SL Paper 3

Discuss the causes and treatments of phenylketonuria.

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]

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

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

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

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

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

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]

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

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

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]

Explain the possible health risks of being overweight.

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

1.

2.

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

Outline consequences of protein deficiency malnutrition.

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]

Explain possible health consequences of diets rich in fats.

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]

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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]

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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]

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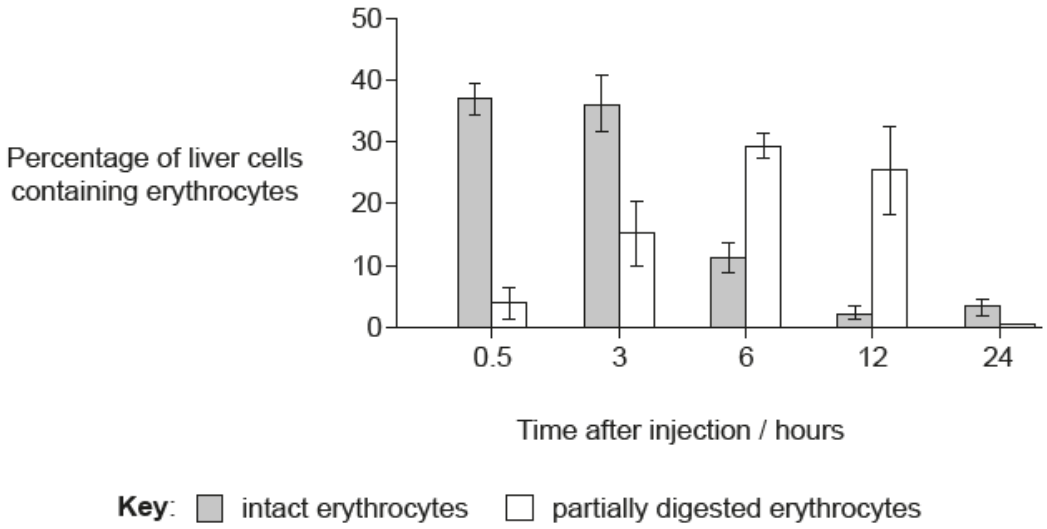
a. Outline the molecular structure of different types of fatty acids. [3]

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

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

Explain a method to quantify the energy content in food.

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.



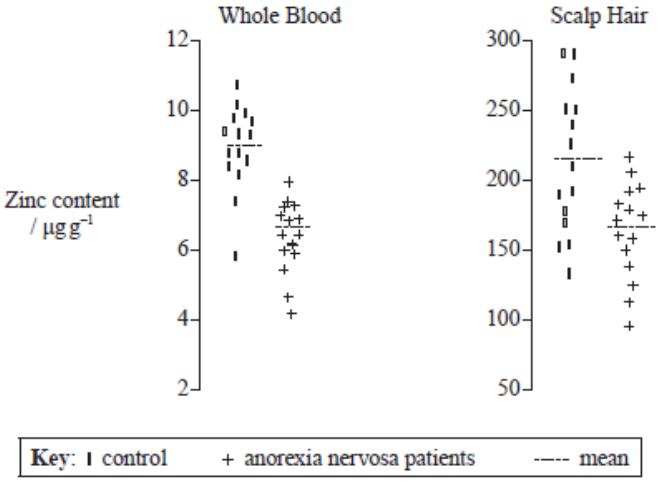
[Source: adapted from D J Loegering, *et al.*, (1987), *Infection and immunity*, pages 2074–2080]

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]

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 T E 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]

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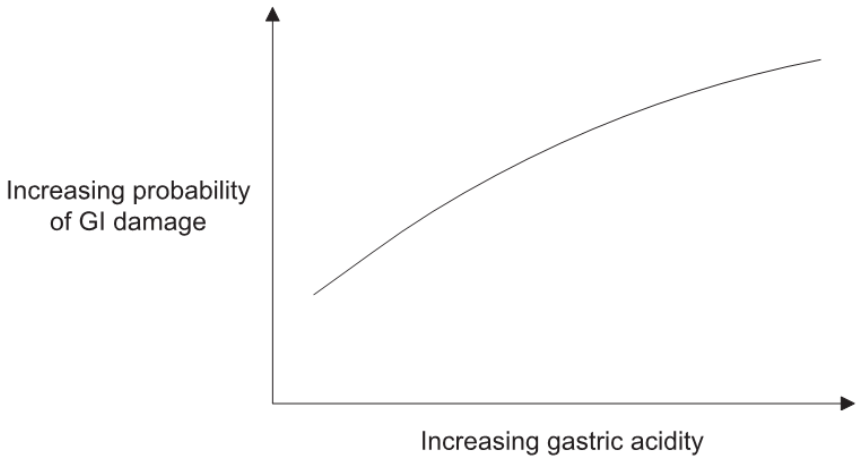
a. Outline the importance of fibre as a component of a balanced diet. [3]

b. Distinguish between minerals and vitamins. [1]

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]

