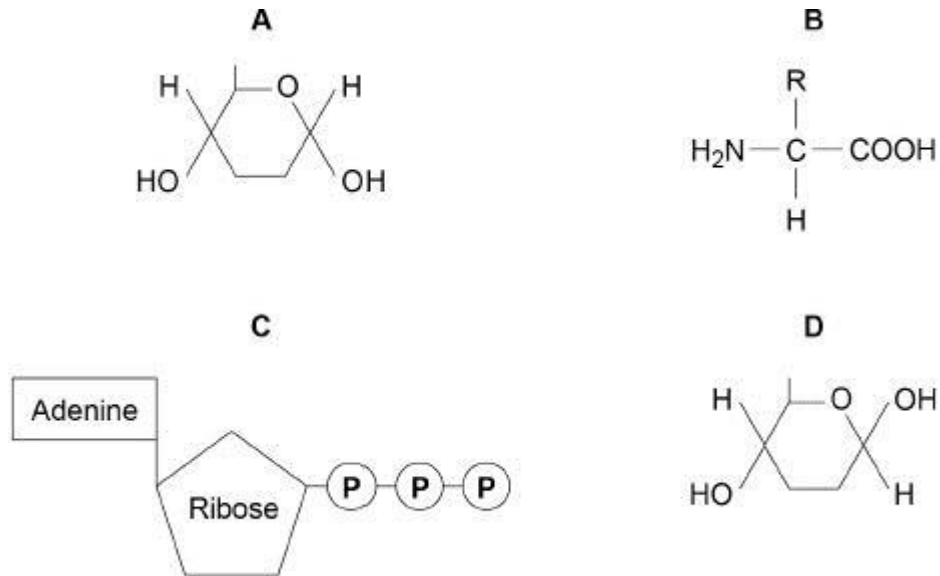


BIOLOGICAL MOLECULES

ATP EXAM Q&A

Q1.

The diagram below shows the structure of molecules found in organisms.



- (a) Complete the table below by putting the correct letter, **A**, **B**, **C** or **D**, in the box next to each statement. Each letter may be used once, more than once, or not at all.

Letter	Statement
	is a monomer in an enzyme's active site
	is a monomer in cellulose
	is produced during photosynthesis and respiration
	forms a polymer that gives a positive result with a biuret test

(4)

- (b) Raffinose is a trisaccharide of three monosaccharides: galactose, glucose and fructose. The chemical formulae of these monosaccharides are:

- galactose = $\text{C}_6\text{H}_{12}\text{O}_6$
- glucose = $\text{C}_6\text{H}_{12}\text{O}_6$
- fructose = $\text{C}_6\text{H}_{12}\text{O}_6$

Give the number of carbon atoms, hydrogen atoms and oxygen atoms in a molecule of raffinose.

(2)

- (b) The movement of Na^+ **out** of the cell allows the absorption of glucose **into** the cell lining the ileum.

Explain how.

(2)

- (c) Describe and explain **two** features you would expect to find in a cell specialised for absorption.

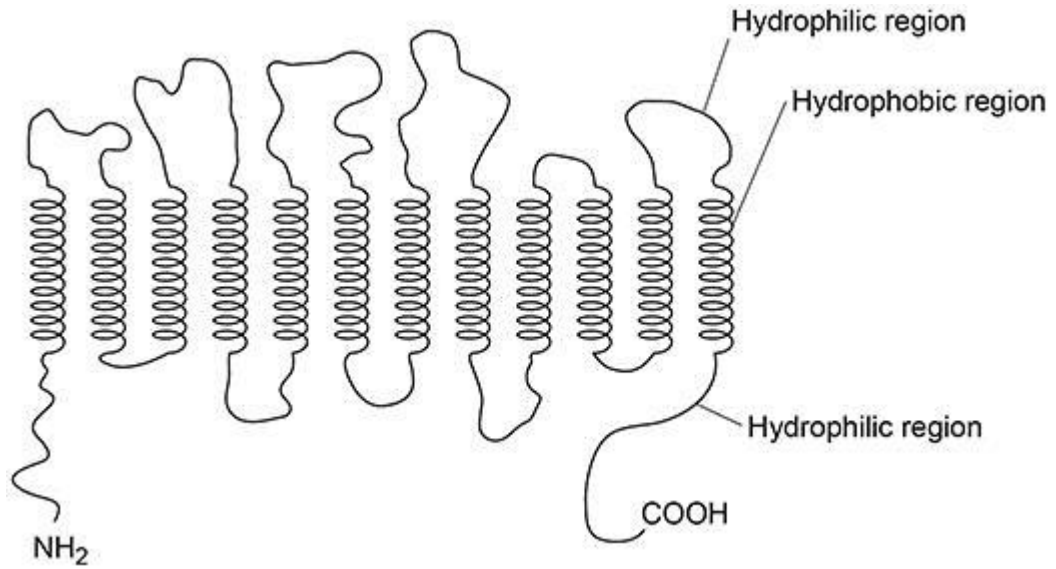
1 _____

2 _____

(2)

Figure 2 is a diagram of one SGLT1 carrier protein.

Figure 2



- (d) Draw phospholipids on **Figure 2** to show how the carrier protein, SGLT1, would fit into the cell-surface membrane.

Do **not** draw more than eight phospholipids.

(2)

- (e) **Figure 2** shows the SGLT1 polypeptide with NH₂ at one end and COOH at the other end.

Describe how amino acids join to form a polypeptide so there is always NH₂ at one end and COOH at the other end.

You may use a diagram in your answer.

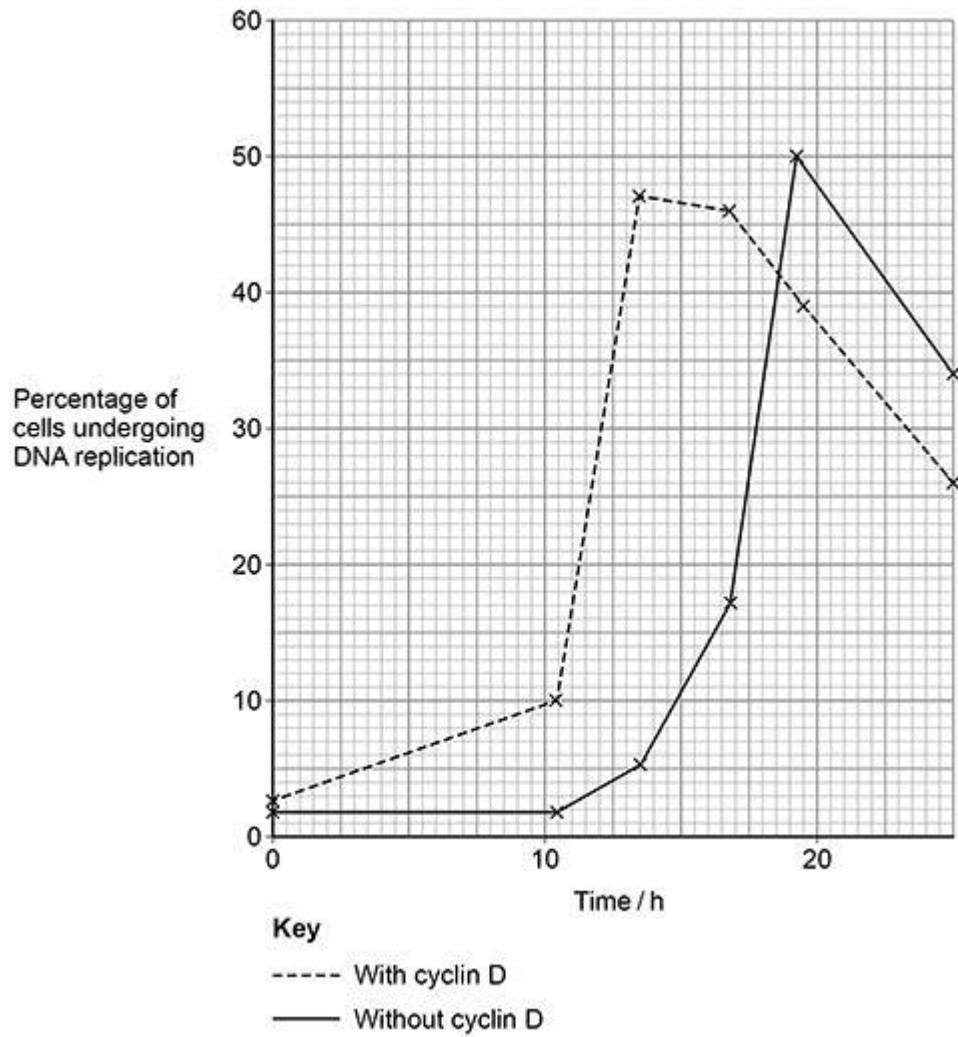
Space for diagram:

Q3.

- (a) Describe the role of DNA polymerase in the semi-conservative replication of DNA.

(2)

The graph below shows the percentage of rat cells undergoing DNA replication. Some cells contained a protein called cyclin D and some cells did not contain cyclin D. All cells were in early interphase at time 0



- (b) It took less time for 25% of cells with cyclin D to be undergoing DNA replication than for 25% of cells without cyclin D.

Use the graph above to calculate this time difference as a percentage decrease.

Show your working.

Answer _____ %

(2)

- (c) Cyclin D stimulates the phosphorylation of DNA polymerase, which activates the DNA polymerase.

(2)

(b) Water is used to hydrolyse ATP.

Name the **two** products of ATP hydrolysis.

1. _____

2. _____

(1)

Hydrolysis of ATP is catalysed by the enzyme ATP hydrolase.

A student investigated the effect of ATP concentration on the activity of ATP hydrolase. She used shortening of strips of muscle tissue caused by contraction as evidence that ATP was being hydrolysed.

- She took four slides **A**, **B**, **C** and **D**, and added strips of muscle tissue of the same length to each slide.
- She then added the same volume of ATP solutions of different concentrations to the four slides and left each slide for five minutes.
- She then recorded the final length of each strip of muscle tissue.

Her results can be seen in the table.

Slide	Concentration of ATP solution added to slide / $\times 10^{-6} \text{ mol dm}^{-3}$	Final length of muscle tissue after 5 minutes / mm
A	2	36
B	4	31
C	6	29
D	8	26

(c) Other than those given, name two variables the student should have controlled.

1. _____

2. _____

(2)

(d) Describe and explain the pattern shown by the data in the table.

Description

Explanation _____

(2)

- (e) The hydrolysis of 1 dm³ of a 1 mol dm⁻³ solution of ATP releases 30 500 J of energy.

60% of the energy released during the hydrolysis of 1 mol dm⁻³ of ATP is released as heat; the rest is used for muscle contraction.

