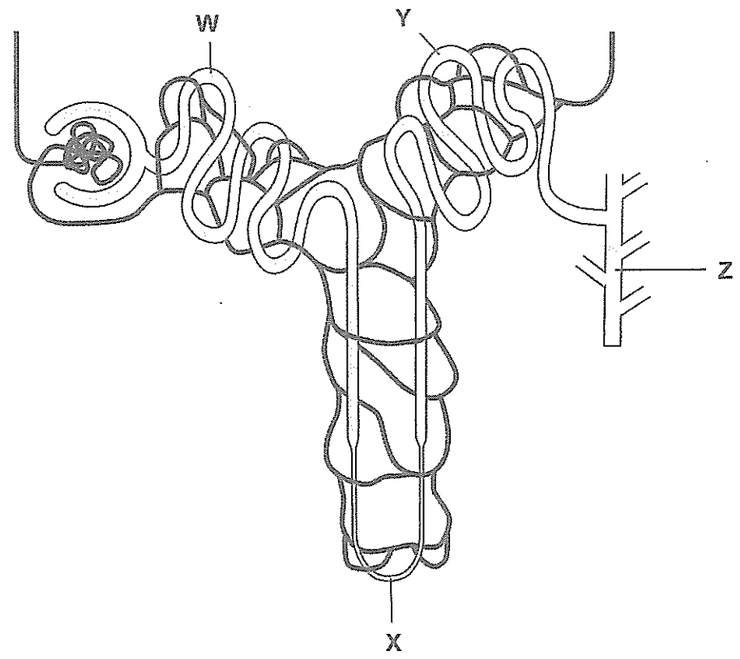
The next question refers to the diagram below.



2. *(2013:1.21)*

Control of water loss from the kidney occurs in different parts of the nephron tubule. However, water regulation is initiated in different ways. The first of these occurs in W and X and the second in Y and Z.

Which of the following is correct?

(a) In W and X, the hormone ADH controls the water loss by changing the concentration of solutes.

(b) In Y and Z, the hormone ADH controls the water loss by changing the permeability of the tubule wall.

(c) In Y and Z, the reabsorption of solutes creates an osmotic gradient so water moves out of the filtrate.

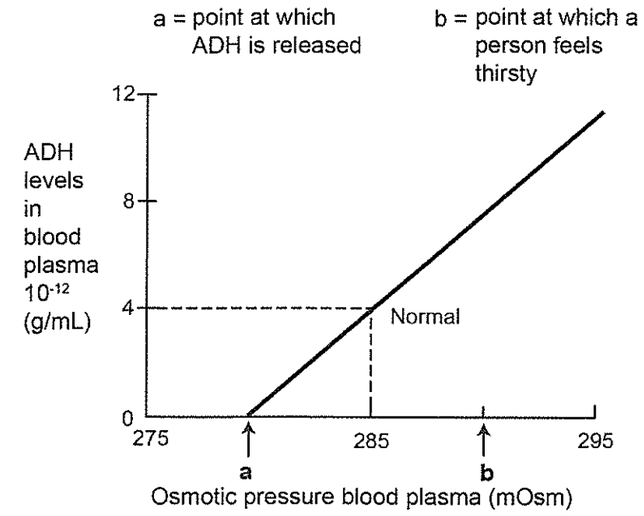
(d) In W and X, the secretion of solutes into the tubule creates an osmotic gradient so water moves into the tubule.

SHORT ANSWER QUESTIONS

3. [10 marks] *(2012:2.37)*

Part (a) of this question refers to the graph shown below.

The effect of blood plasma osmotic pressure on plasma ADH concentration



The unit mOsm stands for milliosmole or one thousandth of an osmole.

(a) Given the information in the graph, describe what would be occurring in the kidney to regulate blood fluid composition at a blood plasma osmotic pressure of 285 mOsm. [2]

CONTINUED NEXT PAGE

(b) Water intoxication is a condition in which too much water is present in the body. Complete the table below, outlining the effect of water intoxication on the body fluids. [3]

	Effect of water intoxication
Would blood plasma osmotic pressure be above or below normal?	
Are the intercellular fluids dilute or concentrated?	
Would urine output be increased or decreased?	

(c) Claire is taking part in a scientific study into the effect of exercise on various body systems. Her blood plasma osmotic pressure was checked using a blood sample taken after she exercised strenuously for 30 minutes. It was measured at 292 mOsm.

