HUMAN BIOLOGY
UNIT 3
2017

Section	Marks	Your mark
Multiple-Choice	60	
Short Answers	100	
Extended Answers	40	
Total	200	

Name: _____

Teacher: _____

TIME ALLOWED FOR THIS PAPER

Reading time before commencing work: Ten minutes
Working time for the paper: Three hours

MATERIALS REQUIRED/RECOMMENDED FOR THIS PAPER

To be provided by the supervisor:

- This Question/Answer Booklet
- Multiple Choice Answer Sheet

To be provided by the candidate:

- Standard items: Pens, pencils, eraser or correction fluid, ruler, highlighter, ruler.

- Special items: Calculators satisfying the conditions set by School Curriculum and Standards Authority for this subject.

IMPORTANT NOTE TO CANDIDATES

- No other items may be taken into the examination room. It is **your** responsibility to ensure that you do not have any unauthorised notes or other items of a non-personal nature in the examination room. If you have any unauthorised material with you, hand it to the supervisor **before** reading any further.

Structure of this paper

Section	Suggested working time	Number of questions available	Number of questions to be attempted	Marks	Percentage
SECTION ONE: Multiple-choice	50 minutes	30	All	60	30
SECTION TWO: Short answers	90 minutes	7	All	100	50
SECTION THREE: Extended answers	40 minutes	3	2	40	20
			Total marks	200	100

Instructions to candidates

1. The rules for the conduct of Western Australian external examinations are detailed in the *Year 12 Information Handbook 2017.* Sitting this examination implies that you agree to abide by these rules.

2. Answer the questions according to the following instructions.

   Section One: Answer all questions on the separate Multiple-choice Answer Sheet provided. For each question shade the box to indicate your answer. Use only a blue or black pen to shade the boxes. If you make a mistake, place a cross through that square, do not erase or use correction fluid, and shade your new answer. Marks will not be deducted for incorrect answers. No marks will be given if more than one answer is completed for any question.

   Sections Two and Three: Write your answers in this Question/Answer Booklet.

3. You must be careful to confine your responses to the specific questions asked and to follow any instructions that are specific to a particular question.

4. Spare pages are included at the end of this booklet. They can be used for planning your responses and/or as additional space if required to continue an answer.
   - Planning: If you use the spare pages for planning, indicate this clearly at the top of the page.
   - Continuing an answer: If you need to use the space to continue an answer, indicate in the original answer space where the answer is continued, i.e. give the page number. Fill in the number of the question(s) that you are continuing to answer at the top of the page.

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Section One: Multiple-choice **30% (60 Marks)**

This section has **30** questions. Answer **all** questions on the separate Multiple-choice Answer Sheet provided. For each question shade the box to indicate your answer. Use only a **blue or black pen** to shade the boxes. If you make a mistake, place a cross through that square, do not erase or use correction fluid, and shade your new answer. Marks will not be deducted for incorrect answers. No marks will be given if more than one answer is completed for any question.

Suggested working time for this section is 50 minutes.

The following information is needed to answer the next FOUR questions.

A patient has complained of the following symptoms to their doctor:

- Feeling a lack of energy
- Unexplained weight gain
- Feeling cold, even though the surrounding temperature is around 25°C.

In response, the doctor had the patient's Thyroid Stimulating Hormone (TSH) levels tested over five consecutive days. The patient's results, measured in milli-international units per litre (mIU/L), can be seen in the table below.

Day	1	2	3	4	5
TSH concentration (mIU/L)	2.0	2.3	2.9	2.7	2.1

A normal range is between 0.4 to 4.0 mIU/L.

1. The range and median for the patient's TSH level was

a) 2.0 to 2.9 with a median of 2.4
b) 2.1 to 2.9 with a median of 2.3
c) 2.0 to 2.1 with a median of 2.9
d) 2.0 to 2.9 with a median of 2.3

2. TSH is a hormone secreted by

a) the hypothalamus and released from the anterior lobe of pituitary gland.
b) the posterior lobe of the pituitary gland and its release is controlled by the hypothalamus.
c) the anterior lobe of the pituitary gland and its release is controlled by the thyroid gland.
d) the anterior lobe of the pituitary gland and its release is controlled by the hypothalamus.

3. Based on the information the patient provided, the disease the doctor was most likely checking for was

a) type 1 diabetes.
b) type 2 diabetes.
c) hypothyroidism.
d) hyperthyroidism.

4. Choose the two correct words to complete the following sentence.

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Given the results showed a normal level of TSH present in the blood, the doctor would now need to detect for the presence of _____ to determine if the _____ gland was dysfunctional.

a) insulin, pancreas
b) thyroxine, parathyroid
c) glycogen, pancreas
d) thyroxine, thyroid

5. Which of the following illustrates a negative feedback mechanism?

a) The loss of excess glucose in urine
b) The secretion of oily substances from the sebaceous glands to reduce water lost from the skin surface
c) The vasoconstriction of the capillaries in the skin to reduce heat loss
d) The mother feeds the baby with breast milk so that the useful nutrients go back to the human body again

6. Many nerve fibres consist of an axon and its myelin sheath. This myelin sheath is

a) responsible for the colour of the grey matter in the brain and spinal cord
b) produced by Schwann cells located along the axon
c) continuous all the way along the cell body
d) responsible for the colour of the grey matter in the peripheral nervous system

7. One hormone molecule causes the manufacture or activation of thousands of enzyme molecules through the process of

a) negative feedback
b) enzyme amplification
c) hormone amplification
d) hormone clearance

8. Which of the following statements about ALL hormones is correct? They

a) change the functioning of cells by changing the type or quantities of proteins made.
b) activate certain genes in the nucleus.
c) change the shape or structure of an enzyme.
d) change the rate of production of an enzyme.

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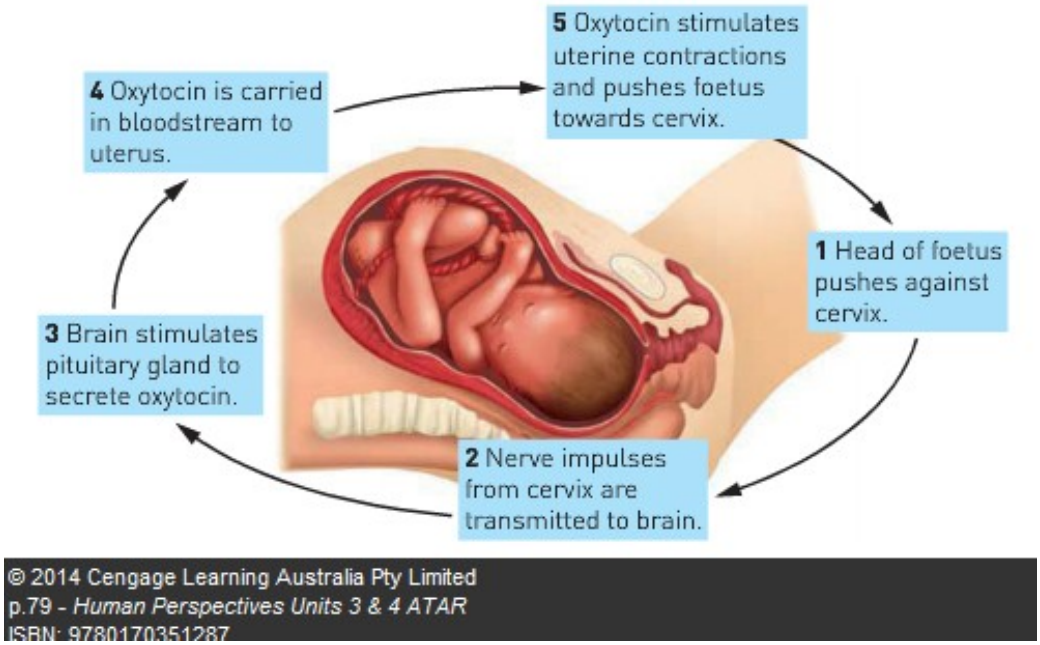
Refer to the following diagram, showing the processes involved in labour, to answer the next THREE questions.