The student added 0.05 cm³ of ATP solution to slide **D**.

Calculate the energy available from ATP for contraction of the muscle on this slide.

Answer = _____ J

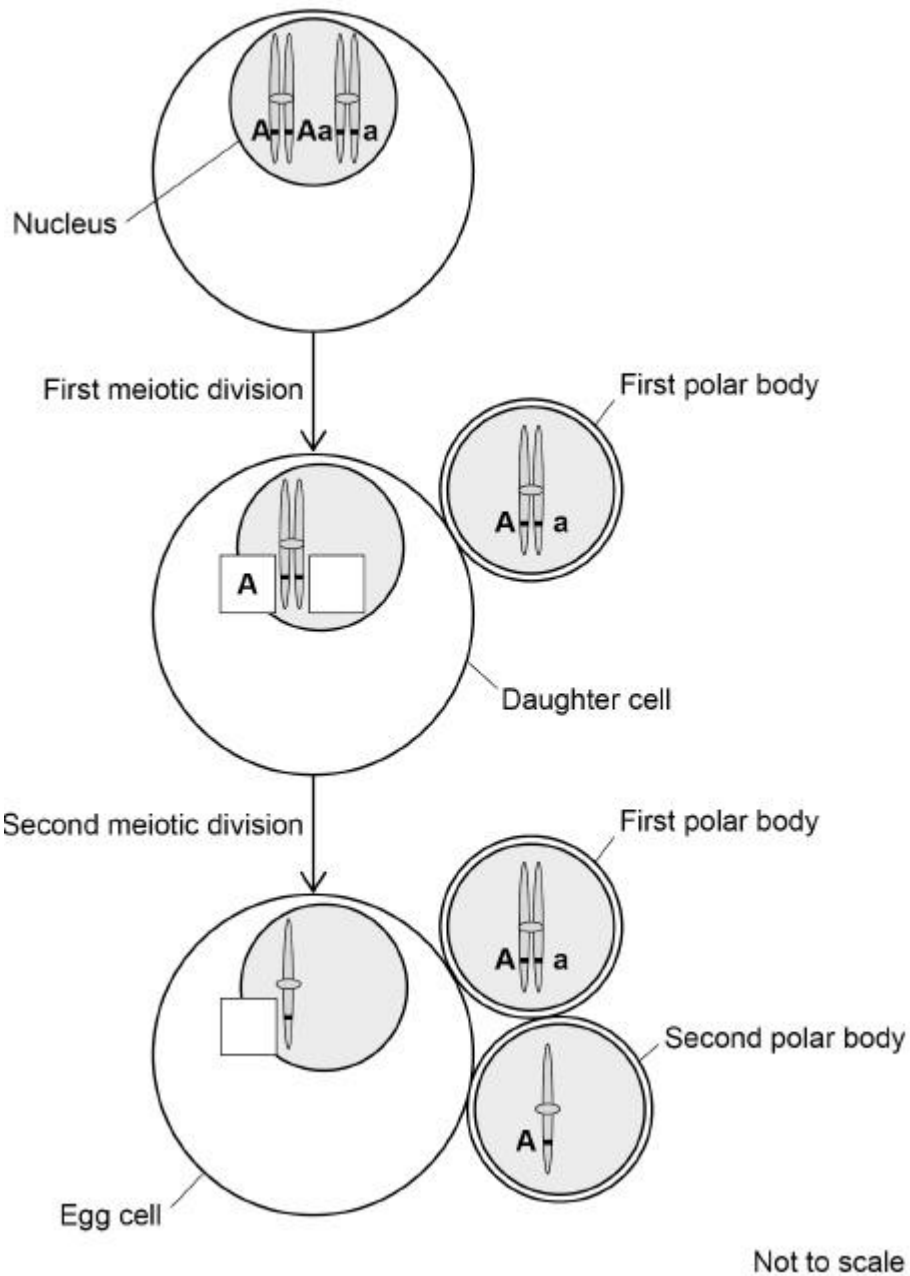
(3)

(Total 10 marks)

Q5.

In women, the first division of meiosis produces one daughter cell that has almost all of the cytoplasm. The other daughter cell consists of a nucleus surrounded by a very small amount of cytoplasm and a cell-surface membrane. This very small daughter cell is called a polar body. Polar bodies do not usually divide. The same process occurs in the second division of meiosis, resulting in one egg cell and two polar bodies.

The diagram shows the formation of an egg cell and two polar bodies during meiosis. It also shows what happens to one pair of homologous chromosomes. This pair carries two alleles of gene A.



(a) Complete the diagram by putting **A** or **a** in the boxes. One box has been completed for you with **A**.

(1)

(b) Put a tick (✓) in the box next to the name of the process that produced the combination of alleles on the chromosome in the first polar body in the diagram.

- Anaphase
- Crossing over
- Independent assortment

Semi-conservative replication



(1)

- (c) A scientist measured the diameter of a polar body and the diameter of the nucleus inside it. The diameter of the polar body was $10.4 \mu\text{m}$ and the diameter of the nucleus was $7.0 \mu\text{m}$. The density of mitochondria in the cytoplasm of the polar body (outside of the nucleus) was 0.08 mitochondria per μm^3 .

Calculate the number of mitochondria in the polar body. You should assume polar bodies and nuclei are spherical.

The formula for the volume of a sphere is $\frac{4}{3} \pi r^3$ where $\pi = 3.14$

Show your working.

Number of mitochondria = _____

(2)

- (d) Mitochondrial diseases are caused by faulty mitochondria. All of a person's mitochondria are inherited from their mother via the egg cell. An egg cell contains approximately 3×10^5 mitochondria.

One proposed treatment to prevent passing on faulty mitochondria involves

- removing the nucleus from an egg cell donated by a woman with healthy mitochondria
- replacing this nucleus with the contents of the polar body from a woman whose egg cells are affected by mitochondrial disease.

Suggest how this treatment prevents inheritance of mitochondrial diseases.

- (b) The new antibiotic is safe to use in humans because it does **not** inhibit the ATP synthase found in human cells.

Suggest why human ATP synthase is not inhibited and bacterial synthase is inhibited.

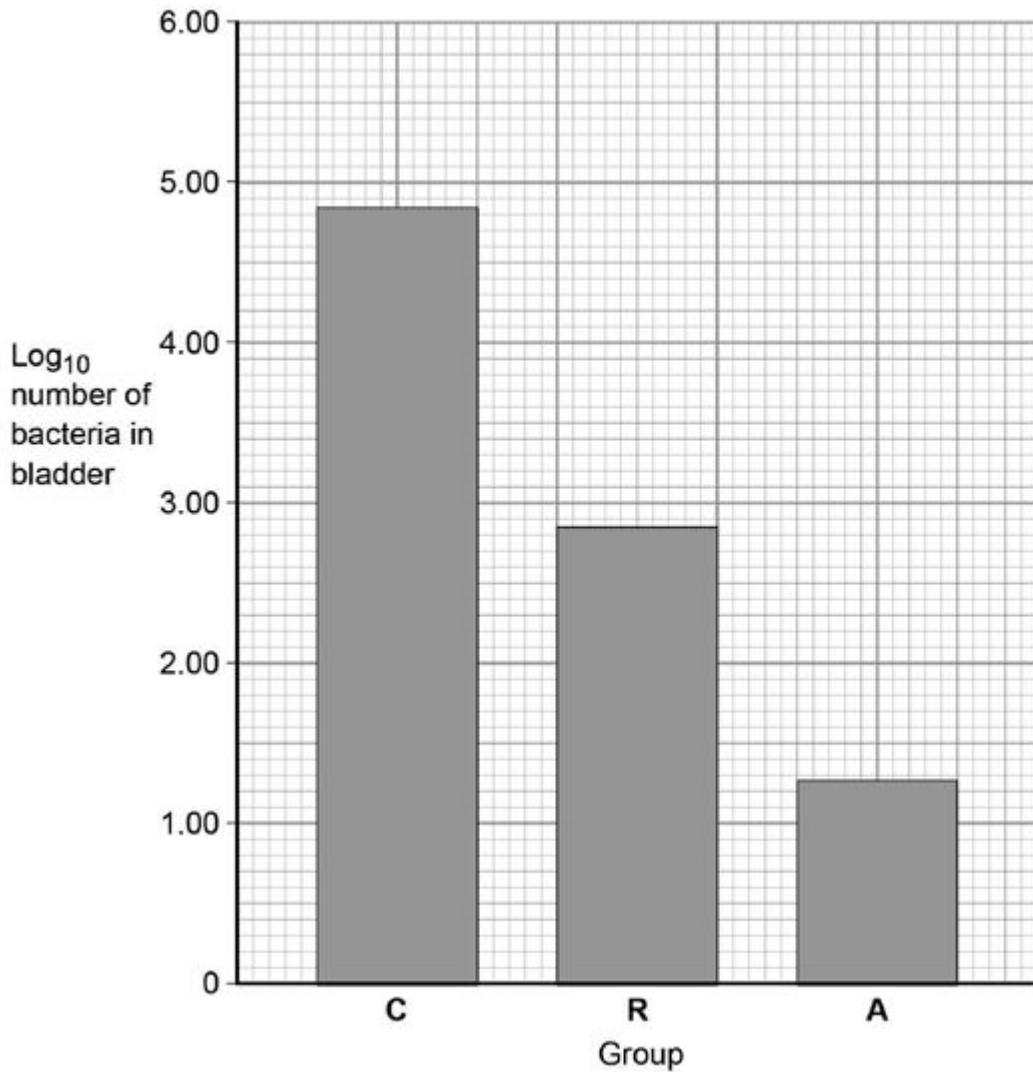
(1)

- (c) The scientists tested the new antibiotic on mice with the same bladder infection. They divided these mice into three groups, **C**, **R** and **A**.

- Group **C** was the control (untreated).
- Group **R** was treated with an antibiotic currently used against this bladder infection.
- Group **A** was treated with the new antibiotic.

They removed samples from the bladder of these mice after treatment and estimated the total number of bacteria in the bladder.

Their results are shown in the graph.



The antibiotics were given to the mice at a dose of 25 mg kg⁻¹ per day.

Calculate how much antibiotic would be given to a 30 g mouse each day.

Show your working.

Answer = _____ mg

(2)

- (d) Calculate the percentage difference in actual numbers of bacteria in group **A** compared with group **R**. The actual number of bacteria can be calculated from the log₁₀ value by using the 10^x function on a calculator.

Show your working.

Answer = _____ %

(2)

- (e) The scientists suggested that people newly diagnosed with this bladder infection should be treated with both the current antibiotic and the new antibiotic.

Explain why the scientists made this suggestion.

