

1. (a)

Location of receptors	Islets of Langerhans/ $\beta$ cells/pancreas;	Hypothalamus;
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Response	(Increase) take up of glucose from blood/conversion of glucose to glycogen;	Dilation;
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4

(b) Answer to include elements -  
triggers effects which return to set level;

1

**[5]**2. (a) (i) Cells of islets of Langerhans / pancreas /  $\alpha$  cells;

1

(ii) High glucagon because –  
eg stimulated by low glucose/  
glycogen must be converted to glucose;  
Low glucagon because –  
e.g. body has absorbed glucose;

2

(b) Clear understanding that a change from the set level initiates mechanism  
returning it;

low glucose  $\rightarrow$  secretion of glucagon  $\rightarrow$  glucose level increases/  
glucagon increase  $\rightarrow$  glucose increase  $\rightarrow$  glucagon decrease;

2

**[5]**

3. All essays are marked using the following scheme.

**Scientific Content** (maximum 16 marks)

Category	Mark	Descriptor
	16	
<b>Good</b>	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	
<b>Average</b>	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	
<b>Poor</b>	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** (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)

<b>Mark</b>	<b>Descriptor</b>
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, one mark for each aspect)

	<b>Descriptor</b>
1	Spelling, punctuation and grammar of an acceptable standard
1	Account presented in scientific language with correct use of technical vocabulary.
1	Overall account logical and coherent

[25]

#### 4. Scientific Content (Maximum 16 marks)

Category	Mark	Descriptor
	16	
<b>Good</b>	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	
<b>Average</b>	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	
<b>Poor</b>	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 (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.

**[25]**

5. (a) Liver;
- (b) (i) Ref to cascade / amplification effect; 1  
 >1 molecule of cyclic AMP formed per glucagon (molecule);  
 each cyclic AMP activates >1 enzyme(molecule) ;  
 each enzyme causes breakdown of >1 glycogen (molecule);  
 each glycogen gives >1 glucose / glycogen is a polymer;  
 glucose diffuses into blood /  
 glucose moves high to low concentration; max 3
- (ii) High glucose concentration stimulates pancreas / detected by  
 pancreas / Islets of Langerhans /  $\beta$  cells;  
 insulin released;  
 insulin causes glucose uptake / glucose  $\rightarrow$  glycogen by liver /  
 by muscles; 3
6. (a) As the temperature falls so the diameter of the cluster decreases but cluster  
 diameter remaining constant at low temperature;  
 the smaller the cluster the lower the surface area;  
 will lose less heat / trap more heat; max. 2
- (b) Axes correctly labelled with cluster temperature on  $x$ -axis;  
 appropriate scale (allow if scale permits accurate plotting of all points);  
 accuracy of plotting;  
 curve of best fit or points joined with straight lines; 4
- (c) (i) Increase in temperature produces increase in rate of enzyme  
 controlled reactions;  
 link between respiration and enzymes;  
 sugars for respiration [Award once];

**[7]**

- (ii) The colder the cluster temperature, the more heat needs to be produced;  
heat production coming from respiration;  
sugars for respiration [Award once]; max. 4
- (d) Carbon dioxide production should follow a similar pattern to sugar consumption / pattern described;  
this is an end product of respiration/also linked to rate of respiration; 2
- (e) Fanning creates a current of air;  
evaporation of water;  
evaporation requires heat energy to vaporise water/reference to latent heat; 3
- (f) (i) Acts as an insulator / trapping air;  
keeping body temperature high enough for activity;  
when insect leaves warmer colony / as cold at high altitude; max. 2
- (ii) Would have been variation in hair length / long-haired and short-haired / use of comparative;  
bees/colonies with longer haired bees bred / reproduced;  
passing on alleles/genes for longer hair to next generation; max. 3
7. (a) High / increasing glucose causes high / increasing insulin;  
*Ignore 'deviates from the norm'.*  
Insulin (concentration) reduces glucose;  
*Ignore references to 'glycogen'.*  
Back to original level;  
This results in / subsequent decrease in insulin level / release; 2 max  
*Ignore references to 'brain'.*
- (b) (i) Drink in a specified (short) time;  
Idea of fasting / controlled diet shortly before test;  
Same level of activity (as 1<sup>st</sup> test);  
Same (specified) temperature of drink;  
Ensure glucose level returns to normal before test; 2 max  
*Ignore references to timing of sampling.*
- (ii) Excreted in urine / respired;  
*Reject 'secretion in urine'.* 1

