SL Paper 3

a. Outline the symptoms of type II diabetes. [2]

b. Explain the dietary advice that should be given to a patient who has developed type II diabetes. [3]

Markscheme

a. a. high blood sugar/glucose levels;

b. sugar/glucose in urine;

c. increased thirst/frequent urination;

d. hunger/weight loss/fatigue/blurred vision/slow healing/skin disorders;

b. a. reduce blood glucose levels as target/ body/muscle cells less sensitive toinsulin / not enough insulin produced;

b. reduce intake of (saturated) fats, to reduce weight;

c. reduce the intake of sugar/simple carbohydrates, causes rapid increase in blood glucose concentration;

d. eat more high fibre foods, satisfy appetite, but cannot be broken down;

e. regular/many small meals, to avoid (rapid) rise in glucose after a big meal;

f. eat complex carbohydrates/carbohydrates with a low glycemic index, digested and absorbed more slowly;

To award the mark, answers require dietary recommendations with a reason. Do not accept comments about increased exercise.

Examiners report

a. Candidates knew the symptoms of diabetes but very few gave explanations for the dietary advice they suggested. Many mentioned the need for exercise, which was irrelevant, and answers such as “eat less sugar and fat” were common. This question was a good discriminator for the top grades.

b. Candidates knew the symptoms of diabetes but very few gave explanations for the dietary advice they suggested. Many mentioned the need for exercise, which was irrelevant, and answers such as “eat less sugar and fat” were common. This question was a good discriminator for the top grades.

b. State **one** symptom of type II diabetes. [1]

c. Explain the dietary advice that should be given to a patient who has developed type II diabetes. [3]

Markscheme

b. decreasing responsiveness to insulin;

high blood glucose;

glucose in urine;

loss of weight / tiredness;

increased production of urine;

dehydration and thirst;

c. regulate diet/total calorie intake and exercise to ensure a balanced energy budget;

low fat diet to avoid weight gain;

consume complex carbohydrates to ensure gradual release of glucose into blood/avoid sudden effect on blood glucose;

eat regular small meals to ensure a steady supply of glucose;

do not go for long periods without meals to avoid large drop in blood glucose;

consume foods (with low glycemic index) to avoid abrupt changes in blood glucose;

Each statement must be justified to gain a mark.

Examiners report

b. This question was well answered on the whole, and most knew the symptoms of type II diabetes. It was noted that weaker candidates tended to write about blood sugar or sugar in urine rather than the more accurate term of glucose.

c. Most answers listed dietary advice without any justification, and since this was an explain question, many gained no marks. There were few accurate descriptions of foods with low glycemic index, a term with which students were expected to be familiar, purely from general knowledge.

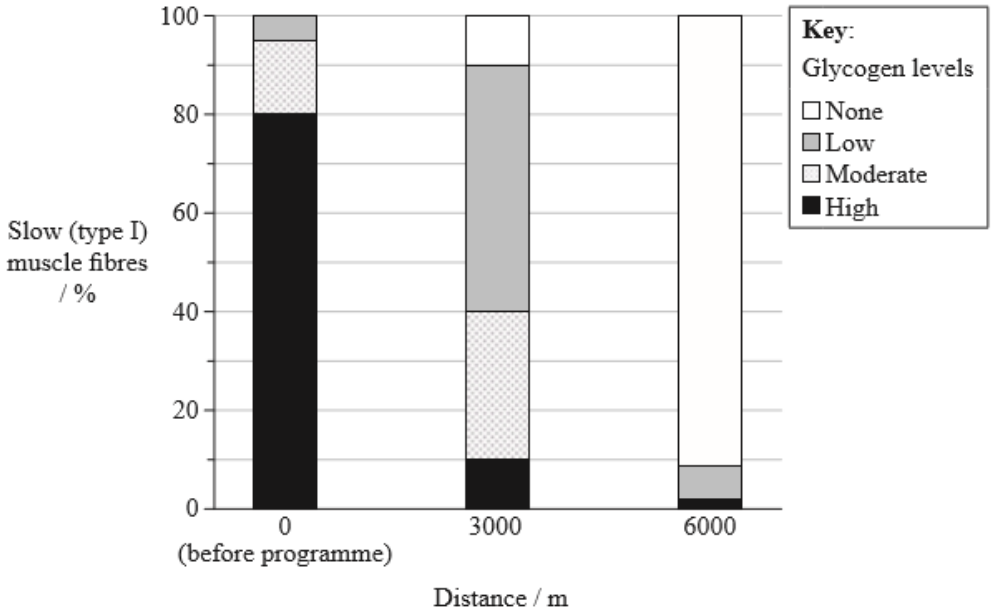
An investigation was conducted among competitive swimmers to determine the effects of two different training programmes.

