SL Paper 3

Discuss the causes and treatments of phenylketonuria.

Markscheme

Causes:

a. phenylketonuria is an inherited / genetic condition / caused by a mutation

b. enzyme phenylalanine hydroxylase/PAH not present/deficient

c. phenylalanine is an essential amino acid

d. inability to convert phenylalanine into tyrosine / phenylalanine builds up in the body

Treatment:

e. requires diet rich in tyrosine «supplements»

f. low in phenylalanine

g. monitor blood phenylalanine levels

h. monitor growth rates / intellectual development

Examiners report

[N/A]

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a. List **two** dietary sources of vitamin D. [1]

a (ii) State an example of these receptors in humans. [1]

b. Discuss exposure to sunlight as a source of vitamin D. [3]

Markscheme

a. *e.g.* cod liver oil / fish liver oil / oily fish (accept correctly named example) / egg yolk / fortified cereal / ONE named dairy product (*i.e.* milk/cheese/ yoghurt)

*Allow any **two** sources for the mark. Reject fish alone.*

a (ii) hair cells of cochlea

b. UV light/sunlight on skin causes chemical production of vitamin D;

UV too low in winter in high latitudes;

vitamin D stored in liver so can make enough to last several months/through winter;

UV light can damage skin and cause skin cancer so exposure needs to be limited;

use of sun-block will inhibit vitamin D production;

covering skin with clothing prevents UV reaching skin; *Accept reference to cultural/religious customs*

Examiners report

a. Many gained the mark here, but a large proportion could not list two valid dietary sources of vitamin D, often giving fruit and vegetables as a possibility. The emphasis should also have been on oily fish.

a (ii). Few correct answers to this part, many suggesting “eardrum”, or simply “hairs in ears”.

b. This question was badly answered on the whole. The main misconception is that sunlight contains vitamin D, and many did not explain the role of the skin in the production of the vitamin. There is, however, an overall general awareness of the connection between UV light and skin cancer

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b. Explain the possible health consequences of diets rich in fats. [3]

c. Outline the consequences of protein deficiency malnutrition. [2]

Markscheme

b. may lead to obesity (which is risk factor for many health problems);

NOT weight gain

(obesity leads to) increased risk of coronary heart disease/gall bladder disease/high blood pressure/diabetes/excess strain on joints; *Accept CHD*

may lead to increase in blood cholesterol/low density lipoprotein/LDL/lipid levels;

deposits impede blood flow / cause diameter of blood vessel to decrease / atherosclerosis / degeneration of artery walls;

health consequences depend on type of fat ingested – high saturated fat;

c. lack of blood plasma proteins;

leading to tissue fluid retention/swollen abdomen;

lethargic/little interest in surroundings;

thin muscles/flaky appearance of skin/sparse hair with lack of pigmentation;

physical and mental development retarded;

Examiners report

b. Most candidates could give at least some appropriate responses to this question and many scored maximum marks.

c. This question produced a lot of vague answers that were not specific enough to gain credit. Many gave “swollen stomach” instead of “swollen abdomen” which was not creditworthy.

Compare the distribution of blood flow at rest and during exercise.

Markscheme

blood flow to brain unchanged with exercise;

blood flow to heart wall/skeletal muscles/skin increased with exercise;

blood flow to kidneys/stomach/intestines/other abdominal organs reduces with exercise;

Examiners report

This was an easy question for most candidates.

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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. Draw a labelled diagram to show the structure of a skeletal muscle sarcomere. [3]

b. Outline the role of myoglobin in muscle fibres. [2]

Markscheme

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

light and dark bands;

Z line;

(thin) actin filaments shown with no gap between these and Z line;

(thick) myosin filaments shown with heads;

b. binds oxygen when level is high;

releases oxygen when level is low;

acts as an oxygen store;

allows muscles to continue with aerobic respiration for longer;

Examiners report

a. Some very poor diagrams were seen. The structure of a skeletal muscle was drawn by many of the candidates, without showing the sarcomere.

b. Many candidates knew that myoglobin is used as an oxygen store.

Describe the causes, consequences and diagnosis of phenylketonuria (PKU).

Markscheme

cause: **[1 max]**

a genetic variation/mutation;

change in gene coding for tyrosine hydroxylase;

consequences: **[1 max]**
results in a failure to metabolize phenylalanine into tyrosine;
results in high levels of ketones in the blood and urine;
results in mental retardation/brain damage;

diagnosis: **[1 max]**
can be made by a simple blood test for the level of phenylalanine;
diagnosis can be made shortly after birth;

Examiners report

A3 was answered very well, with many candidates achieving full marks.

List **two** natural food sources of vitamin D in human diets.

Markscheme

*Award **[1]** for any two natural food sources.*

fatty fish / salmon/tuna/mackerel/sardines/fish oils;

egg / egg yolks;

liver;

mushrooms;

cheese/milk/butter/yogurt/other dairy product;

Do not accept supplemented foods or "fish" alone.

Examiners report

Many candidates could list two natural food sources of Vitamin D. A common error was to give fortified cereals or just fish as an answer.

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a. State a source of vitamin D in a human diet. [1]

b. Discuss exposure to sunlight as a source of vitamin D. [2]

b. Discuss reasons for conservation of biodiversity of a **named** ecosystem. [5]

Markscheme

a. fatty fish *e.g.* mackerel/tuna/sardines/herring *etc.*;

liver;

eggs;

fortified dairy products;

b. sunlight stimulates skin to synthesize vitamin D;

less sun exposure/insufficient vitamin D leads to skeletal deformities/rickets;

UV radiation increases the incidence of skin cancer/melanoma;

vegans/vegetarians are more likely to lack vitamin D so need more exposure to sunlight;

b. *name of ecosystem:*

e.g. (tropical) rainforest;

ethical reason:

every species has a right to life, regardless of whether it is useful/non useful to humans;

potential of undiscovered medicines;

ecological reasons:

better use of the rainforest may occur by respecting the existing balance in concert with the indigenous people;

native species are adapted to local conditions whereas invasive species are less likely to be in balance;

species in the rainforest are interdependent so loss of species threatens the rest of the community;

deforestation of rainforests increases soil erosion/silting of rivers/flooding/CO_2 atmospheric levels;

economic reasons:

ecotourism is a potential source of income;

aesthetic reasons:

loss of beauty of the system;

artists are inspired by the images/flowers/animals of rainforests;

heritage/cultural reasons:

maintenance of the rainforest preserves human cultural diversity;

*Do not award more than **[2 max]** for each category of reasons e.g. not more than **[2]** for ecological reasons.*

Examiners report

a. N/A

b. Surprising how many thought that the sun provided Vitamin D directly and not that the skin is stimulated by sunlight to synthesize it.

b. (b) seemed to be answered very easily and many candidates scored all five marks. Most candidates mentioned the rainforest in their answer.

Explain the possible health risks of being overweight.

Markscheme

a. increased risk of hypertension/high blood pressure

b. high cholesterol/LDL

c. «circulatory problems such as» atherosclerosis/plaque/thrombosis/stroke/heart disease

d. increased chance of **type II** diabetes

OR

unable to control blood sugar level

e. possibly develop osteoarthritis/trouble with joints

f. higher risks of cancers

g. overconsumption of fats/sugars leads to the under consumption of essential nutrients

h. gallstones/gall bladder disease

[Max 4 Marks]

Examiners report

[N/A]

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a.ii. List **two** consequences of anorexia nervosa. [1]

1.

2.

b. Explain the causes, consequences and treatment of phenylketonuria (PKU). [3]

Markscheme

a.ii. *Award **[1]** for any two consequences.*

weight loss;

anemia;

depression/anxiety disorders;

abdominal distension;

hair loss/thinning;

flaky skin;

cessation of menstrual cycle / other hormonal imbalance;

death;

b. *causes*: genetic/inherited (homozygous recessive) disorder / mutation in (gene for) enzyme that converts phenylalanine into tyrosine / lack of phenylalanine hydrolase/PAH;

consequences: phenylalanine converted to phenylketone / mental retardation / brain damage / seizures;

treatment: low-phenylalanine diet / example of substances that cannot be eaten;

(eg any food containing protein / aspartame)

Examiners report

a.ii.The answers to this question on consequences of anorexia nervosa were surprisingly vague and many were not able to give two good replies for the mark.

b. This question on phenylketonuria was either very well done, with many getting 2 or the full 3 marks, or not scoring any marks.

Outline consequences of protein deficiency malnutrition.

Markscheme

lack of blood plasma proteins and tissue fluid retention/abdominal bloating/ swollen abdomen;

kwashiorkor/marasmus develops;

poor growth and development (among children);

(often) mental retardation;

lethargic/little interest in surroundings;

wasting of muscle / thin muscles;

Examiners report

A2 (b) was not well answered as many candidates simply listed did not use appropriate scientific terminology.

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a. List **two** possible variants in the molecular structure of unsaturated fatty acids. [2]

b. State **one** reason to include fibre in the diet. [1]

c. Describe the health consequences of a diet rich in proteins. [3]

Markscheme

a. number of carbons (in the chain/length of chain);

number of double bonds (in the chain) / may be monounsaturated/ polyunsaturated;

cis/trans structure in unsaturated fatty acids / *OWTTE*;

location of double bonds;

counting inwards from opposite end of COOH group/omega 3/omega 7;

b. (bulk) may help regulate digestive process/peristalsis/prevent constipation;

   may lower risk of *colon/intestinal* cancer/appendicitis/diabetes/cardiovascular disease;

   may decrease hunger (helping with control of food intake);

c. quick drop in weight (through loss of body fluids);

   important for children/pregnant/breastfeeding women;

   loss of calcium ions in urine / possible risk of osteoporosis;

   unbalanced diet / lack of essential nutrients;

   e.g. essential vitamins/minerals/fibre;

   possible rise in blood pressure;

   release of ketones into bloodstream/ketosis (causing loss of appetite);

   possible risk of kidney/liver disorders/stones/reduced functioning;

   gout;

Examiners report

a. A2 (a) was well answered by most. Most candidates mentioned monounsaturated and polyunsaturated and some cis and trans.

b. The majority of candidates explained the importance of fibre in the diet with in-depth explanation, although some candidates gave answers without biological jargon, such as "fibres clean the guts".

c. Many candidates gave very long answers talking about the dangers of the fats associated to proteins (for example in beef) but did not make reference to the dangers of a protein-rich diet.

Explain possible health consequences of diets rich in fats.

Markscheme

too much fat may result in weight gain/obesity;

(obesity) increases risk of coronary heart disease;

another health-related risk *e.g.* type II diabetes / atherosclerosis / arteriosclerosis / high blood pressure;

inadequate consumption of other essential nutrients;

Examiners report

There were 2 'explain' questions in this option, but the second one, A2(c) did not cause as many problems.

---

a(i). Outline the function of the appetite control centre in the brain. [3]

a(ii). Outline the implications for the health of a person who has a BMI of 16 kg m^{-2}. [1]

b. Describe a primary succession in a **named** type of habitat. [3]

Markscheme

a(i). a. causes sensation of being full/having eaten too much (when receives messages);

b. stimulated by hormones (insulin, CCK) produced by pancreas/small intestine after eating;

c. stretch receptors in stomach after eating;

d. hormones (leptin) produced by adipose tissue in response to fat storage;

e. send message to appetite control centre in brain;

a(ii). BMI of 16 (kg m^{-2}) is underweight so there is a health risk;

underweight so may be taking in insufficient nutrients;

b. a. named type of habitat; *(e.g. land left after lava flow/glacier retreat / sand dune)*

b. primary succession occurs on bare/lifeless substrate;

c. organisms move into an area and change its nature/pioneers colonize;

d. pioneers are simple autotrophs; *(e.g. lichens grow first)*

e. break down substrate; *(e.g. to form organic soil)*

f. leads to an eventual climax ecosystem; *(e.g. forest)*

g. stages in the succession follow a set sequence;

*Award **[2 max]** if no named type of habitat given or if example is of secondary succession such as after a forest fire*.

Examiners report

a(i). Many candidates were able to get 2 out of the 3 available marks for stating that the appetite control centre causes a sensation of being full and then stating one message sent to the centre after eating. Stretch receptors were often incorrectly stated as being in the small intestine or pancreas and few added that leptin was produced in response to fat storage by adipose tissue.

a(ii). This question asked candidates to outline the implication of the given BMI. Therefore more was expected than simply stating that the person would be underweight.

b. The descriptions of primary succession were not clear or detailed enough. Few used the words pioneer or climax community. Many incorrectly referred to the first plants as mosses rather than lichens. Despite this, the generous mark scheme allowed many to gain 2 marks.

---

a. Outline the importance of acid conditions in the stomach. [2]

c. Suggest **one** reason for a correlation between a low-fibre diet and a higher incidence of gastrointestinal problems. [1]

Markscheme

a. Acidity activates digestive enzyme «pepsinogen»

Hydrolysis/breakdown of food

Acidity destroys unwanted bacteria/pathogens

Provides optimum pH for enzymes/pepsin to function

c. Increased contact time between intestinal wall and food

Increase interaction with surface and undesirable food chemicals

The density/hardness of the stool can make it harder to egest causing damage to tissues

Increases digestive tract conditions/diseases/constipation

Examiners report

a. Most candidates could outline the importance of acid conditions in the stomach.

c. N/A

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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. <u>after eating</u> (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 <u>empty</u> 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. Outline the molecular structure of different types of fatty acids. [3]

b. Evaluate the benefit of reducing cholesterol in the diet. [3]

Markscheme

a. fatty acids share a common structure but differ in the total number of carbon atoms in the chain;

saturated fatty acids have no double bonds between carbon atoms;

unsaturated have double bond(s);

monounsaturated have one double bond / polyunsaturated have more than one double bond;

cis fatty acids have adjacent hydrogen atoms on same side of double bond and *trans* have them on opposite side;

(accept annotated diagrams)

b. cholesterol is a steroid found mainly in animal products;

it builds up in the walls of arteries / causes clogging/narrowing/blockage of artery / atherosclerosis;

lowering its ingestion may lower the probability/ risk of coronary heart disease/CHD;

cholesterol can be synthesized by the liver;

factors other than diet can affect levels of cholesterol / genetic factor more important than diet;

Examiners report

a. Although candidates did not note that fatty acids share a common structure but differ in the total number of carbon atoms in the chain, many were still able to get the full 3 marks for this question. Candidates showed a good understanding of saturated and unsaturated fatty acids as well as what cis and trans referred to. Some candidates were carelessly referring to hydrogen bonds and thus losing marks.

b. Many candidates received 2 but seldom 3 marks for evaluating the benefit of reducing cholesterol in the diet. Most did not seem aware that cholesterol can be synthesized by the liver or that factors other than diet can affect levels of cholesterol.

Explain the benefits of supplementing common foods with vitamins and minerals.