(i) Describe **two** processes that would have occurred in her body during exercise to cause this change in blood plasma osmotic pressure. [2]

(ii) Claire felt thirsty after completing the exercise. In which part of the brain is the centre that triggers the thirst mechanism? [1]

(iii) How would the information travel from the structure identified in Part (ii) and where would it be processed to make Claire feel that she needed to drink water? [2]

4. [5 marks] *(2014:2.35)*

An experiment was conducted on the effects of fluid consumption on urine production. The experiment involved the comparison of water consumption with the consumption of saline solution. Saline solution is a sterile solution of water and salt (normally sodium chloride). The experiment involved 30 subjects, 15 who consumed one litre of water in a five minute period and 15 who consumed one litre of saline solution in the same five minute period. All subjects were required to stay in a small room maintained at a temperature of 25°C and were asked to perform minimal physical activity. Urine production over the three hours following fluid consumption was recorded for all subjects. The results for each group were averaged and are presented below.

Time (minutes)	Urine production (mL)	
	Water consumption	Saline solution consumption
0	24	18
30	360	21
60	450	27
90	255	36
120	48	29
150	30	34
180	27	24

(d) (i) Identify the hormone directly involved in the maintenance of water balance in the body and state the specific part of its target organ that it influences. [2]

(ii) On the basis of the results of the experiment, the consumption of which fluid, water or saline, would have triggered the release of the hormone identified in part (d)(i)? [1]

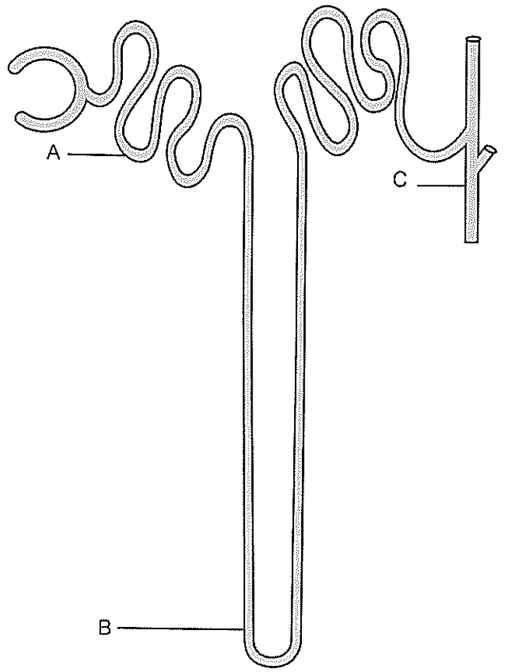
(iii) Explain why people suffering dehydration are given either a saline solution to drink or a saline intravenous drip rather than only water. [2]

5. [6 marks] *(2015:2.38)*

A group of scientists travelled around the world, studying different climates and weather patterns.

During the summer, they were stranded in a desert on a very hot day. Although they did not have any water to drink, they were able to prevent dehydration for a period of time by the involuntary control of water loss from their kidneys.

The following diagram shows three regions in the kidney nephron that would have been involved in preventing their bodies from dehydrating too quickly.



(a) Name the structure labelled B in the diagram of the kidney nephron shown above. [1]

(b) Describe the processes occurring at region A that would have helped the scientists to retain water. [3]

At region C, antidiuretic hormone controls the amount of water lost in the urine.

(c) Explain how this hormone enables the increase in concentration of urine, thus reducing the amount of dehydration the scientists suffered. [2]

EXTENDED ANSWER QUESTIONS

6. [12 marks] *(2010:3.32)*

(a) If you carry out a high level of physical activity, the osmotic pressure in your cells is increased, stimulating two types of feedback mechanisms that enable your cells to regain optimum water levels.

In the situation described above, explain how homeostasis is maintained by

(i) hormonal control [8]

(ii) conscious action [4]

7. [13 marks] *(2013:3.42)*

(a) The Tour de France is a long and difficult road race in which the cyclists ride for many hours a day. They are in danger of overheating and are constantly provided with water along the route.

Explain why it is necessary for water replenishment during a cycling race such as the Tour de France and describe the **two** homeostatic mechanisms that lead to the cyclists drinking the water.