3000 m programme: 6×500 m front crawl swims with 1-minute rests between each swim

6000 m programme: 60×100 m front crawl swims with 20-second rests between each swim

Swimmers were encouraged to maintain an even pace throughout the programmes. The pace was slightly slower in the 3000 m programme than in the 6000 m programme.

Tissue samples were taken from the shoulder muscle of each swimmer, before and after each session. Glycogen levels were analysed in slow (type I) muscle fibres.



[Source: adapted from D H Costill, *et al.*, (1988), *Journal of Swimming Research*, **4**(1), pages 13–18. Used with the author's permission.]

a. Calculate the percentage of slow (type I) muscle fibres that contain low levels of glycogen after the 3000m programme. [1]

b. State the effect of the 3000 m programme on glycogen levels in slow (type I) muscle fibres. [1]

c (i) Compare the effects of the 3000 m programme with the 6000 m programme on muscle glycogen levels. [2]

c (ii) Suggest reasons for the differences between the 3000 m programme and the 6000m programme in their effects on muscle glycogen levels. [2]

d. Suggest **one** limitation of the data. [1]

Markscheme

a. 50 (%)

b. reduces glycogen levels

c (i) a. both lower the glycogen level;

b. <u>much</u> greater reduction with 6000 m programme;

c. no moderate (glycogen) levels exist after 6000 m programme / far more with no glycogen;

c (ii) a. lower levels after 6000 m programme because more energy needed for longer swim;

b. lower levels after 6000 m programme because the pace of swimming was faster;

c. blood systems cannot supply glucose as fast as it is used during intense exercise;

d. slow (type I) muscle fibres only have moderate stamina so are not ideal for faster swimming;

e. less aerobic in 6000 m programme / *vice versa*;

d. a. no measurement of glycogen levels in fast/type II muscle fibres;

b. no mention of sample number/sex;

c. data shows no SD or SE;

Examiners report

a. Almost all could state 50% for a.

b. In b, the command term was state, but many tried to explain at length, usually on extension sheets.

c (i). In c i and ii most were able to obtain 1 mark, with only the better candidates obtaining both.

c (ii). In c i and ii most were able to obtain 1 mark, with only the better candidates obtaining both.

d. Many were able to obtain the mark in d for stating that there was no mention of the sex of the swimmers or comparison of fitness.

---

a. Draw a labelled diagram of a sarcomere. [3]

b. Explain the role of calcium ions in muscle contraction. [2]

Markscheme

a. *Award **[1]** for each structure clearly drawn and correctly labelled.*

Z lines;

actin filaments;

myosin filaments with heads;

light bands and dark bands;

b. Ca^{2+} ions released when a nerve impulse arrives at the muscle;

Ca^{2+} ions are released from the sarcoplasmic reticulum;

binding sites for myosin heads are exposed;

this allows cross-bridges between myosin and actin to form;

Examiners report

a. The diagram of a sarcomere was very poorly done on the whole, with many bearing little resemblance to what was required. Those who did attempt a diagram often managed to gain a mark for showing Z lines, but little else. Quite a large number of candidates left this part of the option blank.

b. This was also not well done. It is a challenging topic, and proved to be a good discriminator for the more able candidates. It is obviously an area which students find difficult to understand.

---

a. State **one** consequence of protein deficiency malnutrition. [1]

b. Outline the reasons for increasing rates of clinical obesity in some countries. [3]

Markscheme

a. lack of blood plasma proteins;

subsequent tissue fluid retention;

swelling of abdomen;

retarded physical and mental development of children;

muscle wastage;

b. sedentary lifestyle/occupations / lack of exercise;

diets high in processed contents / low in complex carbohydrates;

diets high in fat; availability of inexpensive food / large portion sizes;

Examiners report

a. Many candidates just mentioned marasmus or kwashiorkor, but this was just restating the stem, as these terms mean “deficiency of proteins”. Symptoms of the disease were expected.

b. Some candidates scored maximum marks by giving accurate information. Others only mentioned one reason for obesity, so only scored one mark.