[20]

[5]

8. (a) (Vaso) constriction of arterioles / correct reference to shunt vessels or sphincters; *ignore contraction*  
*Reject this first mark if any reference to moving blood vessels.*  
 Less radiation / conduction / convection;  
 Less blood to surface / more blood flows beneath fat; 2 max
- (b) (i) Body cools down / hypothermia;  
 (Low body temperature linked to) insufficient metabolism / muscle contraction; *accept references to enzymes / respiration / energy released*  
 May drown / unable to escape predators; 2 max
- (ii) Oxygen consumption linked to respiration;  
 Heat production linked to respiration;  
 High rate of respiration / more heat production at low temperature; *accept converse* 2 max  
*Reject any reference to 'energy production'.*

[6]

9. *Quality of communication*

*The answers to all sections of this question require the use of continuous prose. Quality of language should be considered in crediting points in the scheme. In order to gain credit, answers should be expressed logically and unambiguously, using scientific terminology where appropriate.*

- (a) *Four marks for four of:*  
 Calcium ions bind to troponin;  
 Remove blocking action of tropomyosin / exposes actin binding sites;  
 ATP allows myosin to join / bind to actin / form cross-bridge;  
 'Re-cocks' myosin cross bridge / allows detachment from actin;  
 Enables calcium ions to be pumped back in;  
 Phosphocreatine allows regeneration of ATP without respiration;  
 Phosphocreatine releases Pi to join ADP; 4 max
- (b) *Six marks for six of:*  
 Endurance athletes exercise for long periods of time;  
 Respire / release energy aerobically;  
 Or too much lactate would accumulate;  
 Slow twitch fibres adapted to aerobic metabolism;  
 As have many mitochondria;  
 Site of Krebs' cycle;  
 And electron transport chain;  
 Much ATP formed;  
 Also are resistant to fatigue; 6 max

(c) *Five marks for five of:*

Receptors in hypothalamus detect increase in core temperature /  
temperature of blood;

Heat loss centre stimulated;

Skin arteries / arterioles dilate / vasodilation;

Shunt vessels / pre-capillary sphincters constrict;

More blood flows to surface (capillaries);

Heat loss by radiation;

Heat loss by evaporation of sweat;

Reduced metabolic rate;

Remove clothing / seek cooler area / cold drink;

5 max

[15]

10. (a) (i) Maintains/ allows efficient/ high level of activity/ movement;  
*[Ignore: Remain active]*

OR Allows/ maintains high/ efficient level of enzyme reactions;  
*[Ignore: Reactions still occur]*

1

(ii) Requires more/ high amount of energy/ food/ respiration rate;  
*[Ignore Loss of energy / heat]*

1

(b) (i) Evaporation of sweat removes heat from skin;  
High(er) rate of sweating leads to low(er) skin temperature;  
*[Ignore: Description only and Vasodilation references]*

2

(ii) Change/ fall in body/ core temperature results in reduced sweating;  
*[Reject: Stops sweating]*  
Reduced sweating results in increase in body core temperature/ body  
core temperature returns to original level; *[Ignore: Hypothalamus and  
receptors references]*  
(This) results in subsequent increase/ return to original level of  
sweating; *[Ignore., Description only]*

max 2

[6]

11. (a) Any two from:

Enzymes at optimum temperature;

(Metabolic) reactions proceed more quickly;

More independent of environment/better able to survive in different  
environment/equivalent;

max 2

(b) (i) Range just shows highest and lowest/SD shows spread of majority;  
Extreme values give false impression of variation/SD less affected  
by extreme values/equivalent;

2

(ii) Allows comparison of animals with different masses;  
Increased mass/increased body size means increased heat generation;

2

(iii) Both increase proportionally up to 25°C/equivalent;