Markscheme

supplies essential nutrients lacking in diet / nutrients added by manufacturers;

benefits lower socio-economic groups as common foods are consumed by most people / reduces the need to purchase supplements;

prevents nutritional deficiencies/deficiency diseases;

named example of mineral/vitamin supplementation; (*e.g. iodine in salt*)

Examiners report

Many candidates were able to get a mark for indicating that supplementing common foods would prevent deficiency diseases or provide nutrients lacking in the diet. However, the fact that "common foods" were the ones the supplemented and the benefit of that were usually overlooked.

Explain a method to quantify the energy content in food.

Markscheme

a. description of apparatus

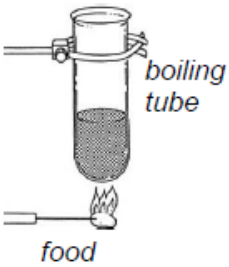
OR

drawing

OR

measured with a calorimeter

Allow other correct described method.



b. measure the initial mass/volume of water

c. measure the initial temperature of the water

d. measure the mass of the food

e. ignite the food and place under the container of water

f. measure the final temperature of the water

OR

calculate the change in temperature of the water

g. heat gained by the water=heat lost by the food

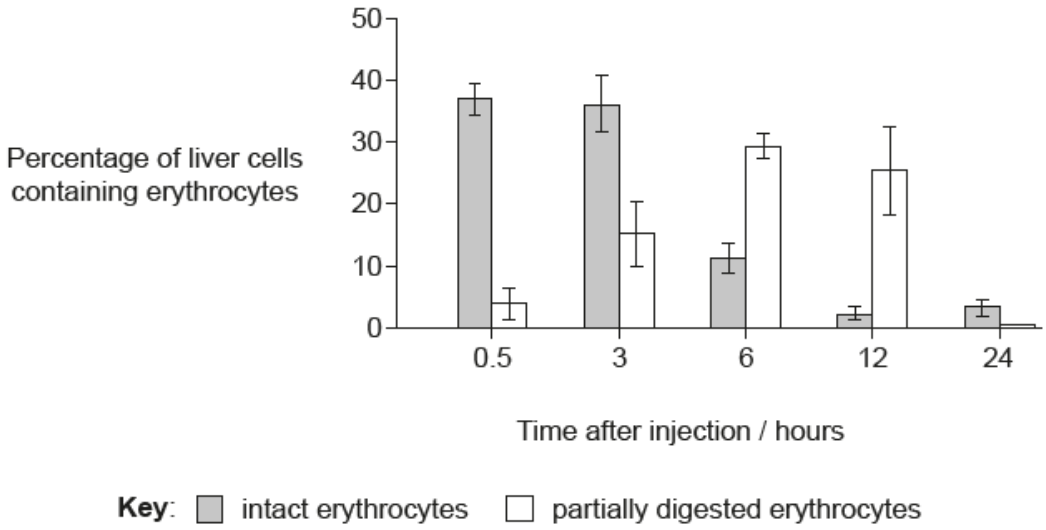
OR

energy=mass of water temperature rise in water x specific heat capacity of water/mass of food

Examiners report

[N/A]

Rats were injected with antibodies that induced phagocytosis of red blood cells (erythrocytes) leading to their breakdown. The graph shows the percentage of intact and partially digested erythrocytes in cells of the liver as observed under the microscope.



[Source: adapted from D J Loegering, *et al.*, (1987), *Infection and immunity*, pages 2074–2080]

a. State the name of the cells that perform the breakdown of erythrocytes in the liver. [1]

b. Describe the breakdown of erythrocytes by liver cells. [3]

c. Outline the fate of the iron from the erythrocytes. [1]

Markscheme

a. Kupffer

b. a. cells phagocytose/engulf the erythrocytes

b. hemoglobin is split into heme group and globins

OR

heme is removed from hemoglobin

c. globins broken down/hydrolyzed to peptides/amino acids

d. heme group separated into iron and bilirubin

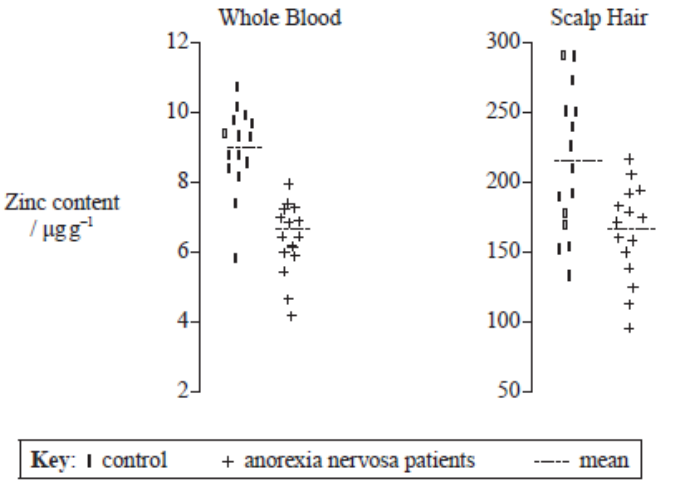
c. a. carried to bone marrow

b. used in the production of hemoglobin/new erythrocytes

Examiners report

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

Zinc (Zn) is an important dietary nutrient. More than 200 enzymes that are dependent on zinc have been identified. One consequence of zinc deficiency is suppression of appetite, due to reduced sensitivity to tastes and smells. A recent study compared the presence of zinc in tissue and fluid samples collected from 15 patients with anorexia nervosa to that from 15 control patients. The results are shown in the graphs below.



[Source: adapted from TE Tuormaa, (1995), *Journal of Orthomolecular Medicine*, **10**, pages 149–164]

a. Compare the zinc content of scalp hair of the control group with that of the anorexia nervosa group. [2]

b. Discuss whether whole blood zinc content of 6 μg g^{-1} would indicate that a person has anorexia nervosa. [2]

c. Discuss whether dietary zinc supplementation would be an effective treatment for anorexia nervosa. [2]

d. Zinc is a mineral. Distinguish between a mineral and a vitamin. [1]

e. State the body mass index (BMI) below which a person is considered to be underweight. [1]

Markscheme

a. mean zinc content higher in control group;

control group more variable;

overlap between two groups / highest of anorexia nervosa group equals mean of control group;

b. (data suggest this is) probable / could be symptom;

other conditions could lead to low zinc;

6 μg g^{-1} is within the lower range of “normal”;

c. zinc supplementation is necessary for insufficient dietary intake / improvement in below normal intake would be resolved;

improved appetite may result;

low zinc may be effect not cause of anorexia nervosa / other causes of anorexia;

d. minerals are inorganic while vitamins are organic;

minerals tend to be in ionic elemental form/small molecules while vitamins tend to be larger molecules;

e. (below a BMI of) 18.5kg m^{-2} *(units needed)*

Examiners report

a. Many candidates answered the comparison well, but many others simply stated numbers instead of comparing.

b. This question was generally answered well. Many candidates realised that this value could be an indicator of anorexia because it was very low, but there was a control person who had this same value.

c. Generally answered well.

d. Many candidates failed to answer this question correctly.

e. Many candidates failed to give the units for BMI.

---

a. Outline the importance of fibre as a component of a balanced diet. [3]

b. Distinguish between minerals and vitamins. [1]

Markscheme

a. fibre/cellulose cannot be digested;

aids peristalsis/helps to prevent constipation/adds bulk;

prevents obesity by increasing bulk in the stomach;

reduces the risk of appendicitis/cancer/hemorrhoids;

slows the rate of sugar absorption/helps prevent diabetes;

b. minerals are inorganic elements (simple compounds from elements in ionic form) and vitamins are organic compounds (which cannot be synthesised by the body);

minerals are all water soluble but only some vitamins are water soluble (others are lipid soluble);

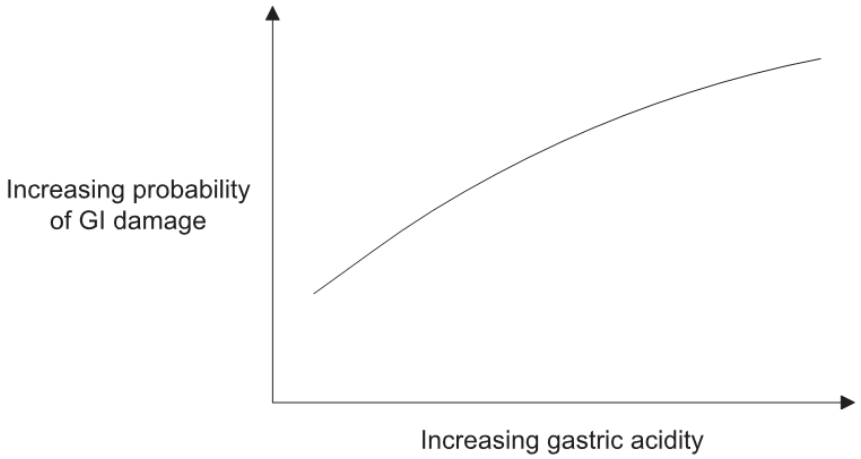
some vitamins are destroyed by exposure to oxygen, minerals are not;

Examiners report

a. This was mainly well answered, but candidates needed to be precise in their points. The connection between preventing obesity by increasing bulk in the stomach is an obvious example of the need for complete statements.

b. There were many irrelevant answers to this question and students seemed very unsure about the nature of vitamins and minerals. Some thought that vitamins are ions, and did not know the difference between inorganic and organic.

The graph shows the relationship between gastrointestinal (GI) damage and gastric acidity in 37 healthy human volunteers.



[Source: Republished with permission of Elsevier Science and Technology Journals, from 'Integrated gastric acidity can predict the prevention of naproxen-induced gastroduodenal pathology in normal subjects', John Plachetka, Gaetano Morelli, Carolyn Hines, Julie Borland, Alison Lyke, Diane Littlefield, Jerry D. Gardner Gastroenterology, Vol. 124, Issue 4, 2003; permission conveyed through Copyright Clearance Center, Inc.]

a. State the relationship between gastric acidity and GI damage. [1]

b. GI damage can include ulcers. Outline the treatment of stomach ulcers. [3]

c. Other than gastric acidity, state a primary cause of stomach ulcers. [1]

Markscheme

a. probability of GI damage increases with increased «gastric» acidity

OR

positive correlation

OWTTE

Do not accept "directly proportional"

b. a. proton pump inhibitors reduce stomach acid «production»

b. antacid/medication to neutralize/decrease acidity

c. «lower acidity» allow GI damage/ulcers to heal

d. antibiotics for *H. pylori*/bacterial infection

e. diet/lifestyle changes/eliminate smoking/alcohol

f. surgery needed with extensive gastric damage

Accept "cauterization" for marking point f

[Max 3 Marks]

c. a. *Helicobacter pylori*/*H. pylori* «infection»

b. use of non-steroidal anti-inflammatory drugs/NSAID/aspirin/ibuprofen

Accept valid examples of NSAID but do not accept trade names

[Max 1 Mark]

Examiners report

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

---

a. Water and minerals are essential in the human diet. List two other types of nutrient in a human diet. [1]

1: . . . . . .
2: . . . . . .

b. Outline the benefits of using iodine as a dietary supplement. [2]

Markscheme

a. (essential) amino acids;

(essential) fatty acids / oils / lipids / fats;

vitamins;

carbohydrates;

b. a. iodine is a mineral that is often scarce in local diets/water supplies;

b.required for normal thyroid function/synthesise thyroxine;

c.prevents goitre/avoid iodine deficiency/avoid absorbing iodine–131/radioactiveiodine;

d.prevents brain damage;[

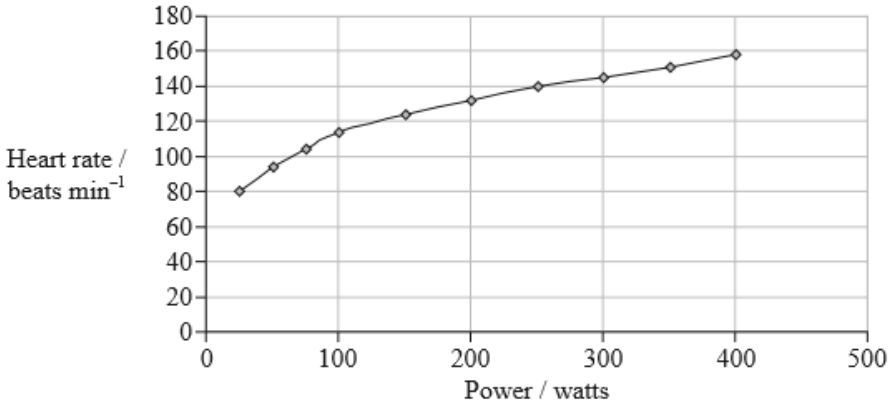
Examiners report

a. Knowledge of nutrients and the need for iodine was sound, although the word goiter was not well known. There was also good knowledge of the benefits and risks of a high protein diet, though many candidates did not score full marks.

b. Knowledge of nutrients and the need for iodine was sound, although the word goiter was not well known. There was also good knowledge of the benefits and risks of a high protein diet, though many candidates did not score full marks.

The data in the graph was obtained from a physically fit rower using a calibrated rowing machine and a heart rate monitor.

Data from physically fit rower



[Source: Adapted from F. Harris, (2009), *ASE School Science Review*, 91, pages 9–14. Used with permission.]

The table shows cardiac output during exercise for an untrained person.

Data from an untrained person

Exercise state	Stroke volume / dm^3 beat^{-1}	Heart rate / beats min^{-1}	Cardiac output / dm^3 min^{-1}
At rest	0.07	75	5.25
Mild exercise	0.10	100	10
Intense exercise	0.13	150	19.50

[Source: Adapted from F. Harris, (2009), *ASE School Science Review*, 91, pages 9–14. Used with permission.]

a. Estimate, using the graph, the resting heart rate of the physically fit rower. [1]

b (i) Estimate, using the graph, the increase in heart rate between exercise at 25 watts and 250 watts. (Show your workings.) [1]

b (ii) Predict, with a reason, whether the increase would be greater **or** less in an untrained person when the power output increases from 25 watts to 250 watts. [1]

Markscheme

a. 60 (beats min^{-1}) *(accept answers in the range of 58 to 64 (beats min^{-1}))*

b (i) (heart) rate 80 (at 25 W) and (heart) rate 140 (at 250 W) (difference =)

60 (beats min^{-1}) *(both needed)*

b (ii) greater as trained rower should have larger stroke volume / each (heart) beat more efficient / *OWTTE* (*accept converse*)

Examiners report

a. Most candidates correctly used the graph in (a) to find the resting heart rate.

b (i) The calculation in (b) (i) was an easy mark for many candidates.

b (ii) Many candidates gave vague answers for part (ii). Simply referring to the fact that the person was untrained and therefore not used to exercise.

Reference in b (ii) needed to be made to stroke volume or efficiency of each heartbeat.

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a (i) State one source of vitamin D in the diet. [1]

a (ii) State how vitamin D can be obtained other than through the diet. [1]

Markscheme

a (i) liver / dairy products / fish / egg yolks / other source.

a (ii) sunlight.

