Name:_____

Questions on The Nervous System and Gas Exchange

Directions: The following questions are taken from previous IB Final Papers on Topics 6.4 (Gas Exchange) and 6.5 (Nerves, hormones and homeostasis). Answer all questions. This will serve as a study guide for the next test.

Due Date: Monday May 7

1. What defines the terms *ventilation*, *gas exchange* and *cell respiration* in mammals?

	Ventilation	Gas exchange	Cell respiration
A.	providing fresh air	replacing oxygen with carbon dioxide in blood in lungs	cellular energy production from glucose
B.	muscle movement to move fresh air into alveoli	replacing carbon dioxide with oxygen in blood in lungs	gases crossing the plasma membrane of a cell
C.	muscle movement to move fresh air into alveoli	replacing carbon dioxide with oxygen in blood in lungs	cellular energy production from glucose
D.	providing fresh air	replacing oxygen with carbon dioxide in blood in lungs	gases crossing the plasma membrane of a cell

(Total 1 mark)

2. Capillaries surround the alveoli in the lungs. Which pair of statements correctly describes the concentrations of oxygen and carbon dioxide in the lungs?

	Oxygen	Carbon dioxide
A.	Higher in the capillaries	Higher in the alveoli
B.	Lower in the capillaries	Higher in the alveoli
C.	Lower in the alveoli	Higher in the capillaries
D.	Higher in the alveoli	Higher in the capillaries

(Total 1 mark)

3. What is the role of active transport in the transmission of nerve impulses by neurones?

A. Propagates an action potential by pumping sodium ions across the membrane out of the neurone.

B. Propagates an action potential by pumping sodium ions across the membrane into the neurone.

C. Initiates the action potential needed for the transmission of an impulse by pumping calcium ions out of the endoplasmic reticulum.

D. Establishes the resting potential needed for the transmission of an impulse by pumping sodium and potassium ions across the membrane.

(Total 1 mark)

4. What substance enters the presynaptic neuron during synaptic transmission and what substance leaves it?

	Substance entering presynaptic neuron	Substance leaving presynaptic neuron
A.	Neurotransmitter	Calcium ions (Ca^{2+})
B.	Neurotransmitter	Sodium ions (Na^{+})
C.	Sodium ions (Na^{+})	Neurotransmitter
D.	Calcium ions (Ca^{2+})	Neurotransmitter

(Total 1 mark)

5. What causes a resting potential to develop in a neuron?

A. Diffusion of sodium and potassium ions

B. Active transport of sodium and potassium ions

C. Active transport of sodium and diffusion of chloride ions

D. Active transport of potassium and diffusion of chloride ions

(Total 1 mark)

6. What conditions are necessary for air to be exhaled from the lungs?

A. Air pressure in the alveoli must become greater than the air pressure in the mouth.

B. Air pressure in the alveoli must become lower than the air pressure in the mouth.

C. Air pressure in the alveoli must become the same as the air pressure in the mouth.

D. There is no change in the air pressure of the alveoli or the mouth.

(Total 1 mark)

7. After depolorization what happens to restore the resting potential?

A. Sodium channels open and sodium ions diffuse out of the neuron

B. Potassium channels open and potassium ions diffuse into the neuron

C. Potassium channels open and potassium ions diffuse out of the neuron

D. Sodium channels open and sodium ions diffuse into the neuron

(Total 1 mark)

8. Which of the following changes occur with the onset of exercise?

A. Increase in pH of blood

B. Increase in rate of cellular respiration

C. Decrease in rate of contraction of the diaphragm

D. Decrease in carbon dioxide concentration of the blood

(Total 1 mark)

9. Which of the following is part of the process of ventilation?

A. Changes in the volume of the thoracic cavity

B. Exchange of gases across the surface of the alveoli

C. Exchange of gases across the surface of capillaries

D. Cellular respiration

(Total 1 mark)

10. The movement of which ion initiates an action potential?

A. Calcium

B. Magnesium

C. Sodium

D. Potassium

(Total 1 mark)

11. Which division describes the central nervous system?

A. Peripheral and central

B. Voluntary and involuntary nerves

C. Brain and spinal cord

D. Sensory and motor nerves

(Total 1 mark)

12. Membrane proteins are critical components of nerve function.

Which process in nerves does **not** require a membrane protein?