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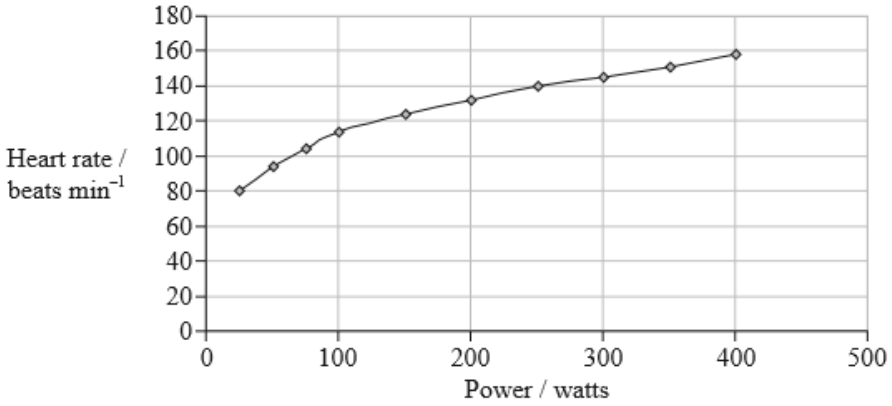
a. Water and minerals are essential in the human diet. List two other types of nutrient in a human diet. [1]

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

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

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]

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]

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

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

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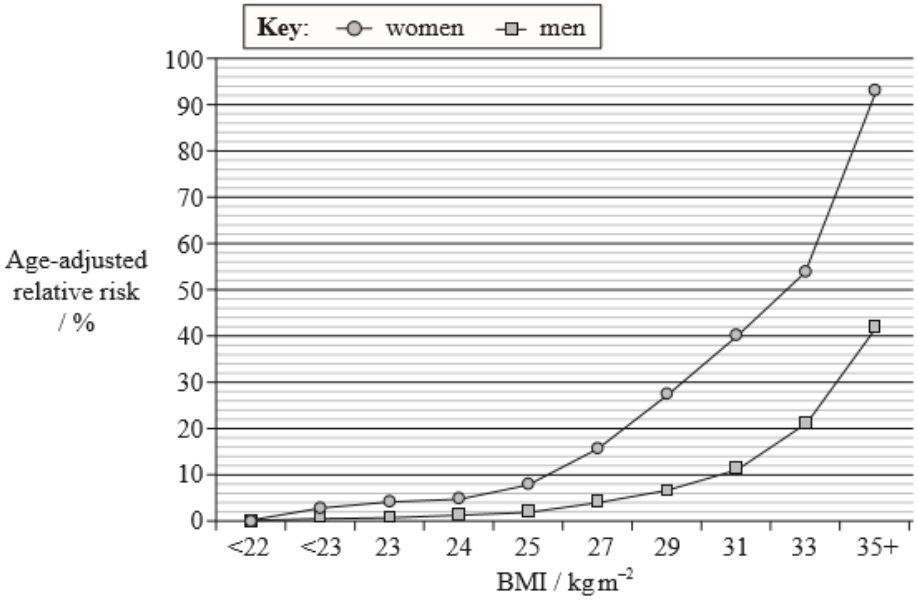
a . State two symptoms of type II diabetes. [2]

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

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]

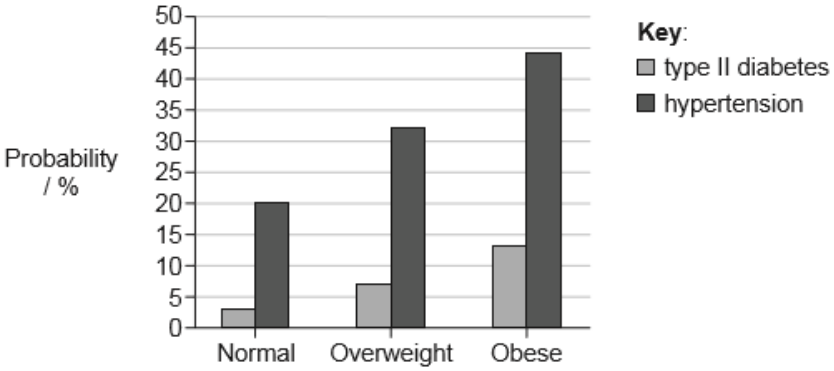
a. Describe the effect of increased BMI on the risk of developing type II diabetes. [2]

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]

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]

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

[Source: Published with permission of the Publisher. Original source: Vázquez M, Olivares JL, Fleta J, Lacambra I, González M. Cardiac Disorders in Young Women With Anorexia Nervosa. *Rev Esp Cardiol* 2003;56:669-73.
]

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. . . . . .

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]

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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]

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]

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

[Source: © International Baccalaureate Organization 2016]