Examiners report

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

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

Explain **two** pieces of dietary advice that might be given to someone suffering from type II diabetes.

Markscheme

(dietary recommendations needed) to reduce blood glucose levels as target/ body/muscle cells less sensitive to insulin / not enough insulin produced;

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

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

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

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

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

To award the mark, answers require recommendation with a reason.

Examiners report

Part (b) on dietary advice for someone suffering from type II diabetes was a more discriminating question as many candidates could not explain the advice they were recommending. No marks were awarded for a short list.

Evaluate the health consequences of a diet rich in polyunsaturated fatty acids.

Markscheme

a. polyunsaturated fatty acids are preferable to saturated fatty acids;

b. decreases risk of cardiovascular disease;

c. provide (concentrated) energy / can lead to obesity;

Examiners report

In c the students usually gained the mark for contributing to obesity, but the expected health comparison with saturated fats was lacking. Some complicated matters by trying to write at length about cis and trans fats.

---

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;

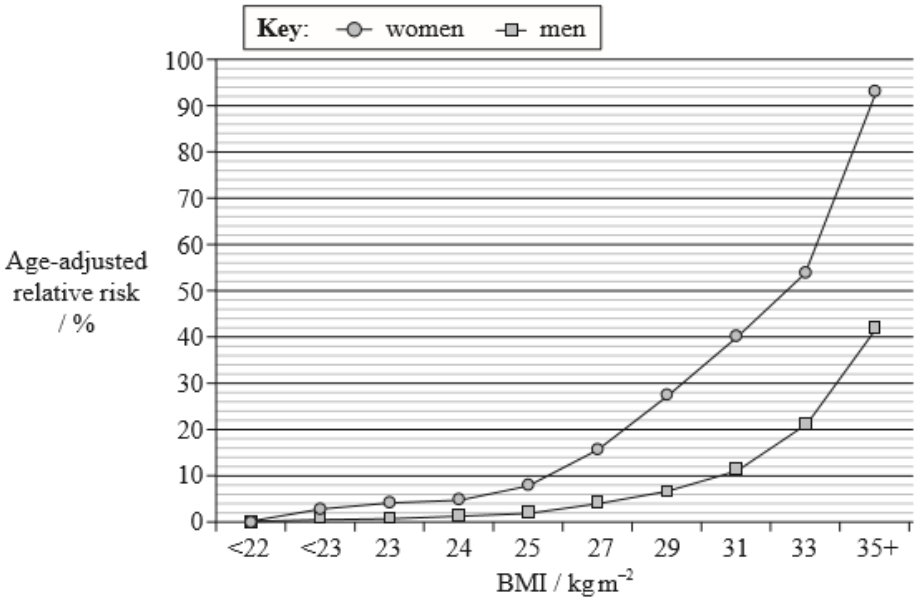
f. diet free of phenylalanine/Phe to avoid symptoms;

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.

Body mass index (BMI) is an important indicator of health. The relationship between a high BMI and percentage risk of developing type II diabetes was studied and the following data presented.



[Source: adapted from J Chan, *et al.*, (1994), *Diabetes Care*, **17**, page 961 and G Colditz, *et al.*, (1995), *Annual International Medical*, **122**, page 481]

a. Describe the effect of increased BMI on the risk of developing type II diabetes. [2]

b. Identify the risk of developing type II diabetes in men with a BMI of 33 kg m^{-2}. [1]

c. Determine, by indicating on the graph, the range of age-adjusted relative risk for women who are overweight but not obese. [1]

d. Explain the dietary advice that should be given to a patient who has developed type II diabetes. [4]

Markscheme

a. higher BMI increases risk of type II diabetes / risk increases as the BMI increases;

   greater risk for women than for men / men have a lower risk than women;

   values above 25 kg m^{-2} increase the risk of diabetes exponentially / BMI below 25 kg m^{-2} shows minimal risk;

b. 21 % (*allow answers in the range of 20 % to 22 %*)

c. indicated by marks on the graph on the vertical axis or on the line of the woman 8 % to 33 % (*allow 1 % error at either end*)

   Information must be indicated on the graph.

d. moderate portions of food to avoid fluctuations in blood sugar levels;

   regular mealtimes to avoid fluctuations in blood sugar levels;

   include unrefined carbohydrates because they are more slowly absorbed; (*accept reverse for refined*)

   include carbohydrates with a low glycemic index; *(accept reverse for high)*

   include fibre-rich foods to slow absorption of sugar;

   limit saturated/trans fats/cholesterol because diabetes increases risk of coronary heart disease;

Examiners report

a. The X axis on this graph did not show linearity, which could have confused candidates.

b. The X axis on this graph did not show linearity, which could have confused candidates.

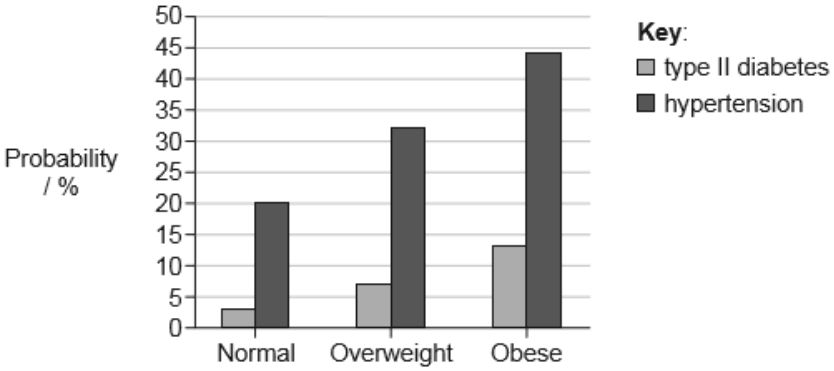
c. The X axis on this graph did not show linearity, which could have confused candidates.

   Indicating on the graph was difficult for many.

d. A large number lost all marks because they did not explain the reasons for the advice and only listed some.

A study undertaken in West Virginia, USA, shows the relationship between body mass and the probability of having hypertension or type II diabetes.

The test subjects in the study were classified as normal, overweight or obese according to their body mass index (BMI).



[Source: adapted from E Thoenen, (2002), *Obesity: Facts, Figures, Guidelines.* Department of Health and Human Resources, West Virginia Health Statistic Center.]

a. Identify the increased probability of an obese person having hypertension relative to someone who has normal weight. [1]

b. Explain how the administration of a drug that stimulates the leptin receptors in the hypothalamus could help treat obesity. [3]

Markscheme

a. 24%

b. a. appetite control (centre) is located in the hypothalamus

b. leptin is a hormone made by fat/adipose cells

c. to inhibit appetite/feeling of hunger
OR
promotes feeling of satiety/fullness

d. the drug mimics the action of leptin

e. (reduced hunger) leads to less food intake/weight loss

Examiners report

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

The QT interval corresponds to the time it takes for the ventricles of the heart to contract and then start to refill with blood before beginning the next contraction. Measures of QT interval were taken from 15-year-old female patients with anorexia nervosa and compared to healthy females of the same age. The body mass, heart rate and the mass of the left ventricle were also measured and the mean values are shown in the table.

	Anorexia nervosa	Healthy
Sample size	30	30
Body mass / kg	39	53
Heart rate / beats per minute	57	83
QT / ms	438	360
Mass of left ventricle / g	76	98

a. Outline the reasons that the female patients with anorexia nervosa have a lower mean ventricle mass than healthy females. [2]

b. Suggest a reason for the difference in QT interval between females with anorexia nervosa and healthy females. [1]

c. State the **two** causes of normal heart sounds. [1]

1. .....

2. .....

Markscheme

a. a. patients with anorexia nervosa do not eat sufficient food/protein/amino acids. *Starving = insufficient food*

b. heart muscles used as an energy source

c. reduced body mass reduces requirement for muscle mass in ventricle

b. decreased left ventricle mass/pressure therefore more time needed to contract

c. atriaventricular/AV valve closing and semilunar/SV valves closing

Both valves need to be addressed for the mark.

Examiners report

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

The table shows the nutritional information for two different types of milk as it is displayed on the carton. The information in both tables is based on a 250 g serving and shows the recommended daily allowance (RDA) for each nutrient.

Whole Milk

	Mass	RDA / %
Total fat	8 g	13
Saturated fat	5 g	24
Cholesterol	26 mg	9
Total carbohydrates	12 g	4
Protein	8 g	16
Sodium	102 mg	4

	RDA / %		RDA / %
Vitamin A	5	Vitamin D	26
Vitamin B12	29	Calcium	29
Vitamin B6	5	Magnesium	6

Skimmed Milk

	Mass	RDA / %
Total fat	480 mg	1
Saturated fat	322 mg	2
Cholesterol	5 mg	2
Total carbohydrates	12 g	4
Protein	5 g	10
Sodium	132 mg	6

	RDA / %		RDA / %
Vitamin A	11	Vitamin D	26
Vitamin B12	18	Calcium	37
Vitamin B6	5	Magnesium	8

a. Calculate how many grams of protein should be consumed each day. Working is not required. [1]

. . . . . g

b. State **one** function of sodium in the diet. [1]

c. Identify, with a reason, which milk provides more energy in a 250 g serving. [1]

d. Suggest, with reasons, which milk would be recommended for someone with osteomalacia. [2]

Markscheme

a. 50 «g»

b. water balance/osmoregulation/transmit impulses along nerves/muscle contraction/blood pressure/ sodium potassium pump/sodium-glucose cotransporter / sodium-amino acid cotransporter

c. whole milk because it contains more fat/energy

Reason is required.

d. a. skimmed milk has more calcium so better

b. both milks have the same amount of vitamin D so no difference between the two.

Skimmed milk alone is worth no marks. Two reasons are required for both marks.

Examiners report

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

---

b. Outline factors that can lead to an individual becoming obese. [3]

c. Amino acid polarity is an important factor in determining the functions of proteins. Explain the importance of polar and non-polar amino acids in membrane proteins. [3]

Markscheme

b. diet rich in carbohydrate/fat;

too much food intake / unbalanced diet / food cheap and readily available;

sedentary lifestyle / lack of training/exercise;

genetic disposition/disorder;

malfunction of hunger centre;

c. polar amino acids are soluble/have stable interactions in water/extracellular fluid/cytoplasm;

non-polar amino acids are soluble/have stable interactions in the lipid bilayer;

polar amino acids strongly hydrophilic and non-polar amino acids are repelled by water/are hydrophobic;

(help to) retain protein in position in the membrane;

polar amino acids form hydrophilic channels/protein pores in membranes;

transmembrane proteins have polar amino acids on either side of the membrane;

Examiners report

b. There were some good answers by the majority of students, with many gaining three marks. Interestingly, few suggested a malfunction of the hunger centre, which was an acceptable alternative.

c. The understanding of many candidates was insufficient to answer this question, and it proved to be a good discriminator. Often students were writing about proteins rather than amino acids.

The following are from the labels of a bag of all purpose white flour (wheat) and a bag of parboil long grain rice. Amounts shown are per serving.

	Flour	Rice
Serving size	30 g	30 g
Fat	0.4 g	0.2 g
Saturated	0.1 g	0 g
Trans fat	0 g	0 g
Cholesterol	0 mg	0 mg
Sodium	0 mg	0 mg
Carbohydrate	22 g	24 g
Fibre	1 g	0 g
Sugars	0 g	0 g
Protein	4 g	2 g

[Source: Flour: Five Roses™, Smucker Foods of Canada Co.;
Rice: NuPak, Shaw Trading Company Limited.]

b (i) Using your knowledge of the energy content of nutrients, calculate the protein energy value of a serving of rice, showing the units. [2]

b (ii) Compare wheat flour and rice as main dietary sources of energy for humans. [2]

c. Evaluate the benefits of reducing dietary cholesterol in lowering the risk of coronary heart disease. [2]

Markscheme

b (i) a. energy value of 100 g protein ≈ 1720 kJ / energy value of protein ≈17 kJ/g;

b. 2g protein
energy value / ECF kJ of 100g protein
34.4 kJ/ECF kJ value;
100g protein

Answer range 34–35 kJ/ECF kJ.
For calculation note error carried forward.
Units required. If no units deduct a mark and indicate in scoris U –1.

b (ii) a. wheat and rice almost equivalent for energy value;

b. rice has only slightly less kJ/energy from fat/protein / more from carbohydrate;

c. considering food miles / availability may be decision factor for choice;

c. a. dietary cholesterol correlated to blood cholesterol/fatty acids;

b. high blood cholesterol is an important risk factor (but not the only cause);

c. some cholesterol required for normal synthesis of body molecules;

d. genetic factors play an important role in determining cholesterol levels;

e. other environmental factors (smoking) play a role in determining cholesterol levels;

Examiners report

b (i) In A2 (b) the majority of candidates could perform the required calculation.

b (ii) Few were able to appropriately compare wheat flour and rice as sources of energy.

c. In A2 (c) many candidates gave very long answers talking about the benefits of reducing cholesterol but did not connect them to heart disease.

Numerous health benefits are associated with diets that include omega-6 fatty acids and omega-3 fatty acids in a ratio between 1:1 and 4:1. When consumed in excess, omega-6 inhibits uptake of omega-3. Many people in developed countries eat large amounts of processed foods and oils, so they consume omega-6 fatty acids and omega-3 fatty acids at a ratio of between 10:1 and 25:1. Such high ratios are associated with many chronic diseases.

Oils	Ratio of omega-6 to omega-3
Flaxseed oil	0.24 : 1
Canola oil	2 : 1
Walnut oil	5 : 1
Olive oil	13 : 1
Sunflower oil	19 : 1
Corn oil	46 : 1
Sesame oil	138 : 1
Grapeseed oil	696 : 1

a. Deduce with reasons which **two** oils would be the best sources of fatty acids for a healthy diet. [2]

b. Outline the meaning of the term essential when used to describe some fatty acids. [2]

c. (i) State the name of the part of the brain where appetite is controlled. [2]

(ii) State the role of the vagus nerve.

