1. ***S & C***

Mark the first answer*. If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then =* ***0 marks***

CREDIT one statement and a suitable explanation related to that (first) given statement *(e.g. S3 + E3 but not S4 + E1)*

DO NOT AWARD 2 marks for 2 statements or 2 explanations

S1 glucose is not the only substrate / there are other substrates;

'fats can (also) be respired' = E1
'fats can be respired as well as glucose' = S1 + E1

E1 named alternative substrate;

or

S2 ATP is produced / energy is released;

DO NOT CREDIT energy *produced / made / created*

E2 (by) substrate level / oxidative, phosphorylation;

or

S3 ATP / energy, required;

E3 (for) phosphorylation / glycolysis;

or

S4 is not a single step reaction / other steps involved / other products / other intermediates;

E4 named stage(s) / named intermediate compound(s);

Krebs cycle / ETC, happens = E4
'other stages such as link reaction are involved' = S4 + E4
e.g. pyruvate / acetyl CoA / acetate

IGNORE *NAD(H) / FAD(H) / ATP*

or

S5 enzymes are involved;

E5 dehydrogenation / decarboxylation / oxidative phosphorylation / named (respiratory) enzyme;

or

S6 coenzymes / NAD, involved;

DO NOT CREDIT *NADP*

E6 oxidative phosphorylation / link reaction / Krebs cycle / glycolysis;

or

S7 glucose does not, combine / react, (directly) with oxygen;

E7 (oxygen) used in oxidative phosphorylation / is final electron acceptor / is final hydrogen acceptor;

[2]

2. (i) ***Mark the first answer***. *If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then =* ***0 marks***

glycolysis / glycolytic pathway;

CREDIT *phonetic spelling but must have 'glycol...'*

1

(ii) ***Mark the first answer***. *If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then =* ***0 marks***

cytoplasm;

CREDIT *cytosol*

DO NOT CREDIT *cytoplasm, in / of, mitochondrion*

1

(iii) ***Mark the first answer for each letter***. *If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then =* ***0 mark***

D ATP;

E NAD;

ALLOW *oxidised NAD*
DO NOT CREDIT *NADP / reduced NAD*

F pyruvate;

ACCEPT *pyruvic acid*

3

[5]

3. ***Award marks from labelled / annotated diagrams – but ensure that mp 2 only awarded if H clearly shown to be accepted by pyruvate***

1 (pyruvate / **F**) converted to lactate;

ACCEPT *lactic acid*
DO NOT CREDIT *if pyruvate → ethanol in the animal is indicated/implied*
DO NOT CREDIT *wrong reaction type (e.g. oxidation)*

2 **F** / pyruvate, accepts hydrogen (atoms);

ACCEPT *pyruvic acid*
DO NOT CREDIT *hydrogen* ***ions*** *(unless also e^-) / molecule*

3 hydrogen from, **reduced** NAD / **reduced E**;

ACCEPT *$NADH$ / $NADH_2$ / $NADH + H^+$*

4 (catalysed by) lactate dehydrogenase;

for pyruvate → lactate ***ACCEPT*** *LDH*

5 no, oxygen / O_2, to act as (final),
hydrogen / electron, acceptor;

6 (so) link reaction / Krebs cycle / ETC, cannot take place;

Needs a clear statement of ***not*** *taking place*
CREDIT *no, electron transport chain / electron carrier chain / chemiosmosis / oxidative phosphorylation*

7 NAD / **E**, regenerated / recycled / able to be re-used;

IGNORE *reduced NAD, oxidised / reoxidised (as this does not give the idea of reusing it)*

8 allows glycolysis to continue / pyruvate continues to be made;

Needs a clear statement

9 limited / small amount of / some, ATP can be produced;

CREDIT *1 ATP (per pyruvate) / 2 ATP (rather than 28-38 per glucose) / only substrate level phosphorylation*
IGNORE *'enough ATP for ...'*

[5]

4. *physical (probably from diagrams)*

1 large nostrils (open) to take in air;

ACCEPT *oxygen*

2 (when submerged) nostrils close / nose closes, to, keep air in / stop air from escaping;