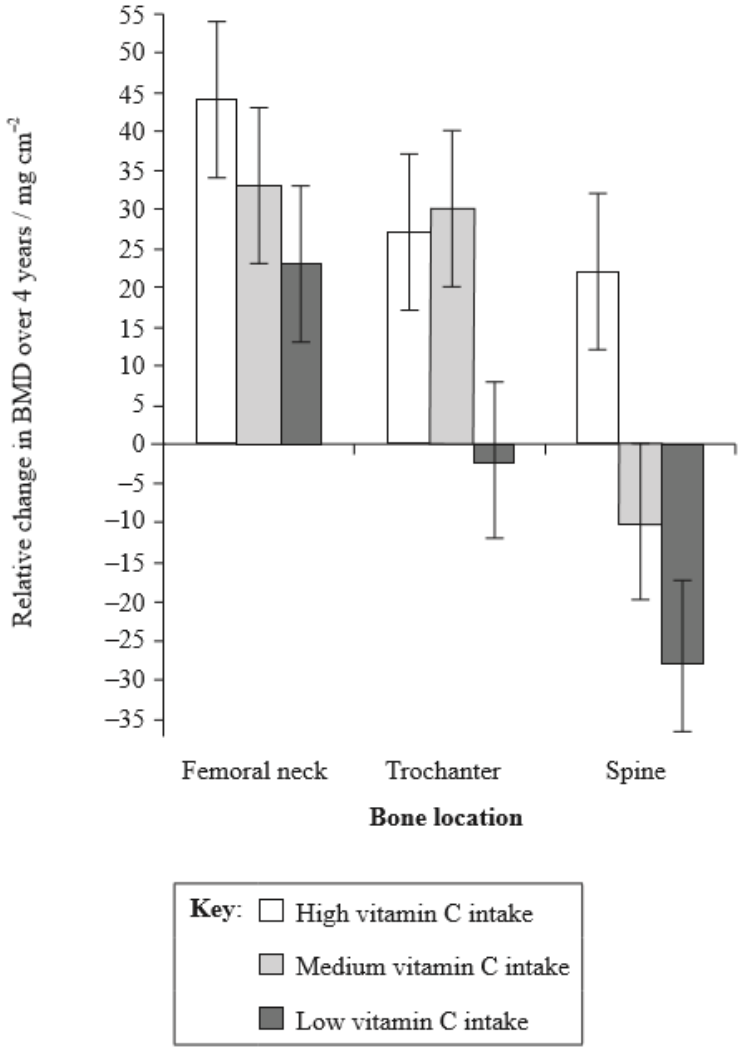
a. Deduce with reasons which **two** oils would be the best sources of fatty acids for a healthy diet. [2]

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.

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]

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]

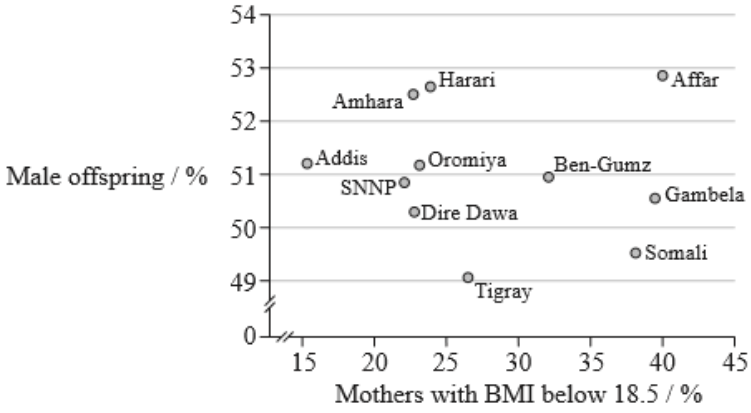
. . . . . kg

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]

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: .....

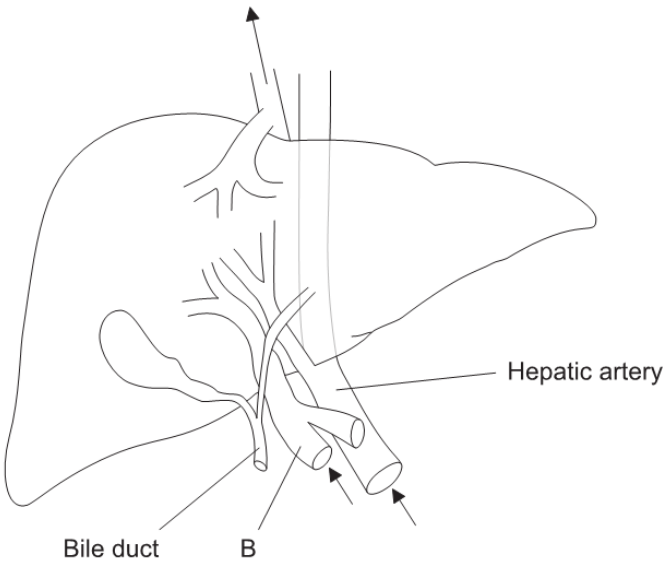
b. Comment on the variation in BMI of mothers in Ethiopia. [2]

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]

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



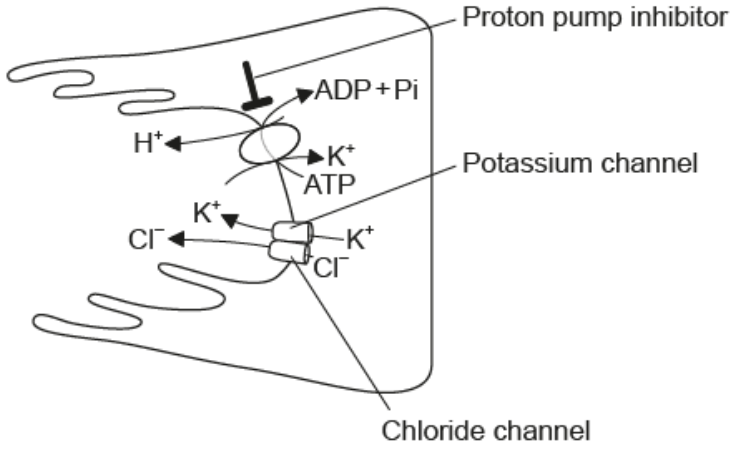
[Source: © International Baccalaureate Organization 2017]