9. In this stimulus-response and feedback process, the effector would be the

   a) cervix.
   b) uterus.
   c) pituitary gland.
   d) oxytocin.

10. The type of feedback involved in this process would be

    a) negative feedback, as the response negates the stimulus.
    b) positive feedback, as the response negates the stimulus.
    c) negative feedback, as the response intensifies the stimulus.
    d) positive feedback, as the response intensifies the stimulus.

11. The hormone responsible for stimulating the contractions of the uterus is

    a) produced in and released from the anterior lobe of the pituitary.
    b) produced in the hypothalamus and sent to the anterior lobe of the pituitary via nerve fibres.
    c) produced in the hypothalamus and sent to the posterior lobe of the pituitary via nerve fibres.
    d) secreted from the hypothalamus and sent to the posterior lobe of the pituitary via blood vessels in the infundibulum.

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12. Which of the following statements about the autonomic nervous system is INCORRECT?

a) It regulates the activities of smooth muscle, cardiac muscle and glands
b) It usually operates without conscious control
c) It is regulated by centres in the cerebral cortex, hypothalamus and the medulla
d) It contains motor and sensory nerve fibres

Refer to the list below to answer the next question. This information shows some normal physiological changes in the human body.

A. Dilation of pupils
B. Increase in heart rate
C. Decreased secretion of saliva
D. Increased secretion from sweat glands
E. Dilation of blood vessels in the skin
F. Decreased levels of adrenalin in blood

13. Which of the changes in the above list would result from stimulation by the sympathetic division of the autonomic nervous system?

a) A, B, C and E
b) A, C, D and F
c) A, B, C, and D
d) B, C, E, and F

14. Substantial injury to the right cerebral cortex results in loss of:

a) voluntary muscular movements of the left side of the body.
b) voluntary muscular movements of the right side of the body.
c) involuntary muscular movements of the left side of the body.
d) involuntary muscular movements of the right side of the body.

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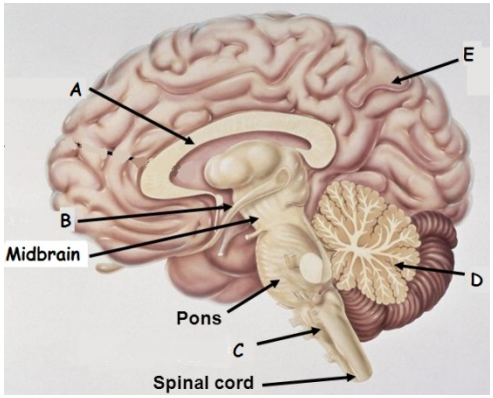
Refer to the diagram below to answer the next question.



15. Which of the following correctly identifies the structures of the central nervous system?

	A	B	C	D	E
a)	Cerebellum	Hypothalamus	Corpus Callosum	Cerebrum	Pituitary Gland
b)	Corpus Callosum	Hypothalamus	Medulla Oblongata	Cerebellum	Cerebrum
c)	Hypothalamus	Corpus Callosum	Medulla Oblongata	Cerebellum	Cerebrum
d)	Corpus Callosum	Hypothalamus	Cerebellum	Medulla Oblongata	Cerebrum

16. The sinoatrial (SA) node or pacemaker of the heart is under autonomic control from which part of the brain?

a) medulla oblongata
b) cerebellum
c) cerebral cortex
d) hypothalamus

17. Which of the following is NOT a property of a reflex?

a) They occur without any conscious thought.
b) They occur spontaneously, without a stimulus.
c) They occur using only a small number of neurons.
d) They occur in the same way each time they happen.

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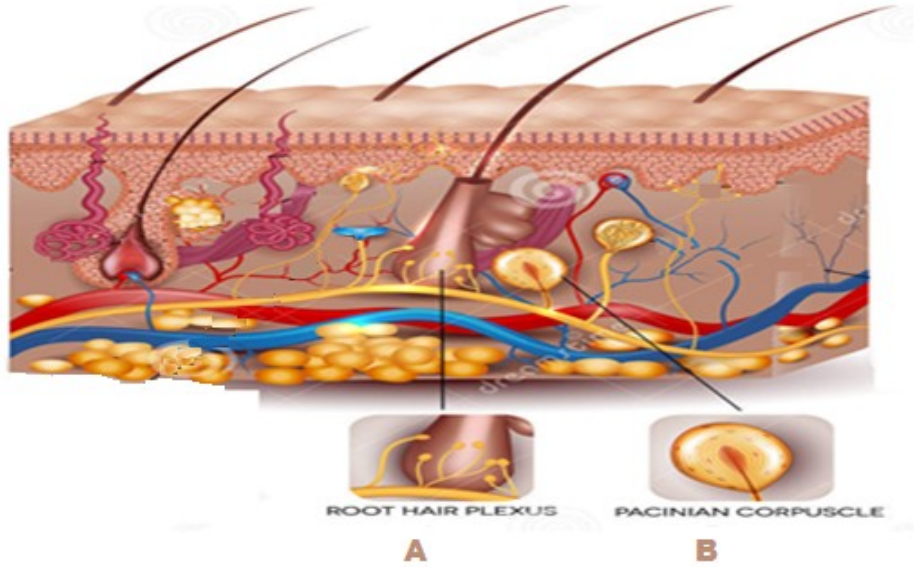
Look at the diagram below and answer the following question.



18. Choose the correct statement that describes the similarity and difference between the receptors labelled in the above diagram.

	Similarity	Difference
a)	Detect heat	A detects cold, B detects heat
b)	Detect pH of body fluids	A detects low pH body fluid and B detects high pH body fluid.
c)	Detect touch	A detects strong pressure, B detects light pressure
d)	Detect touch	A detects light pressure, B detects strong pressure

19. The chemical that transmits a nerve stimulus via a somatic pathway to a muscle fibre is

a) noradrenaline.
b) cholesterol.
c) acetylcholine.
d) adenosine triphosphate.

20. Which of the following is NOT a similarity shared between the endocrine and nervous system?

a) Some hormones are secreted by neurons into the extracellular fluid.
b) Both systems can have an effect on all body cells.
c) Some hormones and neurotransmitters have the same effect on the same target cells.
d) Some chemicals released from both systems function as both hormones and neurotransmitters.

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21. The cerebrospinal fluid (CSF) is important in protecting the nervous system. Which of the following statements about this fluid is correct?

a) The CSF occupies a space between the middle and inner layers of the meninges, where the brain is suspended within this fluid.
b) The CSF acts as a shock absorber, protecting the whole nervous system.
c) The CSF is formed from blood and it circulates through the peripheral nervous system.
d) During its circulation, the CSF takes nutrients to the cells of the brain and spinal cord, re-entering the lymphatic system.

22. A footballer, having received a blow to the head, has come off the field. She complains of having blurred vision. The most likely point of contact would have been the

a) front of the head
b) left hand-side of the head
c) right hand-side of the head
d) rear of the head

23. Which of the following is true about active immunity?

a) The antibody formed will attack any pathogen
b) Both B and T lymphocytes can play a role
c) It is short-lived because no memory cells are involved
d) Prepared immunoglobulins activate this type of immunity

24. An individual contracted Lyme disease after a tick took a blood meal from them. Which of the following methods would describe how this disease was transmitted?

a) By contact
b) By body fluids
c) By a vector
d) By ingestion

25. The enzyme that is found in human tears that helps to kill bacteria is called

a) cerumen.
b) lysozyme.
c) vaccine.
d) leukocyte.