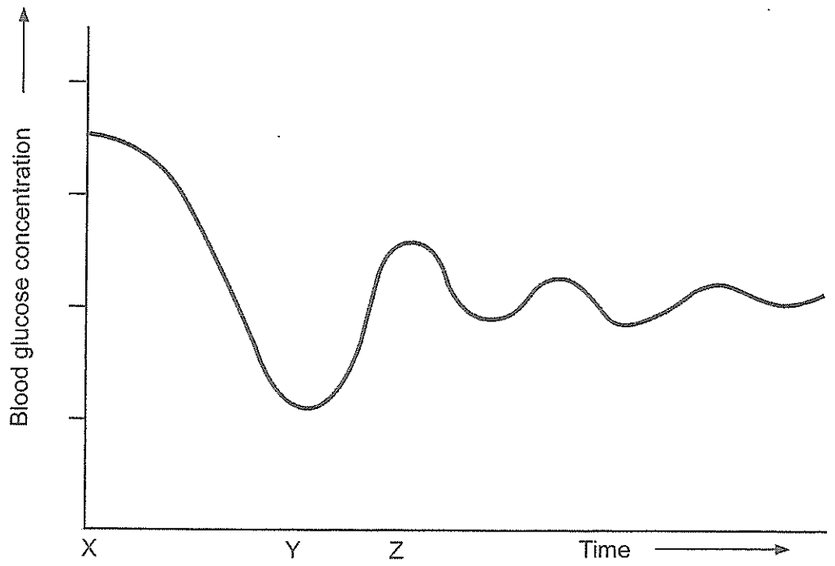
BLOOD SUGAR

SHORT ANSWER QUESTIONS

1. [12 marks] *(2013:2.33)*

The following question refers to the information and graph below.

Prior to having a morning operation, a patient was told to fast (go without food) after an evening meal the night before. The graph below shows changes in the blood glucose concentration throughout the night, while the patient was resting, starting 30 minutes after the evening meal.



(a) Describe how the above graph illustrates a negative feedback model. [2]

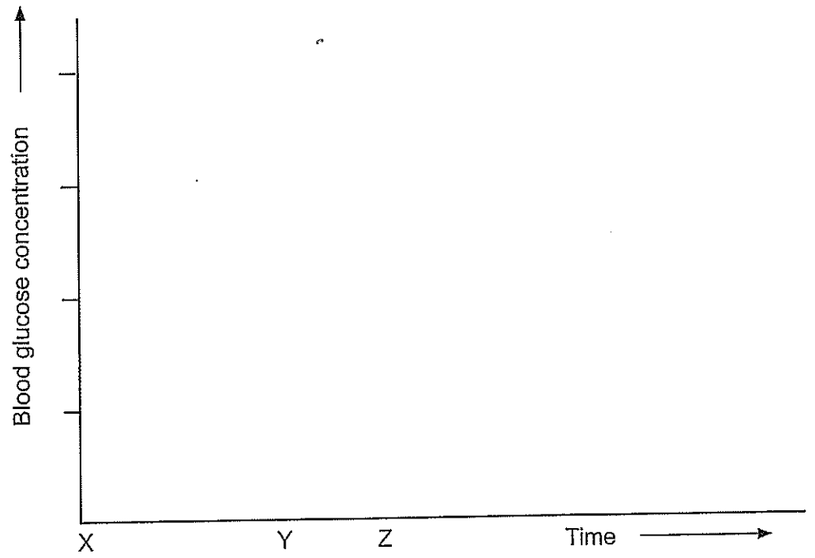
(b) The following questions refer to the change in blood glucose concentration between Points Y and Z on the graph.

(i) Name the hormone that caused the change in blood glucose concentration between times Y and Z on the graph. [1]

(ii) Name the cell type and the specific location within the organ from which the hormone stated in part (b) (i) was secreted. [2]

(iii) Describe **two** responses that led to the change in blood glucose concentration between times Y and Z on the graph. [2]

(c) (i) On the axes below, draw the blood glucose levels of a person suffering Type 2 diabetes (untreated) over this same time period. [1]



(ii) Explain the shape of your graph above in terms of glucose regulation. [4]

EXTENDED ANSWER QUESTIONS

2. [12 marks] *(2011:3.32)*

(b) Glucose is required in the body cells for the production of energy during cellular respiration. To maintain glucose levels in a cell, negative feedback mechanisms are necessary for more glucose to be released into the bloodstream and to enter the cell.

Identify, name the source and describe the role of **three (3)** hormones in increasing glucose levels in the bloodstream.

3. [12 marks] *(2015:3.40)*

(a) There are several hormones involved in the maintenance of optimal glucose levels in the blood.

