1. (a) (i)

Stage	Name of stage	Location in cell
A	Glycolysis	Cytoplasm
B	Krebs cycle / citric acid cycle / TCA cycle	Mitochondrion (*ignore named part)*

1 mark per row;; 2

(ii) 3; 1

(iii) To oxygen;
Produce water; 2

(b) (i) 4; 1

(ii) 34; 1

(c) (i) Correct calculation - $\frac{[\text{answer from (b)(i)} + \text{(ii)}] \text{ x } 31}{2880} \times 100$;

Answer correct from calculation;

OR

Correct answer from (b) / 41% (*no working*) = *2 marks*;; 2

(ii) Lost as heat; 1

(iii) Energy available (more) rapidly / released in a <u>single</u> reaction;
Energy released in small quantities / manageable quantities; 2

(iv) *Any three from:*

Active transport;
Phagocytosis;
Synthesis of glycogen;
Protein / enzyme;
DNA / RNA;
Lipid / cholesterol;
Urea in glycolysis;
Bile production;
Cell division;
Any other valid suggestion; 3 max

[15]

2. (a) More work done / more energy / ATP required;
To overcome greater buoyancy;
Look for idea of buoyancy, not term. 2

(b) (i) Retains oxygen until the partial pressure is low / myoglobin has high affinity for oxygen;
Partial pressure of oxygen late in dive low;
Gives up oxygen (readily) at low partial pressures; 2 max

(ii) Remains under water for long time;
Unable to breathe while under water;
Greater amount of myoglobin can release / provide more oxygen;
More myoglobin, the darker the muscle; 3 max

(c) (i) 0.267 hours or 16 minutes;; 2
Error, but 30 00 cm^3 divided by 250 = 1 mark

(ii) Heart rate slows;
Less blood flowing to / from muscles / liver / gut / blood flow to body other than brain reduced by 90%;
Large volume of blood <u>compared with body mass;</u>
Greater <u>concentration</u> of haemoglobin;
Less blood required to supply heart / to heart muscle; 2 max
Reject imprecise answers relating to 'organs' / 'the body'.

(d) Less blood to muscles / heart muscle / skin; 1

[12]

3. (a) In boxes on diagram, in sequence: 6 3 3; 1

(b) (i) Acetylcoenzyme A; [*Allow: Acetyl coA*] 1

(ii) Link reaction AND Krebs cycle; 1

(c) Converted back to NAD/is dehydrogenated/H removed/is oxidised;
Passes H to pyruvate/reduces pyruvate/produces lactate; 2

[5]

4. (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 <u>small</u> amounts of energy;
Do not credit "producing energy" max 2

(b) Formed when reduced NAD used to <u>reduce</u> / donate H ions to pyruvate / convert pyruvate to ethanol; 1

(c) R.Q. = $\frac{\text{amount } CO_2 \text{ produced}}{\text{amount } O_2 \text{ used}}$;

Anaerobic respiration occurring;
Produces CO_2 but doesn't use O_2 / more CO_2 produced than O_2 used; max 2

[6]

5. (a) (i) Oxidative phosphorylation/electron transport chain/ETC; 1

(ii) Link reaction and Krebs cycle (or clear descriptions); 1

(b) Respiring anaerobically;
Less efficient/requires more glucose for same amount of ATP; 2

(c) Energy from chemical reaction/oxidation/not from light; 1

[5]

6.

Stage of respiration	**Statement**		
	ATP produced	**Carbon dioxide produced**	**Reduced NAD converted to NAD**
Glucose → pyruvate	✓		
Pyruvate → acetylcoenzyme A		✓	
Krebs cycle	✓	✓	
Electron carrier chain	✓		✓

Mark across, one mark for each correct row ; ; ; ; 4

[4]

7. (a) Keeps pH constant;
preventing enzymes / proteins being denatured; 2

(b) (i) A and C;
DNA is genetic material / constituent of chromosomes found in nucleus;

(ii) site of protein synthesis;
ribosomes; 4

(c) Biuret / sodium hydroxide and copper sulphate;
lilac / mauve / purple; 2

[8]

8. (a) (i) Fructose bisphosphate = 6 and pyruvate = 3; 1

(ii) Ethanol; 1

(b) Necessary to allow glycolysis/fermentation / production of pyruvate/ATP formation to continue; 1

OR Needed to remove hydrogen/oxidise more substrate/to be reduced again;

OR Does not mean NAD must be resynthesised;

(c) 2;
reference to 2 ATP used and 4 ATP produced/4 – 2; 2

[5]

9. (a) (i) Correct answer (0.5%) awarded two marks;;

answer involving decimal point in wrong place but derived correctly / correct working only awarded 1 mark 2

(ii) Some fails to encounter chloroplasts/chlorophyll in producers (e.g. some absorbed by water);
reflection;
inappropriate wavelength; max. 2

(b) Only a certain amount of light energy available / not enough energy left;
respiratory loss between each trophic level / loss in faeces; 2