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26. Which of the following organs in LIST 1 correctly matches the mode of defence against a possible pathogen in LIST 2?

	LIST 1	LIST 2
a)	Trachea	Hairs and mucus
b)	Stomach	Impervious barrier
c)	Skin	Sebum and sweat
d)	Urethra	Digestive enzymes

27. When B lymphocytes bind to an antigen they undergo cell division to produce a

a) macrophage and a memory cell.
b) memory cell and a killer T cell.
c) plasma cell and a macrophage.
d) plasma cell and a memory cell.

28. Which of the following is NOT an example of a pathogen?

a) mosquito
b) bacteria
c) protozoan
d) fungi

29. When an individual experiences a rapid onset of a fever they may feel

a) cold and, as a consequence, vasodilation in the skin and shivering occurs.
b) hot and, as a consequence, vasoconstriction in the skin and sweating occurs.
c) cold and, as a consequence, vasoconstriction in the skin and shivering occurs.
d) hot and, as a consequence, vasodilation in the skin and shivering occurs.

30. Vaccination programs that reduce the chance of disease in individuals and increase the immunity of a population is best described as

a) natural passive immunity.
b) artificial passive immunity.
c) natural active immunity.
d) herd immunity.

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Section Two: Short answer **50% (100 Marks)**

This section has **seven (7)** questions. Answer **all** questions. Write your answers in the spaces provided.

Spare pages are included at the end of this booklet. They can be used for planning your responses and/or as additional space if required to continue an answer.
Planning: If you use the spare pages for planning, indicate this clearly at the top of the page.
Continuing an answer: If you need to use the space to continue an answer, indicate in the original answer space where the answer is continued, i.e. give the page number. Fill in the number of the question(s) that you are continuing to answer at the top of the page.

Suggested working time for this section is 90 minutes.

31. **(25 marks)**

Scientists wanted to test the hypothesis that stressful situations could lead to weight gain in humans. It has been acknowledged that glucocorticoids (namely cortisol), are released during times of stress and the presence of these hormones may cause weight gain.

To investigate this theory, scientists exposed the same number of rats (10) to increasingly more stressful situations and then allowed them access to an unlimited supply of food pellets for 15 minutes. To induce stress, the rats were kept in isolation and completely restrained by a belt lined with wool, which was appropriately sized, depending on the age and size of the rat. Once the time of restraint had elapsed, the amount of adrenocorticotropic hormone (ACTH) present in their blood was measured and the average calculated. The average amount of ACTH was measured in picograms per mL of blood. The rats were then freed and allowed access to the food. The scientists recorded the number of pellets that were eaten.
The results from the experiment can be seen below.

		Number of pellets eaten within 15 minutes after release.			
		Trials			
Time of restraint (Hours)	Average amount of ACTH in blood (pg/mL)	1	2	3	Average
0	30	14	14.25	13.75	14
2	60	10	10.25	9.75	10
4	90	8.25	9	8.25	8.5
6	120	17	19	18	18
8	150	21	24	22.5	*22.5*

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(a) Name the independent variable. *Amount of ACTH in blood (pg/mL)* (1 mark)

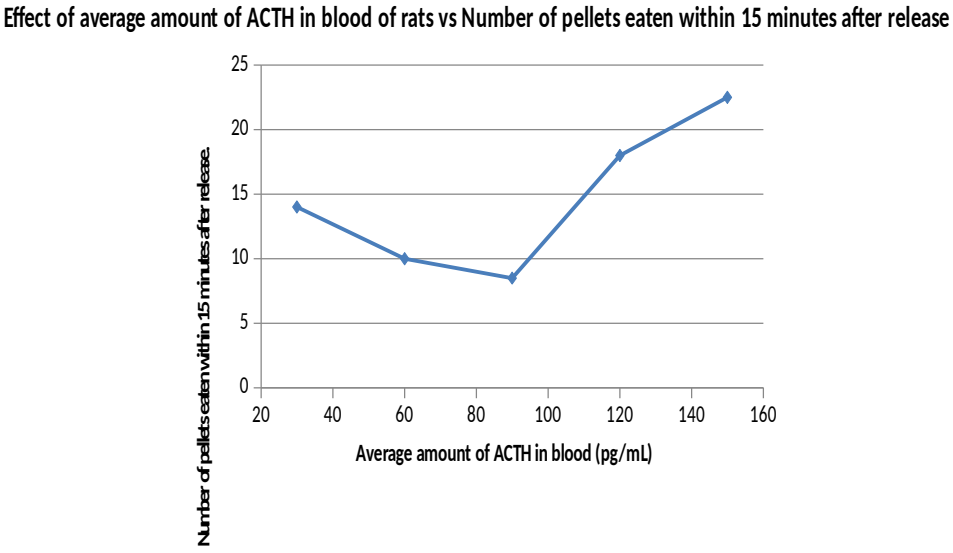
(b) List three controlled variables that would ensure the test was fair. *Any 3 of the following for max 1 mark each.*

- *Unlimited food supply*
- *Same method used to induce stress*
- *Same age of rats*
- *Same eating habits*
- *Same weight of the rats* (3 marks)

(c) Complete the table on the previous page by calculating the average number of pellets eaten for the last test.
See table on previous page. (1 mark)

(d) Plot the results on the graph paper supplied on the next page. (Spare graph grid on page 34)

Graph needs to have the following for one mark each:
Correctly plots points and joins points to form a line/curve (1)
Labelling of X and Y axes with correct name and unit (1)
Uses a suitable scale (1)
Title appropriate with both variables included (1)



(4 marks)

(e) State where in the body, glucocorticoids are released from. *Adrenal Cortex* (1 mark)

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(f) For each situation listed below, give one reason why the scientists:

(i) measured and calculated the average amount of ACTH.

1 mark each correct.

Provided a quantified level (1 mark) to indicate the level of stress the animal was experiencing. (1 mark)

(2 marks)

(ii) measured the amount of ACTH rather than the glucocorticoids.

ACTH is the hormone responsible for stimulating the release of glucocorticoids (1 mark)
It is easier to detect and measure one hormone rather than a number of them (1 mark)

(2 marks)

(g) Using the results of the experiment, explain what effect the amount of ACTH appeared to have on the rats' appetite for the first three tests and provide an explanation as to why this occurred.

MUST provide this or similar observation

- *ACTH appeared to suppress the mices' appetite / the amount they ate decreased after each test (1 mark), from 14 to 10 to 8.5 pellets eaten(1 mark)*
- *Increase in ACTH → increase in cortisol → increase in glycogenolysis and/or gluconeogenesis (1 mark) → increase in blood sugar levels → decrease in appetite (1 mark) or*
- *Appetite supressed as sympathetic nervous system releases noradrenaline (1 mark) which decreases peristalsis/movement of the intestines/stomach. (1 mark)*

(6 marks)

(h) Upon reviewing the procedure of this experiment, an independent scientist claimed,

"The procedure for this experiment was not conducted in an ethical way and the results were invalid given the hypothesis".

Explain what the independent scientist meant by this statement.