Identify **three** of these hormones, state the specific location where they are produced and explain how they assist in the maintenance of optimal blood glucose levels.

GAS CONCENTRATION

SHORT ANSWER QUESTIONS

1. [10 marks] *(2011:2.29)*

(a) When hyperventilation occurs, a person breathes faster and more deeply than normal.

(i) What effect would this have on the level of carbon dioxide in the blood? [1]

(ii) Where in the brain would this change in carbon dioxide level be detected? [1]

(b) A girl had the pH levels in her blood taken immediately before and after swimming 500 metres in a pool. The results showed a drop in pH from 7.4 to 7.3.

What caused this drop in pH to occur? [3]

(c) Describe **three (3)** steps that need to occur so that more oxygen can be delivered to skeletal muscles when they become very active during exercise. [3]

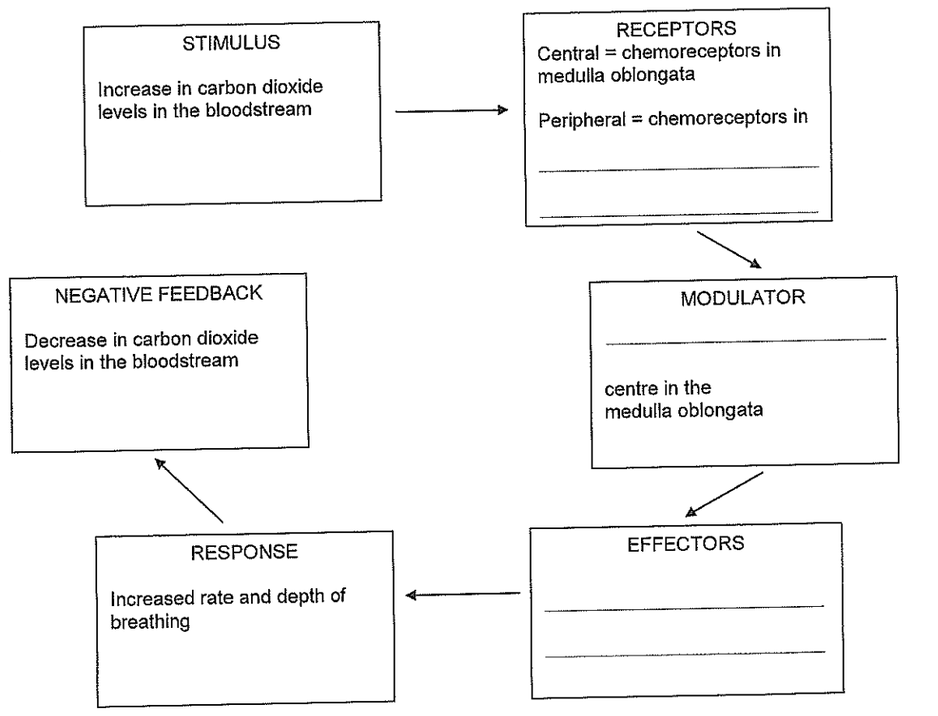
(d) When oxygen levels are extremely low, they have an effect on the regulation of breathing. Provide **two (2)** diseases or environmental situations in which this would happen. [2]

2. [6 marks] *(2014:2.37)*

During cell respiration, carbon dioxide is produced as a waste product. If the rate of cell respiration is increased, carbon dioxide levels in the blood will also increase. The removal of excess carbon dioxide requires an increase in rate and depth of breathing.

Below is a negative feedback model showing that an increase in breathing rate is required to remove the excess carbon dioxide.

(a) The feedback loop below is incomplete, as information is missing from the receptors, modulator and effectors boxes. Complete the feedback loop by writing the appropriate words in the spaces provided. [3]



(b) There are two main modes of transmission of messages in the body. These are carried out either by hormones or nerves. Which of these is stimulating the effectors in the diagram above? [1]

