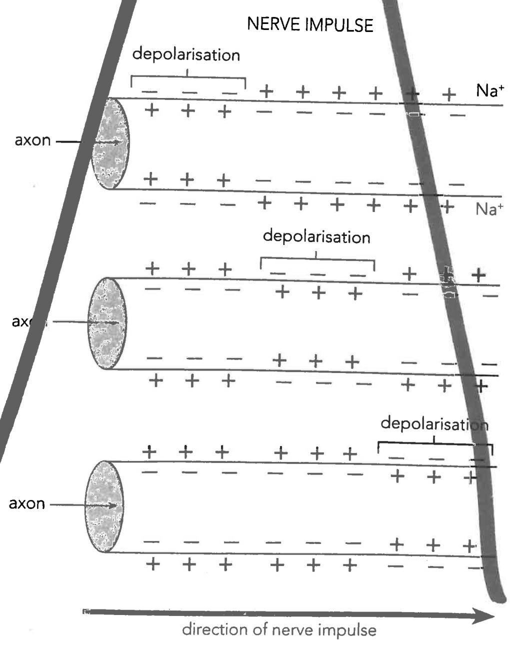
increase, blood flow to the muscles in limbs to increase, blood flow to the skin and digestive organs to decrease, sweating to increase, the pupil of the eye to dilate and the blood sugar level to increase. [any 2]

The parasympathetic nervous system has the opposite effect. That is, heart rate, breathing rate, sweating, all decrease and the pupil of the eye constricts and blood sugar level is lowered. [any 2]

Section 3: Extended Answer (20 marks)

Each dot point = one mark.

- *Propagation refers to the movement of a nerve impulse along a neuron.*
- *Neurons are normally polarised. That is, there is a difference in electrical charge on either side of the membrane of the axon.*
- *This is due to an imbalance in sodium ions on either side of the neuron membrane.*
- *This imbalance or difference is maintained by sodium ions being actively pumped out of the neuron.*
- *When a new nerve impulse arrives in an axon, the axon membrane becomes permeable to sodium ions.*
- *Sodium ions move rapidly into the axon.*
- *The concentration of sodium ions on either side of the membrane is then the same.*
- *The neuron is described as being depolarised.*
- *Gradually, the sodium ions are pumped out of the axon and the original imbalance of ions is restored or, repolarisation occurs.*
- *This restores the unequal distribution of charge across the axon.*
- *The axon returns to its original resting state.*
- *This change in sodium ion concentration (and other ions) generates the nerve impulse.*
- *This activity releases a small amount of electrical energy which causes the adjacent membrane to depolarise.*



- *This effect spreads down the length of an axon (like a chain reaction toppling over a row of dominoes by pushing over the first one in line).*
- *Transmission refers to the movement of a nerve impulse across a synapse from one neuron to the next.*
- *When the nerve impulse reaches a synapse, a transmitter substance (neurotransmitter) is released from the vesicles in the synaptic knob.*
- *The neurotransmitter diffuses across the gap between the neurons.*
- *It attaches to receptor molecules on the next neuron.*
- *This then stimulates the initiation of a new nerve impulse in the second neuron.*
- *The membrane of the next neuron then becomes permeable to sodium ions.*
- *Once sodium ions rush through the membrane, electrical energy is released and the cycle of depolarisation and repolarisation continues.*

TT 4 – HOMEOSTASIS

Section 1 - Multiple Choice (30 marks)

1.	a	6.	c
2.	a	7.	b
3.	d	8.	a
4.	d	9.	b
5.	c	10.	c

Section 2: Short Answer (50 marks)

(i) *vasodilation*
(ii) *cardiac output*
(iii) *liver (or skeletal muscles)*
(iv) *evaporation*
(v) *pH*
(vi) *hypothalamus*
(vii) *lymph*
(viii) *heart rate*
(ix) *radiation*
(x) *optimum*

[10]

2.