- *Unethical because the treatment of the rats was inhumane (1 mark) / there was foreseeable risk of physiological and/or psychological harm. (1 mark)*
- *The results were invalid because the test determined the effects of stress on eating habits on rats and not on humans, as proposed by the hypothesis. (1 mark)*

(2 marks)

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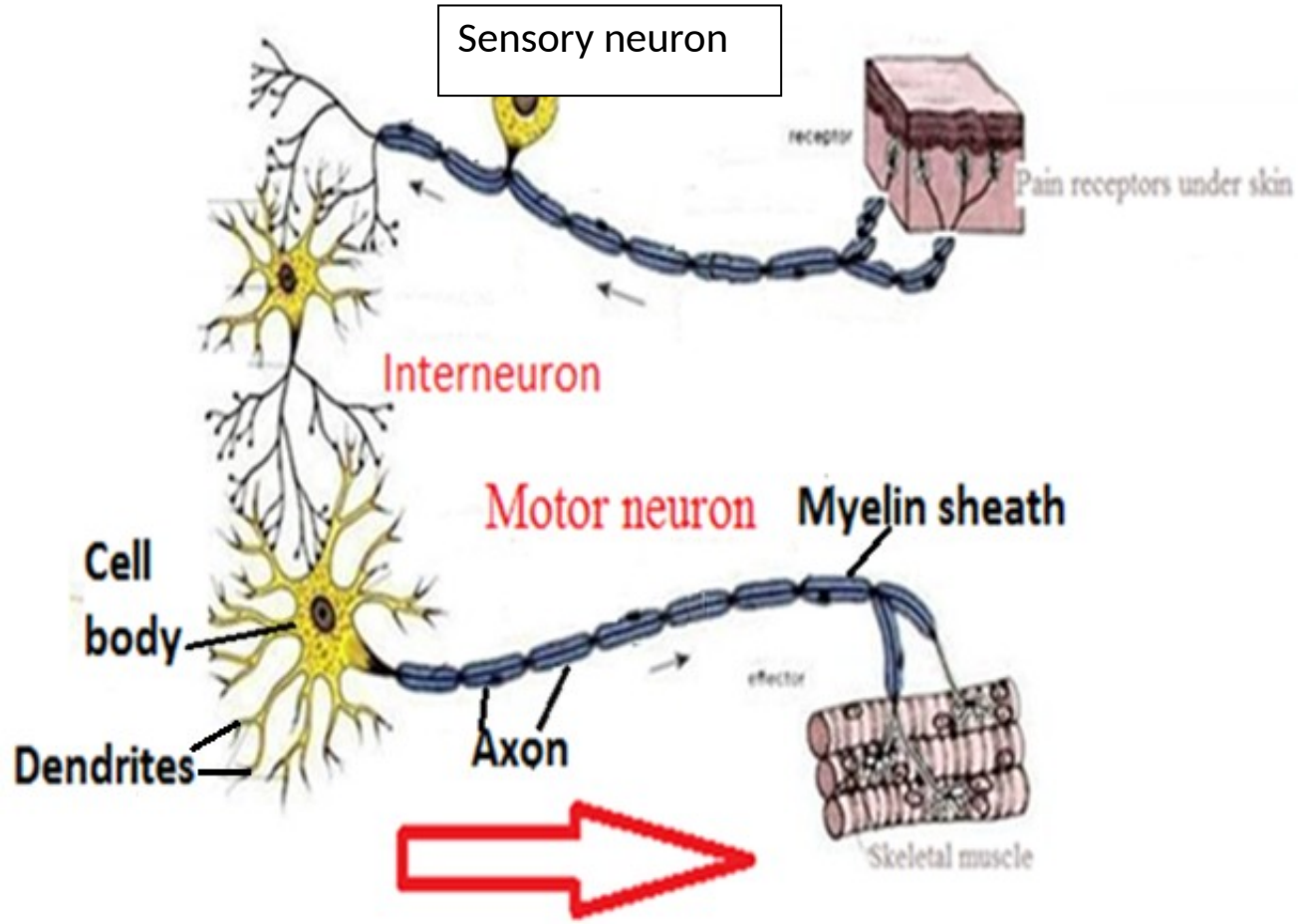
(i) Cortisol has the ability to pass directly through the membrane of liver cells. State what type of hormone cortisol is and explain how it stimulates the cell to form particular proteins.

- *Cortisol is a steroid hormone. (1 mark)*
- *Cortisol/steroid hormone enters the target cell and combines with receptor protein (1 mark)*
- *The hormone-receptor complex activates the genes / controlling the formation of proteins. (1 mark)*

(3 marks)

32. **(15 marks)**

(a) Complete the diagram below of a reflex arc, by drawing a myelinated unipolar neuron in the appropriate space below. (1 mark)



(b) Indicate with an arrow in the rectangular box above, the direction of the nerve impulse through the axon above the rectangular box. (1 mark)

(c) Complete the following table.

Part	Function
Cell Body	*Controls all cell's functions.*
Dendrites	*Receive messages/impulses from other neurons OR* *Carries impulses to the cell body*
Myelin sheath	*Any 1 of 3 (max 1 mark)* *Acts as an insulator* *Protects axon from damage* *Speeds up the movement of an impulse*
Axon	*Carries impulses away from the cell body*

(4 marks)

(d) Label the parts listed in the table onto the multipolar neuron in the diagram above.

(4 marks)

(e) Label each neuron in the diagram above according to their functional type.

(3 marks)

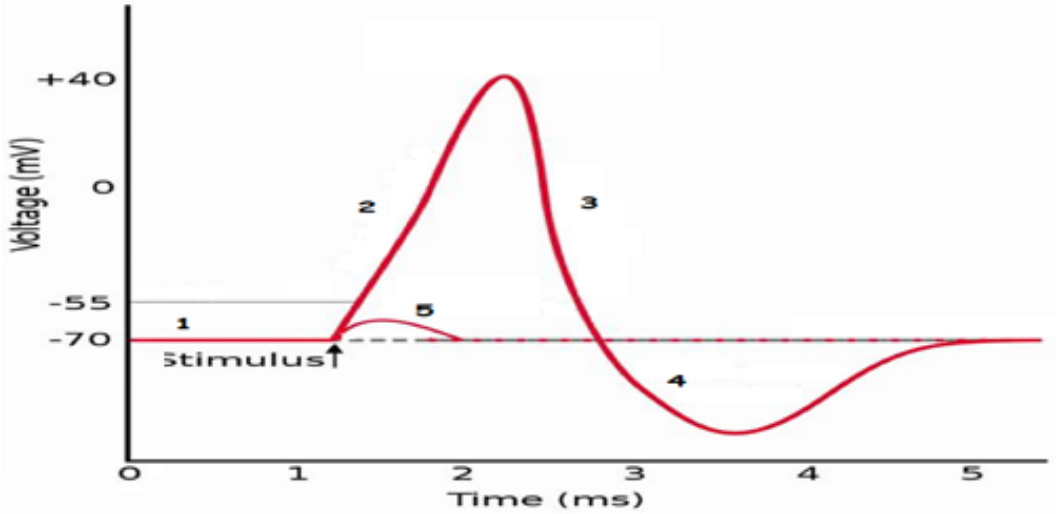
(f) State which of the neurons above cannot regenerate its axon and state why.

- *The interneuron cannot regenerate its axon (1 mark) as it does not have a neurilemma layer, which is responsible for repairing damaged fibres (1 mark).*

(2 marks)

33. **(13 marks)**

Below is an action potential graph, showing the outcome from two different stimuli on the same neuron. Looking at the graph below, answer the questions that follow.



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(a) The first stimulus resulted in the line labelled with the number 5. State TWO reasons why the potential difference quickly returned to -70mV.