ACCEPT *oxygen*
IGNORE *ref to keeping water out*

3 lungs / airways, have high (vital) capacity;

ACCEPT *deep / barrel / large, chest* ***IGNORE*** *big lungs*
CREDIT *large lung <u>volume</u> /*
takes in large <u>volume</u> of oxygen /
larger numbers of alveoli /
larger (exchange) surface area /
increased number of capillaries

links to respiration

4 *idea that* seal, has low(er) metabolic rate / has low(er) respiratory rate / has low(er) energy requirements / uses (relatively) little ATP;

e.g.
- *(streamlined, less resistance so) uses less energy*
- *(insulated so retain heat so) uses less energy*
- *(buoyant so) less energy required*
- *(small flippers so less surface area of extremity so loses less heat so) uses less energy*

5 able to respire anaerobically for a long time / more glycolysis;

'anaerobic' needs time ref

6 large supplies of NAD (to accept H);

7 (this) prevents, build-up of lactate / lowering of pH;

ACCEPT *lactic acid*

8 *idea that* (seal) tolerates lactate / removes lactate quickly;

ACCEPT *lactic acid*

9 *idea that* (seal) tolerates high CO_2 concentration;

10 *idea that* (seal) tolerates low pH / has **more** pH buffers;

synoptic / inference

11 *idea that* blood diverted from certain regions / certain regions have reduced metabolic activity;

DO NOT CREDIT *zero respiration rate*

12 *idea that* has plenty of, haemoglobin / red blood cells / myoglobin (as oxygen source);

13 *idea that* haemoglobin has a higher affinity for oxygen / dissociates less readily / dissociation curve shifted to **left**;

[3]

5. no photophosphorylation;
no ATP produced;
no reduced NADP produced;
no Calvin cycle / no light-independent stage;
no GP to TP / no TP to RuBP;
no fixation of carbon dioxide;

AVP; e.g. no production of, organic molecules / named molecules
A *autotrophic nutrition stops*
R *food*
ref to no respiratory substrate max 3

[3]

6. (i) A glycolysis;
B fermentaion / anaerobic respiration / reduction of pyruvate;
C aerobic respiration / Krebs cycle and oxidative phosphorylation / ETC / electron transport chain; 3

(ii) C;
allow ecf from (i) 1

(iii) A;
allow ecf from (i) 1

[5]

7. (i) (when cyanide absent) complete homogenate can fully respire the glucose/pyruvate to produce carbon dioxide;

(when cyanide is present), pyruvate does not enter the mitochondria;
some carbon dioxide produced when pyruvate is converted to ethanal;
breakdown of the glucose / pyruvate is incomplete;

ref. to anaerobic respiration; max 3

(ii) pyruvate is end product of glycolysis;
pyruvate can enter mitochondria;
carbon dioxide produced in the Krebs cycle and link reaction;
by, decarboxylation / decarboxylase(s);

glucose cannot enter the mitochondria;

AVP; further detail e.g. no carriers for glucose in mitochondrial membranes
glycolytic enzymes not found in mitochondria portion (of homogenate)
glycolytic enzymes found in, cytoplasm / cytosol max 3

(iii) pyruvate is converted to ethanal in cytoplasm;
ethanal is converted to ethanol;
does not involve, cytochromoes / ETC / oxidative phosphorylation;
enzymes in cytoplasm not inhibited by cyanide; max 3

[9]

8. (i) a biological molecule that can be broken down in respiration to release energy; 1

(ii) *award both marks for correct answer*
55/77;
0.7 / 0.71; 2

(iii) 1.0; 1

[4]

9. ref. to potassium hydroxide / soda lime;
ref. to equilibration / use syringe to set manometer fluid (level);

leave for suitable length of time (minimum 20 minutes) and
measure distance moved by fluid;
repeats and calculate mean;
calculate volume of oxygen taken up per minute;

AVP; e.g. ref to set-up of control tube (e.g. same mass of beads as of fungus) or (same volume of inert substance as substance A)
detail of how to calculate volume of oxygen (by multiplying distance moved by fluid in capillary by $2\pi r$) max 4