(c) Incorporated in tissues of decomposers;
passed on to other organisms in decomposer food chain;
lost in respiration by decomposers; max. 2

(d) (i) Excites/raises energy level of electrons;
which pass to carriers/leave chlorophyll; 2

(ii) Fall in production of triose phosphate/no more triose phosphate produced;
triose phosphate production requires ATP/reduced NADP;
produced during passage of electrons along electron transport chain; 3

(e) Energy is available more rapidly because released in single reaction / does not go through as many processes;
ATP releases its energy in small/manageable quantities; 2

(f) (i) Activity / needs of cell linked to level of ATP / ADP ;
link made between high level of one and low level of the other;
level of ADP linked to electron transport and ATP production; 3

(ii) Energy released as heat;
because not used to produce ATP; 2

[20]

10. (a) (i)

Stage	Name of stage	Location in cell
A	Glycolysis	Cytoplasm
B	Krebs cycle / citric acid cycle / TCA cycle	Mitochondrion (*ignore named part)*

1 mark per row;; 2

(ii) 3; 1

(iii) To oxygen;
Produce water; 2

(b) (i) 4; 1

(ii) 34; 1

(c) (i) Correct calculation - $\frac{[\text{answer from (b)(i)} + \text{(ii)}] \times 31}{2880} \times 100$;

Answer correct from calculation;

OR

Correct answer from (b) / 41% (*no working*) = *2 marks*;; 2

(ii) Lost as heat; 1

(iii) Energy available (more) rapidly / released in a <u>single</u> reaction;
Energy released in small quantities / manageable quantities; 2

(iv) *Any three from:*

Active transport;
Phagocytosis;
Synthesis of glycogen;
Protein / enzyme;
DNA / RNA;
Lipid / cholesterol;
Urea in glycolysis;
Bile production;
Cell division;
Any other valid suggestion; 3 max

[15]

11. (a) More work done / more energy / ATP required;
To overcome greater buoyancy;
Look for idea of buoyancy, not term. 2

(b) (i) Retains oxygen until the partial pressure is low / myoglobin has high affinity for oxygen;
Partial pressure of oxygen late in dive low;
Gives up oxygen (readily) at low partial pressures; 2 max

(ii) Remains under water for long time;
Unable to breathe while under water;
Greater amount of myoglobin can release / provide more oxygen;
More myoglobin, the darker the muscle; 3 max

(c) (i) 0.267 hours or 16 minutes;; 2
Error, but 30 00 cm^3 divided by 250 = 1 mark

(ii) Heart rate slows;
Less blood flowing to / from muscles / liver / gut / blood flow to body other than brain reduced by 90%;
Large volume of blood compared with body mass;
Greater concentration of haemoglobin;
Less blood required to supply heart / to heart muscle; 2 max
Reject imprecise answers relating to 'organs' / 'the body'.

(d) Less blood to muscles / heart muscle / skin; 1

[12]

12. (a) 1 and 3; 1

(b) Some energy lost as heat; 1

(c) (i) Arrow indicates between Glucose to Triose phosphate;

(ii) Arrow indicates between Triose phosphate to Pyruvate; 2
[Note: Extra arrow cancels]
[Reject: Ambiguous labels /arrows]

(d) 4; 1

(e) (i) Grana/ thylakolds/ internal membranes; 1

(ii) Reduces/ reducing power/ source of hydrogen/ electrons;
Glycerate-3-phosphate to Triose phosphate/ GP to TP; 2
[Ignore: Reference to molecules]

(f) (i) To show chloroplasts responsible for change; 1

(ii) Photolysis/ light splits water molecule/ excitation of chlorophyll:
Electrons released;
Electrons reduce DCPIP/ DCPIP becomes colourless;
So can only see (green) colour of chloroplasts/ chlorophyll; max 3

(g) (i) Mitochondria are sites of (aerobic) respiration/ active in dark;
Reactions also release hydrogen ions/ electrons;
(Tube B) would also become green/ reduce DCPIP (if responsible);
[Reject: Colourless] [Reject.- Converse argument]
OR Tube B shows light is necessary for colour change;
Mitochondria do not have <u>pigment to absorb light</u>/ chlorophyll; max 2

(ii) Only one set of results/ not repeated; 1
[Reject: Need more results]

[15]

13. (a) (Energy release) only involves a <u>single</u> reaction/<u>one</u>-step/
(energy released) in ATP → ADP (+Pi)/
energy transfer direct to reaction requiring energy; 1
[*Ignore: reference to speed*] [*Reject: "not many steps"*]

(b) Any **two** from:
Need more ATP (than can be produced in photosynthesis)/not enough;
Photosynthesis cannot produce ATP in dark;
Cannot be produced in cells lacking chlorophyll/chloroplasts/
ATP cannot be transported; max 2

(c) Glycolysis/anaerobic respiration/"fermentation";
Does not occur in mitochondria/takes place in cytoplasm; 2

[5]