Markscheme

a. Canola ***AND*** flaxseed/walnut (*Both needed*)

Both have ratios within or close to recommended ratio

b. Fatty acids which have to be obtained in the diet

Fatty acids which cannot be synthesized in the body

c. (i) Hypothalamus (*Do not accept appetite control centre*)

(ii) Transmit impulses from brain to gland cells «in stomach»

Stimulate secretion by «stomach» gland cells

Stimulates secretion of gastric acid

Example of parasympathetic response *eg*: slows heart

Transmit sensory information to the brain

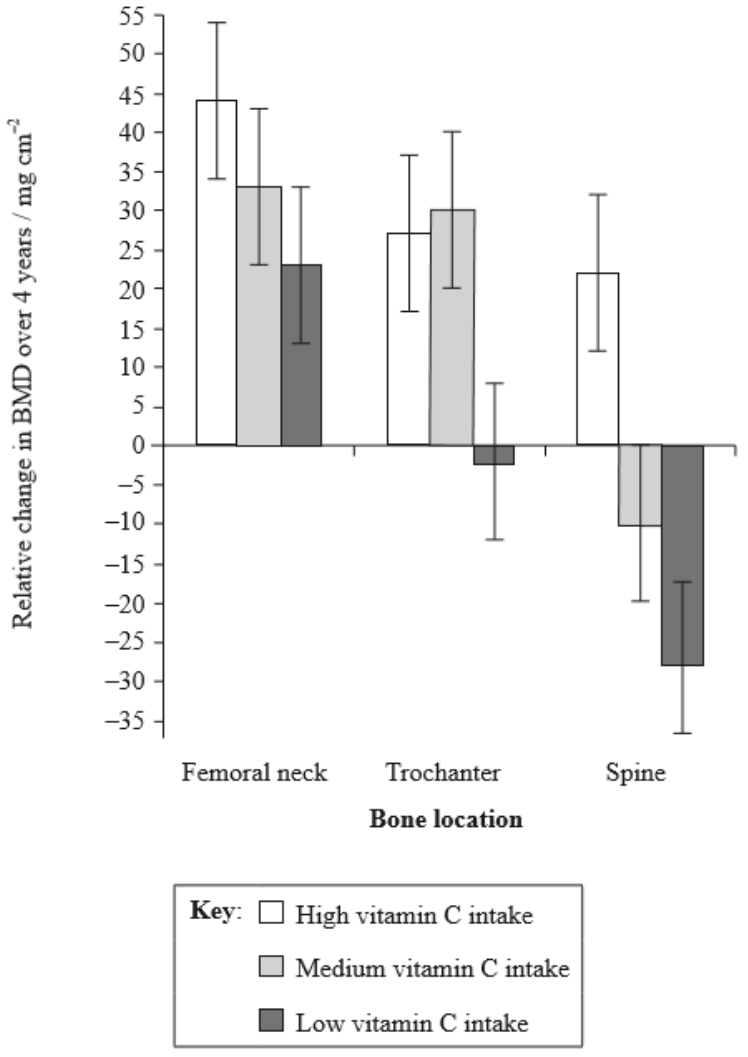
Examiners report

a. Generally well answered.

b. Generally well answered.

c. Generally well answered though a role of the vagus nerve caused some confusion.

Elderly people lose bone mineral density (BMD) with age, and this is the source of many health issues, including higher risk of bone fractures. Researchers measured the change in BMD amongst elderly men considering many factors, over a period of four years. The results presented below show the difference between bone density change due solely to vitamin C intake and bone density loss considering a combination of the other factors represented by the baseline (zero). BMD was measured in the spine and at two femur (thigh bone) locations (femoral neck and trochanter) using scanner images. Daily intake of total vitamin C was categorized as high, medium or low.



[Source: Shivani et al. (2008) "High Vitamin C Intake Is Associated with Lower 4-Year Bone Loss in Elderly Men", *Journal of Nutrition*, vol 138 (10), pp. 1931–8: Figure 4. © American Society for Nutrition.]

a. Outline the effect of vitamin C intake on changes in bone density in the spine. [1]

b. Compare the changes in bone density of the femoral neck with those of the spine. [2]

c. Evaluate the evidence provided by the data that the intake of vitamin C supplements may reduce bone density loss in elderly people. [2]

Markscheme

a. a. high (vitamin C) causes a positive change (in BMD) whereas medium/low causes negative change;

b. inversely proportional (for relative change);

c. if vitamin C intake increases, BMD increases;

b. a. positive change/reduced loss for femoral neck at all levels whereas only at high intake for spine;

b. higher values for femoral neck for each intake category;

c. inversely proportional for both;

d. no overlap between range/standard deviation / clear distinction of protective effect between femoral neck and spine (for high/all intake categories);

c. *Implications:*

a. high intake results in positive value (for all locations);

b. protective effect proportional to intake;

Limitations:
c. proportion of vitamin C intake from supplements / influence of other factors not stated;
d. only a few bone locations measured / sample size unknown / high medium and low not defined;
At least one implication and one limitation required.

Examiners report

a. The data in A1 was understood by most candidates who were able to analyse the data and connect the vitamin C intake to changes in bone density.

b. Many students failed to compare the data and only achieved one mark.

c. Few candidates evaluated the evidence provided. Practice of this style of question is invaluable in preparing for the examination.

Low protein diets are a widespread problem in the developing world. A low protein diet in a pregnant mother could affect a developing fetus. Other mammals are used as a biomedical model for energy metabolism and malnutrition in humans.

In an experiment to study the effect of protein levels in the diet, pregnant mammals were fed diets with different ratios of protein to carbohydrate:

- low protein : high carbohydrate (LP),
- adequate protein : adequate carbohydrate (AP),
- high protein : low carbohydrate (HP).

The table shows the average birth mass of the offspring and the body mass gain of the mother during the pregnancy. The concentration of several substances in the plasma of the mothers was also recorded. LDL (low density lipoprotein) is considered “bad cholesterol” and HDL (high density lipoprotein) is considered “good cholesterol”.

	Offspring birth mass / kg	Mother’s body mass gain / kg	LDL cholesterol / $mmol\,l^{-1}$	HDL cholesterol / $mmol\,l^{-1}$	Glucose / $mmol\,l^{-1}$	Urea / $mmol\,l^{-1}$
LP	1.19	42.1	0.59	0.96	4.24	1.7
AP	1.41	68.3	0.70	0.87	4.04	3.0
HP	1.21	63.1	0.85	0.78	4.20	7.1

[Source: Adapted from: Metges, C.C., Lang, I.S., Hennig, U., Brüssow, K.-P., Kanitz, E. *et al.* (2012) Intrauterine Growth Retarded Progeny of Pregnant Sows Fed High Protein: Low Carbohydrate Diet Is Related to Metabolic Energy Deficit. *PLoS ONE*, **7**(2): e31390. doi: 10.1371/journal.pone.0031390. Table 6]

a. Identify the substance that varies the most in the plasma of the mothers. [1]

b. Calculate the difference between birth mass of offspring whose mothers were fed the AP diet and the HP diet. [1]

. . . . . kg

c. Distinguish between LDL cholesterol and HDL cholesterol in relation to the diet. [1]

d. Explain the low birth mass of offspring born to mothers who were fed the LP diet. [2]

e. In many societies doctors may recommend an HP diet for pregnant humans. Using the data, evaluate this recommendation. [3]

Markscheme

a. urea

b. 0.20 (kg) (less weight in HP)

c. LDL cholesterol increases and HDL cholesterol decreases as (proportion of) protein increases/carbohydrate decreases / *OWTTE*.

d. a. lack of essential amino acids to form protein;

b. not enough protein for growth;

c. not enough amino acids/protein to form muscle/tissues;

d. low protein may affect production of enzymes;

e. *(the data does not support the recommendation):*

a. as HP has the highest level of plasma urea which could be toxic;

b. HP has a high level of LDL/bad cholesterol and a low level of HDL/good cholesterol which could lead to coronary heart disease;

(accept high ratio of LDL: HDL)

c. HP produces a high level of glucose (compared to AP) which could lead to diabetes;

d. HP produces a low birth weight (compared to AP) which may affect development / OWTTE;

(the data does support the recommendation):

e. the mother has a similar weight gain to AP thus avoiding health problems;

Examiners report

a. N/A

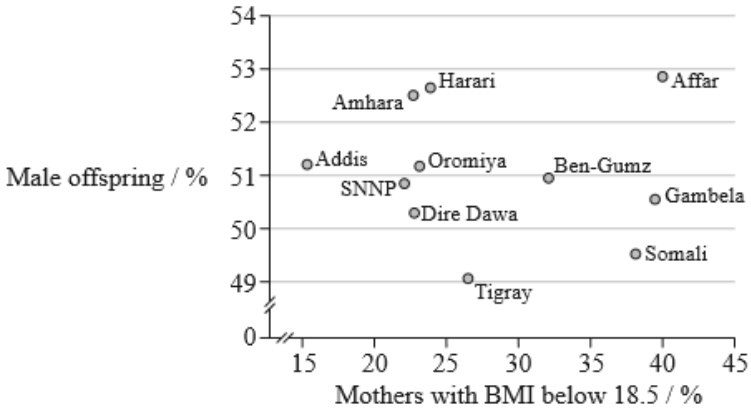
b. N/A

c. This required the candidates to distinguish between LDL and HDL cholesterol. Many candidates failed to refer to the data in their answers so failed to score any marks.

d. N/A

e. The candidates were required to evaluate an HP diet for pregnant humans. Most candidates restated the data and gave no reasons for recommendations. As this was a 3 mark question it proved costly for many candidates. The question did discriminate well.

Malnutrition affects the body mass index (BMI) of mothers. The height and mass of over 7000 mothers in Ethiopia and the sex of their most recently born child was recorded. The graph shows the percentage of mothers with a BMI below 18.5 and the percentage of their most recent births that were males in 11 regions across Ethiopia.



[Source: Aryeh D. Stein, Paul G. Barnett, Daniel W. Sellen, Maternal undernutrition and the sex ratio at birth in Ethiopia: evidence from a national sample, *Proc. R. Soc. Lond. B* (Suppl.), 271, 2004, pages S37–S39, by permission of the Royal Society.]

a. State the regions with the highest and lowest percentage of male offspring. [1]

Region with highest percentage: .....
Region with lowest percentage: .....

b. Comment on the variation in BMI of mothers in Ethiopia. [2]

c. Discuss whether the data supports the hypothesis that malnutrition affects the sex ratio of offspring. [2]

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

e. Suggest **one** factor that could cause malnutrition in mothers. [1]

Markscheme

a. *highest*: Affar;

lowest: Tigray;

(*both needed*)

b. a. evidence of high malnutrition rates / some areas with many mothers below 18.5 BMI;

b. large range/15– 40% range (in mothers below 18.5 BMI);

c. many/6 regions in the range of 20–30 % / many/5 regions in the range of 22–25 % (are below 18.5 BMI);

d. lowest in Addis and highest in Affar/Gambela;

c. a. hypothesis not supported; (*do not award if unqualified*)

b. no clear relationship / as malnutrition (mothers below 18.5 BMI) increases, there is no clear change in percentage male offspring;

c. however, male birth percentage is usually higher than female (above 50 %) regardless of BMI / 9 of the regions are above/2 regions are below;

d. a. no data about sex of the mothers' other children;

b. BMI below 18.5 means individual is underweight but not necessarily malnourished;

c. the number of mothers sampled in each region is not known;

d. no comparison between town and country;

e. no information about age of mothers;

e. food shortages / famine / insufficient food / poor food quality / warfare / epidemics / poverty

Examiners report

a. Almost every candidate gave the correct answers of Affar and Tigray.

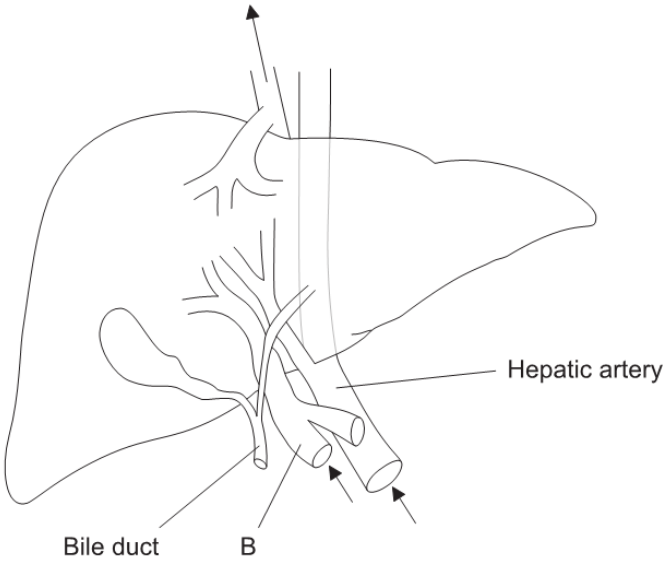
b. In b, even though the question was about mothers, many wrote about the sons, but also correctly commented on the large range.

c. In c most were able to comment that the hypothesis was not supported as there was no clear relationship.

d. In d many noted that there was no data about the sex of the mothers' other children or the age of the mothers.

e. In e many did not relate back to the stem and remember that it was about Ethiopia, resulting in some nebulous answers about 'lack of essential nutrients' etc.

The diagram shows the liver. The arrows show the direction of blood flow into and out of the liver.



[Source: © International Baccalaureate Organization 2017]

a.i. Identify the blood vessel labelled B. [1]

a.ii. Outline the function of the blood vessel labelled B. [3]

b. Distinguish between the structure of liver sinusoids and capillaries. [2]

Markscheme

a.i. «hepatic» portal vein

a.ii. a. takes blood from intestine/spleen/pancreas/stomach to liver

b. carries digested food/nutrients/glucose

c. prevents glucose entering the general circulation

d. helps maintain osmotic potential of blood

e. allows toxins to be removed

[Max 3 Marks]

b. a. sinusoids have open pores/fenestrations/discontinuous endothelium and capillary endothelium is continuous/does not contain fenestrations

b. Kupffer cells are located inside sinusoids but not in capillaries

c. sinusoids larger in diameter than capillaries

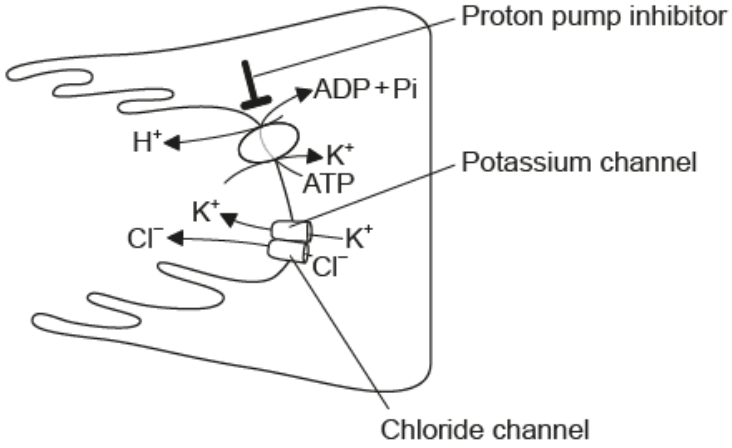
Accept labelled diagrams

[Max 2 Marks]

Examiners report

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

The diagram shows a cell in the lining of the stomach.