[4]

10. (a) (i) removal of, carbon dioxide/carboxyl group;
removal of hydrogen; **R** *H_2/hydrogen molecules/hydrogen ions* **A** *H/2H* 2

(ii) P and Q; 1

(b) 1; 1

(c) (i) 3;
1; 2

(ii)
1 inner mitochondrial membrane/cristae;
2 ref to (NADH) dehydrogenase;
3 hydrogen split into protons and electrons;
4 ref to, electron carriers/ETC/cytochromes;
5 energy released from electrons;
6 ref to protons pumped across membrane;
7 protons accumulate in intermembranal space;
8 proton gradient/pH gradient/H^+ gradient;
9 protons pass through ATPase; **A** *ATPsynthase/ ATP synthetase/stalked particle*
10 ref. to oxygen (final) hydrogen/electron acceptor;
11 formation of water; max 4

(d) fats/fatty acids, not respired;
ref to (β-)oxidation (of fatty acids) requires NAD;
NAD used in breakdown of alcohol;
NAD is, limiting/in short supply/AW;
fats formed from fatty acids plus glycerol;
AVP; e.g. further detail of alcohol/fat metabolism max 3

[13]

11. (i) releases/source of/provides/to give, energy;
for germination;
for growth/protein synthesis/spindle formation/organelle replication/ DNA replication/active transport/cell division/other named function; 2 max

(ii) higher energy density/release twice as much energy per, g/unit mass;
compared to, glucose/protein;
39 kJ g^{-1};
higher proportion of, hydrogen atoms/carbon-hydrogen bonds;
advantage for dispersal/named advantage;
AVP; e.g. ref to coenzyme A formation 2 max

[4]

12. *heat loss*
1 body/blood, temperature rises;
2 may affect/denature, enzymes/proteins;
3 panting cools body;
4 ref. evaporative cooling;

fate of lactate
5 (high) lactate concentration needs to be reduced;
6 due to anaerobic respiration;
7 panting provides extra oxygen/ref. oxygen debt;
8 lactate oxidized to pyruvate;

respiratory gases
9 myoglobin would be reoxygenated;
10 haemoglobin would be reoxygenated;
11 ATP/CP, resynthesised in muscle tissue;
12 removal of extra carbon dioxide; 4 max

[4]

13. (a) for, flying/hovering/beating wings;
muscle activity/AW;
ref. ATP/respiration;
AVP; e.g. explanation of energy demand of flight

small size qualified; e.g. increases heat loss/
ref. large surface area to volume ratio

homeothermic qualified;

migration qualified;

feather growth qualified; e.g. ref. mitosis/protein synthesis max 4

(b) *description*
D1 high(est) incidence of torpor/AW;
D2 low(est) oxygen consumption/AW;
D3 high(est) body mass/AW;
D4 data quote; *3 max*

explanation
E1 less food used;
E2 (for) less respiration/lower BMR/lower body temperature;
E3 more food stored;
E4 as fat;
E5 (food store/fat) for, migration/flight; max 4

(c) flying, easier/uses less energy (with incomplete feathers if mass low);
can, escape predators/find food, (by flying);
food used for feather growth;
therefore, fat stores used/less food stored;
incomplete/missing feathers may reduce body mass; max 2

(d) *yes*
(autumn) high(est) mass birds have low(est) oxygen consumption;
(spring) low(est) mass birds have high(est) oxygen consumption;
data quote mass plus O_2 consumption;
only generate heat in proportion to (small) mass;
but lose it in proportion to (large) surface area;
homeothermic/small birds find it hard to keep warm; max 3

[13]

14. (a) cut/damage, breaks tonoplast/opens vacuole/mixes enzyme and precursor/
AW;
enzyme-substrate collisions/AW;
(enzyme-substrate complex) releases, smell/volatile chemicals; 3

(b) less precursor chemical;
due to, herbivore/fungal/bacterial damage;
due to sulphur recycling;
due to onion being older;
used pyruvate for, link reaction/Krebs cycle/respiration;
AVP; max 2