Use information from the graph in part (c) and your knowledge of evolution of antibiotic resistance in bacteria in your answer.

(3)

(Total 9 marks)

Q7.

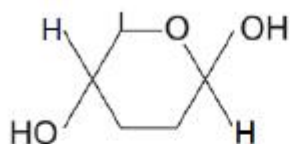
Write an essay on the importance of nitrogen-containing substances in biological systems.

(Total 25 marks)

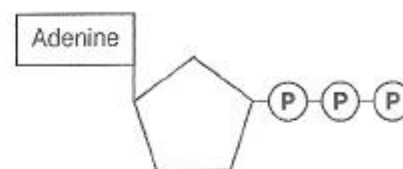
Q8.

The diagram shows four biological molecules.

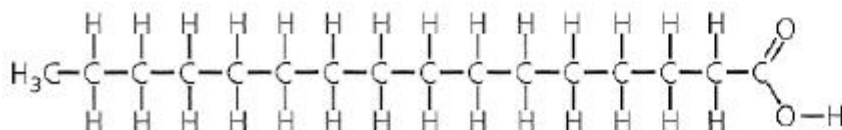
Molecule A



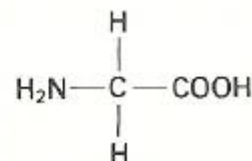
Molecule B



Molecule C



Glycine



- (a) Give the **full** name of:

Molecule A _____

Molecule B _____

(2)

- (b) What type of molecule is molecule C?

(2)

- (c) Glycine, shown in the diagram, is an amino acid.

In the space below, draw a diagram to show the dipeptide produced when two molecules of glycine are joined together.

(2)

- (d) Name the other molecule formed when two molecules of glycine are joined together.

(1)

(Total 7 marks)

(2)

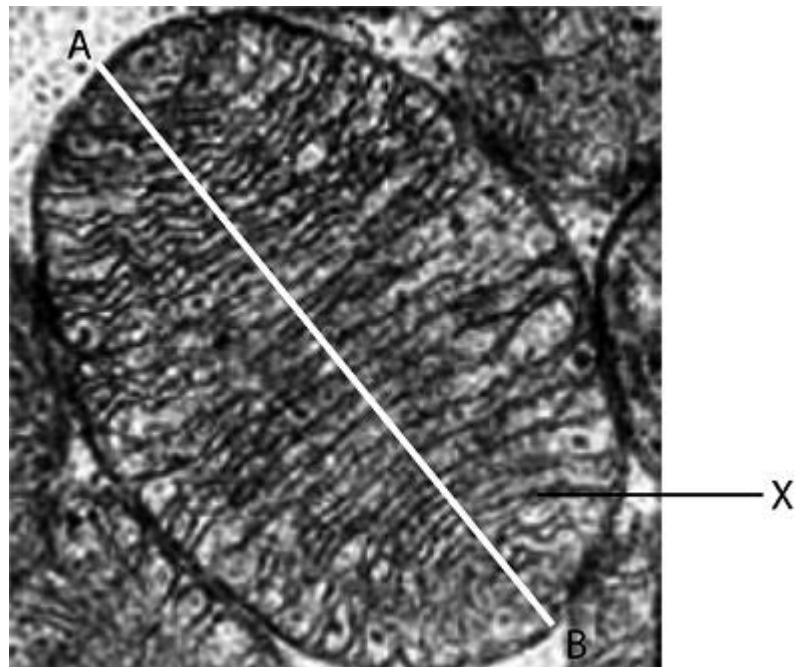
(b) Give **two** ways in which the hydrolysis of ATP is used in cells.

1. _____

2. _____

(2)

(c) This is a photograph (micrograph) of a mitochondrion taken using a scanning electron microscope.



What is the evidence that a scanning electron microscope was used to take this photograph?

(1)

(d) Name the part of the mitochondrion labelled **X** in the photograph.

(1)

- (e) The actual length of the mitochondrion between points **A** and **B** in the photograph is $4\ \mu\text{m}$.

What is the magnification of the mitochondrion in the photograph?

Show your working.

Magnification _____

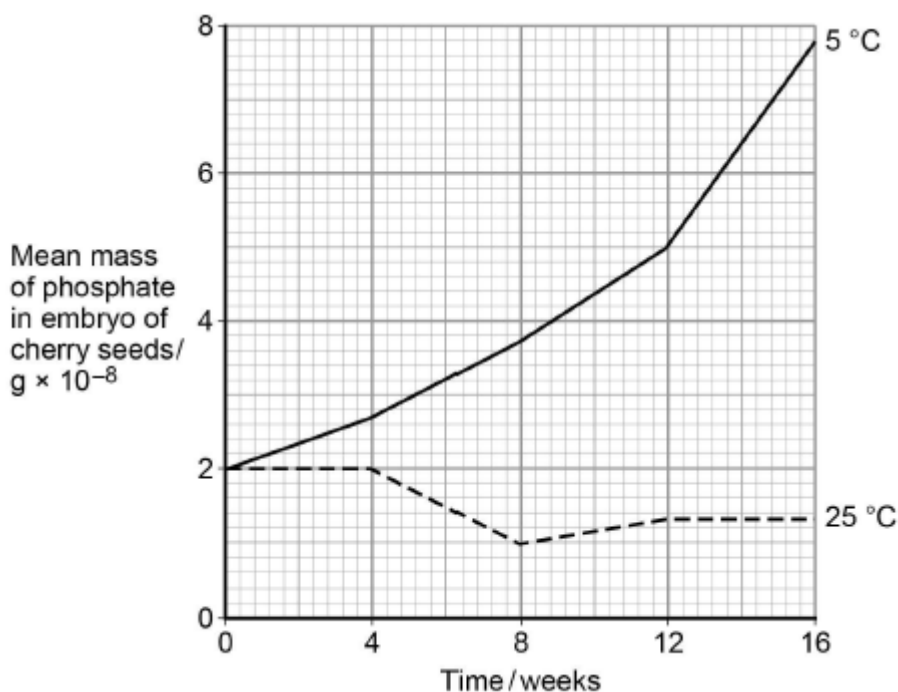
(2)

(Total 8 marks)

Q13.

The seeds of some plant species require chilling (exposure to low temperatures) before the embryos they contain grow into plants. During chilling, storage molecules in the seed that contain phosphate are broken down and phosphates are transported to the embryo. Scientists investigated the change in the mass of phosphate in the embryos of cherry seeds exposed to two different temperatures for 16 weeks.

The following graph shows their results.



- (a) Phospholipids are one of the storage molecules found in cherry seeds.

Name the type of reaction used to break down phospholipids to release phosphate.

(1)

- (b) The scientists concluded that an increase in phosphate in the embryo was linked to growth of the embryo.

Suggest **two** reasons why an increase in phosphate can be linked to growth of the embryo.

1. _____

2. _____

(2)

- (c) Calculate the ratio of the mean mass of phosphate found at 5 °C to the mean mass of phosphate found at 25 °C after 9 weeks of chilling.

Ratio = _____

(1)

- (d) The chilling requirement of seeds of certain plant species is considered to be an adaptation for survival in countries with seasonal changes in environmental conditions.

Suggest how this adaptation may enable these plant species to survive and respond to seasonal changes.

(3)
(Total 7 marks)

Q14.

Write an essay on the control of processes in cells and the importance of these controls.

(Total 25 marks)

Q15.

Write an essay on the importance of ions in biology.

(Total 25 marks)

Q16.

Write an essay on how energy is transferred within and between organisms.

(Total 25 marks)

Q17.

(a) ATP is useful in many biological processes. Explain why.

(4)

(b) Describe how ATP is made in mitochondria.

(3)

(b) Write a simple equation to show how ATP is synthesised from ADP.

(1)

(c) Give **two** ways in which the properties of ATP make it a suitable source of energy in biological processes.

1. _____

2. _____

(2)

(d) Humans synthesise more than their body mass of ATP each day. Explain why it is necessary for them to synthesise such a large amount of ATP.

(2)

(Total 8 marks)

Q19.

(a) Describe the part played by the inner membrane of a mitochondrion in producing ATP.

(3)

(b) A scientist investigated ATP production in a preparation of isolated mitochondria. He suspended the mitochondria in an isotonic solution and added a suitable respiratory substrate together with ADP and phosphate. He bubbled oxygen through the preparation.

(i) Why was the solution in which the mitochondria were suspended isotonic?

(1)

(ii) Explain why the scientist did **not** use glucose as the respiratory substrate.

(2)

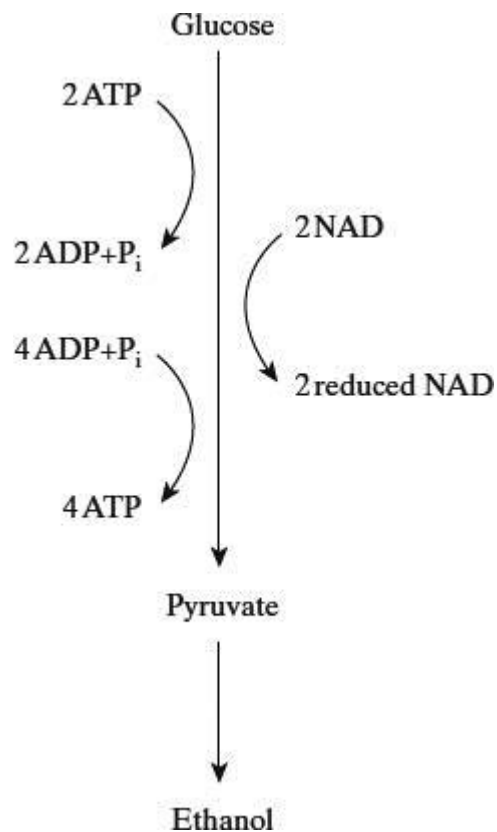
(iii) Explain why the oxygen concentration would change during this investigation.

(1)

(Total 7 marks)

Q20.

The diagram summarises the process of anaerobic respiration in yeast cells.



- (a) (i) In anaerobic respiration, what is the net yield of ATP molecules per molecule of glucose?

(1)

- (ii) Give **two** advantages of ATP as an energy-storage molecule within a cell.

1. _____

2. _____

(2)

- (b) Describe how NAD is regenerated in anaerobic respiration in yeast cells.

(1)

(Total 4 marks)

Q21.

- (a) Mitochondria in muscle cells have more cristae than mitochondria in skin cells. Explain the advantage of mitochondria in muscle cells having more cristae.

(2)

- (b) Substance **X** enters the mitochondrion from the cytoplasm. Each molecule of substance **X** has three carbon atoms.

- (i) Name substance **X**.