[Source: © International Baccalaureate Organization 2017]

a. Outline the importance of the proton pumps in the digestion of foods. [2]

b. Explain the use of proton pump inhibitors to treat patients complaining of stomach pain. [3]

Markscheme

a. a. pumps protons/H^+ into the stomach

b. allows for the production of «hydrochloric» acid

c. «hydrochloric» acid accelerates digestion/activates enzymes

d. gives optimal pH for pepsin/enzyme digestion

b. a. proton pump is a «transmembrane» protein

b. proton pump inhibitors bind to the proton pump

c. hydrogen ions are not sent into stomach lumen
OR
reduction of «gastric» acid production

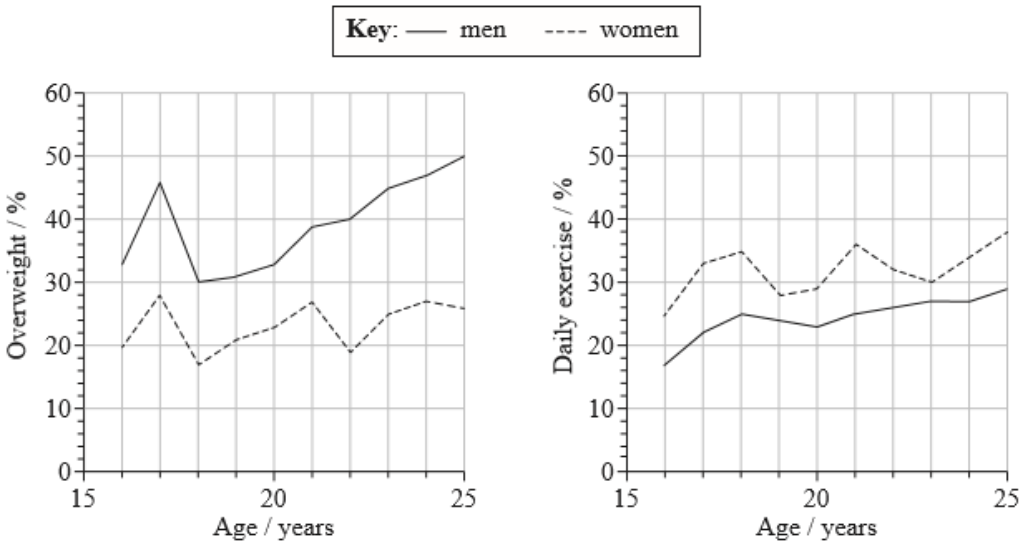
d. increase in pH of stomach

e. relieve symptoms of acid reflux/gastritis/ulcers

Examiners report

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

Within a cross-sectional study “Fit for Life” in Germany, the body mass index (BMI) of volunteers aged between 16 and 25 years was investigated. Volunteers were also interviewed about their daily exercise habits. The graphs below show the percentage of men and women who were overweight, and the percentage who exercised daily.



[Source: adapted from D Leyk, *et al.*, (2008), *Deutsches Ärzteblatt International*, **105**(46), pages 793–800]

a. Measure the difference between the percentage of overweight men and the percentage of overweight women at age 20. [1]

b. State the range of the body mass index (BMI) that corresponds to overweight status. [1]

c. Compare the percentage of men and women who exercised daily. [2]

d. Evaluate the hypothesis that being overweight is due to lack of exercise. [3]

Markscheme

a. 10 (%) (*allow responses in the range of 9 to 11 %*)

b. 25.0 –29.9 / above 25 and below 30

Do not accept 30 as this is classed as obese.

c. more women exercise than men;

both show an increase (between ages 16 to 25);

similar trend lines over time / slightly greater increase in women;

women have greater increases and decreases/greater variability while men gradually increase/stays level;

Award any one of the above marking points if shown as a valid numerical comparison.

d. *(*hypothesis is supported) as the greater percentage of men are overweight and they exercise less than women / *vice versa*;

(hypothesis is supported) lowest percentages of overweight ages (18 and 20) correspond with peaks of exercise;

(hypothesis is not supported) as even though both men and women exercise more over time the percentage overweight also increases;

(hypothesis is not supported) other named factor which influences being overweight; (*e.g. availability of cheap high energy foods* / *large portion sizes* / *increasing use of vehicles for transport* / *changes from active to sedentary occupations* / *genetics*)

BMI does not consider muscle mass/bone structure/bone density;
only narrow range of ages considered;

Examiners report

a. Almost all candidates read the graphs correctly to obtain the correct difference between overweight men and women.

b. Many did not give the correct range for the BMI corresponding to overweight status, giving incorrect upper limits.

c. Many candidates were able to get one mark for indicating that more women exercise than men but only some were able to get a second mark.

d. Candidates struggled with this question, primarily as they did not use the data to evaluate the hypothesis given. Instead of looking at how the data either supports or does not support the hypothesis, they talked in general about factors that could influence being overweight. One comment on the G2 forms indicated that it was hard to find 3 points for an answer to this when in fact the mark scheme provided 6 ways of getting the points.

---

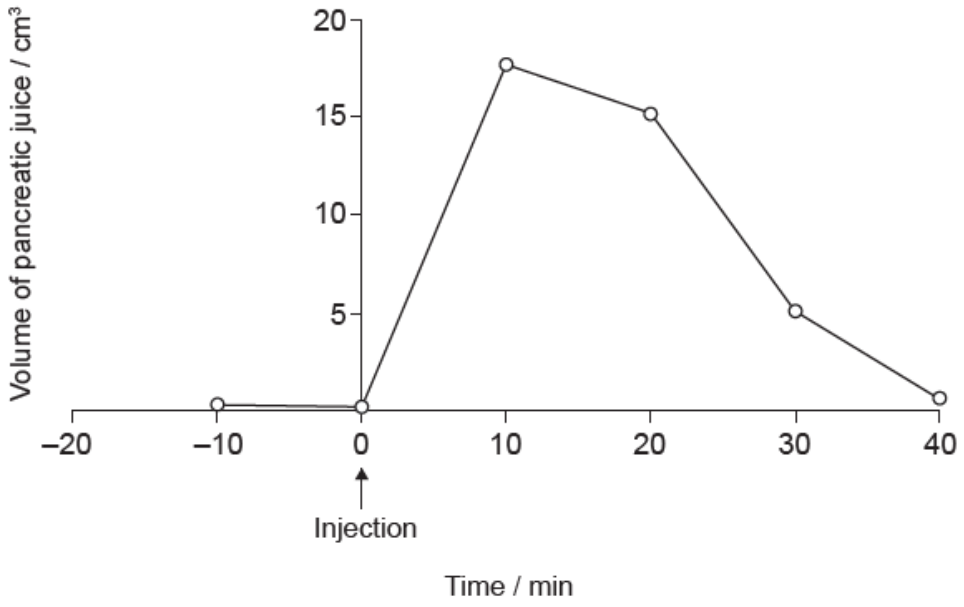
a. State **two** roles of hydrochloric acid in gastric juice. [2]

Role 1:

Role 2:

b. Pancreatic juice is secreted into the pancreatic duct which carries these secretions to the small intestine. [3]

The hormone secretin is released by the small intestine when hydrochloric acid enters it from the stomach. The data below show the volume of pancreatic juice released after an injection of secretin.



[Source: K E Barrett *et al.* (2010) *Ganong's review of medical physiology*, page 438,© McGraw Hill Education.]

Pancreatic secretions contain sodium hydrogen carbonate, making them basic.

Deduce the significance of the response by the pancreas to secretin.

c. State **one** cause of stomach ulcers. [1]

Markscheme

a. a. activation of enzymes/protease/pepsinogen

b. bactericidal action / kills pathogens

c. hydrolysis / breakdown of food

b. a. secretin stimulates an increase in pancreatic secretions

b. pancreatic secretions are released rapidly / within 10 minutes

c. «$NaHCO_3$ in pancreatic secretions» neutralises stomach acid / HCl

d. provides optimal conditions for digestion / enzymes «in the small intestine»

e. by 40 minutes no more hydrochloric acid enters the small intestine

c. an infection by Helicobacter pylori / H. pylori

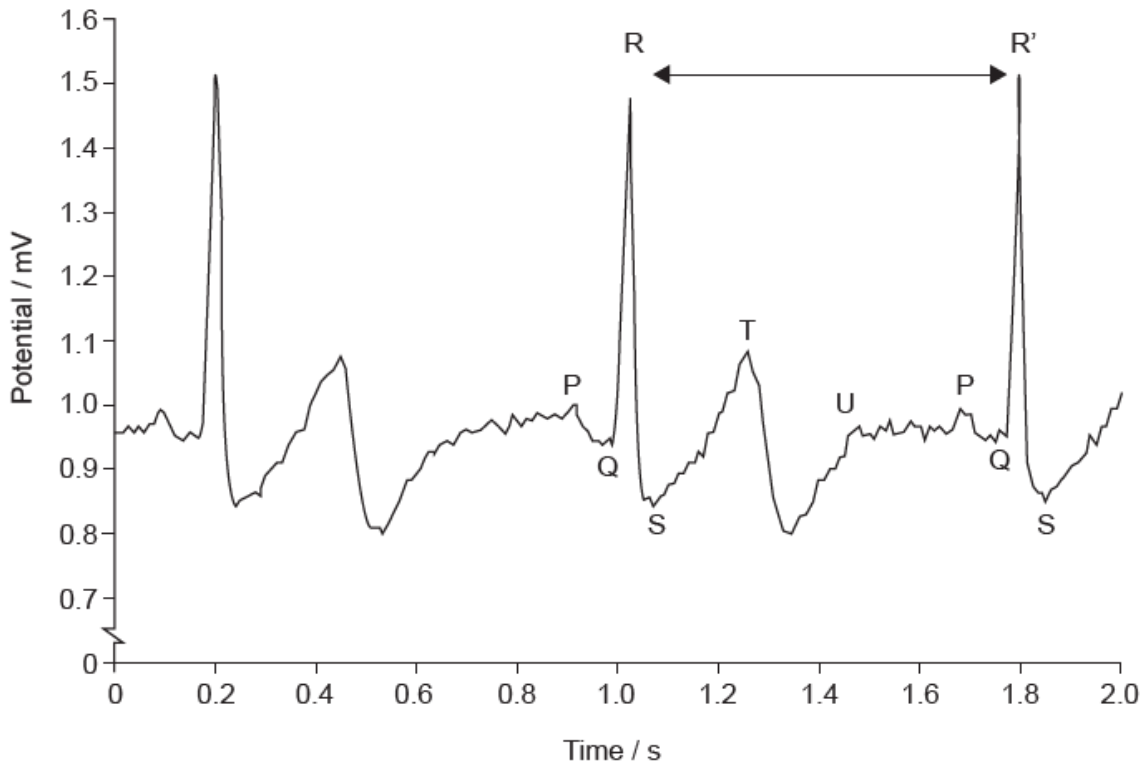
OR

overuse of NSAIDs /aspirin / ibuprofen

Examiners report

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

The graph below shows a normal electrocardiogram (ECG) trace.



a. Using the letters provided, identify the parts of the ECG where the ventricle muscles are contracting. [1]

b. State what is represented by the period between the points R and R'. [1]

c. Outline the use of artificial pacemakers for patients with a heart condition. [2]

Markscheme

a. QRS/ Q to S

b. one cardiac cycle

c. a. artificial pacemakers deliver electrical impulses «to heart muscle»

b. they maintain a regular heart rate / supplement the natural pacemaker

c. they sense missing heart beats and stimulate the heart
OR
correct malfunction of SAN / sinoatrial node

d. they coordinate contractions of atria and ventricles / left and right atria

Examiners report

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

The following nutrients are listed on a packet of dry roasted peanuts.

Per 25 g serving (approximately 28 peanuts)	
Carbohydrates:	4.6 g
Fibre:	2.4 g
Protein:	7.3 g
Saturated fat:	1.9 g
Monounsaturated fat:	6.9 g
Polyunsaturated fat:	4.4 g

a (i) State which listed nutrient does not supply energy. [1]

a (ii) Deduce, with a reason, which listed nutrient provides the most energy per 25 g serving. [2]

b. Outline the differences in molecular structure between the types of fat found in the peanuts. [3]

Markscheme

a (i) fibre

a (ii) monounsaturated fat;

fats contain more energy than carbohydrates or proteins;

fats contain 4000 kJ per 100 g/9 kcal per 100 g;

more monounsaturated fat present than other fats;

b. saturated and unsaturated fats differ in number of single and double carboncarbon bonds/ratio of hydrogen to carbon atoms in fatty acid chains;

saturated fat – carbon atoms all joined by single bonds / have no double bonds / have no increase in number of hydrogen atoms possible;

monounsaturated fat – one double bond in carbon chain / could add two hydrogens in the carbon chain;

polyunsaturated fat – two/more double bonds in the carbon chain;

saturated fatty acid chains tend to be straight while mono/polyunsaturated have kinks/bends;

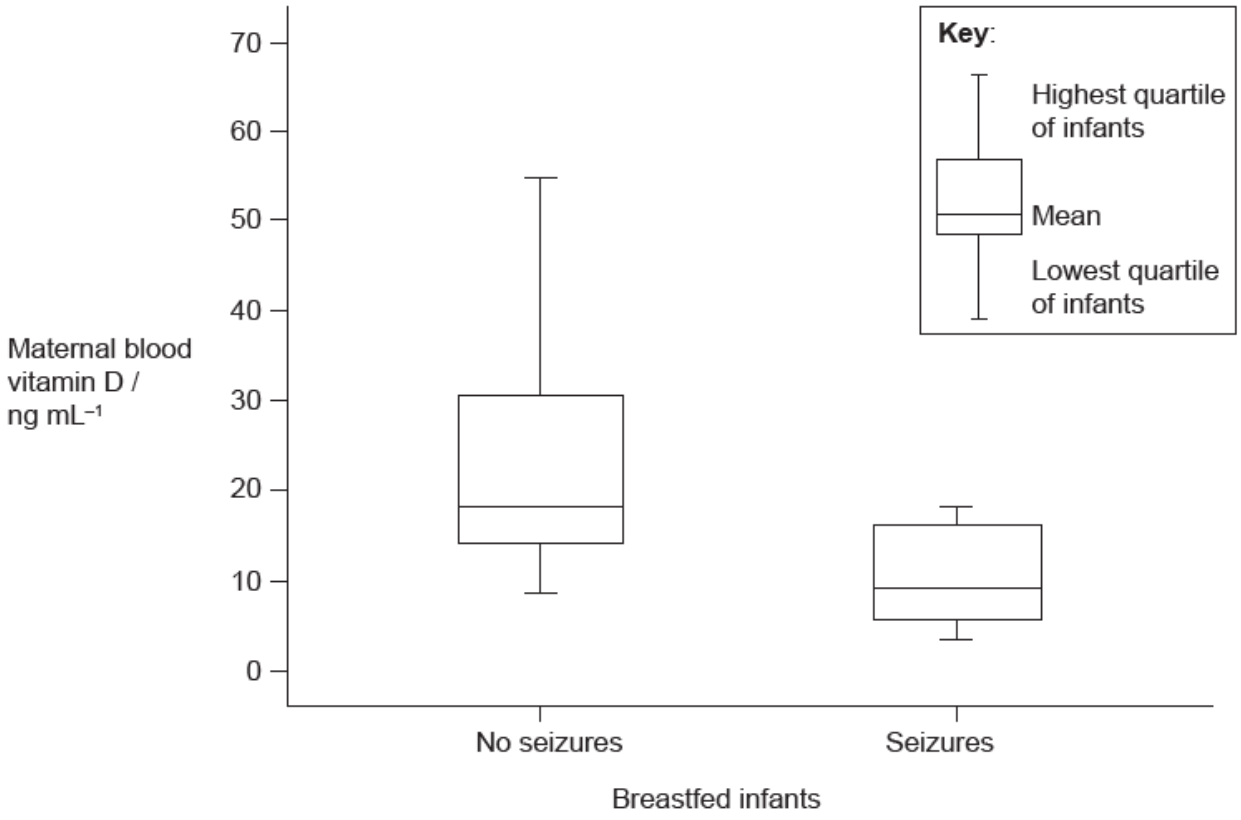
Examiners report

a (i) Many candidates were able to gain the mark for indicating that fibre does not provide energy.

a (ii) Many were able not able to read the nutrient label correctly and see that monounsaturated fats provided the most energy. They incorrectly indicated that proteins did as there were more grams of protein. They did not consider that fats contain more energy than proteins.

b. There were often vague descriptions of the differences between saturated and unsaturated fats. Many indicated that there were double bonds but did not indicate that these were between carbon atoms. Some were confusing double and single bonds with hydrogen bonds.