---

a. Outline the control mechanism for appetite in humans. [2]

b. Explain the possible health consequences of a diet rich in protein. [3]

Markscheme

a. a. appetite control centre (in brain) makes person feel full/satiated/hungry;

b. function is both nervous and hormonal;

c. after eating (centre) responds to hormones/insulin from pancreas/hormones/PYY from small intestine/hormones from adipose tissue/leptin in

response to fat storage;

d. centre responds to hormone/ghrelin released from empty stomach;

e. part of centre responds to levels of lipid/sugar in the blood;

b. a. high amount of one nutrient may cause deficiency in another one;

b. excess protein not stored as protein by the body / converted to fat;

c. results in weight/mass loss in many people (due to fat/carbohydrate deficiency);

d. health problems such as kidney stones/other health problems;

e. high protein as part of a weight/mass loss diet;

Examiners report

a. Most students could outline the control mechanism for appetite.

b. Few were able to achieve well in A3 (b), lacking the detail required of the consequences of protein rich diets.

---

a . State two symptoms of type II diabetes. [2]

b. Explain the causes and consequences of phenylketonuria (PKU). [4]

Markscheme

a . a. glucose in urine;

b. high blood glucose;

c. frequent urination / dehydration/excess thirst;

d. constant hunger;

e. weight loss;

f. tiredness;

b. a. (point) mutation of gene;

b. defective enzyme/phenylalanine hydroxylase (PAH);

c. phenylalanine/Phe not broken down to tyrosine/Tyr;

d. phenylalanine/Phe accumulates;

e. (if not treated) symptoms mental retardation/seizures;

f. diet free of phenylalanine/Phe to avoid symptoms;

Examiners report

a . Questions 2 and 3 were well answered with better candidates gaining near perfect marks.

b. Questions 2 and 3 were well answered with better candidates gaining near perfect marks.

Describe the effects of training on the pulmonary system.

Markscheme

a. ventilation rate at rest is reduced;

b. maximum ventilation rate (during exercise) increases;

c. diaphragm and intercostal muscle strength increase;

d. vital capacity may increase/ VO_2 max may increase;

Do not accept answers relating to cardiac output.

Examiners report

The effects of training were sometimes not related to the pulmonary system.

---

a. Define *tidal volume* and *ventilation rate*. [2]

Tidal volume:

Ventilation rate:

b. Explain the processes that control changes in ventilation rate during exercise. [4]

Markscheme

a. a. *tidal volume*: volume of air taken in with each inhalation/out with each exhalation;

b. *ventilation rate*: number of inhalations/exhalations/breaths per minute;

b. a. exercise increases aerobic respiration;

b. CO_2 concentration in blood increases;

c. drop in pH of blood detected / blood more acidic;

d. breathing centres send impulses to diaphragm and intercostal muscles;

e. increase rate of contraction;

f. increase in ventilation rate increases oxygen uptake/decreases CO_2;

Examiners report

a. N/A

b. Most candidates knew about the need for exchange of oxygen and carbon dioxide but only the stronger candidates could fully explain the processes changing ventilation rate.

---

b (i) State the role of ligaments in human movement. [1]

d. Explain the changes in ventilation rate during exercise. [2]

Markscheme

b (i) connect bones to bones / enable joint movement/flexibility/articulation/ prevent dislocation

d. a. increased (muscle) cell respiration releases more CO_2/decreases pH (in blood);

b. detected by (respiration centre in) brain/medulla;

c. signal sent to respiratory muscles to contract at a faster rate;

d. more oxygen carried by the blood / needed for aerobic (cell) respiration;

Examiners report

b (i) A relatively small number of candidates answered this option, but those who did generally achieved well.

Most candidates could state the role of ligaments.

d. A relatively small number of candidates answered this option, but those who did generally achieved well.

B2 (c) was well answered but B2 (d) was not, with students failing to explain the changes in ventilation during exercise.