- Then heat generation increases faster/equivalent; 2
- (iv) Any two from:  
 Body will “overheat” in very hot environments;  
 As will generate more heat than they can lose;  
 No physiological cooling mechanism; max 2
- (c) (i) Relationship is inverse/equivalent; 1
- (ii) Sweating increases [*Allow: commences*]/panting; 1
- (iii) Any three from:  
 Reduced metabolic rate;  
 Reduced respiration/energy release;  
 Reduced thyroxine secretion;  
 Reduced activity of brown fat cells/body core/liver cells;  
 Reduced physical activity; max 3
- 12.** (a) Metabolism/respiration produces heat;  
 Small surface area to volume ratio;  
 Environmental/air temperature high;  
 Heat gained/lost by radiation;  
 Fat limits heat loss; max 3  
 [*Note: small surface area to volume ratio=large volume to surface area ratio*]
- (b) Skin heated by exposure to sun;  
 Core insulated by fat;  
 Which is subcutaneous/under skin;  
 Cooling effect of water; max 2
- (c) (i) I-F; 1
- (ii)  $I-F-U / I-(F+U)$ ; 1
- (d) (i) Proteins/amino acids contain nitrogen;  
 In amino/NH<sub>2</sub> groups;  
 Amount of nitrogen proportional to amount of protein; max 2
- (ii) Mucus;  
 Enzymes;  
 Cells from lining of gut;  
 Microorganisms/bacteria; max 2

[15]

- (iii) Plant cells are surrounded by cell walls;  
Cellulose/cell walls not digested/broken down;  
Cellulase/cellulose digesting enzymes produced by bacteria;  
Proteins released from cells;  
More nitrogen in faeces of humans/less in ruminants; max 3  
*[Accept: converse argument in non-ruminant]*
- (e) (i) Detection of/recognition/stimulation by antigen;  
B-cells/B-lymphocytes;  
Produce clone/divide/produce plasma cells; max 2  
*[Note: reference to antigens must be in context of triggering process]*  
*[Ignore: references to T-cells]*
- (ii) Rinderpest only affects older animals;  
Older animals exposed to past epidemic;  
Kills young animals but not older ones;  
Virus has long dormancy period; max 2
- (iii) Infected hippos;  
Spread virus/disease to cattle;  
Which reduces profitability; max 2  
*[Ignore: references to methods of transmission]*

**[20]**

13. **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
<b>Good</b>	16	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.
	14	
	12	
<b>Average</b>	10	Some of the content is of an appropriate depth, reflecting the depth of treatment expected from a programme of Alevel study. Generally accurate with few, if any, fundamental errors. Shows a sound understanding of the key principles involved.
	8	
	6	
<b>Poor</b>	4	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.
	2	
	0	

**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]

14. (a) (i) glucagon; *[Insist on spelling]* 1  
(ii) liver; 1  
(b) A change to the normal level initiates a response which reduces the effect/  
reverses/acts against the change; 1

[3]

## 15. Quality of Communication

The answers to all sections of this question require the use of continuous prose. Quality of language should be considered in crediting points in the scheme. In order to gain credit, answers should be expressed logically and unambiguously, using scientific terminology where appropriate.

- (a)
1. Deviation of a value from norm initiates corrective mechanisms;
  2. fluctuations in plasma glucose concentration detected by hypothalamus/islet cells in pancreas;
  3. initial decrease, no food given (in plasma glucose) stimulates (increased) secretion of glucagon;
  4. increases (in plasma glucose) stimulate (increased) secretion of insulin;
  5. correct ref. to role of  $\alpha$  and/or  $\beta$  cells as secretors;
  6. correct ref. to interconversion of glycogen / glucose;
  7. increased/decreased uptake of glucose by cells (as appropriate)/correct ref to change in membrane permeability;
- max 5

- (b) (i)
1. Sensors in skin/hypothalamus detect reduced temperature;
  2. heat gain centre activated/inhibition of heat loss centre;
  3. vasoconstriction/constriction of arterioles in skin surface; (**R** capillaried)
  4. dilation of shunt vessels/constriction of – capillary sphincter;
  5. less blood to skin surface/capillaries
  6. reduced heat loss by radiation;
  7. increased heat gain by increased metabolic rate/respiration/movement/shivering;
  8. decreased heat loss by putting on clothes/huddling/reduced sweating;
- max 5

- (ii)
1. Body temp./37°C is optimum temp for enzymes;
  2. excess heat denatures enzymes/alters tertiary structure/alters shape of active site/enzyme;
  3. substrate cannot bind/eq.;
  4. reactions cease/slowed;
  5. too little reduces kinetic energy of molecules / molecules move more slowly;
  6. fewer collisions/fewer ES complexes formed'
- max 5

[15]

16. (a) Reduced rate of respiration / metabolism / chemical reactions;  
Energy conservation / less energy lost / less heat lost / conservation of stored fat / glycogen / food;
- 2

- (b) Optimum / fast / increased / temperature for enzymes / metabolism / chemical reactions / respiration;  
 Optimum energy release for movement / faster movement / independent of environmental temperature; 2  
*Reject 'for faster activity'*