CONTINUED NEXT PAGE

35 2012:42 **(14 marks)**

(b) *Can use annotated feedback loop diagram.*

• the cerebrum is not involved (in the control of breathing and blood pressure) OR • breathing and blood pressure are controlled by the medulla and not affected by damage to the cerebrum	(1)
Breathing	**(max. 6)**
• the level of carbon dioxide in the blood changes/increases or decreases OR • changes in the hydrogen ion concentration/pH of the blood	(1)
• detected by peripheral chemoreceptors/the aortic and carotid bodies • detected by central chemoreceptors/medulla oblongata	(1)
• respiratory centre/the medulla oblongata	(1)
• stimulation or inhibition of autonomic/sympathetic nerves/phrenic/vagus nerve OR • effect the intercostal muscles and diaphragm/respiratory muscles	(1)
• change rate of contraction/increase or decrease rate of contraction	(1)
• change rate of breathing/increase or decrease rate of breathing OR • negative feedback/the level of carbon dioxide in the blood changes/increases or decreases	(1)

Blood pressure	**(max. 7)**
• blood pressure changes/increases or decreases	(1)
• detected by baroreceptors/carotid and aortic bodies/pressoreceptors	(1)
• vasomotor centre/medulla oblongata/cardiovascular centre	(1)
• Inhibits or stimulates nerve impulses from sympathetic or parasympathetic/autonomic nerves	(1)
• changes diameter of/dilates or constricts blood vessels/causes vasodilation or vasoconstriction OR • change in output/increase or decrease of adrenaline or noradrenaline	(1)
• controlled by hypothalamus • through adrenal medulla	(1)
• changes/increases or decreases heart rate/SA node OR • negative feedback/changes/increases or decreases blood pressure	(1)

Chapter 3: Homeostasis

Feedback Systems

MULTIPLE-CHOICE QUESTIONS

1 (2011:01)	**(a)**

EXTENDED ANSWER QUESTIONS

2 2010:32 **(12 marks)**

(a) (i) **Any 8 points for 1 mark each** – *Annotated feedback loop can be used*

- Osmoreceptors in the hypothalamus
- detect high osmotic pressure/low water concentration in the blood and
- sends an impulse to the posterior pituitary gland
- which increases secretion of antidiuretic hormone/ADH into the bloodstream
- to increase re-absorption of water from

- distal convoluted tubule and collecting duct/nephron tubule
- it increases the permeability of the tubule wall
- allowing osmosis to occur/allowing facultative reabsorption
- due to the osmotic gradient
- created by the high concentration of ions in the renal medulla
- resulting in decreased osmotic pressure

(ii) **Any 4 points for 1 mark each** **(max. of 8 marks)**

- Osmoreceptors in the thirst centre
- of the hypothalamus detect high osmotic pressure/low water concentration in the blood and
- in the cerebral cortex
- a conscious feeling of thirst occurs and the person drinks
- water is absorbed into the blood
- water enters the cells and regains optimal level/decreases osmotic pressure

(max. of 4 marks)

3 2012:42 **(6 marks)**

(a) *Can use annotated diagram* **(max. 6)**

- Stimulus is a change in the environment (external/internal) (1)
- Receptor detects the change (in the environment)/stimulus (1)
- Modulator is the control centre/processes/regulates information from receptor and sends to effector (1)
- Effector carries out a response (1)
- Response changes the effect of the stimulus/alters the original stimulus (1)
- Negative feedback counteracts/changes the direction of the stimulus/creates a stimulus opposite to the original change (1)

Temperature

MULTIPLE-CHOICE QUESTIONS

1 (2012:07)	**(b)**	2 (2014:10)	**(d)**

SHORT ANSWER QUESTIONS

3 2010:22 **(5 marks)**

(a) **Any 1 point for 1 mark**

Continuous movement/exercise (1)
Eating high energy (high calorie/high kilojoule/fatty)/more foods/hot drinks (1)
Huddling/curling/reduce surface area (1)
Hot packs (1)
Shelter (1)

(b) (i) *No marks for just naming. Need the full answer for one mark each.* (2 marks)

Shivering – contraction of skeletal muscles producing heat/increased cellular respiration in muscle cells (1)
Vasoconstriction – reduced diameter of skin arterioles/blood vessels reduces heat loss/reduces blood flow to skin (1)

(ii) Hypothalamus (1)

(c) **Any 1 point for 1 mark**

There is more cooling effect from sweating in the desert as the air is dry and the water can evaporate (1)
There is less cooling effect from sweating in the tropical rainforest as humidity is high/air is saturated and the water can't evaporate (1)

4 2015:38 **(5 marks)**

(d)