List **two** reasons for increases in the rate of clinical obesity.

1. .....
2. .....

Markscheme

a. high calorie / fatty food;

b. cheap high-energy food;

c. large portions / overeating;

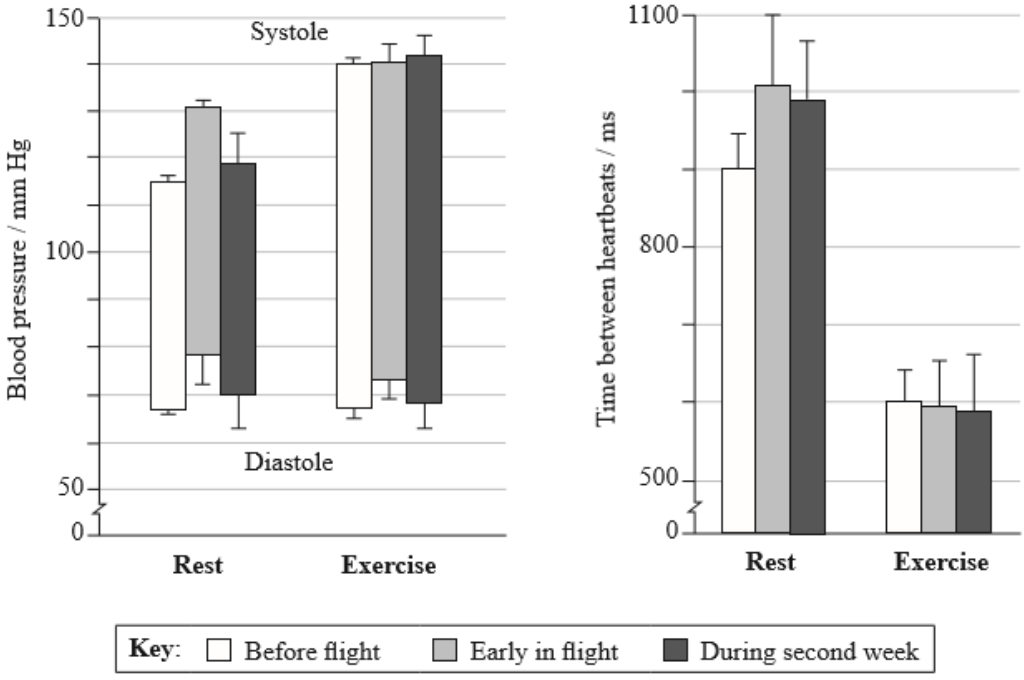
d. lifestyles with less physical activity;

e. economic growth / increases in wealth;

Examiners report

In b, apart from some imprecise answers about ‘fat food’ most were able to score two marks here. Some failed to score both marks by giving too similar answers, e.g. sedentary occupations and too much car travel would be in the same marking point.

Scientists investigated astronauts’ cardiovascular response to exercise in weightless conditions during a Columbia Space Shuttle mission. They measured the blood pressure and the time between heartbeats, both at rest and during moderate exercise. Blood pressure is expressed by two values corresponding to ventricular contraction (systole) and relaxation (diastole). Measurements were taken before the flight, early in the flight and during the second week in space. The following graphs represent average values for each type of measurement.



[Source: *Journal of Applied Physiology*, M. Di Rienz et al.,105, 2008, pages 1569–1575.]

a. Calculate the difference in blood pressure at systole between rest and exercise before flight, giving the units. [1]

b. Outline the response of the astronauts’ cardiovascular system to exercise before the flight. [2]

c. Discuss whether the cardiovascular system has to adjust to weightless conditions in space. [3]

Markscheme

a. 142–117/25 mm Hg (*Units required*)

b. a. pressure at systole/diastole / diastolic/systolic pressure increases;

b. pressure at diastole/diastolic pressure does not change much;

c. time between heartbeats decreases / heart beats/rate faster;

c. *Arguments supporting the need for adjustment:*

a. (blood) pressure increased but then decreased later in flight;

b. time between heartbeats (at rest) increased then decreased / heart rate decreased then increased;

Arguments not supporting the need for adjustment:
c. (blood) pressure/time between heartbeats/heart rate does not change (much) in space;
d. data is from a few trained astronauts and may not reflect general population / *OWTTE*;
e. data for more extended periods of time not included (so difficult to evaluate);
*Award **[2 max]** if only one perspective is presented.*

Examiners report

a. A relatively small number of candidates answered this option, but those who did generally achieved well.