[4]

17. (a) On graph: X where glucose level is below norm  
 AND Y where glucose level is above norm; 1

- (b) EITHER  
 1. Use m-RNA + reverse transcriptase to produce gene / (c)-DNA;  
 2. Restriction enzyme to cut open plasmid;  
 3. Add sticky ends (to insulin gene and to plasmid);  
 OR Allow:  
 1. Cut out insulin gene / cut open plasmid with restriction enzyme;  
 2. Use same restriction enzyme on second DNA;  
 3. Reference to (complementary) sticky ends;  
 4. Use ligase to join 2 DNA molecules;  
 5. Modified plasmid taken up by bacteria; max 4

[5]

### 18. 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	
<b>Good</b>	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	
<b>Average</b>	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	
<b>Poor</b>	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)

<b>Mark</b>	<b>Descriptor</b>
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)

<b>Mark</b>	<b>Descriptor</b>
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.
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**Quality of language** (maximum 3 marks)

<b>Mark</b>	<b>Descriptor</b>
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.

### Additional notes

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.

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.

19. (a) (i) (body temperature always equals the air temperature) because it cannot regulate its body temperature; 1
- (ii) lizard **A** can gain heat from the sun; 1
- (b) movement is dependent upon enzyme-catalysed reactions;  
molecules have less kinetic energy at lower temperatures;  
less enzyme activity;  
slower metabolism / rate of respiration / less ATP available; 2 max
20. (a) metabolic water / from respiration;  
*allow condensation reactions. Ignore 'oxidation'.*  
aerobic / use of oxygen; ('From aerobic respiration' = 2 marks) 2
- (b) 1. dry air (inhaled) causes evaporation from nasal passages / or converse;  
2. cooling due to evaporation;  
3. blood is cooled;  
4. (cool blood) flows from nose to brain / cools brain / keeps brain at const. temp.;
5. allows activity (e.g. foraging for food / escaping predators / not restricted to staying in humid burrow (in hot conditions);  
6. air with high water vapour content leaves lungs / is exhaled;  
7. water condenses in nasal passages;  
8. due to lower temperature;  
9. water can be reabsorbed (into blood) / swallowed / water conservation / less water loss; 4 max

[4]

[6]

21. (a) Hot receptors in skin;  
 nervous impulse;  
 to hypothalamus;  
 blood temperature monitored;  
 heat loss centre involved;  
 vasodilation / dilation of arterioles;  
 more blood to surface / heat lost by radiation;  
 piloerector muscles relax;  
 hairs flatten on skin surface;  
 less insulation;  
 sweating initiated / increased;  
 panting / licking;  
 evaporation removes latent heat;  
 drop in metabolic rate / use less brown fat;  
 accept long term changes such as less fat deposition;  
 thinner fur;  
 migration;  
 accept one behavioural process; max. 8

- (b) Rapid / slow;  
 direct / broadcast;  
 short lived/ long term;  
 mainly electrical ; chemical;  
 delivery via nerves / blood vessels;  
 cause depolarisation of target cell membrane /  
 receptors in membrane of target cell; max. 4

[12]

22. (a) (i) A = insulin  
 (ii) B = glucagon 2

- (b) Hormone B acts on liver cells;  
 causing conversion of glycogen into glucose;  
 via action of an enzyme;  
 gluconeogenesis; max 2

- (c) (i) X = diabetic / unable to produce insulin /  
 unable to regulate blood glucose / sugar; 1  
 (ii) Between 0 -40 minutes, hormone A level would rise as blood  
 glucose rises;  
 between 40 - 60 minutes, hormone A would fall as blood  
 glucose level is falling; 2  
 (iii) Excess insulin / hormone A is still in the circulation,  
 so blood glucose level continues to drop below norm  
 until it is removed or glucagon / hormone B is released; 1

[8]

23. (a) FSH secreted by pituitary gland;

Stimulates growth of follicle;  
 Ovary/follicle cells produce oestrogen;  
 Negative feedback/inhibits secretion of FSH;  
 Oestrogen stimulates secretion of LH/LH from pituitary;  
 LH stimulating ovulation;  
 Second increase in FSH also associated with ovulation; max 6

(b) Stimulus is increased blood temperature;  
 Increase in temperature results from exercise/respiration/metabolism;  
 Detected by receptors in hypothalamus;  
 Hypothalamus is coordinator;  
 In this case, the heat loss centre;  
 Effectors are muscles;  
 Of arteriole;  
 Response involves vasodilation;  
 Increased blood flow to capillaries;  
 Allowing heat loss by radiation/convection;  
 Correct reference to action potential/nerve impulse; max 6