(c) (i) identify mildest/AW;
and breed together;
detail cross-pollination;
idea, repeat/many generations AW;
<u>directional selection</u>;
AVP; e.g. reference to frequency of <u>alleles</u> max 3

(ii) grow in low level of, sulphur/sulphate; 1

(d) method of quantifying onion strength/producing extracts of different concentration;
method of measuring, rotting/antibiotic effect of onion extract;
replicates/mean;
ref. control variable or example;
ref. fungi/bacteria;
AVP; e.g. reference to timescale
AVP; e.g. second controlled variable max 3

[12]

15. *accept labelled sketch diagram for marking points below*

nitrogenous base / purine;
adenine;
pentose / 5 carbon, sugar;
ribose;
three, phosphate groups / Pi; **R** phosphate molecule
phosphorylated nucleotide;

A adenosine as an alternative to adenine **plus** ribose 4 max

[4]

16.
1 NAD / FAD, involved in respiration;
2 associated with, dehydrogenase enzymes / dehydrogenation;
3 2 molecules of NAD (reduced) in glycolysis;
4 link reaction producing 1 molecule of NAD (reduced);
5 Krebs cycle produces 3 NAD (reduced) (per turn of cycle);
6 detail of any one step in respiration where NAD (reduced) is produced;
7 Krebs cycle produces 1 FAD (reduced) (per turn of cycle);
8 carriers / transfers, hydrogen to, inner mitochondrial membrane / cristae / cytochromes / ETC;
9 mitochondrial shuttle (bringing NAD reduced from glycolysis into matrix);

10 NADP involved in photosynthesis;
11 produced in non-cyclic (photo)phosphorylation;
12 hydrogen comes from, water / photolysis;
13 (used in) Calvin cycle / light independent stage;
14 GP to TP step;
15 AVP; e.g. NADP involved in transporting hydrogen from grana to stroma
16 AVP; e.g. hydrogen split into electrons and protons at ETC

credit annotated diagrams 7 max

QWC – clear, well organised using specialist terms;
award QWC mark if three of the following are used

photophosphorylation	cristae	
glycolysis	photolysis	
Calvin cycle	link reaction	
Krebs cycle	dehydrogenase / dehydrogenation	1

[8]

17. **1** light absorbed by, pigment / bacteriorhodopsin / protein ;
2 ref to electron carriers / change in shape of bacteriorhodopsin ;
3 energy released from electrons ; **R** produced / created / made
4 protons into cell wall ;
5 create, proton gradient / electrochemical gradient / pH gradient / proton motive force ;
6 protons, diffuse / move down gradient ;
7 through, ATP synth(et)ase complex / stalked particles ; **A** ATPase
8 (ATP formed from) ADP + P(i) ;
9 AVP ; e.g. ref to chemiosmosis,
ref to energy transducing membrane,
ref to redox reactions. 4 max

[4]

18. **A** ;
C ;
C ;
B ;

[4]

19. ref to oxidative phosphorylation and ATP production ;
needs supply of hydrogen ;
to form reduced, NAD / FAD ;
lipids have more, hydrogen / hydrogen – carbon bonds ;
more acetyl coenzyme A generated / more 'turns' of Krebs cycle ; 2 max

[2]

20. dinitrophenol in body ;
ETC still functioning ;
<u>less</u> ATP formed in respiration ;
food not enough to meet metabolic demands of body / AW ;
had to respire, body tissues / food stores ;
AVP ; e.g. heat production increasing metabolic rate 3 max

[3]

21. (a) avoid attracting a mate of a different species ; *ora*
ensure reproductive isolation ; 1 max

(b) (i) diffusion ; 1

(ii) so that they do not receive oxygen constantly ;
there are mitochondria between them and the cell surface ; 1 max

(c) mitochondria / aerobic respiration / oxidative phosphorylation, inhibited

only briefly ;
oxygen concentration decreases again ;
preventing, action of luciferase / production of light ;
each flash short ; *ora* e.g. so not continuously lit
AVP ; 2 max