In B1 (a) most answers were correct.

b. A relatively small number of candidates answered this option, but those who did generally achieved well.

In B1 (b) Almost all answers were correct, although some candidates failed to have enough detail for two marks.

c. A relatively small number of candidates answered this option, but those who did generally achieved well.

Most answers were poor and tended to be descriptive rather than discussions as required.

Antibiotics are sometimes given orally to poultry to prevent disease that may lead to reduced growth. Antibiotic resistance of bacteria from turkeys and chickens bred for meat and from egg laying hens was measured.

Excrement was collected and *Escherichia coli* bacteria were isolated. These bacteria were tested for resistance to a range of antibiotics and the results are shown below.

Number of antibiotics to which *E. coli* are resistant	Turkeys $n = 43$	Chickens $n = 45$	Egg laying hens $n = 20$
0	7	9	13
1	8	5	3
2	7	7	0
3	2	7	3
4	5	7	1
≥5	14	10	0

[Source:Antibiotic resistance of faecal _Escherichia coli_ in poultry, poultry farmers and poultry slaughterers. A. E. van den Bogaard, N. London, C. Driessen, E. E. Stobberingh. _Journal of Antimicrobial Chemotherapy_, 47, June 1, 763--771. 2001, Oxford University Press.]

a. Calculate the percentage risk of bacteria becoming resistant to more than five kinds of antibiotics in turkeys and egg laying hens. [1]

Turkeys:

Egg laying hens:

b. Compare the incidence of drug resistance in bacteria from chickens and egg laying hens. [2]

c. Discuss the hypothesis that giving antibiotics increases antibiotic resistance in poultry bacteria. [2]

d. Suggest how antibiotic-resistant bacteria are passed from animals to humans. [1]

Markscheme

a. *turkeys:* 33/32.6/32.56 %

egg laying hens: 0 %

Both needed to award the mark.

b. a. none of the egg laying hens have bacteria resistant to 5 or more antibiotics while (10) chickens have bacteria resistant to 5 or more antibiotics;

b. 13/65 % of the egg laying hens have no resistant bacteria while 9/20 % of the chickens have no resistant bacteria;

c. both have approximately same percentage/number of *E. coli* resistant to 1 or 3 antibiotics;

d. egg laying hens have less incidence of antibiotic-resistant bacteria than chickens;

c. a. hypothesis supported for poultry raised for meat but not for egg-laying;

b. turkeys and chickens always have bacteria resistant to more antibiotics than egg laying hens;

c. antibiotic-resistant bacteria are still found in egg laying hens even though antibiotics are rarely given;

d. antibiotic-resistant strains (of bacteria) may have arisen by other means/other than by poultry being given oral antibiotics;

d. from fecal matter to man handling the chickens / by accidental hand to mouth contact / contaminated dust / eating raw meat;

Examiners report

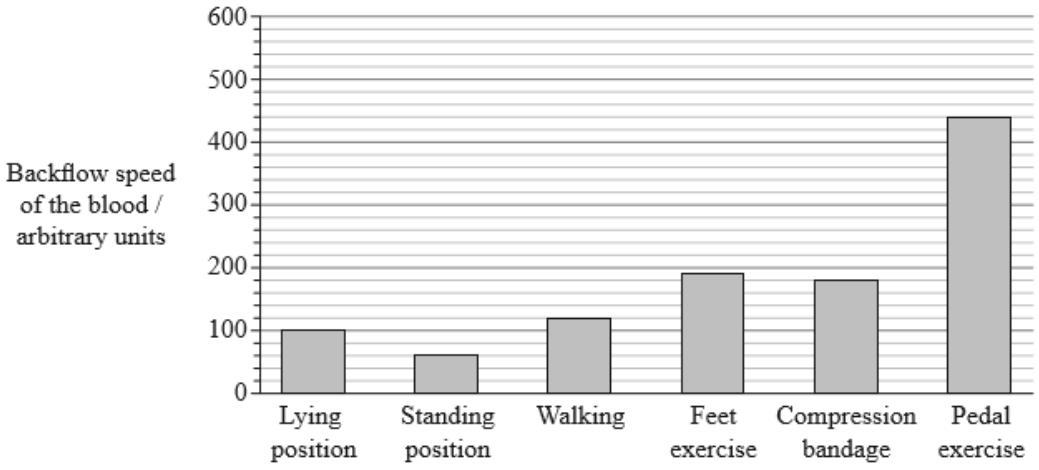
a. The few candidates who attempted this option struggled with this data analysis question. There was quite a bit of confusion about the poultry being resistant to bacteria rather than the bacteria found in the poultry being drug resistant. This caused problems in all parts of this question except (a).