A. Diffusion of neurotransmitter

B. Active transport of sodium

C. Propagation of an action potential

D. Binding of neurotransmitter

(Total 1 mark)

13. Outline the organization of the human nervous system.

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(Total 2 marks)

14. The surface area to volume ratio is an important variable in determining biological structure.

(a) Explain the importance of the surface area to volume ratio as a factor limiting cell size.

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(2)

(b) Define the term *absorption*.

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(1)

(c) State **one** feature of alveoli that adapts them to gas exchange.

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(1)

(d) Figure 1 below shows a cross-section through the small intestine and Figure 2 an enlarged longitudinal section through a single villus.

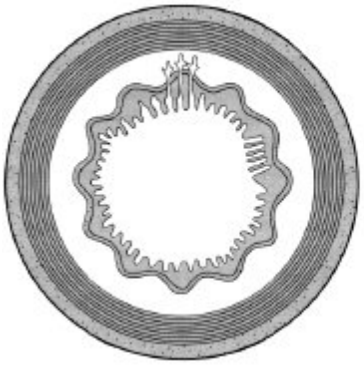

Figure 1

[Source: adapted from M Roberts *et al.*, *Advanced Biology*, Nelson, 2000, page 185]

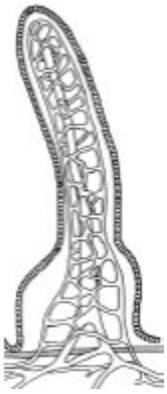

Figure 2

[Source: adapted from Taylor *et al*., *Biological Science 1* Cambridge University Press, 1997, page 244]

Using these diagrams, outline **three** ways in which the structure of the small intestine is related to its function of absorbing food.

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(3)

(Total 7 marks)

15. (a) Explain briefly the principle of negative feedback in homeostasis.

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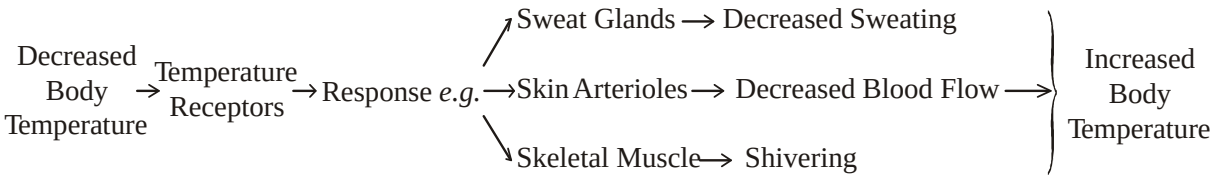
(3)

(b) Draw an arrow on the diagram below to show where negative feedback occurs.



(1)

(c) State the system used to control the response of the skin arterioles.

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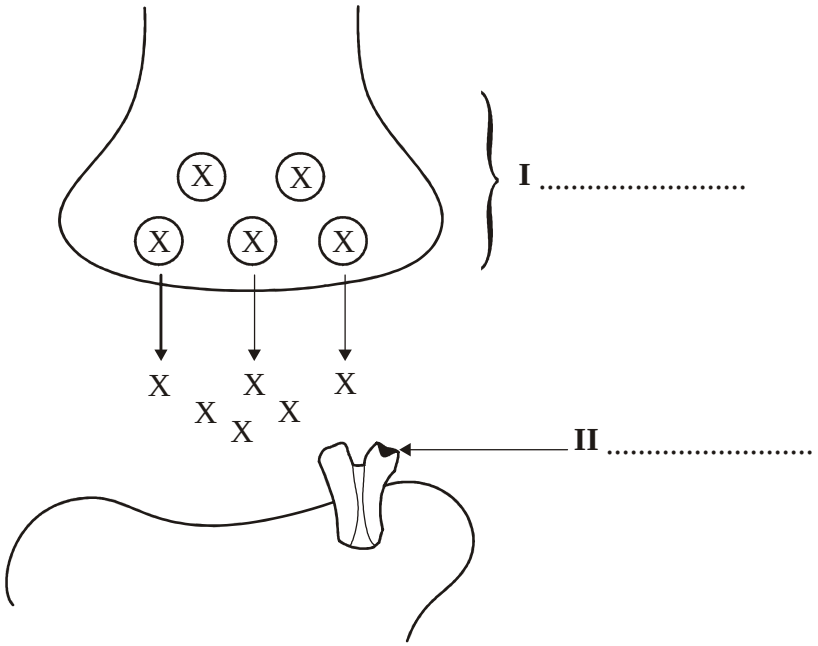
(1)

(Total 5 marks)

16. (a) Identify the labelled parts in the following diagram of two neurons.