14. (a) In boxes on diagram, in sequence: 6 3 3; 1

(b) (i) Acetylcoenzyme A; [*Allow: Acetyl coA*] 1

(ii) Link reaction AND Krebs cycle; 1

(c) Converted back to NAD/is dehydrogenated/H removed/is oxidised;
Passes H to pyruvate/reduces pyruvate/produces lactate; 2

[5]

15. (a) X = Carbon dioxide;
Y = Acetyl coenzyme A; (*ACCEPT* Acetyl CoA)
Z = Water; 3

(b) (i) Cytoplasm; 1

(ii) Mitochondrion; (*IGNORE* named part) 1

(c) On the diagram:

(i) '**A**' (ATP used) – between glucose and triose phosphate; 1

(ii) '**B**' Any **two** from:

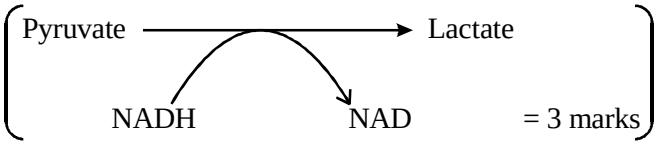
(ATP produced) – between triose phosphate and pyruvate;
in Krebs cycle;
from electron carriers
(to right of bracket & not below grey box); max 2

(d) Any **three** from:

Source of energy/of phosphate;
Active transport;
Phagocytosis / endo- /exocytosis / pinocytosis;
Bile production;
Cell division / mitosis;
Synthesis of: glycogen;
protein / enzymes;
DNA / RNA;
lipid / cholesterol;
urea; max 3

(e) Any **four** from:
Forms lactate; [extras – C_2H_5OH / CO_2 – *CANCEL*]

Use of reduced NAD / NADH;



= 3 marks

Regenerates NAD;

NAD can be re-used to oxidise more respiratory substrate / correct e.g.
/ allows glycolysis to continue;
Can still release energy/form ATP
when oxygen in short supply/when no oxygen; max 4

[15]

16. (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

(c) R.Q. = $\frac{\text{amount } CO_2 \text{ produced}}{\text{amount } O_2 \text{ used}}$;

Anaerobic respiration occurring;
Produces CO_2 but doesn't use O_2 / more CO_2 produced than O_2 used; max 2

[6]

17. (a) (Absorption of) light; 1

(b) Inner membrane/cristae/stalked particles of mitochondria; 1

(c) Plantae (plants) / Protoctista / prokaryotes;
Processes are photosynthesis and respiration /
plants/algae/(some) protoctistans/prokaryotes photosynthesise/have chlorophyll; 2

[4]

18. (a) (i) glycolysis; 1

(ii) oxygen removed from pyruvate/ reduced NAD is oxidised/ donates hydrogen/donates electrons; 1

(iii) allows NAD to be recycled/re-formed;
so that glycolysis/described/ candidates answer to (i) can proceed/
so that (more) glucose can be
converted to pyruvate/so that process X can continue; 2

(b) (i) ATP formed/used;
pyruvate formed/reduced;
NAD/reduced NAD;
glycolysis involved/two stage process; 2 max

(ii) ethanol/alcohol formed by yeast, lactate (*allow lactic acid)*
by muscle cell; CO_2 released by yeast but not by muscle cell; 2

(note: need both parts of the comparison for the mark)

(c) (i) allows anomalies to be identified/increases reliability (of means/ averages/results);
allows use of statistical test; 2

(ii) $\frac{38.3 + 27.6 + 29.4}{3}$ = 31.8/ 31.76/ 31.77;×

(units not required)

÷ (5 × 60) = 0.106/ 0.11/ 0.1; 2

(correct answer scores two marks, however derived.)
(correct mean volume (31.8 cm^3) however derived scores 1 mark)

(iii) Volume(s) less/ no gas evolved;
Glucose has RQ of 1.0;
So (volume) CO_2 evolved = (volume of) O_2 taken in; 3

[15]

19. General principles for marking the Essay:

Four skill areas will be marked: scientific content, breadth of knowledge, relevance and quality of language. The following descriptors will form a basis for marking.

Scientific content (maximum 16 marks)

Category	Mark	Descriptor
	16	
Good	14	Most of the material of a high standard reflecting a comprehensive understanding of the principles involved and a knowledge of factual detail fully in keeping with a programme of A-level study. Some material, however, may be a little superficial. Material is accurate and free from fundamental errors but there may be minor errors which detract from the overall accuracy.
	12	
	10	
Average	8	A significant amount of the content is of an appropriate depth, reflecting the depth of treatment expected from a programme of A-level study. Generally accurate with few, if any fundamental errors. Shows a sound understanding of most of the principles involved.
	6	
	4	
Poor	2	Material presented is largely superficial and fails to reflect the depth of treatment expected from a programme of A-level study. If greater depth of knowledge is demonstrated, then there are many fundamental errors.
	0	

Breadth of Knowledge (maximum 3 marks)

Mark	Descriptor
3	A balanced account making reference to most if not all areas that might realistically be covered on an A-level course of study.
2	A number of aspects covered but a lack of balance. Some topics essential to an understanding at this level not covered.
1	Unbalanced account with all or almost all material based on a single aspect
0	Material entirely irrelevant.