b. Few received more than 1 mark for this section. The only point that was made was that egg-laying hens had a lower incidence of antibiotic-resistance bacteria than chickens.

c. Inability to understand what the table indicated meant that few were able to discuss the hypothesis given.

d. Many were able to get the 1 mark here for accidental contaminated hand to mouth contact. Those who indicated humans received the bacteria from animals when eating meat did not mention this was caused from raw meat.

Backflow is the return of blood to the heart. In legs, backflow is enhanced by the pumping action of leg muscles during movement. When this does not occur efficiently, serious health problems can arise. The backflow speed of 40 patients was measured during the application of different therapy methods. The lying position is the control.



[Source: adapted from postdoctoral thesis of Erich Meyer, Medical faculty of the University of Erlangen-Nürnberg]

a (i) State which activity reduces backflow speed in relation to the control. [1]

a (ii) Suggest a reason why backflow speed is reduced by the activity stated in (a)(i). [1]

b. Determine the difference in backflow speed between the lying position and pedal exercise. [1]

c. Discuss the benefits of exercising to promote high backflow speed. [3]

Markscheme

a (i) standing position

a (ii) leg muscles are not pumping/contracting to help return of blood to the heart;

gravity pulls the blood back towards feet / circulation must overcome gravity to return blood to heart;

b. 340 (arbitrary units)

c. better oxygenation enhances muscle metabolism;

better blood flow/cardiovascular fitness prevents pooling/swelling of ankles and feet/varicose veins;

prevention of thrombosis;

maintenance of muscle strength from better circulation;

maintenance of muscle strength from use of muscles;

Examiners report

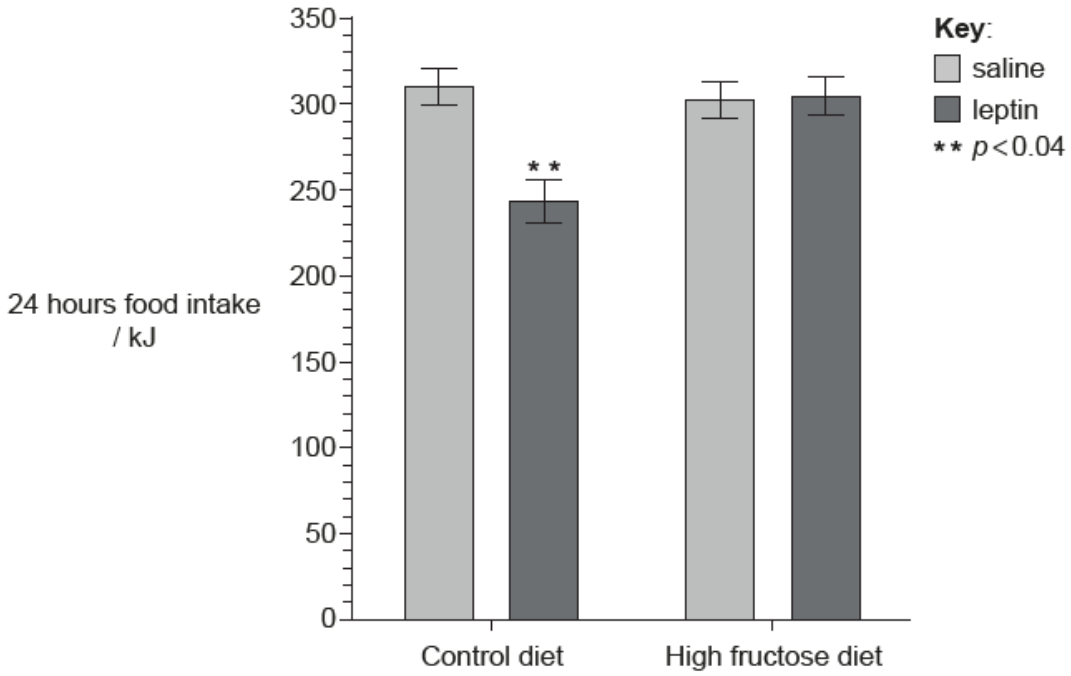
a (i) A relatively small number of candidates answered this option, but those who did generally achieved well.