[12]

24. (a) (i) Hypothalamus; 1  
 (ii) Heat loss centre in hypothalamus;  
 Inhibits heat gain/heat conservation centre;  
 Sends nerve impulses to appropriate part of body; max 2  
*Reference to impulses must involve nerves and be in an appropriate context*

(b) Cannot sweat;  
 And lose heat by evaporation:  
 Still gains heat from environment/muscle activity; max 2

[5]

- 1 ^25. (a) **For principle, maximum of one mark**  
Process involves insulin and glucagon;
- For detail, up to a total of 6 marks**  
Insulin / glucagon secreted by pancreas / islets of Langerhans;  
Hormone receptors in membrane (of target cells);  
(insulin stimulates) conversion of glucose to glycogen / glycogenesis:  
activates / involves enzymes;  
stimulates uptake by cells;  
conversion of glucose to lipid / protein;  
glucagon stimulates conversion of glycogen to glucose;/ glycogenolysis;  
glucagon stimulates conversion of lipid / protein to glucose /  
gluconeogenesis; max 6
- (b) feed on polysaccharides / named example (not cellulose);  
slower digestion therefore no surge in blood sugar level;  
exercise - increased respiration / BMR; 3
- [9]**
26. (a) So that readings are not affected by food recently eaten/  
insulin secretion will be low; 1
- (b) Glucose absorbed into blood from gut causing glucose levels to rise;  
rise detected by pancreas;  
insulin is secreted into blood by pancreas;  
glucose converted to glycogen/fat in liver/muscle;  
increased glucose uptake by (respiring/muscle) cells;  
binds to specific membrane receptors; max 4  
mild diabetic secretes some insulin; 3
- [8]**
27. (a) Respiration for *muscular* activity; (*energy 'needed/used' for respiration'*  
*etc, disqualifies*)  
respiration inefficient / releases waste heat / all energy 'ends up as 'heat' 2
- (b) Larger surface area: volume ratio, or less fat under skin;  
more rapid / more heat loss from body surface. 2

- (c) Humidity reduces diffusion gradient / less difference in water potential;  
less evaporation of sweat;  
less cooling due to use of heat energy for evaporation of sweat. 3
- (d) Temperature receptors stimulated in; (*in skin disqualifies*)  
hypothalamus;  
heat loss centre stimulated;  
nerve impulses to sweat glands;  
increase rate of / start sweat production;  
nerve impulses to skin arterioles;  
vasodilation (*ref to vessels moving disqualifies*) max 5
- [12]**
28. (a) Glucose is being removed from the blood/processed in liver  
Glucose converted to glycogen; 1
- (b) Glucagon;  
Converts glycogen to glucose;  
By activating enzymes;  
Insulin is inhibited; 3
- (c) Gluconeogenesis/glucose produced from non-carbohydrate sources/  
named example; 1
- [5]**
29. (a) Glucose is being removed from the blood/processed in liver;  
Glucose converted to glycogen; 1
- (b) Glucagon;  
Converts glycogen to glucose;  
By activating enzymes;  
Insulin is inhibited; 3
- (c) Only target cells have appropriate receptors;  
These are the proteins in cell surface membrane;  
Receptor sites/hormones with a particular shape;  
Concept of fitting/binding between receptor and hormone; 3
- [7]**
30. (a) Carbohydrate / named example from food / diet / gut; 1
- (b) (i) Pancreas; 1
- (ii) (1 for each hormone correct / per column) 2

Effect of hormone	Insulin	Glucagon
Reduces carbohydrate in reservoir D		✓
Promotes A – fat breakdown	✓	
Promotes C – protein breakdown		✓
Increases rate of outflow at E	✓	

- (c) (i) Glycogen; 1
- (ii) Fats / lipid / triglyceride / adipose; 1
- (d) (Adrenaline) D; 2  
(Thyroxine) E;