Student MUST have the following:

- *The stimulus provided did not exceed the specific membrane potential threshold. (1 mark)*

Student may have either of the following:

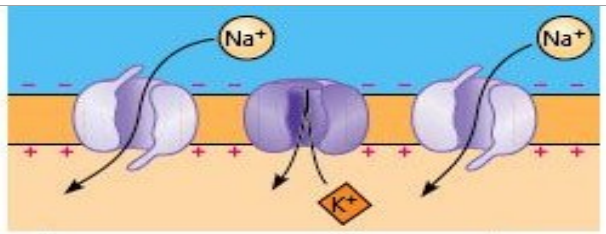
- *Insufficient sodium ion gated channels were stimulated to open (1 mark) OR*
- *Insufficient sodium ions moved across the membrane (1 mark)* (2 marks)

(b) The second stimulus resulted in the line labelled with the numbers 2, 3 and 4. State TWO events that could not possibly occur during the phases shown by the sections labelled 2, 3 and 4.

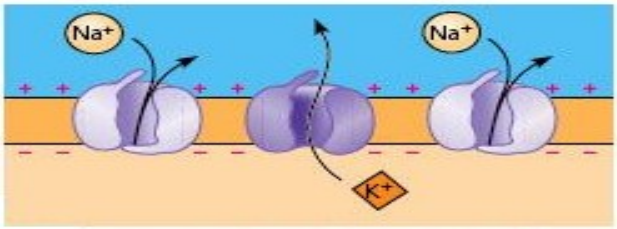
- *The impulse cannot flow backwards. (1 mark)*
- *A new action potential cannot be stimulated. (1 mark)* (2 marks)

(c) Label the following diagrams with the numbers from the above graph, to show what would be occurring with the ions and their respective channels during an action potential.

- *Need to get both answers to get 1 mark.*



Number: *2*



Number: *3*

(1 mark)

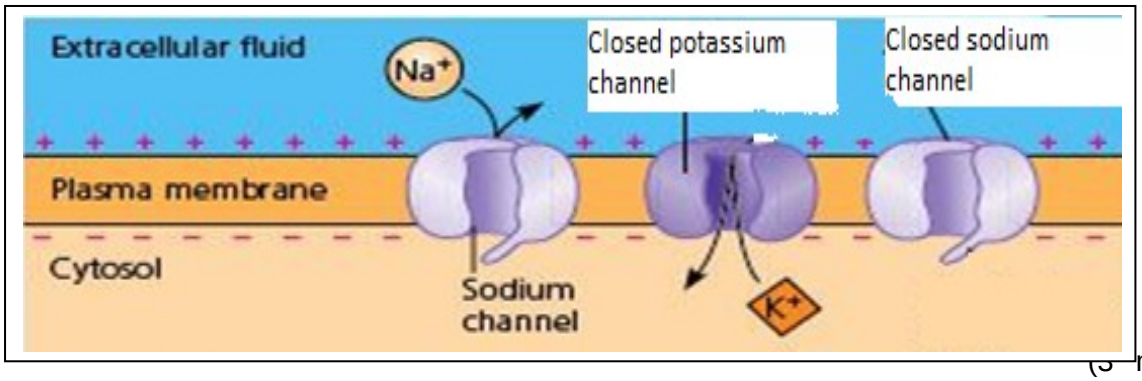
(d) Looking at the action potential graph on the previous page, locate the section labelled with a 1.

In the box below draw a labelled diagram (similar to those shown in (c) above) of this section to show:

(i) The location of the sodium and potassium ions and, if they are moving, the direction the ions would be travelling.

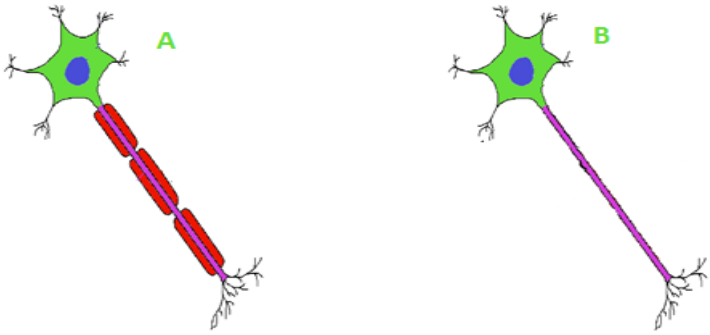
(ii) The gated channels and whether they are open or closed.

(iii) The charge either side of the neuron membrane.



(3 marks)

(e) Look at the diagram below of the different nerve fibres and answer the questions that follow.



(i) State which nerve fibres shown above would be myelinated or unmylinated and whether they would be found in grey or white matter.

A *Myelinated and white matter (1 mark)*

B *Unmyelinated and grey matter (1 mark)* (2 marks)

(ii) State which of the nerve fibres above would conduct an impulse faster and briefly explain why. (3 marks)

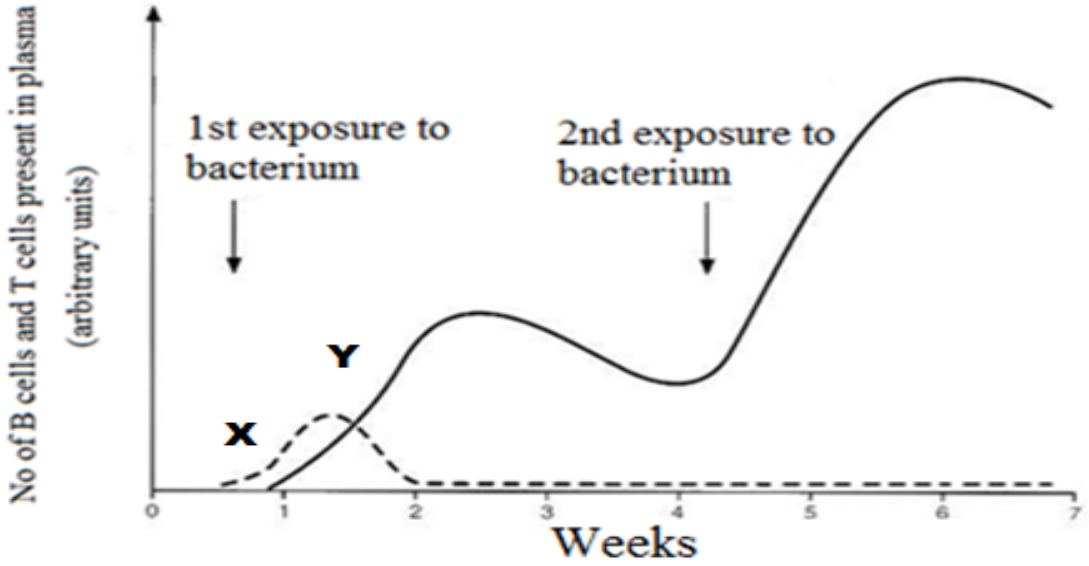
A / Myelinated fibre = faster (1 mark).

Myelin sheath insulates fibre and prevents the flow of ions through the membrane (1 mark), so the action potential jumps from node of Ranvier (where the myelin sheath is absent) to the next. (1 mark)

34. **(15 marks)**

The graph below shows the immune response of a person to a bacterial infection. Refer to the graph to answer the following questions.

Immune response to bacterial infection.



(a) State which of the lines (X or Y) on the graph represent the cloning of the B cells. Explain why you made your choice.

Line X = cloning of B cells (1 mark).

T cells can only be activated/sensitised after a B cell has encountered an antigen and presented it to a T cell (1 mark).

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(2 marks)

(b) The number of cells represented by the Y line after the second exposure was greater and their production was much faster, despite the person never receiving a vaccination. Explain what allowed this to happen.

After the first exposure, the T cells/B cells produced some memory cells (1 mark)

Which were able to recognise the original antigen and reproduce much faster (1 mark)

(2 marks)

(c) After the first exposure to the bacterium, the person experienced an elevation of their body temperature.

i) State the name of this non-specific response. *Fever* (1 mark)

ii) State the name of two effectors and describe how their response contributed to this non-specific defense.