a (ii) A relatively small number of candidates answered this option, but those who did generally achieved well.

b. A relatively small number of candidates answered this option, but those who did generally achieved well.

c. In B1 (c) there were some problems with candidate understanding of the term ‘backflow” though it was defined at the beginning of the Option to aid student responses. This perhaps highlights the importance of noting/highlighting/underlining key terms in the stem of questions to aid in responses.

In an experiment to determine the effect of diet on response to leptin, mice were fed a control diet or a high fructose diet for six months and then either injected with a saline (salt) solution or injected with leptin. The food intake of both groups was then monitored over a 24 hour period.



[Source: adapted from A Shapiro, *et al*., (2008), *The American Journal of Physiology – Regulatory, Integrative and Comparative Physiology*, **295**(5), R1370–R1375]

Leptin is a hormone. Hormones are chemicals produced in one part of the body that have an effect in another part of the body.

a. Distinguish between the effect of leptin injection on 24 hour food intake in the mice fed the control diet and in the mice fed the high fructose diet. [1]

b. Discuss the implications of these results for recommending leptin injections as an appetite suppressant for humans. [2]

c.i. State the tissue that produces leptin in humans. [1]

c.ii. State the target that leptin normally acts on. [1]

Markscheme

a. no effect with fructose diet but «statistically significant» reduction in control

b. a. effectiveness/effect of leptin depends on diet *OWTTE*

b. «if obese people/humans have a» high fructose diet, then it will not suppress appetite

c. «for obese people/humans with a» control/low fructose diet, then it will suppress appetite