Mechanism	What happens in freezing conditions?	This mechanism is controlled by the hypothalamus and transmitted by	How does this help maintain body temperature?
Blood vessels	**Vaso-constriction of skin arterioles**	**Autonomic nervous system/ sympathetic system/nerves**	
Muscles	**Skeletal/ voluntary muscles contract rapidly/ shivering occurs**		**Produces heat**
Metabolic rate		**Hormones/endocrine/thyroxine/ TSH/TSHRF/ adrenaline/ sympathetic nervous system/ autonomic nervous system**	

Answer in each box = 1 mark

Water

MULTIPLE-CHOICE QUESTIONS

1 (2011:12)	**(a)**	2 (2013:21)	**(d)**

SHORT ANSWER QUESTIONS

3 2012:37 **(10 marks)**

(a) Any 2 of the following: (max. 2)
- Increase in ADH concentration
- Distal convoluted tubules/collecting duct would be more permeable to water
- Water being reabsorbed back into the capillaries/renal capillaries

(b)

Changes in bodily fluids	**Effect of water intoxication**	
Would blood plasma osmotic pressure be above or below normal?	Below	(1)
Are the intercellular fluids dilute or concentrated?	Dilute	(1)
Would urine output be increased or decreased?	Increased	(1)

(c) (i)
- Sweating (1)
- Increased expiration/breathing rate (1)

(ii) Hypothalamus (1)

(iii)
- Nerve impulse/electrochemical impulse/nervous transmission/action potential/ nerve fibres (1)
- Cerebrum/cerebral cortex (1)

4 2014:35 **(5 marks)**

(d) (i)
- ADH/antidiuretic hormone (2 marks)
- (acting on)/distal convoluted tubule/DCT/collecting duct (cannot just say nephron/nephron tubules/kidney)

OR
- Aldosterone
- (acting on)/distal convoluted tubule/DCT/collecting duct (cannot just say nephron/nephron tubules/kidney)

(ii) Saline (1 mark)

(iii)
- Saline solution increases osmotic pressure/saline solution does not lower osmotic pressure/drinking saline solution triggers ADH production/saline solution increases water reabsorption/saline solution triggers osmoreceptors (1) (2 marks)
- Allows fluid to be added back to the body without increasing urine production/allows the consumed fluid to not be lost through urine/body is rehydrated faster/less water lost (1)

5 2015:38 **(6 marks)**

(a)
- Loop of Henle (1)

(b)
- Active reabsorption of essential substances/nutrients/amino acids/glucose from A/ nephron/tubule/filtrate (into the blood) (1) (3)
- Osmotic pressure of blood increases/solute concentration of blood increases (1)
- Any one of the following
- Water moves from tubule/A/filtrate into the blood/capillaries
- Water moves by osmosis from dilute to concentrated solution/blood/from where there is a higher concentration of water to lower water concentration

(c)
- Increases permeability of tubule wall/collecting tubule/duct (2)
- More water can be reabsorbed

EXTENDED ANSWER QUESTIONS

6 2010:32 **(12 marks)**

(a) (i) **Any 8 points for 1 mark each** – *Annotated feedback loop can be used* (max. of 8 marks)
- Osmoreceptors in the hypothalamus
- detect high osmotic pressure/low water concentration in the blood and
- sends an impulse to the posterior pituitary gland
- which increases secretion of antidiuretic hormone/ADH into the bloodstream
- to increase re-absorption of water from
- distal convoluted tubule and collecting duct/nephron tubule
- it increases the permeability of the tubule wall
- allowing osmosis to occur/allowing facultative reabsorption
- due to the osmotic gradient
- created by the high concentration of ions in the renal medulla
- resulting in decreased osmotic pressure

(ii) **Any 4 points for 1 mark each** (max. of 4 marks)
- Osmoreceptors in the thirst centre
- of the hypothalamus detect high osmotic pressure/low water concentration in the blood and
- in the cerebral cortex
- a conscious feeling of thirst occurs and the person drinks
- water is absorbed into the blood
- water enters the cells and regains optimal level/decreases osmotic pressure

7 2013:42 **(13 marks)**

(a) Total 13 marks

Explanation	Marks
Explanation for necessity (can be mentioned in the feedback) Increased sweating lowers body temperature/increases heat loss	1–2
Loss of water by sweating replaced by drinking	
Sweating	
Body temperature increases	1–7
Increase due to heat production/increased metabolic rate	
(Thermo)receptors in hypothalamus detect increased temperature	
Autonomic/sympathetic nerve impulse triggered	
Impulse sent to sweat glands	
Sweat glands pump water to surface/more active	
Sweat evaporates from the skin	
Removes heat energy/needs latent heat to evaporate	
Thirst	
Osmotic pressure of blood increases/water level in blood decreases	1–4
Detected by (osmo)receptors in hypothalamus	
Nerve impulse to cerebrum/cerebral cortex/dry throat	
Conscious desire/think about drinking Effectors/skeletal muscle carry out response/drinking action	