(1)

- (ii) In the link reaction substance **X** is converted to a substance with molecules effectively containing only two carbon atoms. Describe what happens in this process.

(2)

- (c) The Krebs cycle, which takes place in the matrix, releases hydrogen ions. These hydrogen ions provide a source of energy for the synthesis of ATP, using coenzymes and carrier proteins in the inner membrane of the mitochondrion.

Describe the roles of the coenzymes and carrier proteins in the synthesis of ATP.

(3)

(Total 8 marks)

Q22.

When one mole of glucose is burned, 2800 kJ of energy are released. However, when one mole of glucose is respired aerobically, only 40% of the energy released is incorporated into ATP. Each mole of glucose respired aerobically produces 38 moles of ATP.

- (a) (i) Calculate how much energy is incorporated into each mole of ATP. Show your working.

Answer _____ kJ

(2)

- (ii) When glucose is respired what happens to the energy which is **not** incorporated into ATP?

(1)

- (b) (i) When one mole of glucose is respired anaerobically, only 2 moles of ATP are produced. Explain why less energy is released in anaerobic respiration.

(1)

- (ii) At the end of a sprint race, a runner continues to breathe rapidly for some time. Explain the advantage of this.

(2)
(Total 6 marks)

Q23.

- (a) Name the substance that muscles use as their immediate energy source.

(1)

- (b) Sports scientists investigated the change in energy sources used during exercise. They measured the percentage of energy obtained from carbohydrate and the percentage of energy obtained from fat in two groups of athletes.

- **Group A** exercised at different intensities for the same time.
- **Group B** exercised at the same intensity for different times.

They calculated the intensity of the exercise as a percentage of VO_2 max.

VO_2 max is the maximum volume of oxygen the athletes can take in per minute.

The results for **Group A** are shown in **Figure 1** and the results for **Group B** are shown in **Figure 2**.

Figure 1

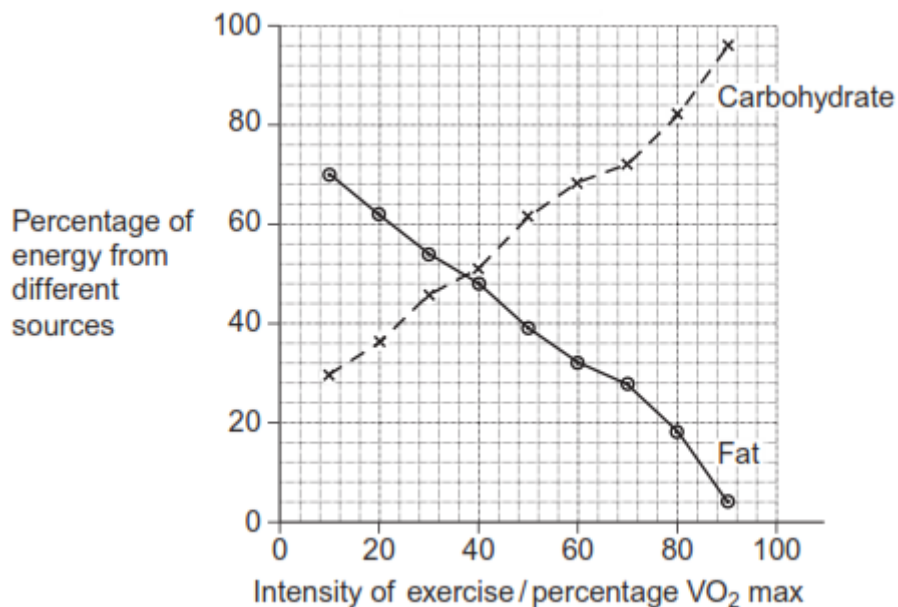
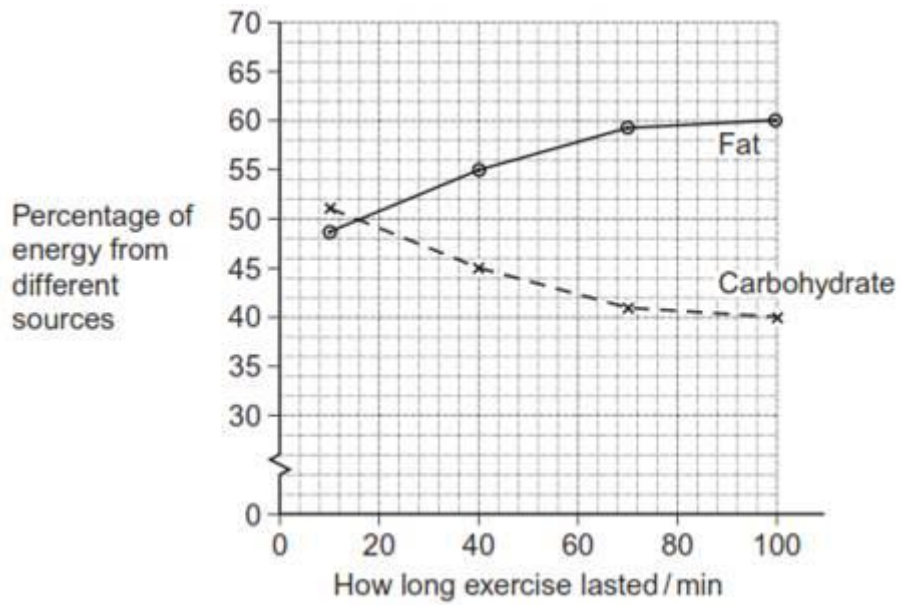


Figure 2



- (i) Calculate the ratio of the percentage of energy from carbohydrate to the percentage of energy from fat when the intensity of exercise is 70% VO_2 max. Show your working.

Answer _____

(2)

- (ii) A person wishes to lose some body fat by exercising. What sort of exercise would be most effective? Use the information in **Figures 1** and **2** to explain your answer.

(Extra space) _____

(3)

(Total 6 marks)

Mark schemes

Q1.

(a)

Letter	Statement
B;	is a monomer in an enzyme's active site
D;	is a monomer in cellulose
C;	is produced during photosynthesis and respiration
B;	forms a polymer that gives a positive result with a biuret test

Must be in correct order

4

(b) C = 18, H = 32, O = 16;

Accept only these answers

1

(c) 1. Heat with acid **and** neutralise;

Accept boil/water bath for heat

Accept named alkali for neutralise

Accept named examples, eg HCl, NaHCO₃

2. Heat with Benedict's (solution);

3. Red precipitate/colour;

Accept other colours eg orange/ brown/green

3

[8]

Q2.

(a) 1. (ATP to ADP + Pi) Releases energy;

Reject 'produces/makes/creates energy'.

2. (energy) allows ions to be moved against a concentration gradient

OR

(energy) allows active transport of ions;

For 'ions' accept Na⁺ or K⁺.

Do not accept if this movement is of glucose not ions.

2

(b) 1. (Maintains/generates) a concentration/diffusion gradient for Na⁺ (from ileum into cell);

Accept '(Maintains/generates) a lower concentration of Na⁺ inside the cell compared with outside the cell'.

2. Na⁺ moving (in) by facilitated diffusion, brings glucose with it

OR

Na⁺ moving (in) by co-transport, brings glucose with it;

Accept 'co-transporter' for 'co-transport'.

2

(c) 1. Folded membrane/microvilli **so** large surface area (for absorption);

Reject references to 'villi'.

Accept 'brush border' for 'microvilli'.

2. Large number of co-transport/carrier/channel proteins **so** fast rate (of absorption)

OR

Large number of co-transport/carrier proteins **for** active transport

OR

Large number of co-transport/carrier/channel proteins **for** facilitated diffusion;

3. Large number of mitochondria **so** make (more) ATP (by respiration)

OR

Large number of mitochondria **for** aerobic respiration

OR

Large number of mitochondria **to** release energy for active transport;

4. Membrane-bound (digestive) enzymes **so** maintains concentration gradient (for fast absorption);

Accept named examples of digestive enzymes.

2 max

(d) 1. Phospholipids drawn with head and two tails;

2. Correctly positioned as a bilayer on either side of SGLT1;

*Some of every 'head' must extend into the hydrophilic region **and** some of every 'tail' must extend into the hydrophobic region.*

Reject phospholipids drawn within the protein.

2

(e) 1. One amine/NH₂ group joins to a carboxyl/COOH group to form a peptide bond;

Accept on diagram, for example (at least) two amino acids joining by a correctly drawn peptide bond (MP1) with NH₂ at one end and COOH at the other (MP2).

Ignore incorrect names of NH₂ and COOH groups.

2. (So in chain) there is a free amine/NH₂ group at one end **and** a free carboxyl/COOH group at the other

OR

Each amino acid is orientated in the same direction in the chain;
Allow ECF for incorrect naming of groups.

2

[10]

Q3.

- (a) 1. Joins (adjacent DNA) nucleotides;
Reject suggestions that it forms hydrogen bonds or joins complementary bases.
Reject 'nucleotide bases'.
2. (Catalyses) condensation (reactions);
3. (Catalyses formation of) phosphodiester bonds (between adjacent nucleotides);

2 max

- (b) Final answer with 2sf or 3sf in range 31.8 to 34.7%;;

1 mark for

5.5 to 6.1 hours

OR

Final answer with 2sf or 3sf in range 46.6 to 53.0%

OR

Correct final answers rounded to more than 3sf

OR

Final answer with 2sf or 3sf in range 30.8 to 31.7 or 34.8 to 35.6%.

2

- (c) 1. Attachment/association of (inorganic) phosphate (to the enzyme);
For 'phosphate/Pi' accept PO_4^{3-} and P in a circle.
Accept 'phosphate goes to the enzyme'.
Ignore named bonding or position of phosphate attaching to enzyme but reject formation of E-S complex.

2. (Released from) hydrolysis of ATP

OR

(Released from) ATP to ADP + Pi;

For ATP accept adenosine triphosphate.

For ADP accept adenosine diphosphate.

2

- (d) 1. Shortens interphase

OR

Cells begin DNA replication earlier OR

DNA replication (starts) faster;
Accept 'starts mitosis earlier'.

2. Fast(er) **cell** cycle/division/multiplication/mitosis

OR

Uncontrolled cell division/mitosis;
Accept '(May result in) mutation in a tumour suppressor gene' OR '(May result in) mutation in an oncogene'.
Ignore uncontrolled growth;

3. (Resulting in) a mass/group of abnormal/excessive cells;
Ignore uncontrolled growth;
Accept '(Resulting in) a growth of abnormal/excessive cells'.

2 max

[8]

Q4.