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]

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

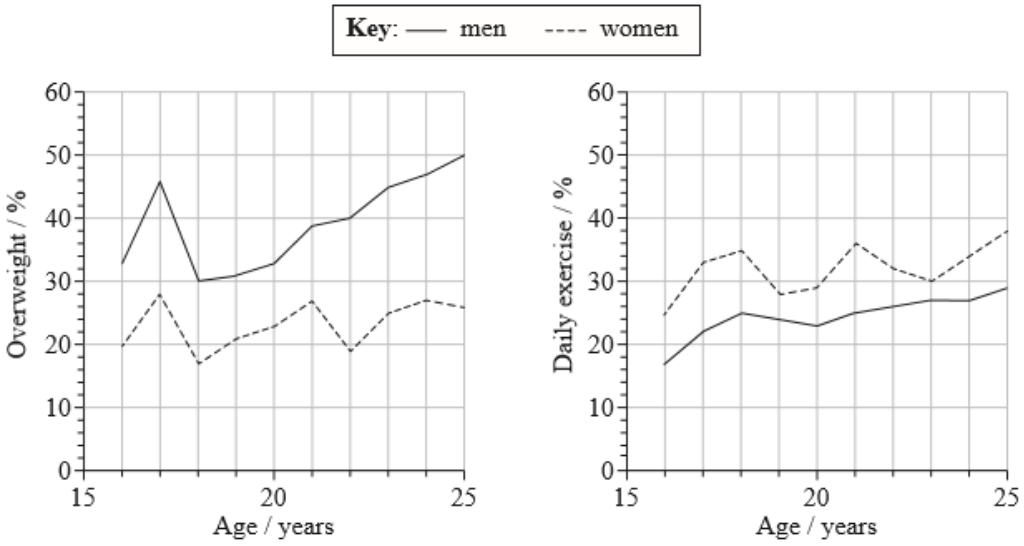


[Source: © International Baccalaureate Organization 2017]

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]

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]

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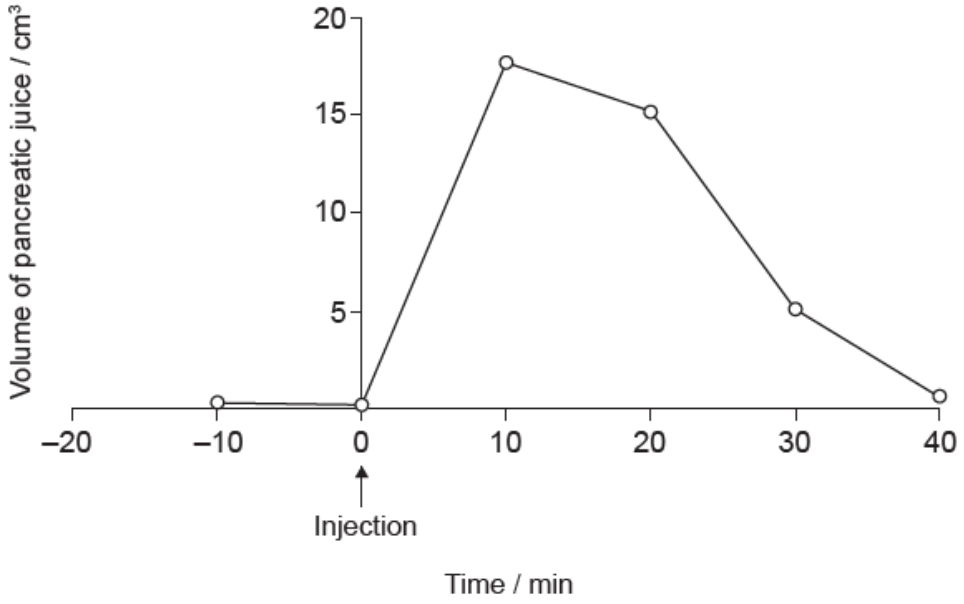
a. State **two** roles of hydrochloric acid in gastric juice. [2]

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.