(max. of 13 marks)

Blood sugar

SHORT ANSWER QUESTIONS

1 2013:33 **(12 marks)**

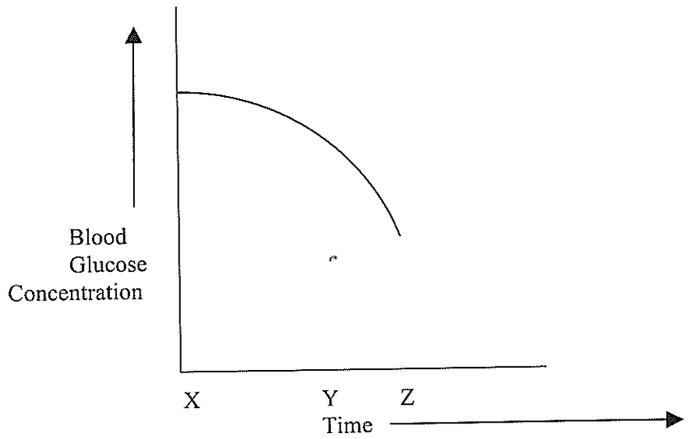
(a) 1 mark each – max. 2
- Negative feedback produces a response in a direction opposite to the original stimulus (1)
- Appropriate description with reference to graph – e.g. following the meal, blood glucose concentration is high then reduces/reduces then rises again due to glucagon secretion (1)

(b) (i) Glucagon (spelling must be correct) (1)

(ii) Alpha cells (1)
Islets of Langerhans/pancreatic islets (1)

(iii) Any two of: (1 mark each – max. 2) (2)
- Glycogen conversion to glucose/glycogenolysis
- Production of glucose from fat (lipids)/gluconeogenesis (of fats/lipids)
- Production of glucose from amino acids (protein)/gluconeogenesis (of amino acids/protein)

(c) (i) Example graph shown below. Note that the start of the line should technically be above the start point of the original for a person suffering type 2 diabetes. However, no marks deducted if line is started at the same point as the original.
- Line shows that the level remains higher for longer and slowly decreases (must decrease slower than original) (1)



(ii) Any four of: (1 mark each – max. 4) (4)
- Insulin is produced/present
- Cells don't respond to insulin
- Cells unable to take up glucose
- Failure to convert glucose to glycogen
- Failure to convert glucose to fat
- Cells unable to use glucose for energy/glycolysis
- Glucose levels remain higher for longer

EXTENDED ANSWER QUESTIONS

2 2011:32 **(12 marks)**

(b) The 3 following hormones for 4 each:
Name: 1 mark. Where produced 1 mark. Description 2 marks, (12)

Glucagon
- Produced by the alpha cells/Islets of Langerhans/pancreas/endocrine pancreas/pancreatic islets
- Enters the liver
- Promotes gluconeogenesis/breakdown of lipids/amino acids
- Into glucose which enters the bloodstream
- Glyconeogenolysis/glycogen to glucose

Cortisol/Glucocorticoids
- Produced by adrenal cortex
- Glycogenolysis/breakdown of glycogen to glucose
- Glucose enters the blood stream
- Removal of amino acids from muscle cell
- Amino acids to liver for gluconeogenesis/amino acid to glucose

Adrenaline/noradrenaline
- Produced by adrenal medulla
- Glycogenolysis/breakdown of glycogen to glucose
- Glucose enters the bloodstream
- Glycogen in muscles is acted on
- Lactic acid is produced
- Lactic acid is converted to glucose in the liver
- Increased insulin receptor numbers on cell surface
- Increased sensitivity of insulin receptors
- Gluconeogenesis

3 2015:40 **(12 marks)**

(a) **Homeostasis of blood glucose levels by THREE hormones.**

Any THREE of the following hormones name of hormone, where produced and how they work – each point per hormone is worth one mark to a maximum of 4 marks = total 12 marks.