- (a) 1. (water has a relatively) high (specific) heat capacity;
Ignore numbers relating to heat capacity
2. Can gain / lose a lot of heat / energy without changing temperature;
OR
Takes a lot of heat / energy to change temperature;
Accept due to H bonding between water molecules

2

- (b) Adenosine diphosphate and (inorganic) phosphate;
Accept ADP for adenosine diphosphate
Accept P_i / PO_4^{3-} / P in a circle for inorganic phosphate
Reject adenine diphosphate
Reject phosphorus / P for phosphate

1

- (c) 1. Species / organism the muscle tissue came from;
OR
Thickness / type / source of the muscle tissue;
Ignore surface area of muscle tissue
2. Temperature of the muscle tissue / ATP solution / slides;
Need to be qualified
3. pH of the ATP solution;
Need to be qualified
Reject concentration / volume of ATP hydrolase

2 max

- (d) Description
1. As concentration of ATP increases, length of muscle decreases;
Accept negative correlation

Explanation

2. More ATP (hydrolysed by ATP hydrolase), **so** more energy released, **so** more muscle contraction / shortening of muscle;

Accept more ATP available for correct/named aspect of muscle contraction

Idea of more is required once.

Reject energy produced

2

(e) 4.88×10^{-6} ;;;

If answer incorrect

EITHER

Allow 1 mark for 0.244

Allow 1 mark for 1.22×10^{-5}

OR

Allow 1mark for 12200 / 1.525

Allow 1 mark for 0.61

Accept 5×10^{-6}

Accept correct answer however expressed

Max 2 for incorrect final answer

3

[10]

Q5.

(a) Lowercase a in both boxes

1

(b) Tick in box next to 'Crossing over';

1

(c) 32.73 / 32.7 / 32 / 33;;

Award 1 max for either

409 (409.2) for difference in volume (but incorrect number of mitochondria);

OR

Answer of 262 (261.9) (using diameter, rather than radius);

2

(d) 1. Egg (created) has nucleus / DNA / genes of (affected) woman / mother;

Accept ref. to zygote / embryo / child for egg

Accept genetic information

Ignore references to alleles

Reject if nucleus from wrong egg / woman

2. It has mostly / many / lots of normal mitochondria (of unaffected woman)

OR

There are few faulty mitochondria;

*Reject ref. to **production** of healthy mitochondria as result of treatment*

2

- (e) 1. Not enough / little ATP produced;
One reason asked for, so list rule applies
Ignore ref. to no ATP produced

2. ATP provides **energy** for (enzyme) reactions

OR

ATP phosphorylates substrates / enzymes, **so** making them (more) reactive;

Accept (leads to) lower activation energy for reaction

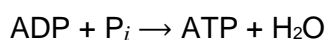
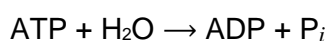
Reject if mention energy produced

2 max

[8]

Q6.

(a)



1

- (b) 1. Human ATP synthase has a different tertiary structure to bacterial ATP synthase

OR

Human ATP synthase has a different shape active site to bacterial ATP synthase

OR

Antibiotic cannot enter human cells/mitochondria

OR

Antibiotic not complementary (to human ATP synthase);

1

- (c) 0.75;
One mark for showing 30 g = 0.03 kg;
One mark for showing 0.025 mg g⁻¹

2

- (d) Answer in range 97.0 – 97.8%;

OR

Answer in range 3288 – 4368%;

2. 1 mark for correct log₁₀ readings from graph converted to actual numbers

- (e) 1. (From the graph in part c) New / old antibiotic does not kill all bacteria;
OR
 (From the graph in part c) Some bacteria are resistant to the new / old antibiotic;
2. Resistant bacteria will reproduce to produce (more) resistant bacteria;
3. (Use of both) one antibiotic will kill bacteria resistant to the other antibiotic;
OR
 Unlikely that bacteria are resistant to both the new and the old antibiotic;
OR
 Use of both antibiotics (likely to) kill all / most bacteria;
- Accept use of 'A' for 'new antibiotic' and 'R' for 'old antibiotic'.*
1. *Must relate to the bacteria that are still present – 'some bacteria are killed' or 'the bacteria number is reduced' is insufficient.*
 2. *Accept 'resistant bacteria reproduce to pass on resistance gene / allele'*
 3. *'Use of both antibiotics will be more effective' is insufficient.*

Q7.

21 – 25	<p>Extended abstract</p> <p>Generalised beyond specific context</p>	<p>Response shows holistic approach to the question with a fully integrated answer which makes clear links between several different topics and the theme of the question.</p> <p>Biology is detailed and comprehensive A-level content, uses appropriate terminology, and is very well written and always clearly explained.</p> <p>No significant errors or irrelevant material.</p> <p>For top marks in the band, the answer shows evidence of reading beyond specification requirements.</p>
16 – 20	<p>Relational</p> <p>Integrated into a whole</p>	<p>Response links several topics to the main theme of the question, to form a series of interrelated points which are clearly explained.</p> <p>Biology is fundamentally correct A-level content and contains some points which are detailed, though there may be some which are less well developed, with appropriate use of terminology.</p> <p>Perhaps one significant error and, or, one irrelevant topic which detracts from the overall quality of the answer.</p>

11 – 15	Multistructural Several aspects covered but they are unrelated	Response mostly deals with suitable topics but they are not interrelated and links are not made to the theme of the question. Biology is usually correct A-level content, though it lacks detail. It is usually clearly explained and generally uses appropriate terminology. Some significant errors and, or, more than one irrelevant topic.
6 – 10	Unistructural Only one or few aspects covered	Response predominantly deals with only one or two topics that relate to the question. Biology presented shows some superficial A-level content that may be poorly explained, lacking in detail, or show limited use of appropriate terminology. May contain a number of significant errors and, or, irrelevant topics.
1 – 5	Unfocused	Response only indirectly addresses the theme of the question and merely presents a series of biological facts which are usually descriptive in nature or poorly explained and at times may be factually incorrect. Content and terminology is generally below A-level. May contain a large number of errors and, or, irrelevant topics.
0		Nothing of relevance or no response.

Commentary on terms and statements in the levels mark scheme

The levels mark scheme for the essay contains a number of words and statements that are open to different interpretations. This commentary defines the meanings of these words and statements in the context of marking the essay. Many words and statements are used in the descriptions of more than one level of response. The definitions of these remain the same throughout.

Levels mark scheme word/statement	Definition
Holistic	Synoptic, drawing from different topics (usually sections of the specification)
A fully integrated answer which makes clear links between several different topics and the theme of the question	All topics relate to the title and theme of the essay; for example, explaining the biological importance of a process. When considering, for example, the importance of a process, the explanation must be at A-level standard. 'Several' here is defined as at least four topic areas from the specification

	covered. This means some sentences, not just a word or two. It does not mean using many examples from one topic area.
Biology is detailed and comprehensive A-level content, uses appropriate terminology, and is very well written and always clearly explained.	Detailed and comprehensive A-level content is the specification content. Terminology is that used in the specification. Well written and clearly explained refers mainly to biological content and use of terminology. Prose, handwriting and spelling are secondary considerations. Phonetic spelling is accepted, unless examiners are instructed not to do so for particular words; for example, glucagon, glucose and glycogen.
No significant errors or irrelevant material.	A significant error is one which significantly detracts from the biological accuracy or correctness of a described example. This will usually involve more than one word. Irrelevant material is several lines (or more) that clearly fails to address the title, or the theme of the title.
For top marks in the band, the answer shows evidence of reading beyond specification requirements.	An example that is relevant to the title and is not required in the specification content. The example must be used at A-level standard.
Response mostly deals with suitable topics but they are not interrelated and links are not made to the theme of the question.	Not addressing the biological theme of the essay (e.g. importance) at <u>A-level standard</u> .

Please note that to obtain full credit, students must use information to show **the importance of nitrogen-containing substances in biological systems**.

Specification Reference	Topic Area
3.1.4 and 3.1.4.2	proteins and enzymes
3.1.5	nucleic acids
3.1.5.2	DNA replication
3.1.6	ATP
3.2.1.1	ribosomes

3.2.2	cell division
3.2.3	transport across membranes
3.2.4	immune response
3.3.3	digestion and absorption
3.3.4.1	haemoglobin
3.4.1	genes and chromosomes
3.4.2	protein synthesis
3.4.3	mutation
3.4.7	investigating diversity
3.5.1	photosynthesis
3.5.2	respiration
3.5.4	nitrogen cycle
3.6.2	nervous coordination
3.6.3	muscles
3.6.4.2	control of blood glucose (and peptide / protein hormones)
3.7.1	inheritance
3.8.1	alteration of DNA sequences
3.8.2.2	regulation of transcription and translation

In order to fully address the question and reach the highest mark bands students must also include at least four topics in their answer, to demonstrate a synoptic approach to the essay.

Students may be able to show the relevance of other topics from the specification.

Note, other topics from beyond the specification can be used, providing they relate to the title and contain factually correct material of at least an A-level standard. Credit should not be given for topics beyond the specification which are below A-level standard.

[25]

Q8.

(a) 1. A = β glucose;

B = Adenosine triphosphate;

do not accept ATP

2

- (b) 1. Saturated; 1
2. Fatty acid; 1
- (c) 1. Peptide bond shown correctly; 2
2. Rest of dipeptide structure shown correctly; 2
- (d) Water; 1

[7]

Q9.

21–25	Extended Abstract Generalised beyond specific context	Response shows holistic approach to the question with a fully integrated answer which makes clear links between several different topics and the theme of the question. Biology is detailed and comprehensive A-level content, uses appropriate terminology, and is very well written and always clearly explained. No significant errors or irrelevant material. For top marks in the band, the answer shows evidence of reading beyond specification requirements.
16–20	Relational Integrated into a whole	Response links several topics to the main theme of the question, to form a series of interrelated points which are clearly explained. Biology is fundamentally correct A-level content and contains some points which are detailed, though there may be some which are less well developed, with appropriate use of terminology. Perhaps one significant error and, or, one irrelevant topic which detracts from the overall quality of the answer.
11–15	Multistructural Several aspects covered but they are unrelated	Response mostly deals with suitable topics but they are not interrelated and links are not made to the theme of the question. Biology is usually correct A-level content, though it lacks detail. It is usually clearly explained and generally uses appropriate terminology. Some significant errors and, or, more than one irrelevant topic.
6–10	Unistructural Only one or few	Response predominantly deals with only one or two topics that relate to the question.

	aspects covered	Biology presented shows some superficial A-level content that may be poorly explained, lacking in detail, or show limited use of appropriate terminology. May contain a number of significant errors and, or, irrelevant topics.
1–5	Unfocused	Response only indirectly addresses the theme of the question and merely presents a series of biological facts which are usually descriptive in nature or poorly explained and at times may be factually incorrect. Content and terminology is generally below A-level. May contain a large number of errors and, or, irrelevant topics.
0		Nothing of relevance or no response.