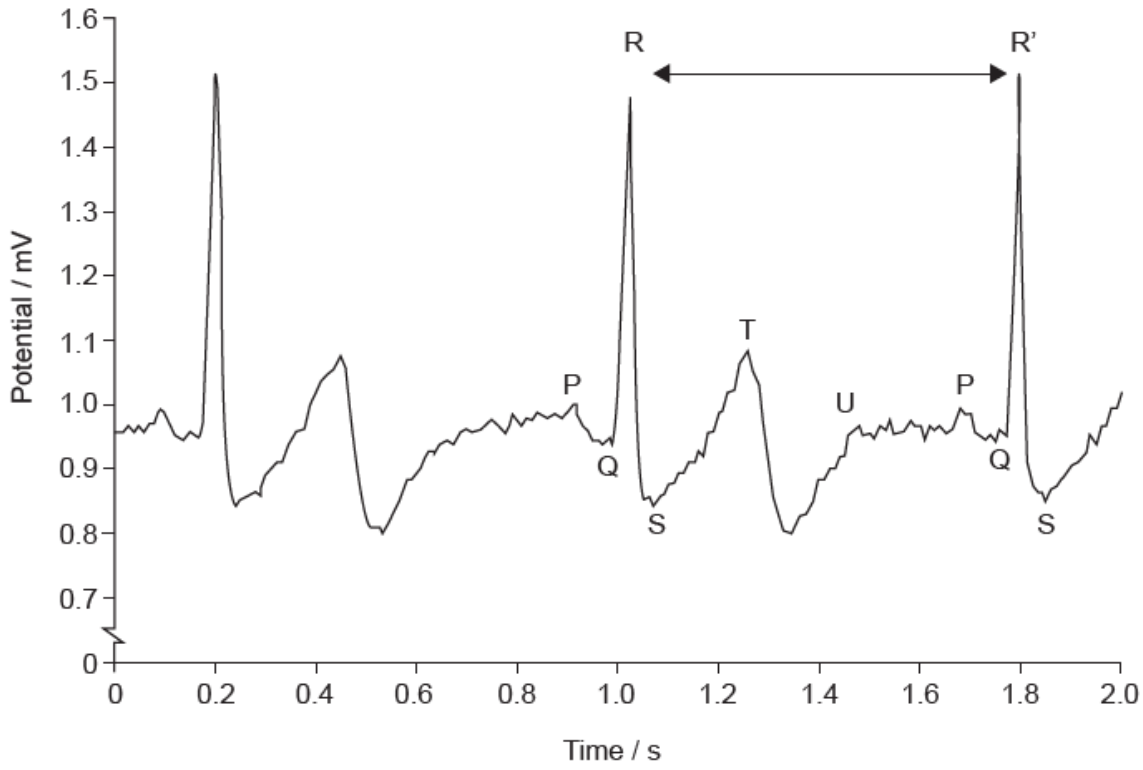
[Source: K E Barrett *et al.* (2010) *Ganong's review of medical physiology*, page 438,© McGraw Hill Education.]

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]

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]

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

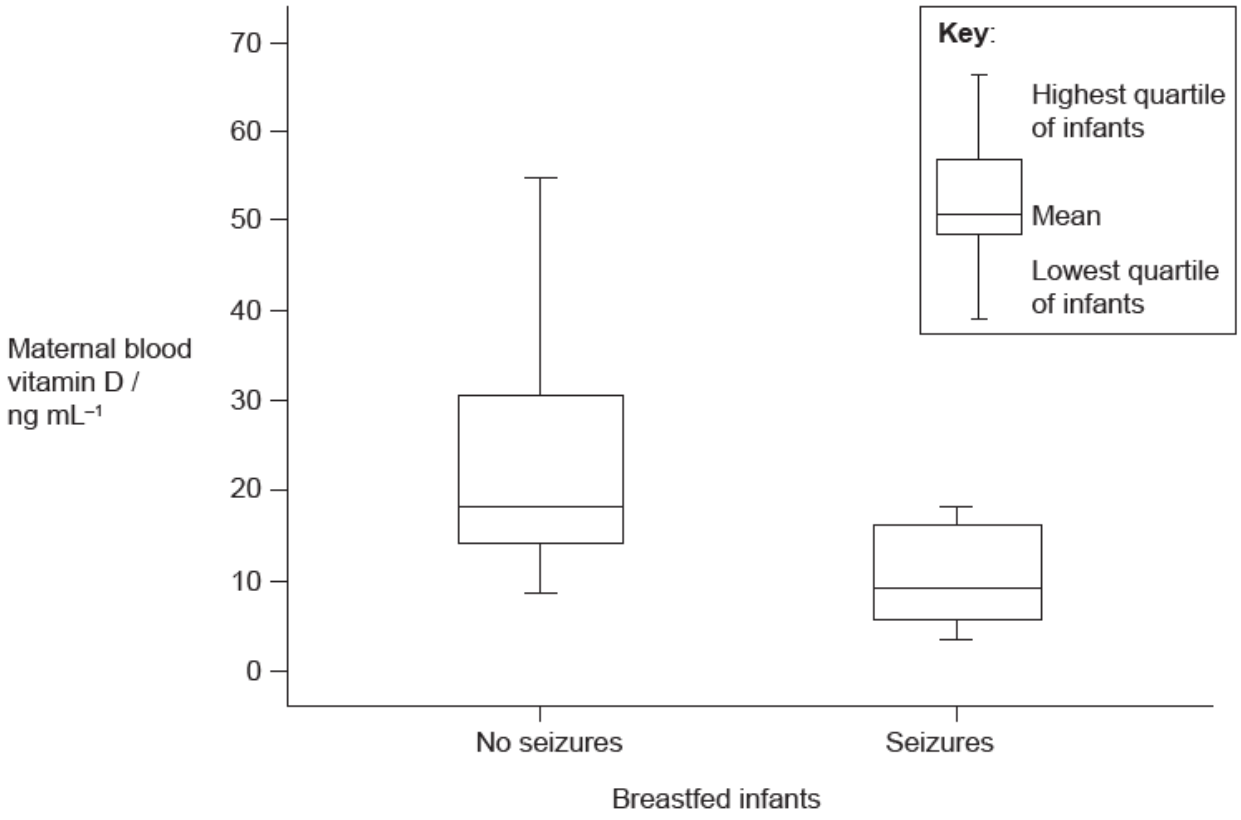
Per 25 g serving (approximately 28 peanuts)	
Carbohydrates:	4.6 g
Fibre:	2.4 g
Protein:	7.3 g
Saturated fat:	1.9 g
Monounsaturated fat:	6.9 g
Polyunsaturated fat:	4.4 g

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]