- **Insulin** (1)
- Produced by beta cells/Islets of Langerhans/pancreatic islet cells (1)

Any two of the following:
- Enhances the transport of glucose into the cells (for cellular respiration) (1)
- Glycogenesis/converts glucose into glycogen in the liver/skeletal muscles (1)
- Conversion of glucose into fat/lipids in adipose tissue (1)

- **Glucagon** (1)
- Produced by alpha cells/Islets of Langerhans/pancreatic islet cells (1)

Any two of the following:
- Glycogenolysis/converts glycogen into glucose in the liver (1)
- Gluconeogenesis of lipids/conversion of fat/lipids into glucose/lipolysis in liver/adipose tissue (1)
- Gluconeogenesis of amino acids in liver/breakdown/conversion of amino acids into glucose (1)

- **Adrenaline/noradrenaline** (1)
- Produced by adrenal medulla (1)

Any two of the following:
- Glycogenolysis/converts glycogen into glucose in the liver/skeletal muscles (1)
- Glycogen in muscles converted to lactic acid/lactic acid converted to glucose in liver (1)
- Enhances release of fatty acids from adipose tissue (1)
- Inhibits insulin secretion from pancreas (1)

- **Cortisol** (1)
- Produced by adrenal cortex (1)

Any two of the following:
- Glycogenolysis/converts glycogen into glucose in the liver (1)
- Releases amino acids from skeletal muscles (1)
- Gluconeogenesis of amino acids in liver/breakdown/conversion of amino acids into glucose (1)
- Can have inhibitory effect on insulin (1)

- **Thyroxine** (1)
- Produced by thyroid gland (1)

Any two of the following:
- Enhance glucose absorption into the blood from the gut/small intestine (1)
- Enhances/increase glucose metabolism in cells/increases rate of cellular respiration (1)
- enhances insulin-dependent entry of glucose into cells (1)
- increases gluconeogenesis and glycogenolysis to release glucose into the blood. (1)

Gas concentration

SHORT ANSWER QUESTIONS

1 2011:29 **(10 marks)**

(a) (i) Decrease (1)

(ii) (Respiratory centre) Medulla oblongata/medulla (1)

(b) 1 mark for each point (3)
- Increase in acidity/production of carbonic acid/production of lactic acid/increase H+ ions/ $CO_2 + H_2O \rightarrow H_2CO_3 \rightarrow H^+ + CO_3^-$
- pH decrease caused by increase in carbon dioxide
- Produced in cellular respiration/increased activity

(c) 1 mark for each point (3)
- Increased rate/depth of breathing
- Increase in cardiac output/heart rate/blood pressure
- Vasodilation in muscle arterioles/blood vessels/increase in muscle blood flow

(d) Any two of: (2)
- Lung disease
- Emphysema
- Cancer
- Asthma
- Any other named lunged disease
- High altitudes
- Loss of pressure in an aircraft
- Diving (without air)
- Fire/smoke

2 2014:37 **(6 marks)**

(a) (3)
- Carotid/aortic bodies
- Respiratory
- Respiratory muscles or diaphragm and intercostal/rib muscles

(b) Nerve/nervous (1)

(c) (2)
- Increase hydrogen ion concentration
- Decrease pH/acidity

Chapter 4: Response to infection

MULTIPLE-CHOICE QUESTIONS

1 (2010:08)	**(b)**	2 (2013:22)	**(c)**	3 (2013:23)	**(b)**	4 (2014:27)	**(a)**
5 (2015:09)	**(a)**						

SHORT ANSWER QUESTIONS

6 2010:28 **(1 mark)**

(a) Antibiotics affect/treat bacteria, while antivirals affect/treat viruses/coat normal cells as form of protection

7 2011:26 **(15 marks)**

(a) Any 5 points for 1 mark each (in correct order) (5)
- Antigens engulfed by macrophages
- Antigens presented to B cells/lymphocytes
- B cells sensitised
- B cells enlarge
- B cells clone
- B cells form plasma cells
- Antibodies are then released into the bloodstream
- Plasma cells produce antibodies

(b) Any two of: (2)
- Response after 1st exposure takes longer to occur/antibodies don't appear immediately after the 1st exposure
- 2nd exposure peaks at a higher level/more antibodies are produced after the second exposure/ due to memory cells
- Levels of antibodies are maintained longer after the second exposure

(c) Memory cells (1)

(d) Any three of: (3)
- Active produces antibodies in response to antigens whereas passive is when given antibodies from another source/person.
- Memory cells produced in active immunity and not in passive.
- Active has a longer lasting effect than passive
- Passive acts faster than active.