(a) *A steady state system maintains homeostasis within the body. It maintains stability within the body. It is controlled by a feedback system.* [1]

(b) *The parts are:*
stimulus – the change in the environment that initiates the system to work.
receptor – detects the change.
regulator or modulator (co-ordinating centre) – based on information from the receptor, decides on the action to be taken by the effector(s).
effector – carries out the response.
response – what happens.

feedback – affects and changes the stimulus. [6]

(c) *In positive feedback, the feedback enhances the original stimulus. It is used for conditions that do not occur often and do not need fine tuning continuously, e.g. the birth process, clotting of blood. [2]*

In negative feedback the response alters the stimulus so that its effect is opposite to what it was originally. It reverses the original stimulus. It is used to maintain conditions that need constant monitoring and adjustment, e.g. blood glucose levels, body temperature. [2]

(d) *Negative feedback systems are more common because they tend to maintain conditions in the body that need constant readjustment to keep within physiological limits, e.g. blood glucose levels or body temperature [1]*

Positive feedback is used for those conditions that do not need fine tuning and do not happen as often. [1]

3.

(a) *Heart rate and stroke volume. [1]*

(b) *Autonomic nervous system (sympathetic nervous system) and adrenalin (and nor adrenalin). [2]*

(c)

(i) *Antidiuretic hormone [1]*

(ii) *With the increase in exercise, the sweating rate has increased (to cool the body).*

- *This has increased water loss from the skin (water loss from the lungs also increases).*
- *This increases the concentration of solutes in the blood (i.e. the osmotic pressure increases).*
- *This is detected by the hypothalamus which sends releasing factors to the posterior pituitary which increases the production and release of antidiuretic hormone.*
- *Antidiuretic hormone increases the permeability of the distal convoluted tubule and collecting duct of the nephron.*
- *More water is reabsorbed back into the blood so the amount of urine produced decreases.* [5]

4.

(i) *If the glucose level is high, insulin is released from the islets of Langerhans in the pancreas. Insulin increases absorption of glucose into cells, promotes glycogenesis (the conversion of glucose into glycogen), converts glucose into fat for storage and stimulates protein synthesis and hence use of glucose by cells. The liver also stores glycogen. [any 2]*

(ii) *If the glucose level is low, glucagon is released from the pancreas.*

This promotes glycogenolysis in the liver (the conversion of glycogen to glucose) and stimulates the liver to convert fats and amino acids into glucose (gluconeogenesis). [2]

(iii) *ACTH from the pituitary stimulates the production and release of glucocorticoids from the adrenal cortex, e.g. cortisol promotes gluconeogenesis (the production of glucose from substances other than carbohydrates (i.e. from amino acids) and the conversion of glycogen into glucose. [2]*

(iv) *Adrenalin (and noradrenalin), causes lactic acid to be produced from glycogen in muscle cells. Lactic acid can be converted to glucose by the liver. [2]*

5.

(a) *At rest the breathing rate is controlled by the respiratory centre in the medulla (which controls the basic rhythm of breathing), the apneustic area in the pons and the pneumotaxic centre in the pons (which inhibits inspiration and stimulates expiration). Movement of the diaphragm is controlled by the phrenic nerve. The intercostal muscles are innervated by the intercostal nerves. Both nerves are spinal nerves. Apneustic area stimulates, pneumotaxic centre inhibits. [3]*

(b) *Carbon dioxide passes easily across membranes and dissolves in the blood and cerebrospinal fluid. Carbon dioxide combines with water to form carbonic acid which dissociates to form hydrogen ions and bicarbonate ions. [1] The medulla contains chemoreceptors that are highly sensitive to the concentration of hydrogen ion (pH) and carbon dioxide. Elevated levels of these result in the stimulation of the inspiratory area in the medulla. [1]*

The carotid and the aortic bodies are also sensitive to changes in hydrogen ion, carbon dioxide and oxygen levels in the blood. Small increases in hydrogen ion and carbon dioxide concentration and large decreases in oxygen levels stimulate them and they in turn stimulate the respiratory centre causing inspiration. [1] During exercise, chemoreceptors (aortic and carotid bodies) in the aorta and carotid arteries pick up a decrease in oxygen level and an increase in the level of carbon dioxide. This results in an increase in the breathing rate. [1]

(c) *The breathing rate is still high after exercise to take in the extra oxygen needed to oxidise the lactic acid that has built up, into pyruvic acid and then into carbon dioxide and water. At the same time this replaces the ATP that has been used.*