Relevance (maximum 3 marks)

Mark	Descriptor
3	All material presented is clearly relevant to the title. Allowance should be made for judicious use of introductory material
2	Material generally selected in support of title but some of the main content of the essay is of only marginal relevance.
1	Some attempt made to relate material to the title but considerable amounts largely irrelevant.
0	Material entirely irrelevant or too limited in quantity to judge.

Quality of language (maximum 3 marks)

Mark	Descriptor
3	Material is logically presented in clear, scientific English. Technical terminology has been used effectively and accurately throughout.
2	Account is logical and generally presented in clear, scientific English. Technical terminology has been used effectively and is usually accurate.
1	The essay is generally poorly constructed and often fails to use an appropriate scientific style and terminology to express ideas.
0	Material entirely irrelevant or too limited in quantity to judge.

[25]

Additional notes on marking

Care must be taken in using these notes. It is important to appreciate that the only criteria to be used in awarding marks to a particular essay are those corresponding to the appropriate descriptors. Candidates may gain credit for any information providing that it is biologically accurate, relevant and of a depth in keeping with an A-level course of study. Material used in the essay does not have to be taken from the specification, although it is likely that it will be. These notes must therefore be seen merely as guidelines providing an indication of areas of the specification from which suitable factual material might be drawn.

In determining the mark awarded for breadth, content should ideally be drawn from each of the areas specified if maximum credit is to be awarded. Where the content is drawn from two areas, two marks should be awarded and where it is taken only from a single area, one mark should be awarded. However, this should only serve as a guide. This list is not exhaustive and examiners should be prepared to offer credit for the incorporation of relevant material from other areas of study.

20. (a) (i) **P** = 3;
Q = acetylcoenzyme A; 2

(ii) 36 ATP, however derived = 2 marks
30 ATP, however derived = 1 mark 2

(iii) *Correct statement in the context of aerobic respiration or anaerobic respiration concerning*:
Oxygen as terminal hydrogen/electron acceptor;
Operation of electron transport chain/ oxidative phosphorylation;
Fate of pyruvate;
Krebs cycle;
Significance of ATP formed in glycolysis; max. 3

(b) (i) Thick walls exclude oxygen;
Produced by photosynthetic cells (of fern and *Anabaena*);
Contain no chlorophyll so do not photosynthesise;
Do not produce oxygen;
Oxygen would inhibit nitrogen fixation process; max. 3

(ii) Decomposers/ bacteria/fungi/saprobionts (in fields);
Convert protein/organic nitrogen (in cells of fern) into ammonium ions (*allow ammonia*);
Ammonium ions (ammonia) converted to nitrite;
Nitrite converted to nitrate;

Allow 1 mark for $NH_3/NH_4^+ \rightarrow NO3_3^-$

By nitrifying bacteria / correctly named;
Nitrate used to form protein / amino acids in rice;
Link between application of fern and protein/cells of rice;
Decomposers respire (suitable substrate) and release CO_2;
Used in photosynthesis by rice; max. 5

[15]

21. (a) pyruvate; 1

(b) Krebs cycle; 1

(c) ATP formed as electrons pass along transport chain;
oxygen is terminal electron acceptor / accepts electrons from electron transport chain;
electrons cannot be passed along electron transport chain if no O_2 to accept them;
forms H_2O / accepts H^+ from reduced NAD/FAD / oxidises reduced NAD/FAD; 3 max

[5]

22. (a) Carbon dioxide; 1

(b) 38; 1

(c) (i) Terminal hydrogen / electron acceptor;
producing water/a safe end product; 2

(ii) 2; 1

[5]

23. (a) (i) To avoid bias/obtain representative sample/
so that statistical tests can be applied to results; 1

(ii) Divide area with a grid/place axes at right angles;
Use random numbers/obtained by specified method;
To obtain coordinates for placing quadrats; max 2

(b) More closely related to economic/ecological effect of worms/
Information not distorted by large number of very small worms; 1

(c) Low temperatures reduce feeding/max feeding activity at 10 °C;
Enzymes relatively inactive;
Also feed less at high temperatures;
Food required for (growth and) reproduction; max 3

[7]

24. (a) correct positions labelled; 2

e.g. K-matrix of mitochondrion
G-cytoplasm

(b) (i) pyruvate;
ADP;
phosphate/Pi;
oxygen;
reduced NAD; max. 2

(ii) carbon dioxide / water / ATP / NAD; 1

(c) (i) oxidation involves the removal of hydrogen; 1

(ii) activate / phosphorylate / raise energy level; 1

[7]

