use the **full technical terms and the detailed data**. *(1 mark: the peer-reviewed study is stronger, with a valid reason — independently checked / no conflict of interest; 1 mark: identifies plain language / minimal jargon for the public versus technical detail for the experts.)*

Q9. (a) A cell copies its DNA during the **S phase** of interphase, and the sister chromatids are pulled to opposite poles during **anaphase**. *(1 mark: S phase; 1 mark: anaphase.)*

(b) The **untreated** culture **increased rapidly** — it roughly **doubled each day, from 10 thousand cells on day 0 to 80 thousand on day 3**. The **treated** culture **stayed about the same**, remaining near **10–11 thousand cells** throughout. *(1 mark: the untreated culture increased / roughly doubled each day, with figures; 1 mark: the treated culture stayed about constant, with figures.)*

(c) Before a cell can divide, it must **copy (replicate) all of its DNA**, so that **each of the two daughter cells receives a complete copy**. A drug that **stops the DNA being copied** means the cell **cannot complete the cell cycle**, so it **cannot divide** — which is why the treated cells did not increase in number. *(1 mark: a cell must copy its DNA before dividing, so each daughter cell gets a complete copy; 1 mark: without copying its DNA the cell cannot divide.)*

(d) A cancer is a mass of cells that **divide uncontrollably**; a drug that **stops cells dividing** would **stop the cancer cells multiplying**, so the tumour would stop growing. *(1 mark.)*

(e) A tissue such as the lining of the gut **loses cells constantly and depends on continual cell division to replace them**. The drug **stops those cells copying their DNA, so they cannot divide**, and the cells that are lost are **not replaced**, so the lining thins and is damaged. *(1 mark.)*