(d) active transport ; **A** e.g. Na^+/K^+ pump
protein synthesis ;
synthesis of named substance ;
movement of organelles ;
phosphorylation of glucose ;
AVP ; ; ; e.g. transcription, translation, anabolic reaction

R respiration, DNA replication, chromosome movement, mitosis 3 max

(e) cells / membranes, damaged / disrupted ;
nitrous oxide released ;
mitochondria stop using oxygen ;
oxygen, allows light production / reaches light-producing organelles ;
in unlimited quantities / continuously, so light is brighter ;

respiration / oxidative phosphorylation, ceases ;
no more, ATP / $NADH_2$;
luciferin, synthesis / regeneration, stops ;
AVP ; 3 max

(f) live bacteria, respire / produce ATP ; *ora* 1

(g) <u>mRNA</u> (coding for luciferase) ; **A** DNA 1

[13]

22. (i) palisade (mesophyll) ;
spongy (mesophyll) ;

mesophyll / chlorenchyma – 1 mark 2

(ii) 1.7, 3.1, 4.0, 4.7, 4.9, 5.0 ; 1

(iii) selection of two temperatures 10 ºC apart ;

respiration
ref to release of carbon dioxide (in dark is measure of respiration) ;
state two figures very close to value of 2, therefore supports ;
(all steps in) respiration enzyme catalysed ;

photosynthesis
data quotes must be from true rate of photosynthesis
only value between 5 ºC and 15 ºC is close ;
photosynthesis does not support as (other) values not near 2 ;
A data quote to illustrate this / ecf
not just enzyme-controlled process / AW ; 4 max

(iv) light intensity limiting factor ;
low rate photosynthesis ;
rate respiration increases at higher temperatures ;
rate respiration, close to / exceeds, rate of photosynthesis ; **A** ora
net primary productivity is lower / sugars broken down more quickly than formed ; 3 max

[10]

23. **1** <u>decomposition</u> / <u>decay</u> / <u>rotting</u> (of grass) ;
2 (microbial) respiration ;
3 (releases) heat ;
4 temperature figures ;
5 uses up oxygen / aerobic ;
6 oxygen figures ;
7 produces carbon dioxide ;
8 carbon dioxide figures ;
9 grass cuttings provide insulation ;
10 AVP ; 5 max

[5]

24. (a) **1** rate of respiration can equal rate of photosynthesis / CO_2 used = CO_2 produced / O_2 used = O_2 produced;
2 ref to compensation point;
3 mitochondria use oxygen;
4 chloroplasts produce oxygen;
5 mitochondria are always active / respiration continues independently of light;
6 chloroplasts are inactive in dark / photosynthesis does not take place without light;
7 oxygen released by, chloroplasts / photosynthesis, can be utilised by mitochondria / respiration;
8 at high light intensities, chloroplasts produce more oxygen than the mitochondria consume;
9 AVP; e.g. valid refs to CO_2 exchange max 4

(b) phosphate ions are used to produce ATP;
in oxidative phosphorylation / Krebs cycle / chemiosmosis / electron transport / ATP synth(et)ase;
ATP leaves mitochondria; max 2

(c) carrier protein / transport protein / transmembrane protein involved;
A ref to a specific channel
concentration of triose phosphate is higher in the chloroplast (than in the cytoplasm);
because it is a product of, photosynthesis / light independent reaction / Calvin cycle;
triose phosphate moves, down concentration gradient / from high to low concentration;
ATP not involved / no energy used; max 2

(d) *ignore references to chloroplasts or mitochondria being cells, having cytoplasm and reference to free ribosomes*

free / naked, DNA; **A** DNA not surrounded by, membrane / envelope
have an inner folded membrane / AW;
ribosomes, smaller than those in cytosol / similar in size to prokaryotic ribosomes; **A** ref to 70S and 80S
circular DNA; **A** loop
AVP; e.g. absence of introns

R absence of a nucleus from the chloroplast or mitochondrion
R ref to membranous organelles as chloroplasts and mitochondria are these organelles max 2

[10]

25. **S;**
R;
S;

A – correct names instead of letters

[3]

26. FAD / NAD; **A** reduced FAD / reduced NAD / AW

[1]