25. (a) Glycolysis/oxidation; 1

(b) Reduced NAD/NADH or other appropriate expression;
ATP; 2

(c) (i) Stroma; 1

(ii) Combines with/accepts carbon dioxide; 1

[5]

26. (a) 3

✓	✓	X
✓	X	✓
✓	X	X

Mark down
Hybrids between ticks and crosses are ambiguous and not acceptable

(b) Flowering plants use water as a source of hydrogen:
Flowering plants have chloroplasts/membrane-bound organelles:
Plants release oxygen as a waste product: max 2

[5]

27. (i) Acetylcoenzyme A linked to Krebs cycle:
Krebs cycle takes place in mitochondria:
or
Glucose linked to glycolysis;
Glycolysis takes place in cytoplasm; 2

(ii) Electron transport system;
ADP required to generate ATP;
Oxygen is a hydrogen acceptor/converted to water; max 2

[4]

28.

Event or description	Occurs or applies to	
	Stage I	**Stage II**
Glycolysis	✓	
Takes place inside the mitochondnon		✓
Acetylcoenzyme A is involved		✓
ATP is synthesised from ADP	✓	✓
Reduced NAD is re-oxidised		✓

Credit per row 5

[5]

29. (a) Glycolysis;
Glucose / hexose sugar (or phosphorylated) and pyruvate (or triose phosphate / GP/PGA). 2

(b) Light-independent reaction / Calvin cycle;
Ribulose bisphosphate (RUBP) and carbon dioxide. 2

(c) Light-independent reaction / Calvin cycle;
Glycerate-3-phosphate / TP and glucose / hexose (phosphate). 2

[6]

30. (a) Needed to make ATP / for phosphorylation; 1

(b) (Oxygen) needed for formation of ATP / phosphorylation;
(Oxygen) used (so its level falls);
(Oxygen) reacts (with 'H') to produce water;
In the electron transport chain / at terminal acceptor;
Allows recycling of reduced coenzymes / NAD / FAD; 3 max

(c) Because equal amounts of ADP were added; 1

(d) Less oxygen available in medium at Z than at Y
OR because oxygen all used up / 'runs out'; 1

(e) (i) Glucose cannot enter mitochondria BECAUSE too large to enter / no carrier system for it;
OR glucose cannot be metabolised / equivalent BECAUSE necessary enzymes not present; 2

(*Note single marks here for a suitable suggestion, and for a connected, plausible reason / also that suggestion and reasons may 'cross over'. Allow, each for 2: "*no cytoplasm, no glycosis, not to pyruvate")

(ii) Label glucose and determine its failure to enter mitochondria;
'Break' mitochondrial membrane (to allow entry of glucose);
'Release' appropriate enzymes from mitochondrion;
Add glycolytic enzymes / 'cytoplasm' to medium in advance;
(**OR** suitable suggestions re. possible reason previously given) 1

[9]

31. (a) D; 1

(b) Krebs cycle;electron transport/transfer chain/oxidative phosphorylation;
(glycolysis negates one point of credit)
(link reaction and glycogenesis etc. are 'neutral') 2

(c) some radioactivity in intermediates/other compounds (e.g. glucose);
ACCEPT idea of less present because of radioactive decay;NOT because of 'rounding off' 1

(d) (1200 / 8000) × 100;
15 (%);
(*allow* (*1800 / 8000*) × *100 = 22.5% for 1 mark*)
(*2 marks for the correct answer as 15% without working,*
1 mark for 22.5%)) 2

[6]

32. General principles for marking the Essay:

Four **skill areas** will be marked: scientific content, breadth of knowledge, relevance and quality of language
The following descriptors will form a basis for marking.

Scientific content (maximum 16 marks)

Category	Mark	Descriptor
	16	
Good	14	Most of the material of a high standard reflecting a comprehensive understanding of the principles involved and a knowledge of factual detail fully in keeping with a programme of A-level study. Some material, however, may be a little superficial. Material is accurate and free from fundamental errors but there may be minor errors which detract from the overall accuracy.
	12	
	10	
Average	8	A significant amount of the content is of an appropriate depth, reflecting the depth of treatment expected from a programme of A-level study. Generally accurate with few, if any fundamental errors. Shows a sound understanding of most of the principles involved.
	6	
	4	
Poor	2	Material presented is largely superficial and fails to reflect the depth of treatment expected from a programme of A-level study. If greater depth of knowledge is demonstrated, then there are many fundamental errors.