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]

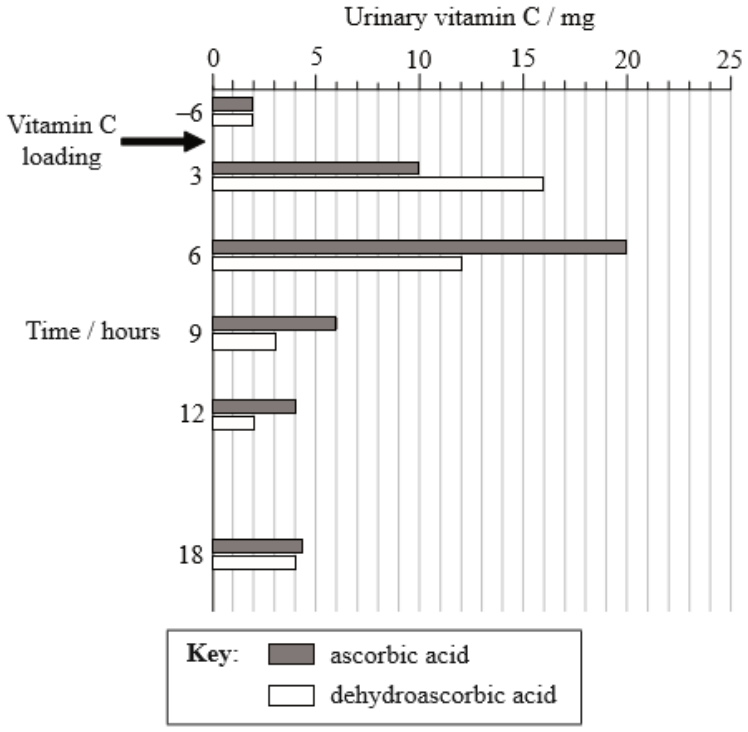
a.i. Describe the relationship between the maternal blood vitamin D levels and the incidence of seizures. [1]

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]

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. Suggest **one** possible reason for these large individual differences. [1]

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]

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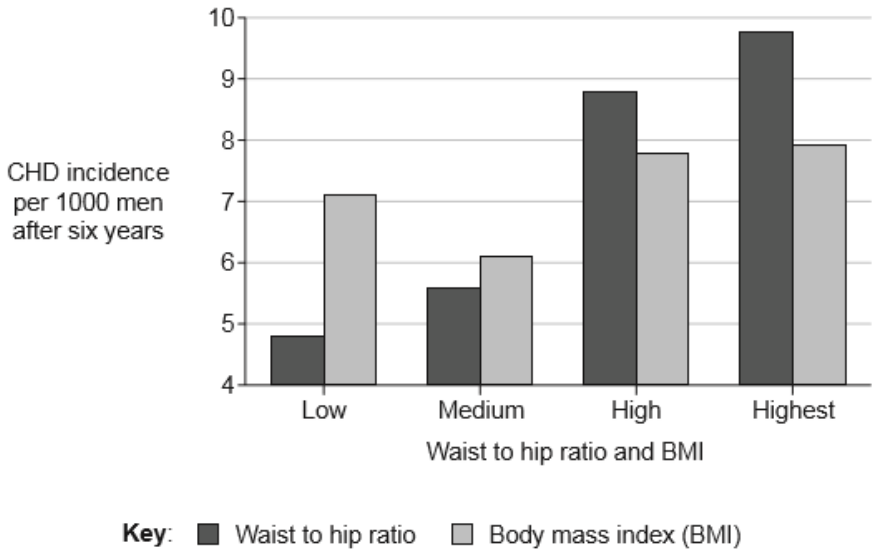
a. The incidence of coronary heart disease (CHD) was investigated among 14 000 people. Baseline measurements of the waist to hip ratio and body mass index (BMI) were collected from the participants. After six years, evidence of CHD was identified in follow-up interviews. The bar chart shows the results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

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]

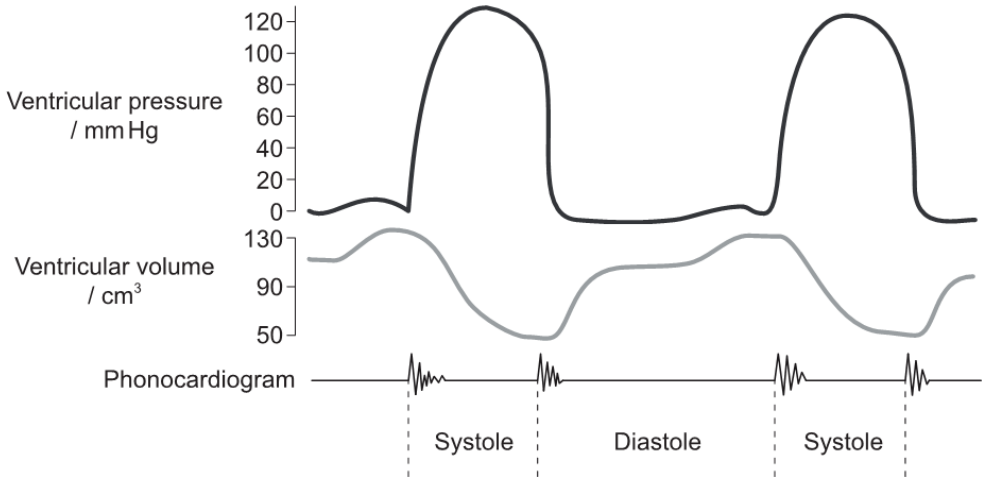
a. Identify the nutrient that is least likely to be deficient in a 45-year-old male in the Piaroa population. [1]

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]

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.