**[8]**

31. (a) increase in blood sugar leads to lower blood sugar  
(homeostatic principle)/ (more) insulin secreted;  
binds to (specific) receptors on (liver/muscle) cells;  
leads to more glucose  
entering cells/carrier activity/  
increased permeability to glucose;  
glucose leaves the blood;  
glucose entering cell converted to glycogen; 4 max
- (b) keeps glucose in muscle cells/glucose phosphate can  
not cross cell membranes;  
muscle cells need glucose for respiration. 2
- (c) sympathetic nervous system active, so adrenaline released;  
adrenaline binds to receptors/acts on muscle cell;  
causing increased glycogen phosphorylase activity;  
more glucose (phosphate) for respiration;  
calcium ions enter muscle cells and glycogen broken down/increase  
in phosphorylase activity;  
lower blood sugar as glucose used by muscles;  
glucagon released and binds to receptors/acts on liver cells;  
causes glycogen to be broken down to glucose/glycogen breakdown increases;  
(one mark for general point that hormones bind to their receptors) 6 max

- (d) blocks A and B/ C and D work together;  
A and B antagonistic to C and D;  
A and B contract to move tail to the left/right, while  
C and D relax, then C and D contract;  
muscles act against/ attached to the backbone; 3 max
- [15]**
32. (a) (i) antibody cannot get through pores (and attack cells);  
glucose small enough to (diffuse) enter / hormones can leave;  
protects from lymphocytes / no antigen on silicon box; 2 max
- (ii) killing animals to use for human (transplant);  
religious objections;  
other valid suggestion; 1 max
- (b) rise/fall in rat blood sugar means more/less glucose enters (diffuses) into box;  
detected by animal pancreas cells that release insulin/glucagon;  
insulin (diffuses) into rat's blood;  
insulin/glucagon makes rat's cells take up/release more glucose; 3 max
- [6]**
33. (a) (i) decrease in consumption up to 25°C then stays constant; 1
- (ii) oxygen used in respiration / metabolism;  
respiration / metabolism releases heat;  
as temp increases less (metabolic) heat required;  
after 25°C basal metabolic rate; 3 max
- (b) countercurrent flow / arterial and venous flow in opposite directions;  
heat from artery transferred to surrounding veins; 2
- [6]**

34. **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
<b>Good</b>	16	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.
	14	
	12	
<b>Average</b>	10	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.
	8	
	6	
<b>Poor</b>	4	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.
	2	
	0	

**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)

<b>Mark</b>	<b>Descriptor</b>
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)

<b>Mark</b>	<b>Descriptor</b>
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 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 were also given credit where appropriate. For example, in the essay on cycles, the menstrual cycle and viral replication from the option modules, and the ornithine cycle, details of which are not required in the specification, were accepted as suitable examples.

## Cycles in biology

### **Ecological cycles**

Nitrogen cycle: role of microorganisms in the processes of saprophytic nutrition, deamination, nitrification, nitrogen fixation and denitrification. (Names of individual species are not required.)

Carbon cycle: role of microorganisms in breakdown (respiration) of complex organic compounds into carbon dioxide making it available for reuse (photosynthesis).

### **Metabolic cycles**

Krebs cycle: acetylcoenzyme A combines with four-carbon molecule to produce a six-carbon molecule which enters Kreb's cycle; the four carbon compound is regenerated during cycle involving series of oxidation reactions and release of carbon dioxide; production of ATP and reduced NAD and FAD.

Electron transport chain: cyclical reduction and oxidation of NAD, FAD and other 'carriers'

Synthesis and breakdown of ATP

Light-independent reactions - Carbon dioxide accepted by RuBP to form two molecules of glycerate-3-phosphate, reduction of glycerate-3-phosphate to carbohydrate, and regeneration of RuBP.

### **Physiological cycles**

Negative feedback mechanisms: Regulation of body temperature / blood glucose / blood water potential.

Cardiac cycle: relate pressure and volume changes in the heart and aorta to maintenance of blood flow.

Role of tropomyosin, calcium ions and ATP in the cycle of actomyosin bridge formation.

Nerve function – depolarisation / repolarisation of a neurone in terms of differential membrane permeability and cation pumps, synthesis and re-synthesis of acetylcholine (synaptic transmission) / rhodopsin (rods) and restoration of a resting potential.

### **Life cycles**

Mitosis / Cell cycle – explanation of stages of mitosis, importance in growth and asexual reproduction - vegetative propagation.

Meiosis – importance in maintaining constant chromosome number from generation to generation;  
outline of process (details of stages not required)

Examples of life cycles might be provided in terms of mitosis, meiosis, fertilisation and chromosome number.