Breadth of Knowledge (maximum 3 marks)

Mark	Descriptor
3	A balanced account making reference to most if not all areas that might realistically be covered on an A-level course of study
2	A number of aspects covered but a lack of balance. Some topics essential to an understanding at this level not covered
1	Unbalanced account with all or almost all material based on a single aspect.
0	Material entirely irrelevant

Relevance (maximum 3 marks)

Mark	Descriptor
3	All materials presented is clearly relevant to the title. Allowance should be made for judicious use of introductory material
2	Material generally selected in support of title but some of the main content of the essay is of only marginal relevance.
1	Some attempt made to relate material to the title but considerable amounts largely irrelevant.
0	Material entirely irrelevant or too limited in quantity to judge

Quality of Written Communication (maximum 3 marks)

Mark	Descriptor
3	Material is logically presented in clear, scientific English. Technical terminology has been used effectively and accurately throughout
2	Account is logical and generally presented in clear, scientific English. Technical terminology has been used effectively and accurately throughout
1	The essay is generally poorly constructed and often fails to use an appropriate scientific style and terminology to express ideas
0	Material entirely irrelevant or too limited in quantity to judge

[25]

33. (a) removal of hydrogen/dehydrogenation;
by enzymes/dehydrogenases;
H accepted by NAD/reduced NAD formed;
in Krebs cycle, FAD (used as well); 3 max

(b) oxygen is terminal/final electron acceptor;

combines with electron and hydrogen (to form water); 2

[5]

34. (a)

	Process	
	Respiration	Photosynthesis
Name of coenzyme	NAD	NADP
Stage in the process where coenzyme is reduced	*Glycolysis* *and* *link reaction/Krebs cycle*	*light dependent*
Stage in the process where coenzyme is oxidised	*electron transport chain*	*light independent*

1st column,
glycolysis and Krebs cycle/link reaction;
oxidative phosphorylation/ETC;

2nd column,
light dependent, then light independent; 3

(b) used to reduce G3P;
to sugar/triose phosphate/fructose/glucose; 2

[5]

35. (a) (i) pyruvate; 1

(ii) reacts (with coenzyme A) to give acetylcoenzyme A;
decarboxylation / CO_2 given off;
NAD reduced / oxidation; 2

(b) only glycolysis in anaerobic conditions / CO_2 only produced in Krebs cycle;
with oxygen get aerobic respiration involving Krebs cycle / link reaction;
with release of (radioactively labelled) carbon dioxide;
CO_2 given off in link reaction; 3 max

[6]

36. (a) phylum, class, family, genus; 1

(b) (i) presence of a nucleus / membrane bound organelles / named organelles only 80S ribosomes / lacks a cell wall; 1

(ii) lacks a cell wall / no chitin / is motile / has one nucleus / no hyphae; 1
(*do not credit it has a nucleus*)

(*credit only one answer relating to a lack of cell wall; if more than one answer is given in* (*i*) *and / or* (*ii*)*, incorrect answers negate*)

(c) (i) more recent common ancestor / DNA in common; 1

(ii) mutation;
there is variation;
genes (coding) for protein / cytochrome c with different structures;
EITHER
individuals with a modified cytochrome c have a selective advantage / are selected for;
these individuals are more likely to survive to have offspring / have more offspring;
(*must link a comparison of survival to reproduction*)
gene / allele frequency changes over generations / time;
OR
changed structure does not affect protein function;
these structural differences accumulate over time; 4 max

[8]
QWC 1

37. (a) (i) to increase surface area (for carbon dioxide absorption); 1

(ii) oxygen is used / carbon dioxide emitted is absorbed;
so decrease in volume / pressure; 2

(iii) change of level of (manometer) liquid over time;
bore of tube;
mass of snails;
time interval; 3 max

(b) (i) *valid similarity taking into account SD e.g. between 5 and 15 °C*
both show little effect of temperature / intakes similar between 5 and 15 °C; 1
valid difference taking into account SD above 15 °C e.g.
rise at 20 °C and above is less when snails kept in sea water; 1

(ii) standard deviations high;
means unreliable;
(*accept 25 °C being out of normal range for snail / not enough temperature readings for 1 mark*) 2

[10]

38. (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]

39. ***General Principles for marking the Essay:***

Four skill areas will be marked: scientific content, breadth of knowledge, relevance and quality of language. The following descriptors will form a basis for marking.

Scientific Content (maximum 16 marks)

Category	Mark	Descriptor
Good	16 14 12	Most of the material reflects a comprehensive understanding of the principles involved and a knowledge of factual detail fully in keeping with a programme of A-level study. Some material, however, may be a little superficial. Material is accurate and free from fundamental errors but there may be minor errors which detract from the overall accuracy.
Average	10 8 6	Some of the content is of an appropriate depth, reflecting the depth of treatment expected from a programme of A-level study. Generally accurate with few, if any, fundamental errors. Shows a sound understanding of the key principles involved.
Poor	4 2 0	Material presented is largely superficial and fails to reflect the depth of treatment expected from a programme of A-level study. If greater depth of knowledge is demonstrated, then there are many fundamental errors.

Breadth of Knowledge (maximum 3 marks)

Mark	Descriptor
3	A balanced account making reference to most areas that might realistically be covered on an A-level course of study.
2	A number of aspects covered but a lack of balance. Some topics essential to an understanding at this level not covered.
1	Unbalanced account with all or almost all material based on a single aspect.
0	Material entirely irrelevant or too limited in quantity to judge.