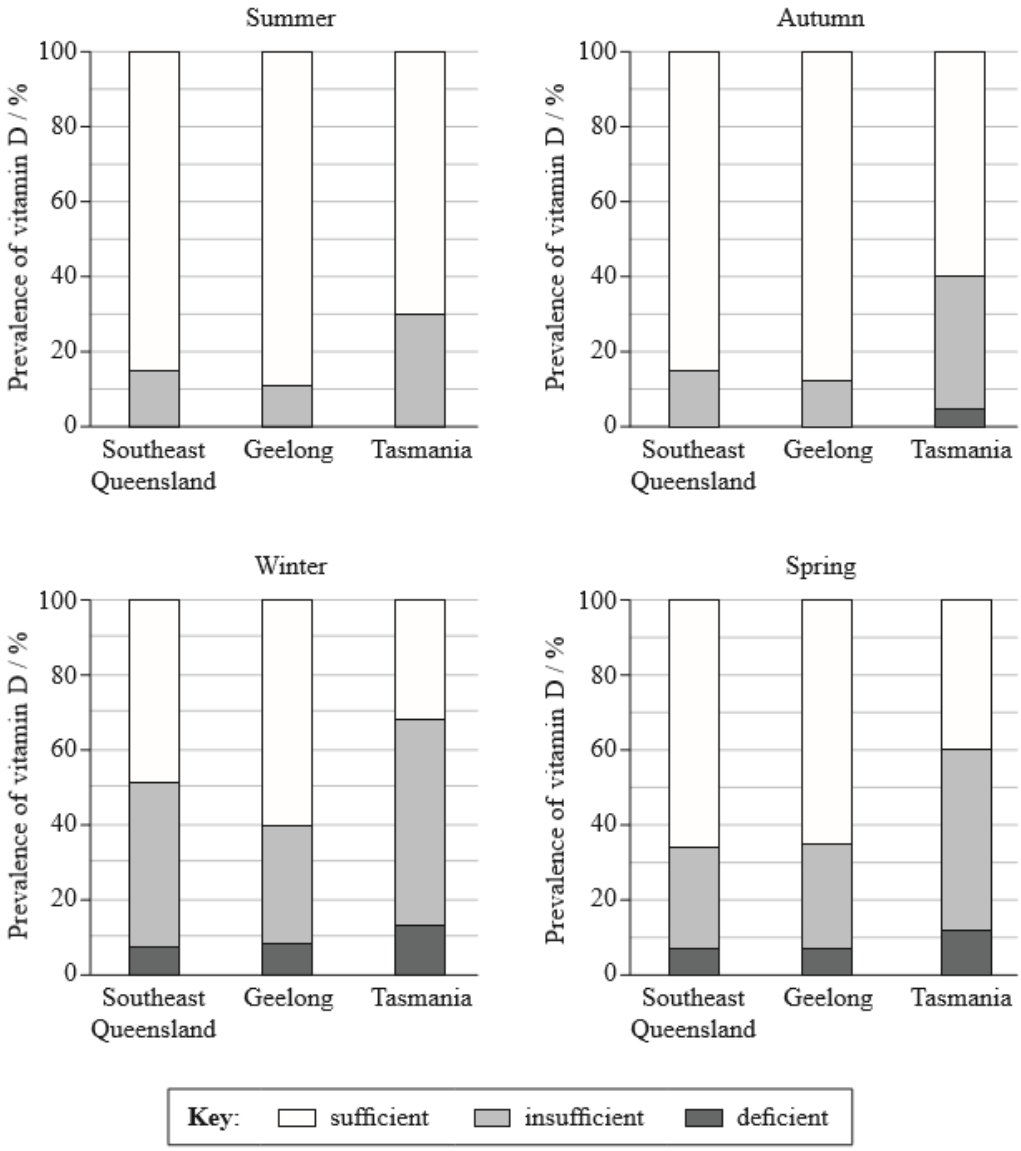
[Source: Wiggers, Carl J. 1923. Modern Aspects of the Circulation in Health and Disease, 2nd ed. Philadelphia: Lea & Febiger, p. 97.]

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]

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]

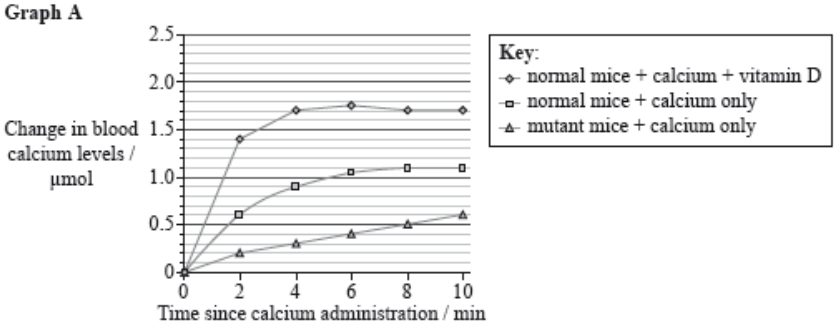
a (iii). Determine what percentage of women in Geelong have insufficient vitamin D levels in winter. [1]