(2)

(b) Explain the roles of calcium ions in the following activities:

(i) in the transmission of nerve impulses;

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(2)

(ii) in skeletal muscle contraction.

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(2)

(Total 6 marks)

17. (a) (i) Define the term *homeostasis*.

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(1)

(ii) State which **two** systems are involved in the control of homeostasis.

1. .....

2. .....

(1)

(b) Describe the roles of the kidney in homeostasis.

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(2)

(c) Using an example, explain the role of negative feedback in homeostasis.

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(3)

(Total 7 marks)

18. Describe the response of the human body to low external temperatures.

(Total 4 marks)

19. Explain the principles of synaptic transmission.

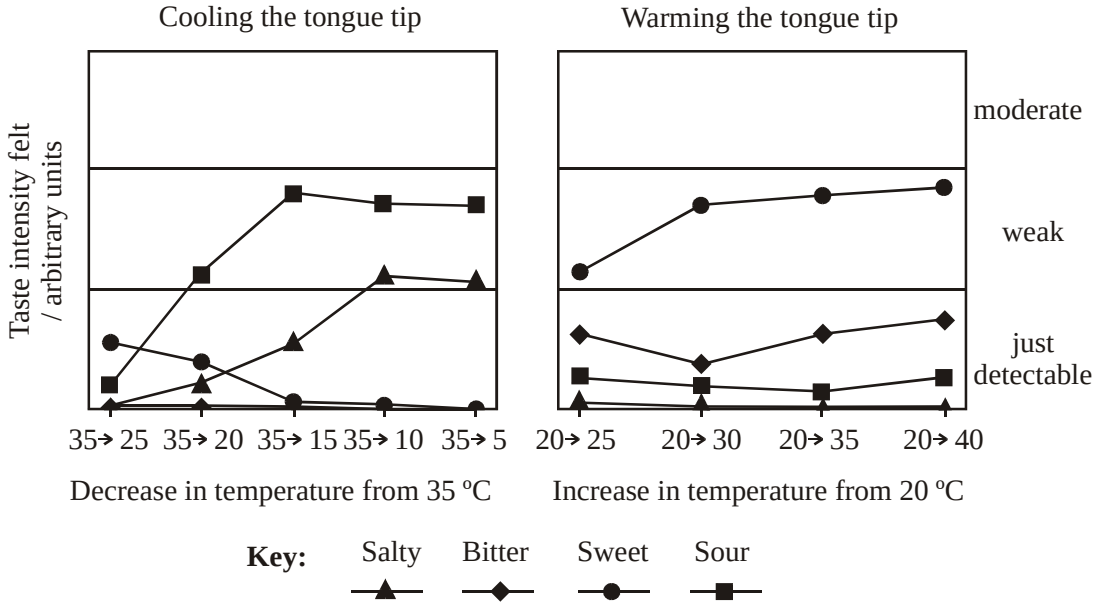
(Total 8 marks)

20. Explain the need for, and the mechanism of, ventilation of the lungs in humans.

(Total 8 marks)

21. The sense of taste is normally caused by the stimulation of chemoreceptors in the taste buds of the tongue. There are four main "tastes": sweet, salty, bitter and sour. The tongue also has receptors for temperature. It is known that the taste of food can vary according to whether it is cold, warm or hot. Scientists discovered that just warming or cooling parts of the tongue, even when no food was present, also caused a sensation of taste.

Scientists experimented with a group of people. They gradually cooled the tips of their tongues and measured the intensity of the taste felt by each member of the group. The experiment was repeated, this time warming the tip of the tongue. The graphs show the average values for the group.