- *Blood vessels under the skin vasoconstrict to redirect body heat to the core. (1 mark)*
- *Skeletal muscles oscillating at a high rate (10-20 tremors/second) increase temperature of the body. (1 mark)*

(2 marks)

iii) Describe two benefits an elevated body temperature is believed to provide as the body fights against a disease.

- *High body temperature inhibits bacterial/viral growth (1 mark)*
- *Increased heat, increases rate of chemical reactions, which helps the body cells repair themselves faster. (1 mark)*

(2 marks)

(d) There are two types of antibiotics. Name each type and describe how they kill bacteria.

- *Bactercidal antibiotics (1 mark) kill bacteria by changing the structure of the cell wall / membrane (1 mark) OR by disrupting the action of essential enzymes (1 mark)*
- *Bacteriostatic antibiotics (1 mark) stop bacteria from reproducing (1 mark)*

(4 marks)

(e) The number of doctors that are becoming reluctant to prescribe antibiotics for every patient that presents with an infection is increasing. Describe one reason why doctors would feel this way.

- *If bacteria are more frequently exposed to antibiotics, then they have a greater chance to evolve / mutate (1 mark) and develop resistance / a resistant strain to the antibiotic (1 mark)*

(2 marks)

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35. **(15 marks)**

Free divers are athletes who descend underwater as far as possible without breathing apparatus. Before diving into the water, the free diver deliberately hyperventilates.

(a) State what hyperventilation is and what effect it has on the gas concentration in the blood.

- *Hyperventilation is rapid deep breathing, (1 mark)*
- *where more oxygen than required is taken in and so oxygen levels are increased and (1 mark)*
- *more carbon dioxide than necessary, is removed, so carbon dioxide levels are decreased (1 mark)* (3 marks)

(b) Hyperventilation can occur voluntarily or involuntarily. It can occur involuntarily in response to severe pain or extreme fear.

Complete the following table to distinguish between the two different efferent nervous divisions that can regulate hyperventilation.

	Names of two different nervous efferent divisions	
	Autonomic	*Somatic*
Neurotransmitters	*Acetylcholine or noradrenaline*	*Acetylcholine*
Effector(s) / target organ(s)	*Diaphragm and Intercostal muscles*	*Diaphragm and Intercostal muscles*

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Effect of neurotransmitter on effector(s) / target organ(s)	*Excitation or inhibition*	*Always excitation*
The number of neurons between the CNS and effector	*2*	*1*

1 mark awarded for each correct pair. No ½ marks can be given. (5 marks)

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(c) Explain how voluntary hyperventilation allows the free diver to stay underwater for longer.

- *Chemoreceptors most sensitive to carbon dioxide levels and least to oxygen levels (1 mark)*
- *Decreased carbon dioxide levels delays the stimulation of the chemoreceptors (1 mark),*
- *this delays the stimulation of the inspiratory centre, which would otherwise force the diver to take a breath (1 mark).*

(3 marks)

(d) Whether an individual hyperventilates or not, drowning can still occur if the individual is under the water and does not get to the surface in time to inhale.

Explain why a person could drown if they:

(i) Did hyperventilate

The diver could deplete their oxygen levels to a point they lose consciousness (1 mark) before the chemoreceptors respond to the low oxygen levels and force the diver to take a breath (1 mark)

(ii) Did not hyperventilate

The elevated carbon dioxide levels could stimulate the chemoreceptors, which would stimulate the inspiratory centre (1 mark) forcing the diver to take a breath underwater and inhale a large amount of water (1 mark). (4 marks)

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(12 marks)

36. A marathon runner is just about to complete a race in hot weather and he is sweating, feels thirsty and his skin is red and hot.

(a) Complete the following table to summarise the body's symptoms to the exercise in the hot environment.

Symptoms	**Stimulus**	**Receptor**	**Modulator**	**Effector**	**Response**
Red and hot skin	Increased body temperature	Thermoreceptor	Hypothalamus	*Blood vessels*	*Dilated blood vessels*
Sweating	Increased body temperature	Thermoreceptor	*Hypothalamus*	Sweat glands	Sweat released onto the surface of this skin
Thirsty	Increased osmotic pressure	*Osmoreceptor*	Hypothalamus	*Cerebral cortex*	Conscious decision to have a drink.

(5 marks)

(b) After the race, despite the large volumes of plain water consumed by the athlete, he feels light headed, has a headache and feels nauseous.

As a result of the light headedness, the athlete stumbled forwards and grazed his hands. The palms of his hands are now bleeding, red, swollen, hot and painful.

(i) Based on the symptoms listed, name the internal non-specific defensive response that has been stimulated as a result of the injury.

Inflammatory response (1 mark)

(ii) Describe the sequence of events that would keep the wound free of infection and allow the wound to heal.

- *The damage would stimulate mast cells to release histamine and heparin (into tissue fluid).*

  (1 mark)

- *Histamine increases blood flow through the area and increases permeability of capillary walls.*

  (1 mark)

- *Heparin prevents clotting in the damaged area. (1 mark)*
- *Clotting does form around the wound to stop spread of pathogens (1 mark)*
- *Phagocytes are attracted to the area and actively consume antigens (1 mark)*
- *New cells are produced by mitosis and replace damaged cells. (1 mark)*

(6 marks)

37. **(5 marks)**

(a) The pituitary gland is sometimes referred to as the “master gland” however; it could be argued the hypothalamus should have this title. Describe how the hypothalamus controls the secretion of hormones from the anterior and posterior lobe of the pituitary gland. (5 marks)

- *Anterior lobe controlled by releasing and inhibiting factors (1 mark) from the*

  hypothalamus (1 mark) that reach the anterior lobe via network of

  blood vessels/infundibulum (1 mark).

- *Hormones (oxytocin and ADH) are produced in the hypothalamus (1 mark) and passed along nerve fibres to the posterior lobe, to be secreted (1 mark)*

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Section Three: Extended answer **20% (40 Marks)**

This section contains **three (3)** questions. You must answer **two (2)** questions. Make sure you clearly indicate which question you are answering and write your answers in the space provided.

Spare pages are included at the end of this booklet. They can be used for planning your responses and/or as additional space if required to continue an answer.

- Planning: If you use the spare pages for planning, indicate this clearly at the top of the page.
- Continuing an answer: If you need to use more space to continue an answer, indicate in the original answer space where the answer is continued, i.e. give the page number. Write the number of the question(s) that you are continuing to answer at the top of the additional space page.

Responses could include clearly labelled diagrams with explanatory notes; lists of points with linking sentences; clearly labelled tables and graphs; and annotated flow diagrams with introductory notes.

Suggested working time: 40 minutes.

