

6.4 Organisms - Responses to their environment (A-Level Only) - Homeostasis 2 Mark schemes

Q1.

- (a) Maintaining a constant internal environment; 1
- (b) Binds to (specific) receptor;
On muscle / liver cell;
Activation of enzymes (in liver);
Hydrolysis of glycogen;
(Facilitated) diffusion of glucose out of (liver cells) cells;
Increases blood glucose levels; 4
- (c) (i) 0 / zero; 1
- (ii) 1. Filtration, out of blood (plasma) / into renal capsule;
2. (Hydrostatic) pressure ;
3. PCT;
4. All reabsorbed;
5. Active transport; 3 max
- [9]**

Q2.

- (a) ADH;
(accept vasopressin) 1
- (b) reabsorption / passes back into blood;
by active transport; 2
- (c) (sodium) ions pumped out of ascending limb;
water passes out of descending limb (into high concentration in tissue fluid /
interstitial fluid);
some sodium ions re-enter descending loop (by diffusion);
high concentration at base of loop / some ions diffuse out near base
increasing concentration outside loop; 3 max
- [6]**

Q3.

- (a) (i) Group 1: To see 'normal' response / non-diabetic response /
as comparison with diabetic response;
- Group 3: To ensure any difference was due to exenatide /
not due to salt / as comparison to show effect of exenatide on
diabetes / to ensure effect was not psychosomatic /
to see placebo effect; 2
- (ii) Different mass of person → different amount insulin secreted /
larger person secretes more insulin / (valid) basis for comparisons

between people;
Ignore refs to accuracy

1

- (b) Any three from:
Increases sensitivity of pancreas cells to glucose;
Increases insulin secretion (by pancreas) / similar insulin production as healthy / non-diabetic / Group 1;
So more stimulation of cells / of liver / of muscles;
Causes more glucose uptake (from blood) / blood glucose level lowered / kept at normal level / can control blood glucose conc.;
Person can consume more carbohydrate / glucose / doesn't need special diet / will not develop symptoms of diabetes;

3 max

[6]

Q4.

- (a) (i) 1. In the ascending limb sodium(ions) actively removed;
2. Ascending limb impermeable to water;
3. In descending limb sodium(ions) diffuse in;
4. Descending limb water moves out / permeable to water;
5. Low water potential / high concentration of ions in the medulla / tissue fluid;
6. The longer the loop / the deeper into medulla, the lower the water potential in medulla / tissue fluid;
7. Water leaves collecting duct / DCT;
8. By osmosis / down water potential gradient;
(credit once only)

6 max

- (ii) 1. When water potential of the blood too low;
2. Detected by receptors in the hypothalamus;
3. Pituitary secretes / releases (more) ADH;
4. ADH increases the permeability / recruitment of aquaporins / opens channels for water in the DCT / collecting duct;
5. More water is reabsorbed / leaves the nephron moves into the blood;
6. By osmosis down the water potential gradient;

4 max

- (b) (i) Ammonia not urea;
Ammonia (into labyrinth) enters by diffusion, not (ultra) filtration;
Reabsorption of glucose from labyrinth, not PCT / no reabsorption in PCT;
All salt reabsorbed / no salt in urine, comparison to humans;
Concentrated urine not produced;

3 max

- (ii) Water potential lower in cytoplasm of cells / fresh water higher water potential than cells / idea of water potential gradient;
(Removal of excess water) prevents osmotic damage;

OR

All salts reabsorbed (because difficult to replace);
Take in excess water and need to remove it;

2

[15]

Q5.

- (a) e.g. urea / amino acids / fatty acids / glycerol / ion / small protein;
(one mark for two of above) 1
- (b) blood pressure decreased;
(less pressure) forms less filtrate; 2
- (c) microvilli provide large surface area;
carrier proteins (in membrane) for active transport;
channel proteins for facilitated diffusion;
specific carriers for specific molecules / sodium pumps;
(many) mitochondria for active transport; 2 max
- (d) (i) up to 2.2 mg cm^{-3} all glucose reabsorbed / above 2.2 mg cm^{-3} excess
glucose not reabsorbed / at 2.2 mg cm^{-3} threshold value reached;
saturation of carriers / active transport mechanism; 2
- (ii) decrease in insulin production / receptors not responsive to insulin /
specific damage to tubule described / membrane less permeable to
glucose; 1

[8]**Q6.**

- (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
- (b) cannot interact with / move tropomyosin 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

[6]**Q7.**

- (a) (i) (Kidneys) *function*: removes urea from blood, *evidence from graph*: when
kidneys not working the level of (blood) urea rises; 1
- (ii) (Liver) *function*: makes urea / adds urea to blood, *evidence from graph*:
no rise in urea (when liver not working) OR when working, urea not

removed, so level rises;

1

- (b) *Shown on graph. Firstly need to demonstrate change in gradient at 12 hours. Time 0 to 12 hours – steady decline in urea level (below line Q); Curve horizontal from 12 hours; Still award full credit if the line falls to x axis within first 12 hours and remains on the x axis thereafter.*

2

[4]

Q8.