DNA replication – semiconservative replication;  
Predator / prey life cycles

**Breadth of Knowledge; max 3 marks**

One mark for each type of cycle covered

Ecological (**E**); Metabolic (**M**); Physiological (**P**); Life (**L**)

(The letters shown in bold should be used alongside relevant part of essay)

35. (a) insulin binds to specific receptors (on membranes);  
insulin activates carrier proteins / opens channels / causes more channels to form;  
insulin increases the permeability of liver/muscle cells/tissues to glucose;  
insulin action results in glucose conversion to glycogen / glycogenesis; 3 max
- (b) glucose is used in cell respiration / as energy source / in metabolism;  
*(must qualify how glucose is used)*  
glucose enters cells / converted to glycogen in cells;  
glucose is excreted / in urine;  
*(do not credit no reabsorption of glucose in kidneys)* 2 max
- (c) line from 80mg, increasing but keeping below line for diabetic, dropping to 80mg; *(line must stabilise at, or fluctuate around 80mg)* 1
- (d) (i) fast acting insulin reduces blood glucose from breakfast;  
slow acting insulin reduces blood glucose from other meals before the evening meal / eliminates the need to inject at lunch;  
*(must be a reference to the meals)*  
*(one mark if neither of the above but a clear reference is made to glucose conversion to glycogen);* 2
- (ii) glucagon is still active;  
glycogen converted to glucose / glycogenolysis;  
insulin injected at breakfast causes cells to take up glucose too slowly for levels to become dangerously low;  
person is not active so little glucose used in respiration;  
*(do not credit statements about consuming large breakfasts)* 1 max
36. (a) (thermo)receptors in skin;  
*(accept receptors in hypothalamus if after reference to cooled blood)*  
impulses via nerves/neurones to or from; *(once only)*  
hypothalamus;  
heat gain/temperature centre (in hypothalamus);  
contraction /constriction of arterioles; *(not capillaries, or just vasoconstriction)*  
diversion through shunt vessels; 4 max
- (b) (i) reduced/no evaporation of sweat;

- due to reduced gradient / saturation/high water content of air;  
less heat loss by (latent) heat of evaporation; 2 max
- (ii) skin vessels open/vasodilatation; (*movement dq*)  
blood diverted from muscles / limited total volume of blood; 2
- [8]**
37. (a) as distance from skin surface increases the temperature increases/  
steep temperature gradient;  
temperature at depth of 50mm/inside of blubber similar to  
body core temperature; 2
- (b) EITHER  
1. increased (blood) temperature results in increased blood flow through  
capillaries in blubber / vasodilation in blubber;  
2. increased skin temperature;  
3. increased loss of heat from skin;  
4. decreased temperature results in reduced blood flow through  
blubber capillaries/ vasoconstriction in blubber;  
5. correct reference to (sphincter/circular) muscles of arterioles;  
6. correct reference to role of shunt vessels;  
OR  
1. decreased (blood) temperature results in decreased blood flow  
through capillaries in blubber / vasoconstriction in blubber;  
2. decreased skin temperature;  
3. decreased loss of heat from skin;  
4. increased temperature results in increased blood flow through  
blubber capillaries/ vasodilation in blubber;  
5. correct reference to (sphincter/circular) muscles of arterioles;  
6. correct reference to role of shunt vessels; 4 max
- (c) counter-current principle;  
temperature of blood flowing to flipper greater than that leaving it /  
temperature of blood greater in artery than vein;  
therefore heat (energy) transfer artery to vein;  
less heat lost as not transferred to environment/transferred to body core; 3 max
- (d) 1. salt/(sodium) ions diffuse into descending limb;  
2. water moves out of descending limb;  
3. salt/(sodium) ions actively removed from ascending limb;  
4. ascending limb impermeable to water;  
5. low water potential/ high concentration of ions in medulla/tissue fluid;  
6. water leaves collecting duct / distal tubule;  
7. due to difference in water potential / by osmosis; 6 max