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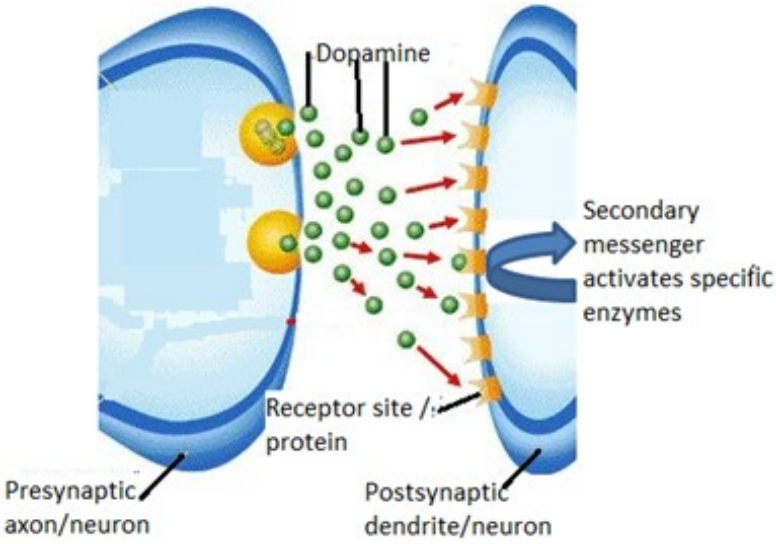
38. **(20 marks)**

(a) The neurotransmitter, dopamine stimulates target neurones in the same manner as an amine hormone would affect a target cell. It can have an excitatory or inhibitory effect on the action potential of the target neuron, depending on whether it has D1 or D2 receptors. If the neuron has D1 receptors, sodium ion (Na+) channels are stimulated to be opened and if the neuron has D2 receptors, potassium ion (K^+) channels are stimulated to open.

(i) Using a labelled diagram, describe how dopamine would move from the presynaptic neuron, across the synapse, to enter and activate a specific target neuron.

(5 marks)



- *MUST HAVE. Complete diagram, as labelled above. (1 mark)*

ANY FOUR OF THE FOLLOWING for 1 mark each, MAX OF 4 marks.

- *Dopamine released from vesicles, (1 mark)*
- *and diffuses across gap. (1 mark)*
- *Dopamine attaches to receptor protein/site in the membrane of the postsynaptic dendrite/ neuron (1 mark)*
- *Dopamine can only bind with a specific receptor. (1 mark)*

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- *The combination of the neurotransmitter with the (specific) receptor causes a secondary messenger to diffuse through the cell (1 mark) and*
- *Activate specific enzymes (1 mark)*

(ii) State whether the D2 receptors would cause an excitatory or inhibitory effect on the action potential of the target neuron and describe why this response would occur.

- *D2 receptors = inhibitory effect because, (1 mark)*
- *The sodium ion gated channels are not stimulated and remain closed (1 mark)*
- *If D2 receptors are stimulated, potassium ion gated channels are stimulated to open, which causes the inside of the cell to become electrically negative. (1 mark)*
- *If there is a negative charge inside the cell and a positive charge outside the cell, then the neuron remains polarised OR becomes hyperpolarised) (1 mark)*
- *and an action potential cannot be stimulated (1 mark)*

(4 marks)

(b) Cocaine prevents the reabsorption of dopamine and noradrenaline (norepinephrine) into the axon of the presynaptic neuron. This action has its greatest effect on those neurones with D1 receptors.

(i) State whether the constant supply of dopamine would stimulate the presynaptic neuron to be depolarised or remain polarised and describe why this would occur.

- *The neuron would be stimulated to be depolarised (1 mark)*
- *Constant presence of Dopamine would continually stimulate D1 receptors which would open Sodium ion gated channels, which would allow Sodium ions to flow into the neuron / making the membrane more permeable to Sodium ions and allowing them to flow in (1 mark)*
- *The polarity of the membrane now becomes positive on the inside and negative on the outside (and the neuron is depolarised)(1 mark)*
- *Repolarisation occurs next and an action potential / nerve impulse occurs (1 mark).*

(4 marks)

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(ii) The constant supply of noradrenaline would stimulate the autonomic nervous system. State which division of the autonomic nervous system would be stimulated and describe how five different parts of the body would be affected by this neurotransmitter.

Autonomic nervous division = sympathetic division (1 mark)

Any one of the following parts and their matching responses awarded 1 mark each, to a maximum of 5 marks.

Part	*Effect of noradrenaline/sympathetic nervous division*
Heart	*Increases rate and strength of contraction*
Lungs	*Dilates bronchioles*
Stomach, intestines	*Decreases movement/ peristalsis*
Liver	*Increases breakdown of glycogen to glucose / glycogenolysis*
Iris of the eye	*Dilates pupil*
Sweat glands	*Increased sweat secretion*
Salivary glands	*Decreases saliva secretion*
Blood vessels of Skin	*Vasoconstriction / constricts vessels*
Blood vessels of Skeletal muscles	*Vasodilation / dilates vessels*
Blood vessels of Internal organs	*Vasoconstriction EXCEPT in heart and lungs*
Urinary bladder	*Relaxes wall muscles*
Adrenal medulla	*Stimulates hormone/adrenaline secretion*

(6 marks)

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39. **(20 marks)**

Bacillus cereus is a bacterium that can cause food poisoning, usually contracted from rice meals which have been allowed to rest at room temperature for hours, particularly at a buffet. If the bacterium is exposed to high temperatures or acidic conditions, they will enter a dormant state and develop a heat and chemical resistant cell wall, until their surrounding environment is favourable again. This dormant and protective state is referred to as being an endospore.

An infection is initially indicated by vomiting and/or diarrhoea and then 30 minutes to 6 hours later the lymph glands/nodes can become swollen. Most patients recover within 6 to 24 hours.

(a) Describe how the non-specific defences initially triggered in response to the infection destroy or remove some of the *Bacillus cereus* and explain why they are incapable of completely eradicating the bacteria.

- *Protective reflex/ Non-specific defence = vomiting (1 mark) the contraction of the abdomen and diaphragm muscles expelling the stomach contents/pathogen (1 mark)*

- *Protective reflex/ Non-specific defence = diarrhoea (1 mark) the increased contractions of the muscles of the intestinal wall expel the irritant/pathogen (1 mark)*
- *Macrophages engulf bacterium via phagocytosis and (1 mark)*
- *release substances to destroy pathogen (1 mark)*
- *Stomach acids destroy/kill bacterium (1 mark) but*
- *Acidic conditions stimulate bacterium to become endospores, which resists acid conditions, allowing bacterium to enter bloodstream, (then lymphatic system) (1 mark)*
- *Fever stimulates bacterium to become endospores, which resists temperature spike, allowing bacterium to enter bloodstream, (then lymphatic system) (1 mark)*
- *Lymphoid tissue in lymph nodes/glands trap bacteria in meshwork of fibres, (1 mark)*
- *where macrophages and phagocytes can attack the bacterium and endospores (1 mark)*

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(10 marks)

(b) The swollen lymph nodes are an indication of the specific defences the body employed to destroy the bacterium. State what an antibody is and describe the steps that would occur during a humoral response.

- *An antibody is a substance/special protein that is produced in response to a specific (non-self) antigen (1 mark)*
- *The presence of an antigen activates B-cells where they enlarge and divide to become a clone (1 mark)*
- *Most of the clone become plasma cells, which produce the specific antibodies for the specific antigen (1 mark)*
- *The antibodies then circulate within the circulatory and lymphatic system to the site of infection (1 mark)*
- *B-cells of the clone that did not become plasma cells remain as memory cells (1 mark)*
- *Antibodies destroy pathogen by:*
- *Combining with foreign enzymes/bacterial toxins and inactivating them (1 mark)*
- *Coating bacteria to make them easier to consume by phagocytes/macrophages (1 mark)*
- *Causing the bacteria to agglutinate (1 mark)*
- *B-cells also present the bacterium/pathogen to T-cells, to be destroyed via Cell-mediated immunity (1 mark)*
- *Correctly annotated diagram, as below (1 mark)*