Breastfed infants with rickets sometimes have seizures due to low blood calcium levels. A study was carried out to investigate the relationship between maternal blood vitamin D levels and the incidence of these infant seizures.



[Source: M M Salam and A S El-Sakka, (2010), *Pakistan Journal of Biological Sciences*, 13(9), pages 437–472]

a.i. Describe the relationship between the maternal blood vitamin D levels and the incidence of seizures. [1]

a.ii. Deduce the reason for rickets in these infants. [1]

b. Identify the reason for vitamin D not being considered to be a typical vitamin. [1]

c. Outline the reason for some amino acids being classified as essential amino acids. [1]

Markscheme

a.i. infants from mothers with low levels of vitamin D have an increased chance of developing seizures

Accept answers in the converse.

a.ii. lack of vitamin D in breast milk OR lack of vitamin D leads to lack of bone mineralization/calcium uptake

b. it can be synthesized by humans «in skin»

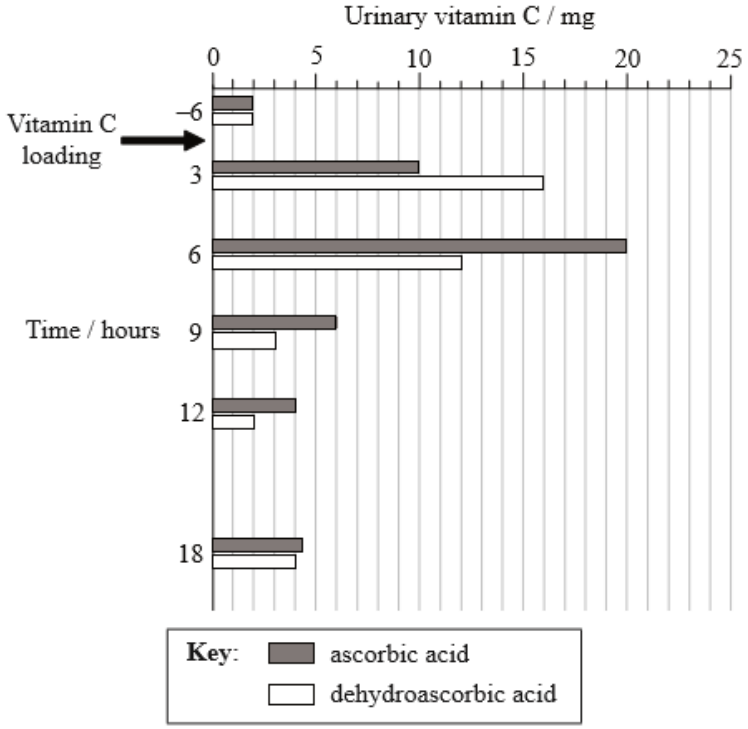
c. a. they cannot be synthesized by humans

b. they must be present in the diet

Examiners report

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

Vitamin C is an important component of a healthy diet. Because it is water-soluble it cannot be effectively stored and excess vitamin C is released in the urine. In order to investigate the ability of the body to retain different chemical forms of vitamin C, 17 healthy, female university students, between the ages of 18 and 22, were placed on a low vitamin C diet (< 5 mg per day) for three days. The test subjects were divided into two groups and were given an oral vitamin C loading of either ascorbic acid (176 mg) or dehydroascorbic acid (174 mg). Levels of vitamin C in the urine were measured six hours before and at regular intervals over a 24 hour period following vitamin C loading. The negative value indicates time before vitamin C loading.



Masaru TSUJIMURA, Shizu HIGASA, Kazuhiro NAKAYAMA, Yoshiko YANAGISAWA, Sadahiko IWAMOTO and Yasuo KAGAWA. 2008. 'Vitamin C Activity of Dehydroascorbic Acid in Humans — Association between Changes in the Blood Vitamin C Concentration or Urinary Excretion after Oral Loading'. *J. Nutr. Sci. Vitaminol.*, 54: 315-320, 1 table.

a. State the urinary vitamin C content for each of the two study groups six hours before vitamin C loading. [1]

Ascorbic acid: .....

Dehyrdoascorbic acid: .....

b. Calculate the percentage increase in urine levels of vitamin C for the ascorbic acid study group during the first three hours after vitamin C loading. [1]

c. Compare the trends in vitamin C release for the two test groups during the first twelve hours after vitamin C loading. [2]

d. Large individual differences in the urine level of ascorbic acid and dehydroascorbic acid were recorded between test subjects after 24 hours. [1]

Suggest **one** possible reason for these large individual differences.

e. Scurvy is a disease that is due to vitamin C deficiency. Evaluate the importance of this investigation for finding ways to combat vitamin C deficiency. [2]

Markscheme

a. *Ascorbic acid*: 2 mg (*units are needed*)

Dehydroascorbic acid: 2 mg (*units are needed*)

Both required for the mark.

b. 400 (%) *(working not required)*

c. more ascorbic acid (40 mg) than dehydroascorbic acid (33 mg) is released/excreted;

more dehydroascorbic acid (16 mg) than ascorbic acid (10 mg) is released/excreted in the first three hours / dehydroascorbic acid peaks before ascorbic acid;

from six hours onwards more ascorbic acid is released than dehydroascorbic acid;

maximum release of dehydroascorbic acid at three hours whereas maximum release of ascorbic acid at six hours;

ascorbic acid release rises then falls whereas dehydroascorbic release falls (until 12 hours after loading);

d. genetic variability / differences in vitamin C metabolism / differences in vitamin C requirements / differences in levels of uptake into blood / size/weight of individuals

e. both chemical forms are released/excreted so supplements need to be given regularly;

using dehydroascorbic acid instead of ascorbic acid does not improve vitamin C retention / dehydroascorbic acid could be marginally better as less is excreted;

study only looks at young/healthy/female subjects;

period of vitamin C deficiency is too short / need a longer period to allow scurvy to develop;

Examiners report

a. Most candidates gave the correct answer, but many omitted the units, and a few simply gave the title of the horizontal axis.

b. There were a lot of incorrect answers of 500%. As mentioned earlier, calculation of percentage change continues to present difficulties for many.

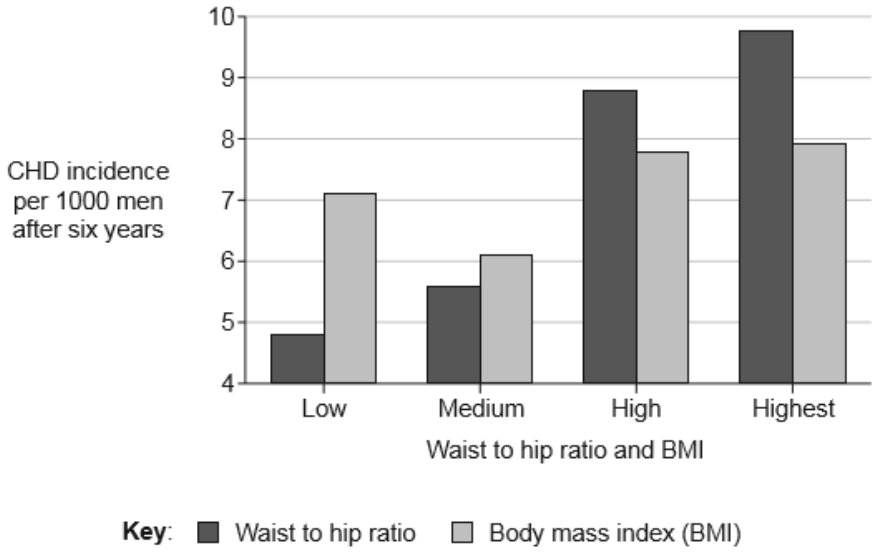
c. The majority of students managed to gain 2 marks, but again, weaker responses did not give comparative statements about the two vitamin C supplements.

d. Few candidates could offer a sensible reason such as size/weight of individuals, genetic variability or differences in vitamin C requirements/metabolism.

e. It seems that many students did not understand the question, as many were writing about the importance of vitamin C in the fight against scurvy, with no reference to the data provided.

---

a. The incidence of coronary heart disease (CHD) was investigated among 14 000 people. Baseline measurements of the waist to hip ratio and body mass index (BMI) were collected from the participants. After six years, evidence of CHD was identified in follow-up interviews. The bar chart shows the results for the men only. [1]



[Source: adapted from AR Folsom, *et al.*, (1998), *American Journal of Epidemiology*, **148** (12), pages 1187–1194, by permission of Oxford University Press]

Deduce with a reason whether the waist to hip ratio **or** the BMI most clearly correlates to incidence of CHD.

b. Explain how electrical signalling in the heart leads to ventricular contraction [4]

Markscheme

a. Waist to hip ratio as increasing ratio shows increasing CHD incidence/increasing BMI does not

Reason required

b. Cardiac muscle transmits electrical signals

OR

cardiac muscle is myogenic

SA node initiates signal

Signal spreads over atria

Reaches the AV node

Signal passes through bundle of His/Purkinje fibres

Signal delayed at AV node/bundle of His

Delay allows ventricles to fill «as atria contract»

Conducting fibers spread signal across ventricle walls

Ventricles contract

Examiners report

a. Both parts (a) and (b) were well answered.

b. Both parts (a) and (b) were well answered with many full mark answers explaining how electrical signalling leads to ventricular contraction.

Iron, folic acid and vitamin B12 (cyanocobalamin) are important components of a healthy diet. These nutrients are necessary for the production of the red blood cells in the body that transport oxygen to the tissues. Deficiency of any of these nutrients can lead to anemia, a condition that causes weakness, tiredness and shortness of breath.

In a study of the Piaroa, a population living in a remote area of Venezuela, investigators discovered very high levels of anemia, especially amongst young children and females of childbearing age. The table below shows the incidence of anemia and deficiencies of iron, folic acid and vitamin B12 in this population, as a percentage.

Sex and age / years	Anemia / %	Iron deficiency / %	Folic acid deficiency / %	Vitamin B12 deficiency / %
Female				
1–3	100	56	75	0
4–10	100	31	50	10
11–20	90	55	90	20
21–40	94	41	80	5
41+	80	33	38	0
Mean	93	43	67	7
Male				
1–3	100	50	75	25
4–10	91	36	50	0
11–20	83	25	88	22
21–40	65	26	100	9
41+	90	18	57	33
Mean	86	31	74	18
Overall mean	**90**	**37**	**70**	**12**

[Source: adapted from M García-Casal, *et al.*, (2009), *Archivos Latinoamericanos de Nutrición*, www.alanrevista.org]

a. Identify the nutrient that is least likely to be deficient in a 45-year-old male in the Piaroa population. [1]

b. Identify the age and sex of the group that suffers from the least amount of anemia in the Piaroa population. [1]

c. Compare the data for the three nutrients in 11–20-year-old females with the data for 11–20-year-old males. [2]

d. The data in the table indicates differences in the incidence of anemia between males and females. Suggest possible causes of these differences. [2]

Markscheme

a. iron

b. 21– 40-year-old males

c. more females than males have iron deficiency (55 %/25 %);

very small difference / 2 % difference between males and females for vitamin B12 deficiency and folic acid deficiency;

Allow valid numerical comparisons.

Accept reverse argument for first point.

d. females lose blood while menstruating;

extra nutrients needed while pregnant;

extra nutrients needed while breastfeeding;

differences in diet/vegetarian/vegan / low ferretin levels;

males receive more food than females/perceived to have greater need/status;

Examiners report

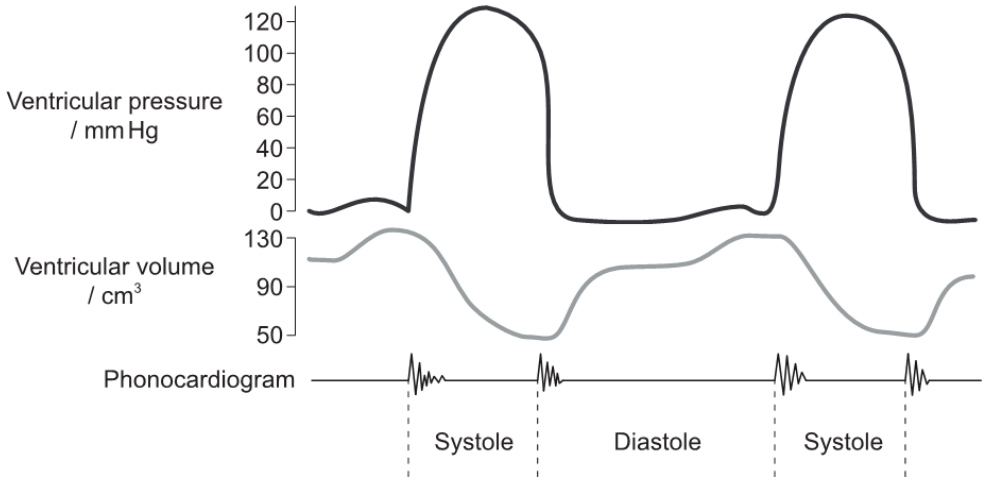
a. Most candidates gave the correct answer.

b. The majority were able to identify the correct group of individuals.

c. Most candidates could state that more females than males had iron deficiency anaemia, but many did not state that there was only a very small difference between males and females for B12 deficiency and folic acid deficiency.

d. Many candidates gained the two marks, but there were a lot of vague answers which did not gain credit. Students do need to try and be specific when suggesting possible answers.

The diagram shows changes in the pressure and volume of the left ventricle during normal heartbeat. The phonocardiogram records heart sounds during the cardiac cycle.