**[15]**

38. (a) large surface area;  
so increases heat loss (to the air);  
OR

- increased blood flow into ears;  
so increases heat loss; 2 max
- (b) more movement needs greater energy use/ muscle contraction;  
more heat generated through respiration;  
OR  
in sun, more heat absorbed;  
harder to lose heat by sweating/vasodilation; 2 max
- [4]**
39. (a) (i) different shape/different tertiary structure/  
different sequence of amino acids; 1
- (ii) insulin unable to attach to receptors;  
reduced/no uptake of glucose into cells / no carrier proteins/channels  
for glucose transport; 2
- (iii) glucose reabsorbed/absorbed into blood;  
from proximal tubule;  
by active transport/involving membrane carriers; 3
- (b) (i) larger genetic component; 1  
*(must be comparative)*
- (ii) number of cases studied;  
matched samples;  
age of twins;  
named environmental factor;;  
*(allow 2 marks for 2 different factors if no overlap in effect)*  
family history of diabetes;  
method of diagnosis;  
same sex in non-identical twins; 2 max
- [9]**
40. (a) moves to 40°C side, then later to 20°C;  
gets lighter in hot side and darker in cool side;  
lighter as it absorbs heat/darker as it loses heat;  
by conduction/convection/radiation; 3 max

- (b) lizard finds favourable environment;  
(helps it to) maintain constant body temperature;  
advantage of this, e.g. for enzyme activity; 2 max
- (c) receptors in blood vessels/skin;  
nerve impulses produced;  
go to coordinator/brain/hypothalamus;  
motor neurones send nerve impulses;  
to effectors/muscles; 3 max
- 41.** (a) uptake of oxygen / production of carbon dioxide; 1
- (b) constriction / narrowing / shunt effect;  
of arterioles;  
less blood flow to capillaries;  
reduces heat loss via radiation / conduction / convection; 3 max
- (c) (i) metabolism releases heat;  
increase in environmental temperature provides heat / warms mammal;  
less heat required from metabolism which falls / levels off; 3
- (ii) lack of thermoregulatory control at high temp. / positive feedback;  
increase in temperature increases metabolism / respiration; 2
- 42.** (a) (i) maintaining a constant internal environment; 1
- (ii) *one mark for example of factor kept constant; one mark for explaining its importance;*  
e.g.  
temperature / pH; optimum for enzymes / effect of pH /  
temperature on enzyme activity;  
*OR*  
water potential / blood glucose;  
effect of osmotic / blood glucose imbalance on cells; 2 max

**[8]****[9]**

- (b) (i) 1. hypothalamus (contains the thermoregulatory centre);  
 2. has receptors which detect temperature changes of blood;  
 3. receives impulses from receptors in skin;  
 4. nerve impulses transmitted (from hypothalamus / brain);  
 5. results in vasoconstriction / constriction of arterioles / dilation of shunt vessels;  
 6. diversion of blood to core / specified organ / less blood to skin;  
 7. muscular contraction / shivering generates heat via respiration;  
 8. release of thyroxine / adrenaline;  
 9. increase in metabolic rate / respiration;  
 10. correct reference to negative feedback mechanisms; 7 max
- (ii) larger surface area to volume ratio;  
 less insulation / steeper thermal gradient;  
 more heat loss by conduction; 2 max
- (c) cannot interact with / move tropomyosin; (*allow troponin*)  
 from binding sites on actin;  
 (*reject active sites*)  
 myosin(heads) do not bind / actinomyosin not formed;  
 does not activate ATPase / energy not released from ATP; 3 max

[15]

43. (a) Glucose (from digestion of meal) absorbed; 1  
 (b) taken up by cells;  
 used in respiration / converted to glycogen; 2  
 (c) 09:00 to 11:00 glucagon secreted;  
 (Glucagon) stimulates breakdown of glycogen to glucose;  
 11:00 to 12:00 insulin secreted;  
 Insulin stimulates uptake of glucose by cells / conversion to glycogen;  
 Explanation of negative feedback; 4 max

*Q For the first marking point, answers must refer to glucagon.  
 References to spelling alternatives, such as glycogen, glycogon  
 or glucose should not be awarded credit*

[7]

44. (a) Easy to manage / can be kept safely in small space;  
 Genome / strains well known;  
 Physiology similar to humans / can be used to predict human behaviour; 2 max
- (b) Same as control but inject with equal volume of solvent only; 1

- (c) (i) Heat lost from tail;  
By conduction / convection / radiation; 2

*Q Award credit to answers that refer to the evaporation of sweat from the tail.*

*Q Award credit to answers that are the converse of the above, relating to the rectal temperature*

- (ii) Standard deviations show mean rectal temperatures are significantly different (in the two groups);  
Rectal temperature indicates core temperature / heat generation;  
Tail temperatures not significantly different (in the two groups);  
Tail temperatures indicate no difference in heat loss;  
None of the mice died (in this experiment); 3 max

*Q If candidates fail to gain credit above, they can be awarded one mark for a clear statement that MDMA increases heat production but does affect not heat loss.*

**[8]**