- (a) bacteria have ligands / antigens / proteins / glycoproteins / polysaccharides (on membrane / wall);

1

complementary to receptors / fits / binds / attaches to specific receptor

1

- (b) enzymes denatured / tertiary / secondary structure altered / altered active sites / breaks hydrogen bonds;

1

prevents named chemical reactions / metabolic pathways;

1

- (c) inhibits / kills other bacteria / fungi / decomposers / reduces competition;

1

- (d) 1 prepare a bacterial lawn / culture / sample;
(*accept mix bacteria with agar / medium*)
2 with oil and one with control / water / range of concentrations;
3 appropriate method of standardising how sample applied,
e.g. discs / wells;
4 appropriate measure of effectiveness / size / diameter of clear zone;
5 the larger the zone the greater the effectiveness;
6 use of aseptic technique;
(*ignore haemocytometer*)

4 max

[9]

Q9.

- (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;
(*must be comparative*)

1

- (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]

Q10.

- (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

[5]

Q11.

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	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	
Average	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	
Poor	4	Material presented is largely superficial and
	2	

	0	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.
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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]

Topic areas for assessment of scientific content:

- (1) principle of negative feedback – departure from a norm initiates changes which restore a system to the norm. (P)
- (2) importance in homeostasis; principles of detection of change, role of receptors, corrective response, role of effectors. (H)
- (3) regulation of blood glucose; roles of receptors in pancreas, secretion of insulin or glucagon; effect of insulin on surface membrane receptors / carrier proteins in stimulating uptake of glucose and glycogenesis; role of glucagon in glycogenolysis. (G)
- (4) regulation of blood water potential; role of receptors in hypothalamus; secretion of ADH from pituitary; effect of ADH on permeability of d.c.t. and collecting duct; role of loop of Henle in maintaining high

- ion concentration in the medulla; effect on urine concentration. (W)
- (5) control of ventilation; stimulation of chemoreceptors in medulla; effect on inspiration; stimulation of stretch receptors in lungs; stimulation of expiratory cells in medulla. (B)
- (6) control of heartbeat; roles of chemoreceptors and pressure receptors; inhibitory and acceleratory centres in medulla; effect on SAN and rate of heartbeat; effect of change in rate on pH / pressure of blood. (HB)
- (7) metabolic pathways; examples of build-up of a product in a metabolic pathway resulting in inhibition of its formation. (M)
- (8) population stability; effect of increasing competition / predation on increasing population size and restoration of balance. (Pop)
- (9) (selection – stabilising selection resulting in constancy of species) (S)

Any other sensibly argued example showing negative feedback should be credited.

In a good essay the description of the changes in a system should be clearly related to the principles of negative feedback, with sufficient detail for the relationship to be explained.

Assessment of breadth of knowledge:

3 marks

Clear understanding of principle of negative feedback and coverage of 4 examples with sufficient detail to illustrate the principle effectively.

2 marks

3 examples described in some detail, but without necessarily making the link explicit.

1 mark

reference to 2 examples.

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 are 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

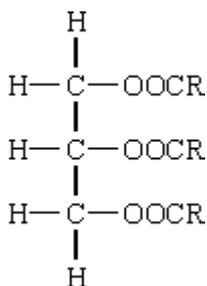
- relevant;
- at an appropriate depth for A level and
- accurate.

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.

Q12.

- (a) 3 fatty acids attached;
ester bond correct;

(H on glycerol component, O attached to carbon, R at other end)



2

- (b) not made of monomers / many repeating units;

1

- (c) (many) mitochondria present in brown fat cells;
mitochondria release heat / energy; (*ignore ATP*)
white fat cells for fat storage / reduced fat storage in brown fat cells;

3

[6]

Q13.

- (a) Binds to receptor on target/liver/muscle cell;

Reject reference to insulin as an enzyme

Causes more transport/carrier proteins to become active/
move to (plasma) membrane;

Glucose (diffuses) into cells (and lowers blood glucose);

(Enzymes in cells) convert glucose to glycogen;

Stimulates fatty acids/lipid/fat formation (from glucose);

Raises rate of respiration (in cells), using more glucose;

3 max

- (b) (i) 27 : 39;
1 : 1.44;

2 marks for 1 : 1.44

Accept 0.69 : 1

Accept 9 : 13

2

- (ii) One suitable reason; with explanation;

e.g. undiagnosed

Diabetic coma/brain cells not enough respiration;

Due to low blood glucose/acidosis/dehydration;

Heart attacks/coronary heart disease;

Due to faster atheroma formation/damage to arteries;

Kidney failure;

Due to damage to blood vessels;

2 max

[7]

Q14.

- (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 80 mg, increasing but keeping below line for diabetic,
dropping to 80 mg;
(line must stabilise at, or fluctuate around 80 mg)

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

[9]

Q15.

- (a) (epithelial cell) of tubule cells carry out active transport;
transport chloride / sodium ions out (of filtrate);
against concentration gradient;
into surrounding tissue / tissue fluid;
creates / maintains water potential gradient for water reabsorption;
countercurrent multiplier;
- (b) if water potential of blood falls, detected by receptors in hypothalamus;
leads to ADH released from pituitary gland;
ADH makes cells of collecting duct / distal convoluted tubule permeable to water;
(accept DCT)
- water leaves filtrate by osmosis;
smaller volume of urine produced;
(accept converse if water potential of blood rises)
- (c) (autonomic reflex),
autonomic ganglion involved;
extra synapse outside the spinal cord;
inhibitory rather than excitatory neurone;
more neurones involved;

5 max

4 max

2 max

[11]