[Source: modified from Cruz and Green, *Nature* (2003) **403**, page 889]

(a) Identify which taste was felt most strongly when the tip of the tongue was

(i) cooled.....

(ii) warmed.....

(1)

(b) Compare the effects on the taste of **sweetness**, of warming and cooling the tip of the tongue.

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(2)

(c) It is important that such experiments use a population sample that is representative. Suggest **two** biological criteria the scientists would have used to select the people to be tested.

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(1)

(d) Explain whether cooling or warming the tip of the tongue has the greater effect on the sensation of taste.

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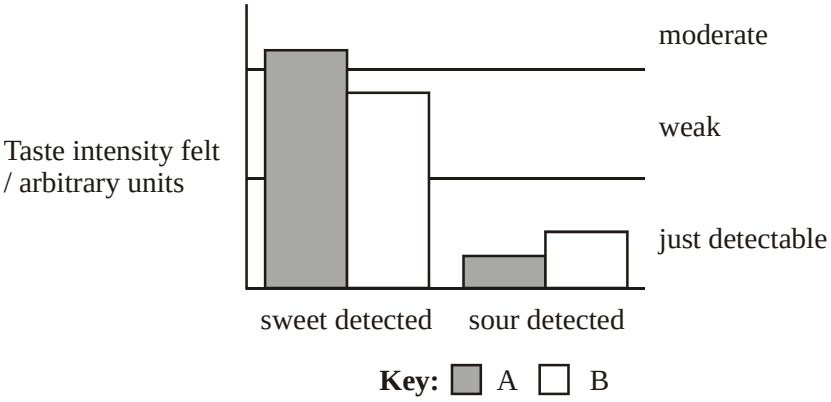
(2)

The scientists discovered that there were two types of chemoreceptor in the tongue tip. They called these A and B. They tested these chemoreceptors using solutions of sucrose to find out the type of taste and the intensity felt. The results are shown in the bar chart.



(e) Compare the effects of sucrose on the A and B chemoreceptors by giving **two** similarities and **two** differences.

Similarities .....

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Differences .....

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(4)

(Total 10 marks)

1. C

[1]

2. D

[1]

3. D

[1]

4. D

[1]

5. B

[1]

6. A

[1]

7. C

[1]

8. B

[1]

9. A

[1]

10. C

[1]

11. C

[1]

12. A

[1]

13. the nervous system is divided into the central nervous system / CNS (brain and spinal cord) and the peripheral nerve system / PNS (nerves);
CNS consisting of brain and spinal cord;
PNS consisting of motor and sensory nerves;
sensory neurons carry impulses to the CNS;
motor neurons carry impulses from the CNS;

Accept any of the above if clearly explained in a labelled diagram.

[2]

14. (a) as a cell grows, volume increases faster than surface area / surface area : volume ratio decreases;
the rate of consumption of resources / nutrients / oxygen is a function of volume;
the rate of production of wastes is a function of volume;
the rate of exchange of wastes / nutrients is a function of surface area;
the rates of diffusion are too low relative to cell needs for larger cells; 2 max

(b) absorption is taking up of a substance by the skin / mucous membranes / digestive tract / cell membranes / layers of cells / the bloodstream; 1

(c) large total surface area / many alveoli;
a wall consisting of a single layer of (flattened) cells;
moist lining;
dense network of capillaries; 1 max

(d) villus intestinal wall has many folds to increase surface area (: volume ratio);
surface of villus close to blood vessels so materials can easily diffuse;
surface of villus close to lymph vessels so lipids can be easily absorbed;
greater surface area related to greater rate of diffusion;
villus wall consists of single layer of cells; 3 max
Do not accept microvilli – not visible in diagrams.

[7]

15. (a) *Award **[2 max]** for reason.*
change in environment is sensed / detected;
response to bring the system back to normal state / set point / within limits;
when the normal state reached, the response is stopped;
this prevents over reaction;
internal environment fluctuates around norm / small fluctuations; 3 max

Examples are acceptable only if they support marking points given above.