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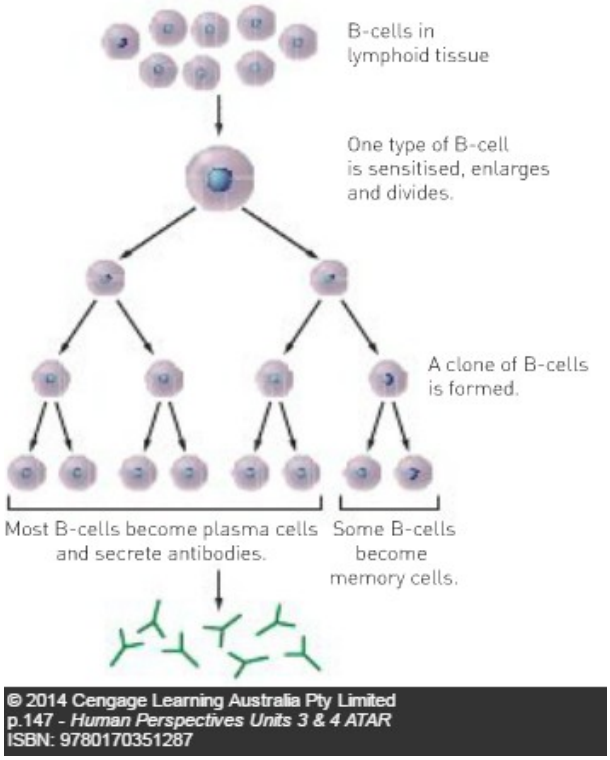

(10 marks)

40. **(20 marks)**

Under normal circumstances, homeostatic control mechanisms ensure blood glucose levels (BGLs) are maintained at a constant level. People with diabetes mellitus are incapable of maintaining their BGLs and they can experience increased urination (polyuria) if they consume a meal high in glucose.

(a) Explain how the pancreas and liver would reduce the BGLs in someone who was not a diabetic.

Pancreas

- *Beta cells/Islets of Langerhans detect high glucose levels (1 mark)*
- *Production and release of insulin (1 mark)*

Liver

Any 3 of the following (max 3 marks)

- *Glucose conversion to glycogen (glycogenesis) (1 mark)*
- *Glucose conversion to fat (and stored into adipose tissue) (1 mark)*
- *Accelerates transport of glucose from blood into cells (1 mark)*
- *Increase in rate of cellular respiration (1 mark)*

(5 marks)

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(b) Explain the cause and treatments of type 1 and type 2 diabetes.

Type of diabetes	*Cause*	*Treatment*
Type 1	*A fault in the immune system/autoimmune disease that causes the destruction of beta cells (in the islets of Langerhans) of the pancreas (1 mark).* *Therefore do not produce insulin and cannot store glucose as glycogen (1 mark)*	*Regular injections of insulin (1 mark) OR* *Use of a programmable pump that provides a continuous supply of insulin (under the skin) (1 mark)*
Type 2	*A development of (cellular) insulin resistance as a result of (1 mark)* *insufficient physical activity / being obese / a diet high in fat / a diet high in sugar and salt / smoking / genetic predisposition.* *(Any 1 reason = 1 mark)*	*A management program that aims to keep blood glucose levels within the normal range (1 mark)* *OR* *Regular exercise and low glucose/carbohydrate intake (1 mark)*

(6 marks)

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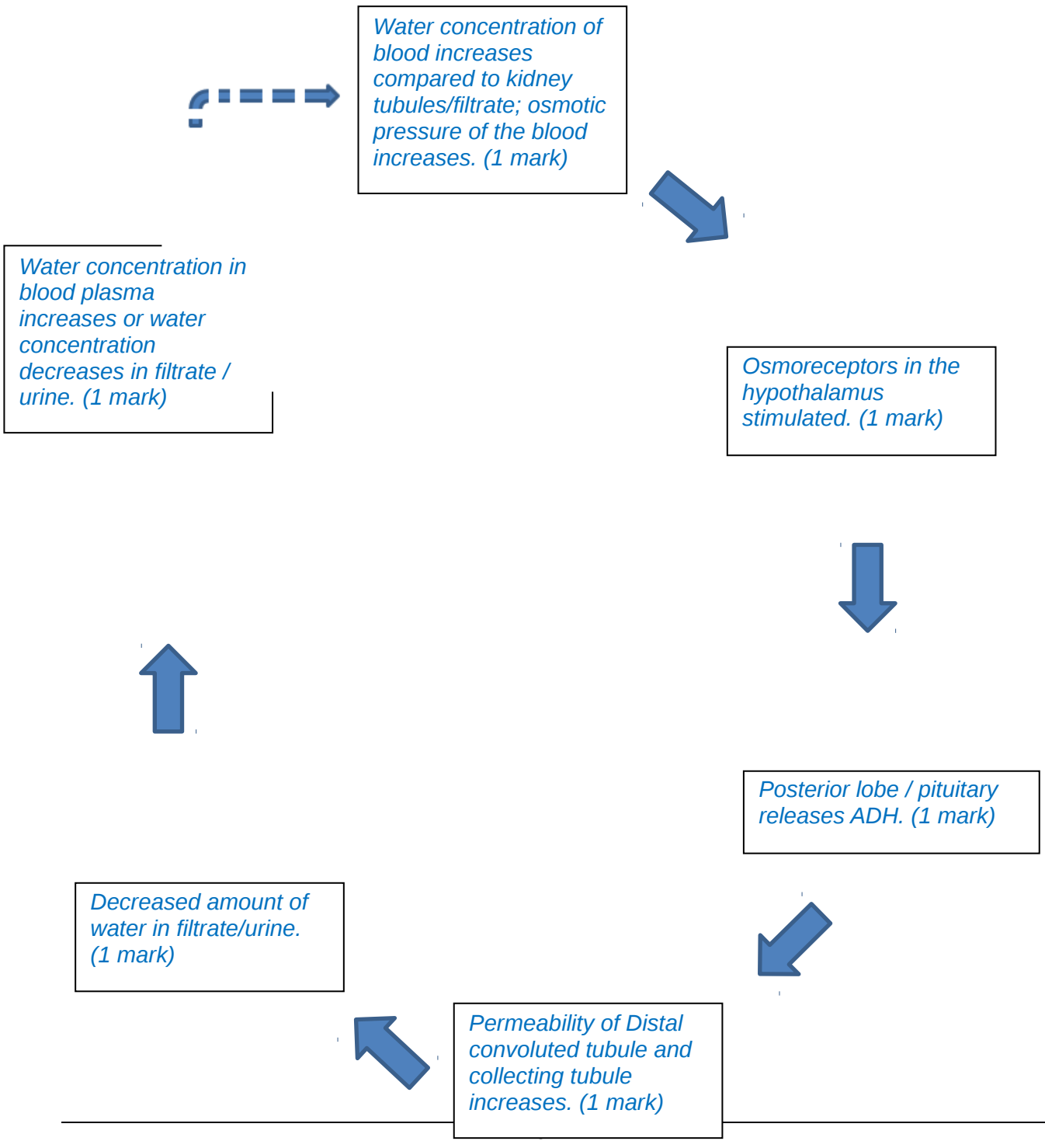
(c) The high amounts of glucose in a diabetic's blood plasma can lead to a high osmotic pressure within the blood plasma.

Describe what effect this stimulus would have on the action of antidiuretic hormone (ADH) in controlling water balance and explain why a diabetic would urinate excessively and feel thirsty.

Each statement in the flow chart below worth 1 mark each



Thirst

- *With high blood glucose levels, water concentration decreases within the blood plasma and this increases the osmotic pressure (1 mark)*

- *Osmoreceptors in the thirst centre are stimulated which stimulates a thirst reflex (1 mark)*

Frequent urination

- *When the blood glucose levels are high in the filtrate and in the blood plasma, the glucose cannot be reabsorbed into the blood and so is excreted through the urine (1 mark) along with the water in the urine.*

(9 marks)

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