Body temperature is also higher as a result of the exercise. Consequently chemical reactions in the body proceed at a faster rate, using ATP faster and more oxygen is required to produce it. Only when the body conditions return to the pre-exercise state will the breathing rate return to the normal resting rate. [3]

Section 3: Extended Answer (20 marks)

- *Humans are warm-blooded – homeothermic.*
- *Normal body temperature is 37°C. [1]*
- *Thermoreceptors in the hypothalamus detect body temperature. [1]*

Mechanisms of heat loss include: [2 marks per example]

- *Radiation – refers to heat transfer by infra-red rays from a hotter object to a colder one. There is no contact between the objects, e.g. standing in the Sun and absorbing heat from it.*
- *Convection – heat transfer due to the movement of air (or liquid) over the body, e.g. when you stand in a cold wind, the heat from your body is carried away by the air and you feel cold.*
- *Conduction – heat transfer due to physical contact between two objects. The hotter one loses heat to the cooler one, e.g. cold hands wrapped around a hot mug absorb heat from the mug.*

Physiological responses: [5 examples = 5 marks]

- *Sweating – increases the rate of evaporation from the skin. To change a liquid into a gas requires energy and the heat energy needed is taken from the skin so one feels cooler.*
- *Vasodilation – increase in diameter of arterioles causing a flushing of the skin which goes red.*
- *Vasoconstriction – reduction in diameter of the surface blood vessels (arterioles), resulting in a pale skin and this reduces heat loss by radiation and convection.*
- *Shivering – increased contraction and relaxation of voluntary muscles produces heat.*
- *Contraction of the erector pili muscles causes hairs to stand upright in an attempt to trap air next to the skin providing insulation. As we are not terribly hairy it is not very effective and results in 'goosebumps'.*
- *Increased metabolism due to increased levels of adrenalin and noradrenalin being released. The hypothalamus via sympathetic neurons stimulates the adrenal medulla to release these.*
- *Elevated thyroxine levels due to the hypothalamus causing the pituitary to release thyroid stimulating hormone also cause an increase in metabolism resulting in more heat production.*

Behavioural responses: [5 examples = 5 marks]

- *Level of activity. The more activity, the higher the rate of respiration in the muscles and more heat is released. If behaviour is reduced (sitting still) less heat is produced by the muscles.*
- *Amount of clothing/exposure of skin surface. Wear more layers of clothing in colder situations to trap layers of warm air and increase insulation. Reduce layers of clothing in hot weather to increase rate of radiation and evaporation.*
- *Ingesting hot food and drinks – increases oxidation of food, producing heat.*
- *Curling up small – to reduce surface area through which heat can be lost.*

Allocate 2 marks for presentation, spelling, grammar and clarity.

T 5 – RESPONSE TO INFECTION

Section 1: Multiple Choice (30 marks)

1. *d*	6. *d*
2. *d*	7. *b*
3. *a*	8. *c*
4. *c*	9. *a*
5. *d*	10. *d*

Section 2: Short Answer (50 marks)

1. *Lymphoid tissue (bone marrow, tonsils, spleen, thymus gland, lymph nodes), lymphocytes (T and B cells), antibodies [any 2]*
2. *Any substance capable of producing a specific immune response [1], e.g. micro-organisms, toxins, pollen grains, transplanted tissues, large molecules such as proteins [1]*
3. (i) *antibody*
   (ii) *red bone marrow*
   (iii) *T cells*
   (iv) *plasma cells*
   (v) *phagocytosis*
   (vi) *immunity*
   (vii) *vaccine*
   (viii) *lymph node*
   (ix) *thymus gland*
   (x) *bone marrow*
   (xi) *antiviral*
   (xii) *stem cells*
   (xiii) *pathogen*
   (xiv) *pandemic*
   (xv) *interferon*

   [15]
4. *A primary response occurs after the first exposure to an infectious agent. It takes some time for the immune system to respond so the pathogen reproduces and you get sick. [2]*
   The secondary response happens when you are exposed to the same pathogen a second time. As a consequence of the first exposure, memory cells were produced that rapidly detect and respond to the pathogen, so the immune response is much faster, often not resulting in any symptoms. [2]
5. *Natural immunity occurs when you are exposed to a disease and develop antibodies*