Commentary on terms and statements in the levels mark scheme

The levels mark scheme for the essay contains a number of words and statements that are open to different interpretations. This commentary defines the meanings of these words and statements in the context of marking the essay. Many words and statements are used in the descriptions of more than one level of response. The definitions of these remain the same throughout.

Levels mark scheme word/statement	Definition
Holistic	Synoptic, drawing from different topics (usually sections of the specification)
A fully integrated answer which makes clear links between several different topics and the theme of the question	All topics relate to the title and theme of the essay; for example, explaining the biological importance of a process. When considering, for example, the importance of a process, the explanation must be at A-level standard. 'Several' here is defined as at least four topic areas from the specification covered. This means some sentences, not just a word or two. It does not mean using many examples from one topic area.
Biology is detailed and comprehensive A-level content, uses appropriate terminology, and is very well written and always clearly explained.	Detailed and comprehensive A-level content is the specification content. Terminology is that used in the specification. Well written and clearly explained refers mainly to biological content and

	use of terminology. Prose, handwriting and spelling are secondary considerations. Phonetic spelling is accepted, unless examiners are instructed not to do so for particular words; for example, glucagon, glucose and glycogen.
No significant errors or irrelevant material.	A significant error is one which significantly detracts from the biological accuracy or correctness of a described example. This will usually involve more than one word. Irrelevant material is several lines (or more) that clearly fails to address the title, or the theme of the title.
For top marks in the band, the answer shows evidence of reading beyond specification requirements.	An example that is relevant to the title and is not required in the specification content. The example must be used at A-level standard.
Response mostly deals with suitable topics but they are not interrelated and links are not made to the theme of the question.	Not addressing the biological theme of the essay (e.g. importance) at <u>A-level standard</u> .

How nucleotides, molecules derived from nucleotides and nucleic acids are important in keeping organisms alive.

In order to fully address the question and reach the highest mark bands, students must include at least five topics in their answer, to demonstrate a synoptic approach to the essay.

Specification reference	Topic area
3.1.6	ATP
3.1.4.2	Enzymes – ATP, phosphorylation and activation energy
3.1.5	Nucleic acids – information carrying molecules
3.2.2	Mitosis
3.2.3	Transport across membranes – active transport and co-transport
3.3.3	Absorption
3.4.1	DNA, genes and chromosomes
3.4.2	DNA and protein synthesis – ribosomes as nucleic acids – mRNA, tRNA – etc.
3.4.3	Genetic diversity – mutations

3.4.	Meiosis
3.4.4	Diversity and adaptation
3.5.1	Photosynthesis
3.5.2	Respiration
3.6.2	Nerve impulses
3.6.3	Muscle contraction
3.6.4.2	Control of blood glucose – second messenger and cAMP
3.6.4.3	Control of blood water potential
3.8.1	Control of gene expression – Mutations
3.8.2	Gene expression
3.8.2.2	Regulation transcription and translation

In order to fully address the question and reach the highest mark bands students must also include at least four topics in their answer, to demonstrate a synoptic approach to the essay.

Students may be able to show the relevance of other topics from the specification.

Note, other topics from beyond the specification can be used, providing they relate to the title and contain factually correct material of at least an A-level standard. Credit should not be given for topics beyond the specification which are below A-level standard.

[25]

Q10.

- (a)
1. Calcium ions diffuse into myofibrils from (sarcoplasmic) reticulum;
 2. (Calcium ions) cause movement of tropomyosin (on actin);
 3. (This movement causes) exposure of the binding sites on the actin;
 4. Myosin heads attach to binding sites on actin;
 5. Hydrolysis of ATP (on myosin heads) causes myosin heads to bend;
 6. (Bending) pulling actin molecules;
 7. Attachment of a new ATP molecule to each myosin head causes myosin heads to detach (from actin sites).

5 max

- (b)
1. Releases relatively small amount of energy / little energy lost as heat;
Key concept is that little danger of thermal death of cells
 2. Releases energy instantaneously;
Key concept is that energy is readily available
 3. Phosphorylates other compounds, making them more reactive;
 4. Can be rapidly re-synthesised;
 5. Is not lost from / does not leave cells.

2 max

[7]

Q11.

21 – 25	<p>Extended abstract</p> <p>Generalised beyond specific context</p>	<p>Response shows holistic approach to the question with a fully integrated answer which makes clear links between several different topics and the theme of the question.</p> <p>Biology is detailed and comprehensive A-level content, uses appropriate terminology, and is very well written and always clearly explained.</p> <p>No significant errors or irrelevant material.</p> <p>For top marks in the band, the answer shows evidence of reading beyond specification requirements.</p>
16 – 20	<p>Relational</p> <p>Integrated into a whole</p>	<p>Response links several topics to the main theme of the question, to form a series of interrelated points which are clearly explained.</p> <p>Biology is fundamentally correct A-level content and contains some points which are detailed, though there may be some which are less well developed, with appropriate use of terminology.</p> <p>Perhaps one significant error and, or, one irrelevant topic which detracts from the overall quality of the answer.</p>
11 – 15	<p>Multistructural</p> <p>Several aspects covered but they are unrelated</p>	<p>Response mostly deals with suitable topics but they are not interrelated and links are not made to the theme of the question.</p> <p>Biology is usually correct A-level content, though it lacks detail. It is usually clearly explained and generally uses appropriate terminology.</p> <p>Some significant errors and, or, more than one irrelevant topic.</p>
6 – 10	<p>Unistructural</p> <p>Only one or few aspects covered</p>	<p>Response predominantly deals with only one or two topics that relate to the question.</p> <p>Biology presented shows some superficial A-level content that may be poorly explained, lacking in detail, or show limited use of appropriate terminology.</p> <p>May contain a number of significant errors and, or, irrelevant topics.</p>
1 – 5	<p>Unfocused</p>	<p>Response only indirectly addresses the theme of the question and merely presents a series of biological facts which are usually descriptive in nature or poorly explained and at times may be factually incorrect.</p> <p>Content and terminology is generally below A-level.</p>

		May contain a large number of errors and, or, irrelevant topics.
0		Nothing of relevance or no response.

Commentary on terms and statements in the levels mark scheme

The levels mark scheme for the essay contains a number of words and statements that are open to different interpretations. This commentary defines the meanings of these words and statements in the context of marking the essay. Many words and statements are used in the descriptions of more than one level of response. The definitions of these

Levels mark scheme word/statement	Definition
Holistic	Synoptic, drawing from different topics (usually sections of the specification)
A fully integrated answer which makes clear links between several different topics and the theme of the question	<p>All topics relate to the title and theme of the essay; for example, explaining the biological importance of a process.</p> <p>When considering, for example, the importance of a process, the explanation must be at A-level standard.</p> <p>'Several' here is defined as at least four topic areas from the specification covered. This means some sentences, not just a word or two. It does not mean using many examples from one topic area.</p>
Biology is detailed and comprehensive A-level content, uses appropriate terminology, and is very well written and always clearly explained.	<p>Detailed and comprehensive A-level content is the specification content.</p> <p>Terminology is that used in the specification.</p> <p>Well written and clearly explained refers mainly to biological content and use of terminology. Prose, handwriting and spelling are secondary considerations. Phonetic spelling is accepted, unless examiners are instructed not to do so for particular words; for example, glucagon, glucose and glycogen.</p>
No significant errors or irrelevant material.	<p>A significant error is one which significantly detracts from the biological accuracy or correctness of a described example. This will usually involve more than one word.</p> <p>Irrelevant material is several lines (or more) that clearly fails to address the</p>

	title, or the theme of the title.
For top marks in the band, the answer shows evidence of reading beyond specification requirements.	An example that is relevant to the title and is not required in the specification content. The example must be used at A-level standard.
Response mostly deals with suitable topics but they are not interrelated and links are not made to the theme of the question.	Not addressing the biological theme of the essay (e.g. importance) at <u>A-level standard</u> .

Please note that to obtain full credit, students must use information to show **the importance of movement**.

Specification Reference	Topic Area
3.1.4.2	Enzyme-catalysed reactions
3.1.5.2	DNA replication
3.1.6	ATP
3.2.2	Cell division
3.2.3	Transport across membranes
3.2.4	Immune response
3.2.2	Gas exchange
3.3.3	Digestion and absorption
3.3.4.1, 4.2	Mass transport
3.4.2	DNA and protein synthesis
3.4.3	Meiosis
3.5.1	Photosynthesis
3.5.2	Respiration
3.6.1	Survival and response
3.6.1.2	Receptors
3.6.1.3	Control of heart rate
3.6.2.1	Nerve impulses
3.6.2.2	Synapses
3.6.2.2	Synaptic transmission

3.6.3	Skeletal muscle
3.6.4.2	Control of blood glucose concentration
3.6.4.3	Control of blood water potential
3.7.3	Evolution (population isolation and movement between)
3.8.2.2	Regulation of transcription and translation
3.8.2.3	Gene expression and cancer

In order to fully address the question and reach the highest mark bands students must also include at least four topics in their answer, to demonstrate a synoptic approach to the essay.

Students may be able to show the relevance of other topics from the specification.

Note, other topics from beyond the specification can be used, providing they relate to the title and contain factually correct material of at least an A-level standard. Credit should not be given for topics beyond the specification which are below A-level standard.

[25]

Q12.

- (a) 1. From ADP and phosphate;

Accept $\text{P}/\text{PO}_4^{3-} / \text{P}$

Reject P/Phosphorus

Reject use of water in the reaction

2. By ATP synthase;
3. During respiration/photosynthesis;

2 max

- (b) 1. To provide energy for other reactions/named process;

Reject 'produce' energy

2. To add phosphate to other substances **and** make them more reactive/change their shape;

2

- (c) (Can see) 3D image;

1

- (d) Crista/cristae;

Ignore matrix

1

- (e) Value between 20,750 (83mm) and 21,250 (85mm) two marks;;
Formula given/used but calculation wrong, award 1 mark

$\text{Magnification} = \frac{\text{image size}}{\text{Object size}}$

(Large number divided by 4)

2

Q13.