Relevance (maximum 3 marks)

Mark	Descriptor
3	All material presented is clearly relevant to the title. Allowance should be made for judicious use of introductory material.
2	Material generally selected in support of title but some of the main content of the essay is of only marginal relevance.
1	Some attempt made to relate material to the title but considerable amounts largely irrelevant.
0	Material entirely irrelevant or too limited in quantity to judge.

Quality of language (maximum 3 marks)

Mark	Descriptor
3	Material is logically presented in clear, scientific English. Technical terminology has been used effectively and accurately throughout.
2	Account is logical and generally presented in clear, scientific English. Technical terminology has been used effectively and is usually accurate.
1	The essay is generally poorly constructed and often fails to use an appropriate scientific style and terminology to express ideas.
0	Material entirely irrelevant or too limited in quantity to judge.

[25]

Guidelines for marking the essay

Introduction

The essay is intended for the assessment of AO4 (Synthesis of knowledge, understanding and skills) and Quality of Written Communication (Sections 6.4 and 6.5 in the specification). Examiners are looking for

- evidence of knowledge and understanding at a depth appropriate to A level
- selection of relevant knowledge and understanding from different areas of the specification
- coverage of the main concepts and principles that might be reasonably be expected in relation to the essay title
- connection of concepts, principles and other information from different areas in response to the essay title
- construction of an account that forms a coherent response
- clear and logical expression, using accurate specialist vocabulary appropriate to A level

Assessing Scientific Content

Maximum 16 marks.

Descriptors are divided into 3 categories: Good (16, 14, 12), Average (10, 8, 6) and Poor (4, 2, 0). Only even scores can be awarded, i.e. not 15, 13, etc.
Examiners need first to decide into which category an essay comes.

A good essay

- includes a level of detail that could be expected from a comprehensive knowledge and understanding of relevant parts of the specification
- maintains appropriate depth and accuracy throughout
- avoids fundamental errors
- covers a majority of the main areas that might be expected from the essay title (These areas will be indicated in the mark scheme). (Occasionally a candidate may tackle an essay in an original or unconventional way. Such essays may be biased in a particular way, but where a high level of understanding is shown a high mark may be justified.)
- demonstrates clearly the links between principles and concepts from different areas.

Note that it is not expected that an essay must be 'perfect' or exceptionally long in order to gain maximum marks, bearing in mind the limitations on time and the pressure arising from exam conditions.

An average essay

- should include material that might be expected of C/D/E grade candidates
- is likely to have less detail and be more patchy in the depth to which areas are covered, and to omit several relevant areas
- is likely to include some errors and misunderstandings, but should have few fundamental errors
- is likely to include mainly more superficial and less explicit connections

A poor essay

- is largely below the standard expected of a grade E candidate
- shows limited knowledge and understanding of the topic
- is likely to cover only a limited number of relevant areas and may be relatively short
- is likely to provide superficial treatment of connections
- includes several errors, including some major ones

Having decided on the basic category, examiners may award the median mark, or the ones above or below the median according to whether the candidate exceeds the requirements or does not quite meet them.

Marking the essay

In marking scientific content, letters in the margin show each key area covered; these are used to assess the breadth of criteria. A single tick is used to indicate accurate coverage of each significant area, and a double tick to emphasise 'good depth of content.' Errors are indicated with a cross. A squiggly line in the margin is used to highlight irrelevance and 'Q' to highlight poor use of terminology, unclear grammar and inappropriate style.

Specific guidance for assessing Scientific Content and Breadth of Knowledge in Essays

The following provides guidance about topics which might be included in the essays. It is not an exclusive list; the assessment of scientific content does not place restrictions on topics that candidates might refer to, provided they are

• relevant;
• at an appropriate depth for A level and
• accurate.

It is not expected that candidates would refer to all, or even most, of the topics to gain a top mark; the list represents the variety of approaches commonly encountered in the assessment to the essays. In both essays, topics either from the option modules or beyond the scope of the specification should also given credit where appropriate.

Energy transfers which take place in living organisms

(1) ATP (A)
synthesis from ADP and P
role as an energy source

(2) photosynthesis (P)
excitation of electrons
generation of ATP and reduced NADP
photolysis
reduction of glycerate phosphate to carbohydrate
structure of chloroplast in relation to energy transfers

(3) respiration (R)
net gain of ATP in glycolysis
production of ATP in Krebs cycle
synthesis of ATP associated with electron transfer chain
ATP production in anaerobic respiration
structure of mitochondrion in relation to energy transfers