(b) *Award **[1]** for an arrow <u>from</u> "increased body temperature" <u>pointing</u> to "temperature receptors".* 1

(c) (autonomic) nervous system / endocrine 1

[5]

16. (a) I: presynaptic neuron / (pre)synaptic knob / bulb / bouton;
II: binding site / (post synaptic) receptor for (neurotransmitter); 2

(b) (i) (Ca_{2+}) diffuses into presynaptic neuron;
causes vesicles to migrate / move to (presynaptic) membrane;
causes vesicles to fuse with (presynaptic) membrane;
causes / leading to exocytosis / release of neurotransmitter / named example; 2 max

(ii) released in muscle cells under nervous stimulation;
binds to protein / troponin in muscle;
(troponin and) tropomyosin moves away from and uncovers binding sites;
allows myosin (head) to bind to actin (for contraction);
sarcomere shortens; 2 max

[6]

17. (a) (i) homeostasis maintains the internal environment at a constant level / between narrow limits 1

(ii) nervous system <u>and</u> endocrine system 1

*Both are required for **[1]**.*

(b) helps to maintain water balance (of the organism);
by retaining or excreting water;
helps to maintain blood pH;
excretion of urea / salts / gets rid of wastes; 2 max

(c) a rise in level would feedback to decrease production;
as levels drop to low this would feedback to increase production;
eg blood glucose concentration / body temperature; 3

*Award **[2 max]** if example given is inappropriate.*

[7]

18. thermoreceptors / sensory input
hypothalamus acts as a thermostat;
metabolic rate increases;
shivering / goose bumps / hairs raising / sweat glands inactive;
vasoconstriction of skin arterioles;
blood flow from extremities is reduced / blood flow to internal organs is increased;
increased activity;
heat is transferred in blood;

[4]

19. nerve impulse travels to end of presynaptic neuron;
triggers influx of Ca^{2+};
causes synaptic vesicles to fuse with membrane;
release neurotransmitter molecules into synaptic cleft;
(neurotransmitter) crosses / diffuses across channel;
(neurotransmitter) binds to receptors on next / postsynaptic neuron;
causes ion channels to open on neuron;
eg Na^+ diffuse into postsynaptic neuron;
can inhibit / excite;
by hyperpolarizing / depolarizing;
neurotransmitter degraded;
Ca^{2+} pumped back into the synaptic cleft;
acetylcholine / GABA / dopamine / serotonin / other examples of neurotransmitter; 8 max
*(Plus up to **[2]** for quality)*

[8]

20. draws fresh air / oxygen into the lungs;
removal / excretion of CO_2;
maintains concentration gradient of O_2 / CO_2 / respiratory gases;

diaphragm contracts;
(external) intercostal muscles contract;
increased volume (of thorax / thoracic cavity);
decreasing air pressure in lungs;
air rushes in down air pressure gradient;

converse of the above causes exhalation;
abdominal muscles contract during active exhalation;
elastic recoil of lungs helps exhalation; 8 max
*(Plus up to **[2]** for quality)*

[8]

21. (a) *(Both answers are required for **[1]**)*
cooled: sour;
warmed: sweet; 1

(b) warming causes a greater sensation of sweetness than cooling;
on warming the sensation of sweetness increases (but) on cooling the sensation decreases;
on cooling sweetness becomes undetectable (but) on warming it becomes more detectable;
sensation of sweetness on warming is always "weak" but cooling it is always "just detectable";
neither cooling nor warming causes moderate taste intensity; 2 max
(Accept other suitable paired answers based on the data in the graph.)

(c) *(Two correct answers are required for **[1]**)*
age / gender / ethnic origin / health / sensitivity to taste / smoker (or non-smoker) / genetic (taster / non-taster) / drugs (use) / pregnancy; 1
(not size / weight)

(d) cooling;
because two tastes (sour and salty) detectable (weakly) compared with only one (sweet) when warmed;
responses to cooling show the greatest changes; 2

(e) *similarities **[2 max]***
both (A and B) result in sweetness being detected;
both (A and B) result in sourness being detected;
both give a greater sensation of sweetness than sourness;

*differences **[2 max]***
A (chemoreceptors) give a greater sensation of sweetness than B;
B (chemoreceptors) give a greater sensation of sourness than A;
the difference between sweet and sour taste intensity for A is greater than the difference between sweet and sour for B; 4 max

[10]