d. results for mice may not be the same for humans *OWTTE*

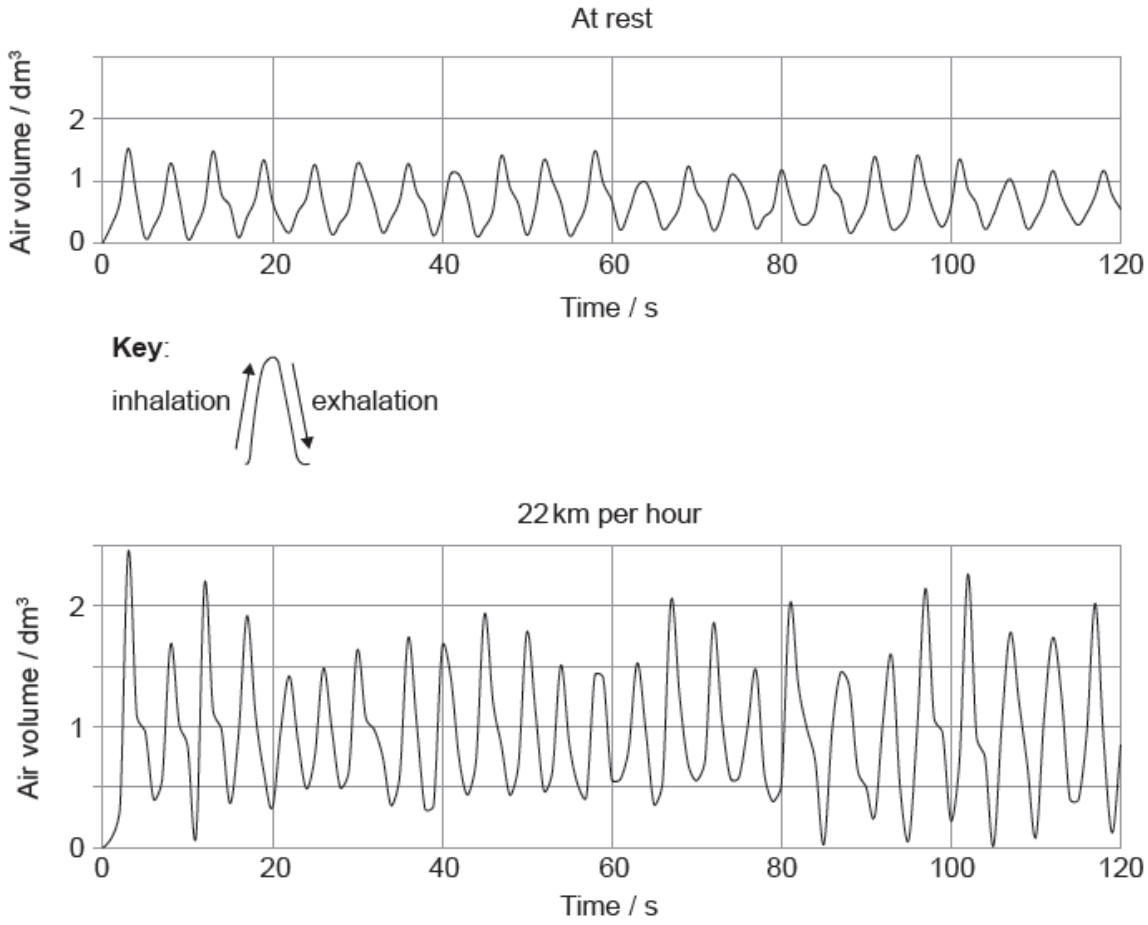
c.i. adipose/fat tissue

c.ii. hypothalamus

Examiners report

a. [N/A]
b. [N/A]
c.i. [N/A]
c.ii. [N/A]

A spirometer was used to measure the ventilation rate of a person at rest and pedaling at 22 km per hour on an exercise bike.



a. Calculate the difference in ventilation rate between resting and exercising. [1]

b. Explain the change in the tidal volume during exercise. [3]

Markscheme

a. 25 – 22 = 3 breaths in 2 min = 1.5 breaths per min/0.025 breaths per sec

Units required.

b. a. exercise increases / results in higher rate of respiration

b. exercise produces more carbon dioxide / consumes more oxygen

c. increased tidal volume excretes more carbon dioxide / obtains more oxygen

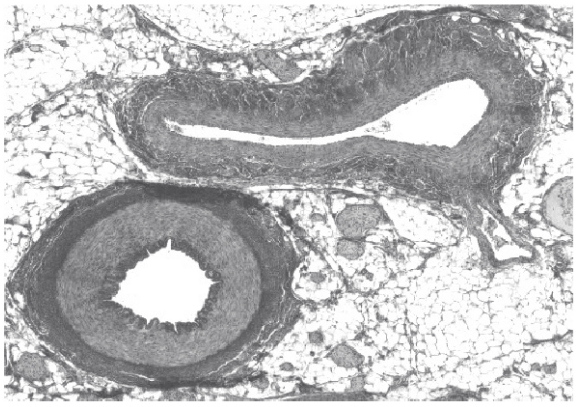
d. increased tidal volume increases gas exchange «across alveoli»

e. concentration gradient«s» of gases is maintained

Examiners report

a. [N/A]
b. [N/A]

The micrograph shows a transverse section through blood vessels of a mammal.



[Source: This book was originally published by OpenStax College, released under the CC-By license: https://creativecommons.org (https://creativecommons.org/) The eBook was adapted by Frank Lee.]

a. Identify the vein by labelling it with the letter V. [1]

b. Distinguish between the vein and the artery with reference to structures visible in the micrograph. [2]

Markscheme

a. label pointing to the upper of the two blood vessels in the micrograph

Note: check the answer carefully as the scan of the diagram is not always clear for candidates writing in pencil

b. a. vein has larger lumen

b. vein has less elastic tissue

c. vein has less muscular/thinner walls/tunica media

OR

ratio of wall thickness to lumen is less in the vein

d. vein less rounded/squashed more easily

Accept inverse for artery

Do not accept non-visible differences such as valves

No ECF

[Max 2 Marks]

Examiners report

a. [N/A]
b. [N/A]