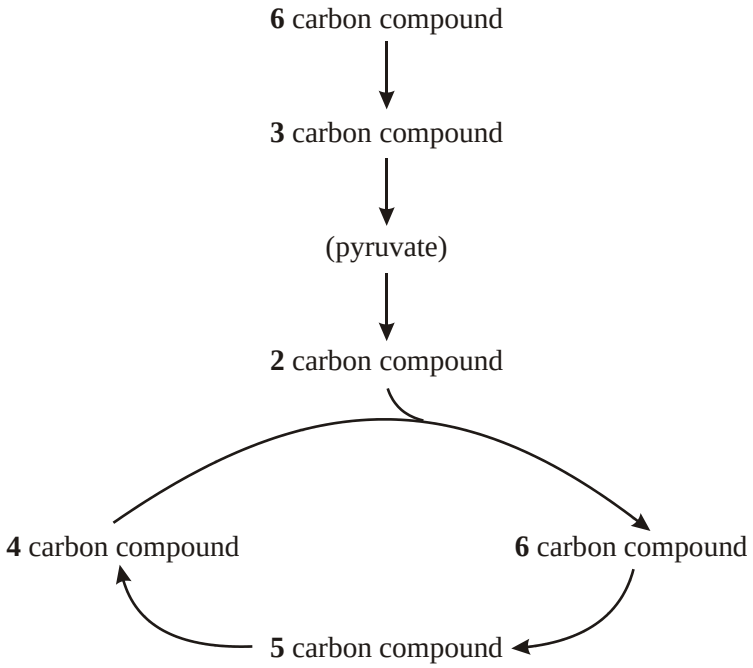
(4) uses of energy in biological processes (B)

active transport
muscle contraction
nerve transmission
synthesis
translocation
kidney function
nitrogen fixation
receptors

Breadth of knowledge

3 marks	reference to all 4 areas
2 marks	ATP + 2 other areas
1 mark	any 2 areas

40. (a)



(1 mark for three correct answers)

(2 marks for six correct answers) 2

reduced NAD/NADH/$NADH_2$;
reduced FAD/FADH/$FADH_2$; 3
ATP;

[5]

41. (a) (i) in case normal coffee differs in some other way;
to control concentration of caffeine; 1 max

(ii) not telling them what the drink contained / purpose of experiment; 1

(b) (i) able to continue for longer; *(not just increases performance)*
(disqualify if also refers to fatty acids and glycerol) 1

(ii) breakdown of fats;
at increased rate / by mobilisation of fat stores; 2

(c) (i) idea that volumes of oxygen and carbon dioxide the same;

reference to equal moles, or quotient as 1 divided by 1/ or 6 by 6; 2

(ii) glycogen is a carbohydrate / broken down to glucose, linked to RQ;
with no caffeine, RQ nearer 1.0 / less carbon dioxide exhaled and more oxygen inhaled (or vice versa);
with caffeine higher proportion of fats/fatty acids respired;
increased time to exhaustion suggests slower use of glycogen: 3 max

[10]

42. (a) matrix; 1

(b) pyruvate;
ADP;
P / inorganic phosphate;
reduced NAD;
oxygen; 2 max

(c) larger surface area for electron carrier system / oxidative phosphorylation;
provide ATP / energy for contraction; 2

[5]

43. (a)

✓	✓	x;
x	x	✓;
✓	✓	✓
✓	x	x

4

(b) (i) pyruvate/succinate/any suitable Krebs cycle substrate; 1

(ii) ADP and phosphate forms ATP;
oxygen used to form water / as the terminal acceptor; 2

(iii) Y X W Z;
order of carriers linked to sequence of reduction / reduced carriers cannot pass on electrons when inhibited; 2

[9]

44. (a) Glycolysis;
Glucose and pyruvate/pyruvic acid; 2

(b) Light-independent reaction;
Ribulose bisphosphate/RuBP and carbon dioxide; 2

(c) Light-independent reaction;
Triose phosphate and glucose/hexose; 2

Q *Do not accept sugar or carbohydrate as alternative for glucose*

[6]

45. (a)
1 Sample of ground beetles captured and counted (a);
2 Released and second sample captured;
3 Count total number of beetles (B) and number marked (b);
4 Total population (A) estimated from the relationship $\frac{a}{A} = \frac{b}{B}$;
5 Detail of method e.g. pitfall trap/marking with tippex;
6 Refinement to ensure greater accuracy e.g. large number/ marking in position such that does not affect survival; 5 max

(b)
1 Mowing prevents growth of woody plants;
2 By cutting off growing point;
3 The longer the interval between mowing, the further succession can progress;
4 With frequent mowing diversity of plants will be less;
5 Fewer insect inhabitants/niches available; 5

Q *Since this is an ecological question, use of appropriate ecological terminology is expected. Credit such terms as producer, consumer, habitat, and niche. Do not credit inappropriate terminology such as "places" to live and "fighting for food".*

(c)
1 Higher carbon dioxide concentration at night/during darkness;
2 Photosynthesis only takes place during light;
3 Photosynthesis removes carbon dioxide and respiration adds carbon dioxide;
4 Respiration taking place throughout 24 hours;
5 Quantitative consideration such as that in plants overall photosynthetic rate greater than respiration rate;
6 Human effect such as additional carbon dioxide from heavy daytime traffic/street lighting could prolong photosynthesis; 5 max

[15]