- (a) Hydrolysis (reaction); 1
- (b) 1. (Phosphate required) to make RNA;
 2. (Phosphate required) to make DNA;
1 and 2. If neither DNA or RNA are named allow one mark for nucleotide/nucleic acid/phosphodiester bonds/sugar-phosphate backbone.
 3. (Phosphate required) to make ATP/ADP;
 4. (Phosphate required) to make membranes;
Ignore: phospholipids without reference to membranes.
 5. (Phosphates required) for phosphorylation;
Accept: as additional mark points any named biological molecule containing phosphate e.g. NADP, AMP, RuBP. 2 max
- (c) Accept answer in range from 3.7 : 1 to 4.1 : 1;
Reject any ratio not : 1. 1
- (d) 1. Seeds/embryo remain dormant/inactive in winter/cold
OR
 Growth/development of seed/embryo during winter/cold;
Ignore: hibernate.
Accept: 'seed survives winter/cold'.
Reject: plant develops or seed germinates during winter/cold.
 2. Seeds/plants develop in spring/summer
OR
 Seeds/plants develop when temperature/light increases;
Accept: seeds/plants develop when more light or when temperature is higher.
Accept: seed germinates/'sprouts' during spring/summer or when temp/light increases.
 3. Plant photosynthesise (in spring/when warm);
 4. Produce (more) seeds/offspring in spring/growing season; 3 max

[7]

Q14.

21 – 25	<p>Extended abstract</p> <p>Generalised beyond specific context</p>	<p>Response shows holistic approach to the question with a fully integrated answer which makes clear links between several different topics and the theme of the question.</p> <p>Biology is detailed and comprehensive A-level content, uses appropriate terminology, and is very well written and always clearly explained.</p>
---------	---	---

		<p>No significant errors or irrelevant material.</p> <p>For top marks in the band, the answer shows evidence of reading beyond specification requirements.</p>
16 – 20	<p>Relational</p> <p>Integrated into a whole</p>	<p>Response links several topics to the main theme of the question, to form a series of interrelated points which are clearly explained.</p> <p>Biology is fundamentally correct A-level content and contains some points which are detailed, though there may be some which are less well developed, with appropriate use of terminology.</p> <p>Perhaps one significant error and, or, one irrelevant topic which detracts from the overall quality of the answer.</p>
11 – 15	<p>Multistructural</p> <p>Several aspects covered but they are unrelated</p>	<p>Response mostly deals with suitable topics but they are not interrelated and links are not made to the theme of the question.</p> <p>Biology is usually correct A-level content, though it lacks detail. It is usually clearly explained and generally uses appropriate terminology.</p> <p>Some significant errors and, or, more than one irrelevant topic.</p>
6 – 10	<p>Unistructural</p> <p>Only one or few aspects covered</p>	<p>Response predominantly deals with only one or two topics that relate to the question.</p> <p>Biology presented shows some superficial A-level content that may be poorly explained, lacking in detail, or show limited use of appropriate terminology.</p> <p>May contain a number of significant errors and, or, irrelevant topics.</p>
1 – 5	Unfocused	<p>Response only indirectly addresses the theme of the question and merely presents a series of biological facts which are usually descriptive in nature or poorly explained and at times may be factually incorrect.</p> <p>Content and terminology is generally below A-level.</p> <p>May contain a large number of errors and, or, irrelevant topics.</p>
0		Nothing of relevance or no response.

Commentary on terms and statements in the levels mark scheme

The levels mark scheme for the essay contains a number of words and statements that are open to different interpretations. This commentary defines the meanings of these words and statements in the context of marking the essay. Many words and statements are used in the descriptions of more than one level of response. The

definitions of these remain the same throughout.

Levels mark scheme word/statement	Definition
Holistic	Synoptic, drawing from different topics (usually sections of the specification)
A fully integrated answer which makes clear links between several different topics and the theme of the question	<p>All topics relate to the title and theme of the essay; for example, explaining the biological importance of a process.</p> <p>When considering, for example, the importance of a process, the explanation must be at A-level standard.</p> <p>'Several' here is defined as at least four topic areas from the specification covered. This means some sentences, not just a word or two. It does not mean using many examples from one topic area.</p>
Biology is detailed and comprehensive A-level content, uses appropriate terminology, and is very well written and always clearly explained.	<p>Detailed and comprehensive A-level content is the specification content.</p> <p>Terminology is that used in the specification.</p> <p>Well written and clearly explained refers mainly to biological content and use of terminology. Prose, handwriting and spelling are secondary considerations. Phonetic spelling is accepted, unless examiners are instructed not to do so for particular words; for example, glucagon, glucose and glycogen.</p>
No significant errors or irrelevant material.	<p>A significant error is one which significantly detracts from the biological accuracy or correctness of a described example. This will usually involve more than one word.</p> <p>Irrelevant material is several lines (or more) that clearly fails to address the title, or the theme of the title.</p>
For top marks in the band, the answer shows evidence of reading beyond specification requirements.	An example that is relevant to the title and is not required in the specification content. The example must be used at A-level standard.
Response mostly deals with suitable topics but they are not interrelated and links are not made to the theme of the question.	Not addressing the biological theme of the essay (e.g. importance) at <u>A-level standard</u> .

The control of processes in cells and the importance of these controls..

Topics

O	3.1.3. and 3.2.4.	Organelles and processes
T	3.1.3. 3.1.3.	Transport across membranes Cholera
I	3.1.5.	Immune response
I	3.2.2.	Meiosis
C	3.2.5.	Mitosis and cell cycle and DNA replication
Tr	3.2.7.	Passage of water through plant
E	3.4.2. 3.4.3. 3.4.3.	ATP Photosynthesis Respiration
G	3.2.10. 3.4.8.	Antibiotics and genetic variation Inheritance
N	3.5.1. 3.5.2.	Receptors Nerve impulses and synapses
Tr	3.2.7.	Passage of water through plant
Mc	3.5.3.	Muscle contraction
H	3.5.4.	Control of blood glucose concentration – hormones – plant growth substances
Cd	3.2.6. 3.5.6.	Cell differentiation Polypeptide synthesis and gene mutations
Cd	3.5.7. 3.5.8.	Gene expression Gene therapy

H If a candidate writes at great length about plant growth substances and hormones, then the topic can be split to allow more credit

In order to fully address the question and reach the highest mark bands students must also include at least four topics in their answer, to demonstrate a synoptic approach to the essay.

Students may be able to show the relevance of other topics from the specification.

Note, other topics from beyond the specification can be used, providing they relate to the title and contain factually correct material of at least an A-level standard. Credit should not be given for topics beyond the specification which are below A-level standard.

Q15.

21 – 25	<p>Extended abstract</p> <p>Generalised beyond specific context</p>	<p>Response shows holistic approach to the question with a fully integrated answer which makes clear links between several different topics and the theme of the question.</p> <p>Biology is detailed and comprehensive A-level content, uses appropriate terminology, and is very well written and always clearly explained.</p> <p>No significant errors or irrelevant material.</p> <p>For top marks in the band, the answer shows evidence of reading beyond specification requirements.</p>
16 – 20	<p>Relational</p> <p>Integrated into a whole</p>	<p>Response links several topics to the main theme of the question, to form a series of interrelated points which are clearly explained.</p> <p>Biology is fundamentally correct A-level content and contains some points which are detailed, though there may be some which are less well developed, with appropriate use of terminology.</p> <p>Perhaps one significant error and, or, one irrelevant topic which detracts from the overall quality of the answer.</p>
11 – 15	<p>Multistructural</p> <p>Several aspects covered but they are unrelated</p>	<p>Response mostly deals with suitable topics but they are not interrelated and links are not made to the theme of the question.</p> <p>Biology is usually correct A-level content, though it lacks detail. It is usually clearly explained and generally uses appropriate terminology.</p> <p>Some significant errors and, or, more than one irrelevant topic.</p>
6 – 10	<p>Unistructural</p> <p>Only one or few aspects covered</p>	<p>Response predominantly deals with only one or two topics that relate to the question.</p> <p>Biology presented shows some superficial A-level content that may be poorly explained, lacking in detail, or show limited use of appropriate terminology.</p> <p>May contain a number of significant errors and, or, irrelevant topics.</p>
1 – 5	<p>Unfocused</p>	<p>Response only indirectly addresses the theme of the question and merely presents a series of biological facts which are usually descriptive in nature or poorly explained and at times may be factually incorrect.</p>

		Content and terminology is generally below A-level. May contain a large number of errors and, or, irrelevant topics.
0		Nothing of relevance or no response.

Commentary on terms and statements in the levels mark scheme

The levels mark scheme for the essay contains a number of words and statements that are open to different interpretations. This commentary defines the meanings of these words and statements in the context of marking the essay. Many words and statements are used in the descriptions of more than one level of response. The definitions of these remain the same throughout.

Levels mark scheme word/statement	Definition
Holistic	Synoptic, drawing from different topics (usually sections of the specification)
A fully integrated answer which makes clear links between several different topics and the theme of the question	All topics relate to the title and theme of the essay; for example, explaining the biological importance of a process. When considering, for example, the importance of a process, the explanation must be at A-level standard. 'Several' here is defined as at least four topic areas from the specification covered. This means some sentences, not just a word or two. It does not mean using many examples from one topic area.
Biology is detailed and comprehensive A-level content, uses appropriate terminology, and is very well written and always clearly explained.	Detailed and comprehensive A-level content is the specification content. Terminology is that used in the specification. Well written and clearly explained refers mainly to biological content and use of terminology. Prose, handwriting and spelling are secondary considerations. Phonetic spelling is accepted, unless examiners are instructed not to do so for particular words; for example, glucagon, glucose and glycogen.
No significant errors or irrelevant material.	A significant error is one which significantly detracts from the biological accuracy or correctness of a described example. This will usually involve more

	than one word. Irrelevant material is several lines (or more) that clearly fails to address the title, or the theme of the title.
For top marks in the band, the answer shows evidence of reading beyond specification requirements.	An example that is relevant to the title and is not required in the specification content. The example must be used at A-level standard.
Response mostly deals with suitable topics but they are not interrelated and links are not made to the theme of the question.	Not addressing the biological theme of the essay (e.g. importance) at <u>A-level standard</u> .

The importance of ions in biology.

Topics

P	3.1.3. and 3.2.2.	Phosphate in structure of phospholipids, structure of membranes, nucleotides, DNA and RNA
T	3.1.3 3.1.3	Water potentials and osmosis, chloride ions and cholera Co-transport involving sodium ions
H	3.2.4.	Haemoglobin and iron
Tr	3.2.7.	Passage of water through plants, symplast and root pressure
Tr	3.4.1. 3.4.3.	ATP and ADP Protons in photosynthesis, including reduced NADP and phosphorylated intermediates
R	3.4.4. 3.4.4.	Protons in respiration, reduced NADS and FAD and phosphorylated intermediates Glycolysis and lactate
F	3.4.5. 3.4.6.	Use of (NPK) fertilisers Nitrogen cycle
N	3.5.1. 3.5.2.	Chemoreceptors, heart rate and Pacinian function Nerve impulses and synapses
M	3.5.3.	Calcium ions and muscle contraction, and phosphate from ATP
G	3.5.8.	Genetic fingerprinting, electrophoresis

In order to fully address the question and reach the highest mark bands students must also include at least four topics in their answer, to demonstrate a synoptic approach to the essay.