[Source: Wiggers, Carl J. 1923. Modern Aspects of the Circulation in Health and Disease, 2nd ed. Philadelphia: Lea & Febiger, p. 97.]

a. State the relationship between pressure and volume in the left ventricle. [1]

b. Explain the events that cause the sound shown on the phonocardiogram at the start of systole. [2]

c. Outline reasons for fitting an artificial cardiac pacemaker. [2]

Markscheme

a. as pressure increases volume decreases

OR

inverse correlation

Accept reverse argument

Do not accept "inversely proportional"

b. a. when the ventricle contracts blood presses/pressure acts on the AV valve

b. this closes the AV valve «which causes the sound»

The valve must be identified as the AV or atrioventricular valve

c. a. required when rate of heartbeat/heart contraction is too slow/irregular

b. produces electrical impulse that stimulates heartbeat/heart contraction

c. needed when SA node is defective

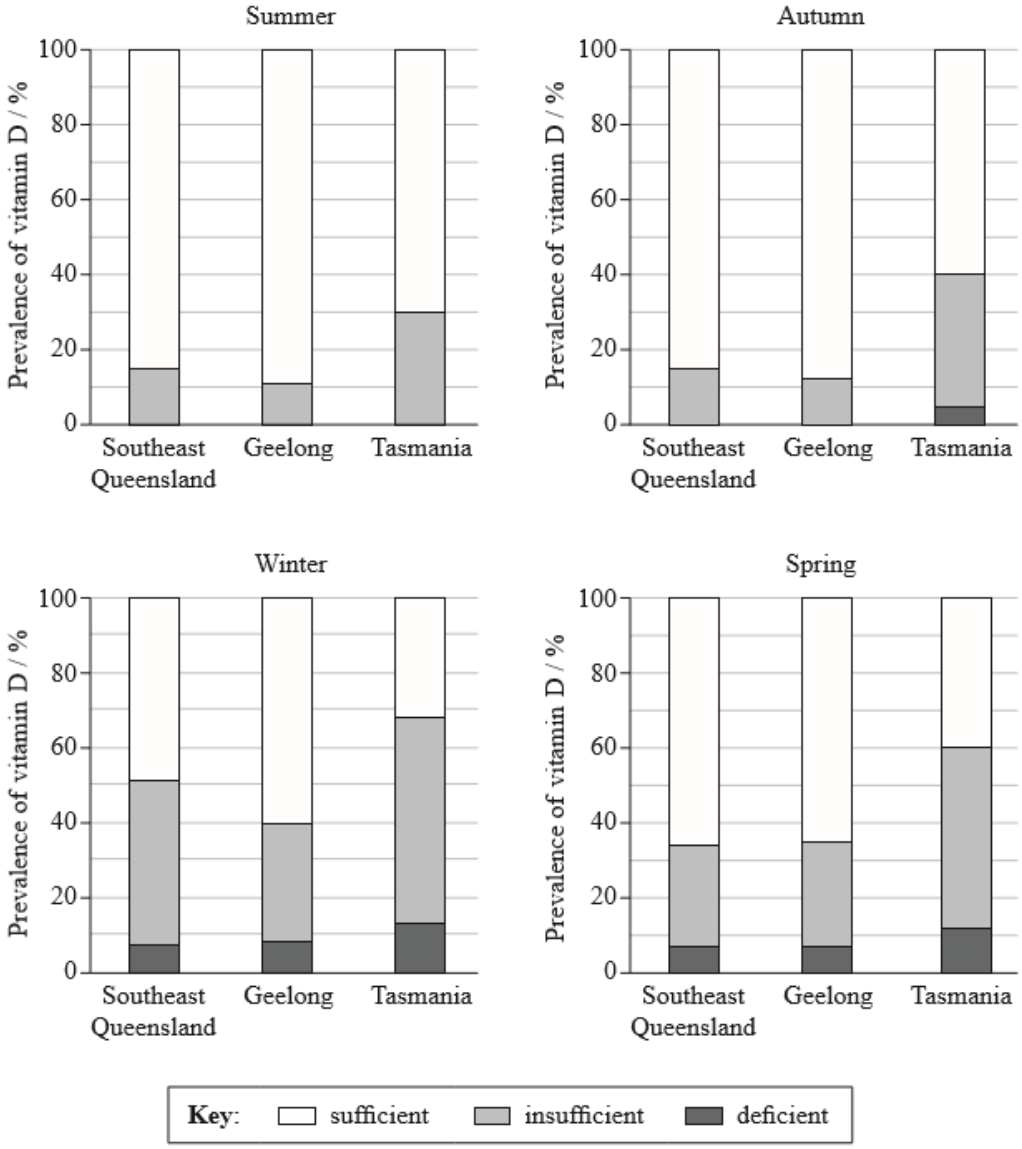
Accept "regulate the heartbeat" for marking point a

[Max 2 Marks]

Examiners report

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

In Australia, a study was undertaken among women to determine the vitamin D levels in their blood. Levels of vitamin D were categorized as sufficient, insufficient and deficient to determine how prevalent each category was. Three locations at three different latitudes and four different seasons were used. A data summary is shown in the graphs below.



Van der Mei, I.A., Ponsonby, A.-L., Engelsen, O., Pasco, J.A., McGrath, J.J., *et al.* (2007) "The high prevalence of vitamin D insufficiency across Australian populations is only partly explained by season and latitude". *Environ. Health Perspect.*, 115(8): doi:10.1289/ehp.9937.

a (i). Identify the season when the women are least likely to suffer from vitamin D deficiency. [1]

a (ii). Using the data from all four seasons, identify the **two** locations where the patterns of vitamin D are most similar. [1]

a (iii). Determine what percentage of women in Geelong have insufficient vitamin D levels in winter. [1]

b. Compare the deficiency levels of vitamin D at all three locations. [3]

c. Location and season were found to account for only a small part of the deficiencies. Suggest, with reasons, how the behaviours of different people could influence the levels of vitamin D in their blood. [2]

Markscheme

a (i) summer

a (ii) Geelong and (Southeast) Queensland (*both needed*)

a (iii) (40 – 8) = 32% (*accept answers in the range of 31 % to 33 %*)

b. *similarity*:

none of the locations are deficient in Summer;

Geelong and (Southeast) Queensland have similar prevalence/levels of deficiency at all times of the year;

difference:
only Tasmania shows a deficiency in autumn;
Tasmania shows the highest prevalence of deficiency;
(Southeast) Queensland shows less prevalence/levels of deficiency overall;
*To award **[3]**, answers must address at least one similarity and one difference.*

c. diets rich in vitamin D could raise vitamin D levels; (*vice versa*)

use of sunscreen/staying out of the sun/hats/clothing can reduce the production of vitamin D by the skin; (*vice versa*)

use of dietary supplements containing vitamin D can reduce deficiency levels;

Examiners report

a (i) N/A

a (ii) N/A

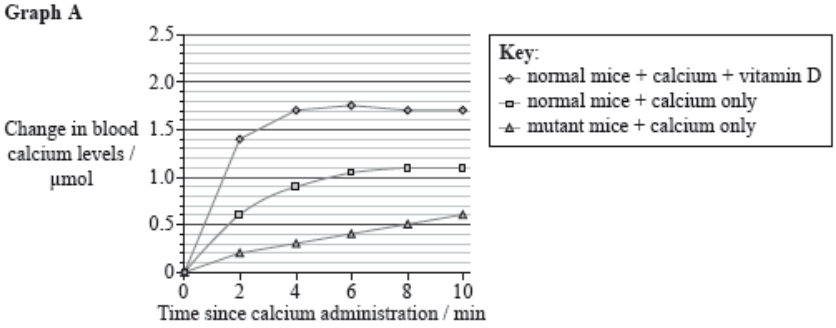
a (iii) N/A

b. The data in A1 was well understood by most candidates who were able to compare the data in A1 (b).

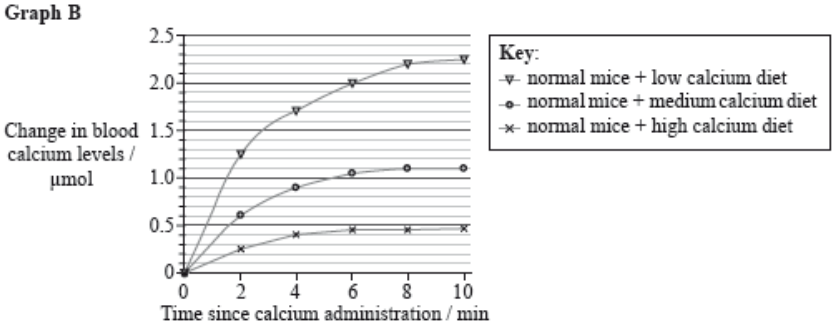
c. The data in A1 was well understood by most candidates who were able to compare the data in A1 (b) and suggest behaviours to influence their levels of vitamin D. Many candidates gave only one behaviour, thereby denying themselves the opportunity for a second mark. Most explained that people could expose themselves to more or less sunlight but few discussed dietary supplements.

Rickets, caused by a defective vitamin D receptor (VDR), can be prevented by high calcium intake. A series of experiments were performed to test this. The results are shown in the graphs. Graph A shows the change in blood calcium levels after calcium administration in normal mice with and without addition of vitamin D. It also shows the change in blood calcium levels in mutant mice, which lack the vitamin D receptor. Graph B shows the change in blood calcium levels after calcium administration in normal mice after being subjected to one week of low, medium and high calcium diets.

Graph A



Graph B



[S. J. Van Cromphaut, M. Dewerchin, J. G. J. Hoenderop, I. Stockmans, E. Van Herck, S. Kato, R. J. M. Bindels, D. Collen, P. Carmeliet, R. Bouillon et al. (2001) "Duodenal calcium absorption in vitamin D receptor-knockout mice: Functional and molecular aspects" PNAS, 98 (23), pp. 13324–9. Figure 2 (adapted). Copyright 2001 National Academy of Sciences, USA.]

a. State the change in blood calcium levels in normal mice 10 minutes after the administration of calcium, with and without the addition of vitamin D. [1]

With vitamin D:

Without vitamin D:

b. Compare the changes in blood calcium levels in normal mice and in mutant mice after the administration of calcium. [2]

c. Explain, using graph B, the changes in blood calcium levels for the mice with different diets. [2]

d. Discuss whether the scientists were able to support their hypothesis that rickets caused by the defective vitamin D receptor can be prevented by the intake of large amounts of calcium. [2]

Markscheme

a. *with vitamin D:* (from 0.0 to) 1.7 µmol *(units required – allow answers in the range of 1.65 to 1.75 µmol)*

without vitamin D: (from 0.0 to) 1.1 µmol *(units required – allow answers in the range of 1.05 to 1.15 µmol)*

Both needed to award the mark.

b. a. both increase with time;

b. normal mice have a greater increase in blood calcium levels than mutant mice (after ten minutes);

c. normal mice have a maximum change of 1.1 µmol while mutant mice have a maximum change of 0.6 µmol;

d. mutant mice show gradual increase while normal mice show rapid increase followed by a plateau;

c. a. mice with low calcium diets have a greater increase in blood calcium levels (after calcium administration) because their body absorbs more calcium;

   b. if they have had a high calcium diet they do not need to absorb so much calcium / *vice versa*;

   c. probably receptors are all occupied/inhibited / less receptors;

d. a. hypothesis supported as blood calcium levels increased in mutant mice after intake of calcium (graph A);

   b. but less than in normal mice / perhaps not enough to cure disease/rickets;

   c. administering vitamin D also shows an increase in blood calcium levels (graph A);

   d. but no good administering vitamin D as the receptor is defective;

   e. in a high calcium diet, less absorption occurs (graph B), so might not be the solution;

   f. should have tested mutant mice with different diets;

Examiners report

a. Most candidates read the graphs correctly to obtain the correct numerical values but a surprising number lost marks for not including units.

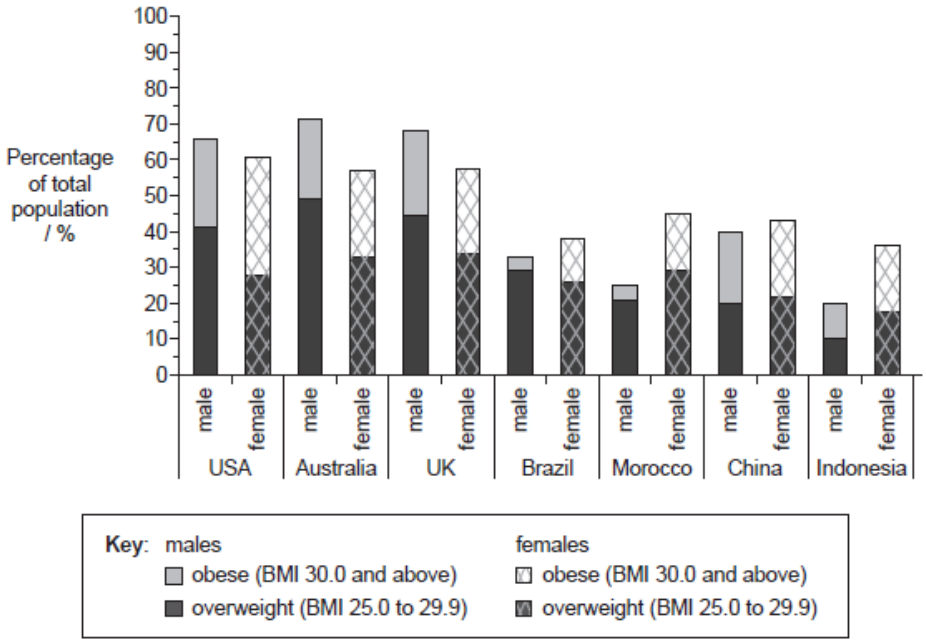
b. Most candidates were able to get two marks for recognizing that although both mutant and normal mice showed an increase in calcium levels over time, the normal mice had a greater increase which was rapid and then plateaued while the mutant mice had a more gradual increase. Candidates need to be careful that when they answer a compare question, that they actually compare the two items requested rather than simply describe each.

c. Candidates struggled with this question as they did not “explain” the changes in blood calcium levels; they simply stated what was in the graph. Those who did attempt an explanation, understood that the mice with a low calcium diet would need to absorb more calcium and therefore the increase in blood calcium levels would be more. Very few commented on that fact that receptors were involved in some way.

d. Candidates also struggled with this question. Stronger candidates were able to get two marks for the support of the hypothesis shown in graph A or that it was not supported as shown in the lower absorption of calcium in high calcium diets in graph B. No candidates commented on the idea that that the investigation did not test mutant mice on different diets.

Nationally representative data was collected on body mass index (BMI) from 1985 to 2004.

The graph shows overweight and obesity patterns in adult males and females from seven countries.