Students may be able to show the relevance of other topics from the specification.

Note, other topics from beyond the specification can be used, providing they relate to the title and contain factually correct material of at least an A-level standard. Credit should not be given for topics beyond the specification which are below A-level standard.

[25]

Q16.

21 – 25	<p>Extended abstract</p> <p>Generalised beyond specific context</p>	<p>Response shows holistic approach to the question with a fully integrated answer which makes clear links between several different topics and the theme of the question.</p> <p>Biology is detailed and comprehensive A-level content, uses appropriate terminology, and is very well written and always clearly explained.</p> <p>No significant errors or irrelevant material.</p> <p>For top marks in the band, the answer shows evidence of reading beyond specification requirements.</p>
16 – 20	<p>Relational</p> <p>Integrated into a whole</p>	<p>Response links several topics to the main theme of the question, to form a series of interrelated points which are clearly explained.</p> <p>Biology is fundamentally correct A-level content and contains some points which are detailed, though there may be some which are less well developed, with appropriate use of terminology.</p> <p>Perhaps one significant error and, or, one irrelevant topic which detracts from the overall quality of the answer.</p>
11 – 15	<p>Multistructural</p> <p>Several aspects covered but they are unrelated</p>	<p>Response mostly deals with suitable topics but they are not interrelated and links are not made to the theme of the question.</p> <p>Biology is usually correct A-level content, though it lacks detail. It is usually clearly explained and generally uses appropriate terminology.</p> <p>Some significant errors and, or, more than one irrelevant topic.</p>
6 – 10	<p>Unistructural</p> <p>Only one or few aspects covered</p>	<p>Response predominantly deals with only one or two topics that relate to the question.</p> <p>Biology presented shows some superficial A-level content that may be poorly explained, lacking in detail, or show limited use of appropriate terminology.</p> <p>May contain a number of significant errors and, or, irrelevant topics.</p>

1 – 5	Unfocused	<p>Response only indirectly addresses the theme of the question and merely presents a series of biological facts which are usually descriptive in nature or poorly explained and at times may be factually incorrect.</p> <p>Content and terminology is generally below A-level.</p> <p>May contain a large number of errors and, or, irrelevant topics.</p>
0		Nothing of relevance or no response.

Commentary on terms and statements in the levels mark scheme

The levels mark scheme for the essay contains a number of words and statements that are open to different interpretations. This commentary defines the meanings of these words and statements in the context of marking the essay. Many words and statements are used in the descriptions of more than one level of response. The definitions of these remain the same throughout.

Levels mark scheme word/statement	Definition
Holistic	Synoptic, drawing from different topics (usually sections of the specification)
A fully integrated answer which makes clear links between several different topics and the theme of the question	<p>All topics relate to the title and theme of the essay; for example, explaining the biological importance of a process.</p> <p>When considering, for example, the importance of a process, the explanation must be at A-level standard.</p> <p>'Several' here is defined as at least four topic areas from the specification covered. This means some sentences, not just a word or two. It does not mean using many examples from one topic area.</p>
Biology is detailed and comprehensive A-level content, uses appropriate terminology, and is very well written and always clearly explained.	<p>Detailed and comprehensive A-level content is the specification content.</p> <p>Terminology is that used in the specification.</p> <p>Well written and clearly explained refers mainly to biological content and use of terminology. Prose, handwriting and spelling are secondary considerations. Phonetic spelling is accepted, unless examiners are instructed not to do so for particular words; for example, glucagon, glucose and glycogen.</p>

No significant errors or irrelevant material.	A significant error is one which significantly detracts from the biological accuracy or correctness of a described example. This will usually involve more than one word. Irrelevant material is several lines (or more) that clearly fails to address the title, or the theme of the title.
For top marks in the band, the answer shows evidence of reading beyond specification requirements.	An example that is relevant to the title and is not required in the specification content. The example must be used at A-level standard.
Response mostly deals with suitable topics but they are not interrelated and links are not made to the theme of the question.	Not addressing the biological theme of the essay (e.g. importance) at <u>A-level standard</u> .

How energy is transferred within and between organisms.

Topics

P	Photosynthesis
Ec	Energy transfer through ecosystems
F	Food production
D	Digestion (as in fuel)
Ab	Absorption (by cells)
Mt	Mass transport
R	Respiration
A	ATP
Sr	Stimuli and responses
Mc	Muscle contraction
N	Nerve impulses

The topics listed contain material that could be made relevant to the title. Writing about these topics in a general sense may not address the question.

Candidates may make correct use of material from other topics.

A includes where candidates use information about a topic in the specification but go beyond what is expected for our A level.*

In order to fully address the question and reach the highest mark bands students must also include at least four topics in their answer, to demonstrate a synoptic approach to the essay.

Students may be able to show the relevance of other topics from the specification.

Note, other topics from beyond the specification can be used, providing they relate to the title and contain factually correct material of at least an A-level standard. Credit should not be given for topics beyond the specification which are below A-level standard.

[25]

Q17.

- (a)
1. Releases energy in small / manageable amounts;
1. Accept less than glucose
 2. (Broken down) in a one step / single bond broken immediate energy compound / makes energy available rapidly;
2. Accept easily broken down
 3. Phosphorylates / adds phosphate makes (phosphorylated substances) more reactive / lowers activation energy;
3. Do not accept phosphorus or P on its own
 4. Reformed / made again;
4. Must relate to regeneration
- (b)
1. Substrate level phosphorylation / ATP produced in Krebs cycle;
Accept alternatives for reduced NAD
 2. Krebs cycle / link reaction produces reduced coenzyme / reduced NAD / reduced FAD;
2. Accept description of either Krebs cycle or link reaction
 3. Electrons released from reduced / coenzymes / NAD / FAD;
 4. (Electrons) pass along carriers / through electron transport chain / through series of redox reactions;
 5. Energy released;
5. Allow this mark in context of electron transport or chemiosmosis
 6. ADP / ADP + Pi;
6. Accept H⁺ or hydrogen ions and cristae
 7. Protons move into intermembrane space;
7. Allow description of movement through membrane
 8. ATP synthase;
8. Accept ATPase. Reject stalked particles
- (c)
1. In the dark no ATP production in photosynthesis;
1. In context of in photosynthetic tissue / leaves
 2. Some tissues unable to photosynthesise / produce ATP;

4

6 max

3. ATP cannot be moved from cell to cell / stored;
4. Plant uses more ATP than produced in photosynthesis;
5. ATP for active transport / synthesis (of named substance);

5

[15]

Q18.

(a)

	Photosynthesis	Anaerobic respiration	Aerobic respiration
ATP produced	✓	✓	✓
Occurs in organelles	✓		✓
Electron transport chain involved	✓		✓

1 mark per column

Mark ticks only. Ignore anything else if different symbols such as crosses are used as well.

If crosses are used instead of ticks allow cross as equivalent to a tick.

Reject tick with a line through

3

(b) $ADP + P_i \rightarrow ATP$;

Both sides correct, but allow other recognised symbols or words for phosphate ion. Reject P unless in a circle.

Accept = as equivalent to arrow

Accept reversible arrow

Ignore any reference to kJ / water

1

(c) 1. Energy released in small / suitable amounts;

2. Soluble;

3. Involves a single / simple reaction;

1. In context of release, not storage. Ignore producing energy / manageable amounts.

2. Reject "broken down easily / readily". Reject "quickly / easily resynthesised".

2 max

(d) 1. ATP cannot be stored / is an immediate source of energy;

2. ATP only releases a small amount of energy at a time;

2

[8]

Q19.

- (a) Electrons transferred down electron transport chain;

Provide energy to take protons / H⁺ into space between membranes;

Protons / H⁺ pass back, through membrane / into matrix / through ATPase;

Energy used to combine ADP and phosphate / to produce ATP;

Accept: alternatives for electron transport chain.

3 max

- (b) (i) Prevent damage to mitochondria caused by water / osmosis / differences in water potential;

Accept: other terms that imply damage e.g. shrink / burst

1

- (ii) Glucose is used / broken down during glycolysis in cytoplasm / not in mitochondria;

Accept: 'glucose is converted to pyruvate' for description of breakdown

Glucose cannot cross mitochondrial membrane / does not enter mitochondria;

Accept: only pyruvate can

2

- (iii) Terminal / final acceptor (in electron transport chain) / used to make water;

Could be shown by symbols

1

[7]

Q20.

- (a) (i) 2 (molecules)

1

- (ii) Cannot pass out of cell;
Quickly / easily broken down (hydrolysed) / broken down in a on-step reaction / immediate source of energy;
Stores / releases small amounts of energy;
Do not credit "producing energy"

max 2

- (b) Formed when reduced NAD used to reduce / donate H ions to pyruvate / convert pyruvate to ethanol;

1

[4]

Q21.

- (a) (more cristae / larger surface area) for electron transport chain / more enzymes for ATP production / oxidative phosphorylation;
muscle cells use more ATP (than skin cells)(not just more respiration);

2

- (b) (i) pyruvate; 1
- (ii) carbon dioxide formed / decarboxylation;
hydrogen released / reduced NAD formed;
acetyl coenzyme A produced; 2 max
- (c) NAD / FAD reduced / hydrogen attached to NAD / FAD;
H⁺ ions / electrons transferred from coenzyme to coenzyme /
carrier to carrier / series of redox reactions;
energy made available as electrons passed on;
energy used to synthesise ATP from ADP and phosphate /
using ATPase;
H⁺ / protons passed into intermembrane space;
H⁺ / protons flow back through stalked particles / enzyme; 3 max

[8]

Q22.

- (a) (i) 29.47(29.5);
(2 marks for correct answer)
40% / 0.4 of 2800 / 38; 2
- (ii) released as heat; 1
- (b) (i) glucose only partly broken down / only broken down to lactate; 1
- (ii) lactate / lactic acid has built up / been produced;
oxygen used to break down lactate / convert it back to
pyruvate / glucose / glycogen; 2

[6]

Q23.

- (a) ATP 1
- (b) (i) 2.57:1/2.6:1/18:7;
Correct answer however derived scores two marks
72:28 scores one mark
Correct working from wrong figures scores 1 mark
Accept
0.4 / 0.39 / 0.389 / 0.3889 2 max
- (ii) Low intensity;
At low intensity/below 40% mainly fat used / at high intensity/
above 40% mainly carbohydrate used;
Long duration exercise;
Percentage fat used increases with time / percentage
carbohydrate used decreases with time;