[Source: adapted from B Popkin, (2006), *American Journal of Clinical Nutrition*, **84**, pages 289–298]

a. State which country has the lowest total percentage of overweight and obese adults. [1]

b. Distinguish between the levels of male obesity and female obesity. [2]

c. Compare the overweight and obesity patterns in Australia and Morocco. [2]

d. Suggest **two** possible reasons for the differences in BMI from the reported countries. [2]

Markscheme

a. Indonesia

b. a. higher percentage of obese females (compared to males);

b. greatest difference is in Morocco/Brazil;

c. least difference (between obese males and females) is in China/UK;

Accept numerical distinctions.

c. a. higher total percentage of overweight/obese in Australia (compared to Morocco);

b. Australia has more overweight/obese males than females and Morocco has more overweight/obese females than males / *vice versa*;

c. less difference between male and female obesity in Australia than Morocco / *vice versa*;

d. more overweight than obese in both Australia and Morocco;

d. a. different availability/poverty/costs of inexpensive high-energy/high fat/high sugar foods;

b. portion sizes / availability of away-from-home food/fast food;

c. different levels of activity / sedentary lifestyle;

d. cultural differences;

e. nutritional education;

f. genetic/inherited differences;

Examiners report

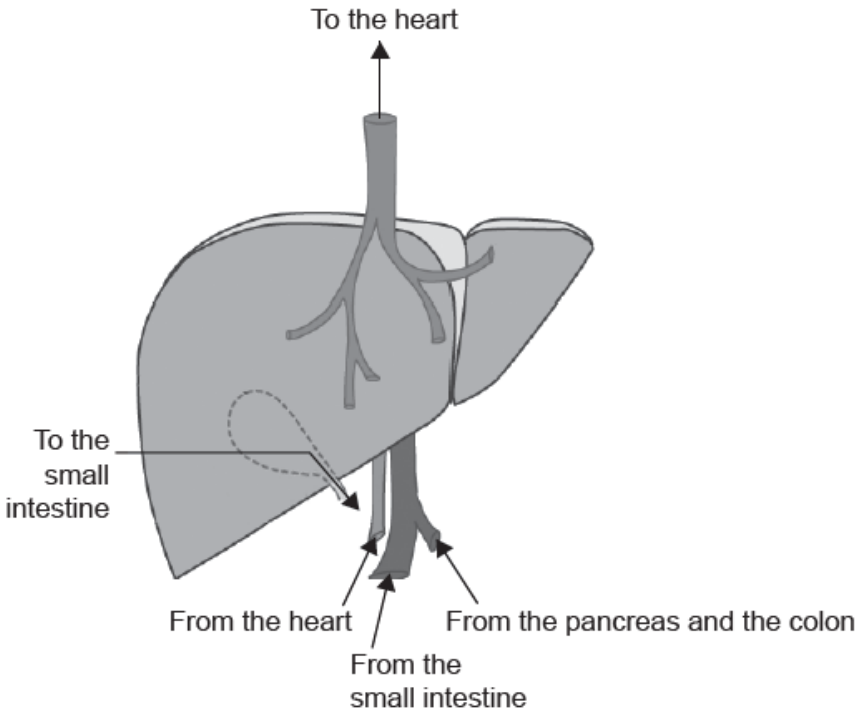
a. Overall, the candidates performed well in the interpretation of the data though a few could not read the stacked bar chart.

b. Overall, the candidates performed well in the interpretation of the data though a few could not read the stacked bar chart.

c. Weaker candidates were unsure whether to compare overweight and obesity or Australia and Morocco.

d. [N/A]

The diagram below shows the liver and main vessels associated with it.



[Source: Adapted with permission of the Canadian Cancer Society, Liver Cancer: The Liver, http://www.cancer.ca/en/cancer-information/cancer-type/liver/anatomy-and-physiology/?region=nb, accessed 14 July 2017]

Suggest advantages of the blood supply from the pancreas passing directly into the liver.

Markscheme

a. the liver can respond quickly to hormones made by the pancreas

b. the pancreas secretes insulin / glucagon into the blood «traveling directly to the liver»

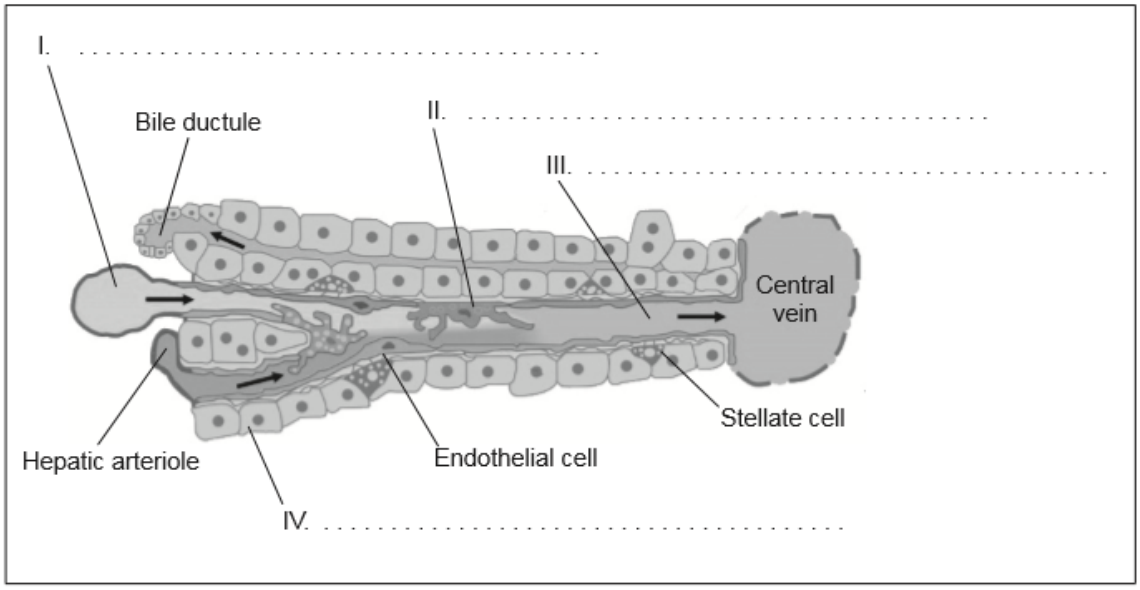
c. «the hormones released by the pancreas» stimulate the liver to store / release glucose

d. allows rapid regulation of blood glucose levels

Examiners report

[N/A]

a. The liver's unique blood supply and system of ducts allow proper functioning of its hepatocytes and Kupffer cells. These cells are found throughout the liver in functional units called liver lobules. The image shows a cross section of the blood and bile paths in a liver lobule. [2]



[Source: Ute Frevert, Sabine Engelmann, Sergine Zougbédé, Jörg Stange, Bruce Ng, Kai Matuschewski, Leonard Liebes, Herman Yee. Intravital observation of Plasmodium berghei sporozoite infection of the liver. *PLoS Biol.*: 2005, 3(6);e192 PubMed 15901208]

Label the structures I, II, III and IV.

b. Outline functions of hepatocytes that involve changing the chemical composition of the plasma. [2]

Markscheme

a. *I*: Portal venule (*Do not accept portal vein in place of venule*)

II: Kupffer cell

III: «Hepatic» sinusoid

IV: Hepatocyte/hepatic cell

*Award **[1]** for any two correctly labelled*.

b. Can store or release glucose

OR

regulate nutrient levels

Can remove toxins from/detoxify blood

Produce plasma proteins

Synthesis of cholesterol/phospholipids/bile salts

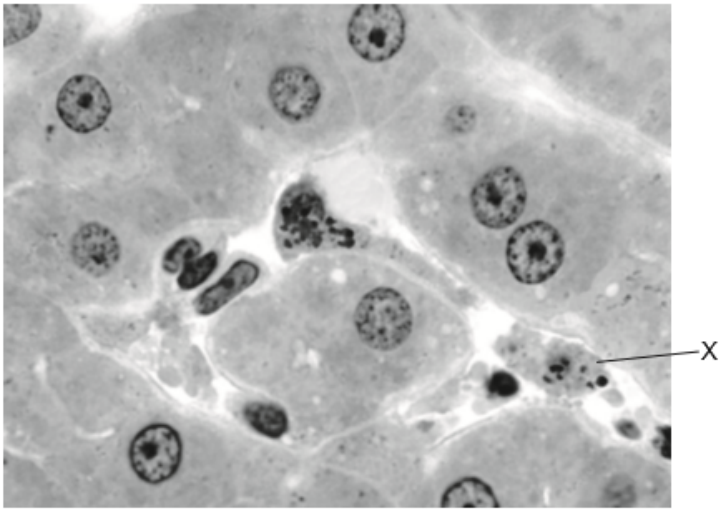
(*Do not accept functions of Kupffer cells* (*eg: breaking down red blood cells*))

Examiners report

a. Discriminated well. Few candidates recognised structure I as a venule.

b. Discriminated well. The better candidates successfully outlined functions of hepatocytes.

The micrograph shows a section through the human liver.



[Source: Dr Thomas Caceci, Virginia Tech/Carilion School of Medicine.]

a. The cell labelled X is only found in the liver and is associated with the wall of a sinusoid. [3]

(i) Identify cell X.

(ii) Outline the function of cell X.

b. Explain the importance of bilirubin in the onset of jaundice. [4]

Markscheme

a. (i) Kupffer cell

(ii)

a. they are macrophages/phagocytes

b. break down red blood cells

c. separates heme (group) from (protein) globin chain

There is no ECF here.

b. a. «jaundice is» a yellowish pigmentation of the skin/whites of eyes

b. caused by high levels of bilirubin in blood/tissues

Simply stating "caused by high levels of bilirubin" is not enough for marking point b. However "tissues" may be implied as part of the answer to marking point a.

c. comes from breakdown of red blood cells

d. results from the breakdown of the heme group of hemoglobin

e. released into blood when excess is produced

f. released into blood when bile ducts blocked

g. normally excreted with bile

h. jaundice is often seen in liver disease such as hepatitis/liver cancer/chronic alcoholism/cirrhosis
OR
newborn/neonatal jaundice «due to immature liver»

Examiners report

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

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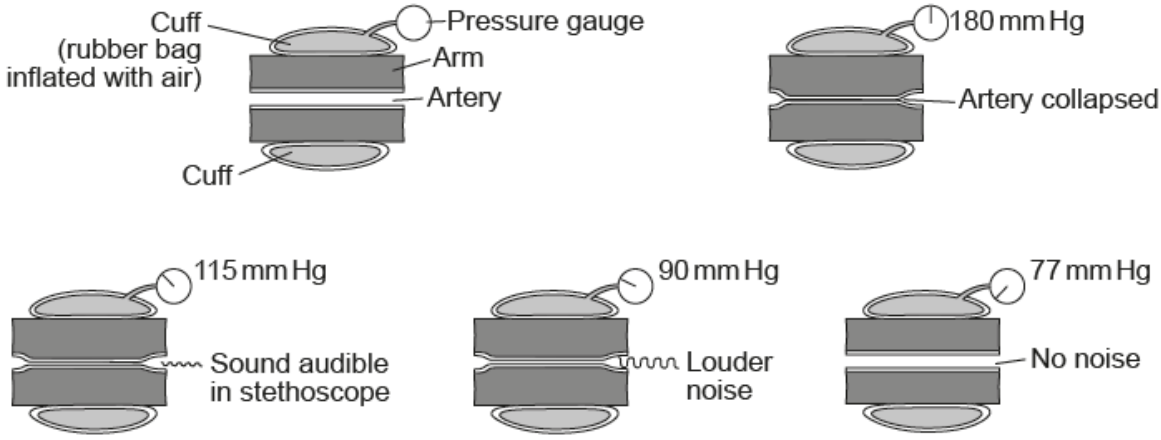
a. The diagram shows the use of a sphygmomanometer in the measurement of blood pressure. [1]



[Source: adapted from CA Villee, (1972), *Biology*, Sixth Edition, page 357]

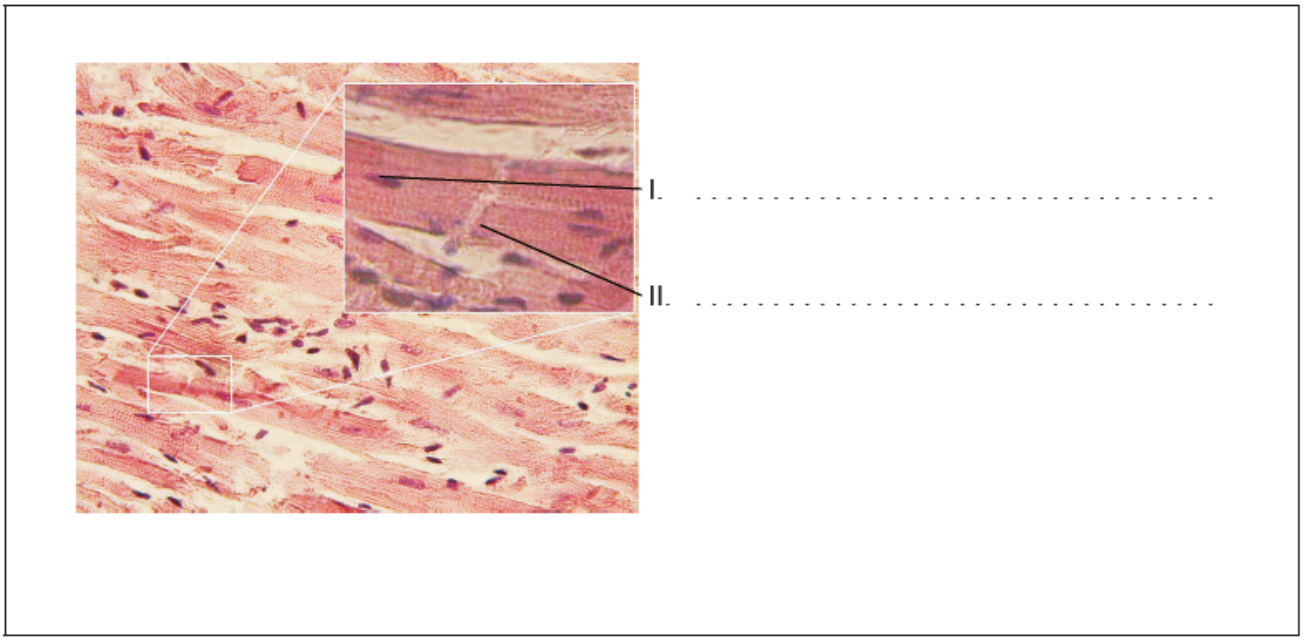
Identify the systolic pressure and diastolic pressure for this adult male.

Systolic pressure (mm Hg):

Diastolic pressure (mm Hg):

b. Explain the meaning of systolic and diastolic pressure. [3]

c. The photomicrograph shows cardiac muscle. Label the structures I and II. [2]



[Source: https://en.wikipedia.org/wiki/Cardiac_muscle#/media/File:Glanzstreifen.jpg]

Markscheme

a. systolic: 115

diastolic: 77 «mmHg»

Both needed for the mark.

b. a. «systolic/diastolic» pressure is the force of blood on arteries

b. systolic pressure is measured when the ventricle contracts

OR

systolic pressure is when blood is being pumped out of the heart

c. diastolic pressure is measured when the ventricles are filled with blood
OR
heart is at rest/relaxed

c. *I*: nucleus

II: intercalated disc

Examiners report

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