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

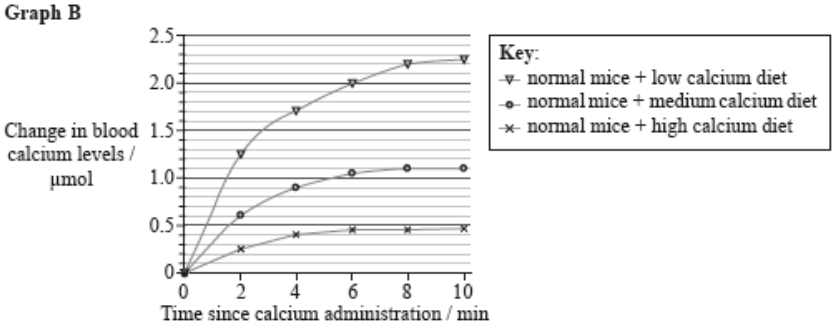
c. Location and season were found to account for only a small part of the deficiencies. Suggest, with reasons, how the behaviours of different people could influence the levels of vitamin D in their blood. [2]

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:

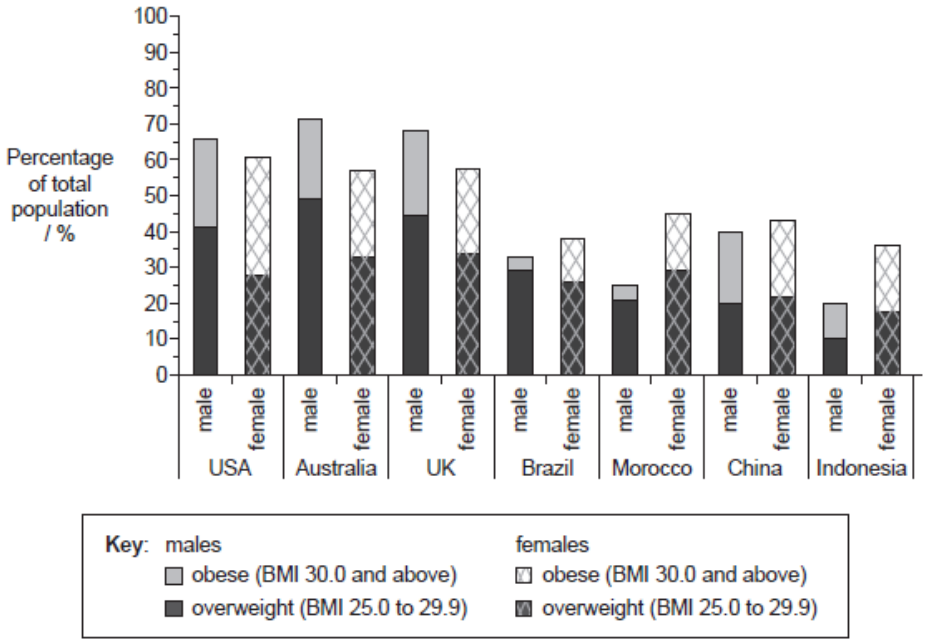
b. Compare the changes in blood calcium levels in normal mice and in mutant mice after the administration of calcium. [2]

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]

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]

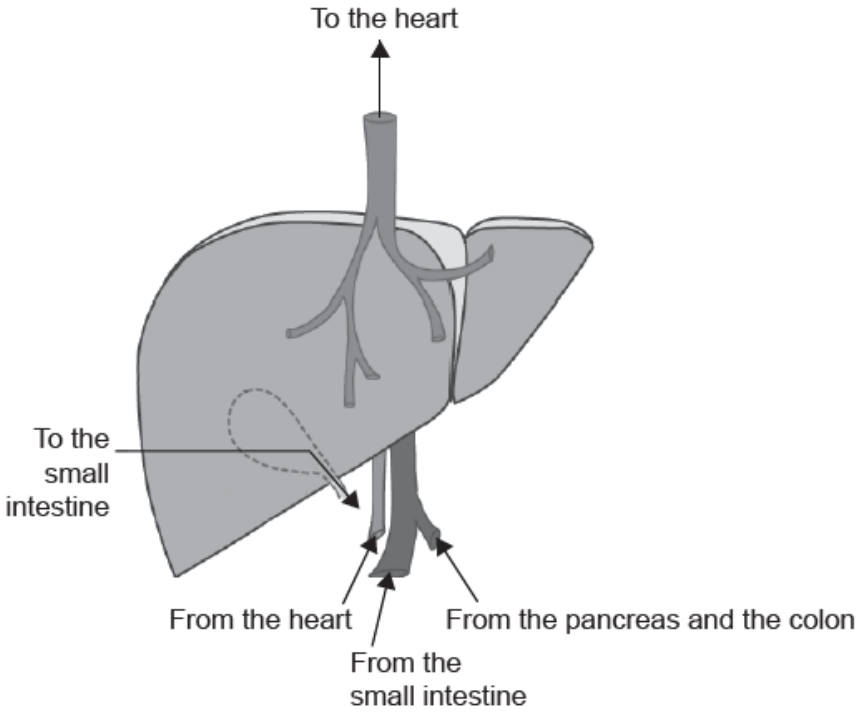
a. State which country has the lowest total percentage of overweight and obese adults. [1]

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]

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.

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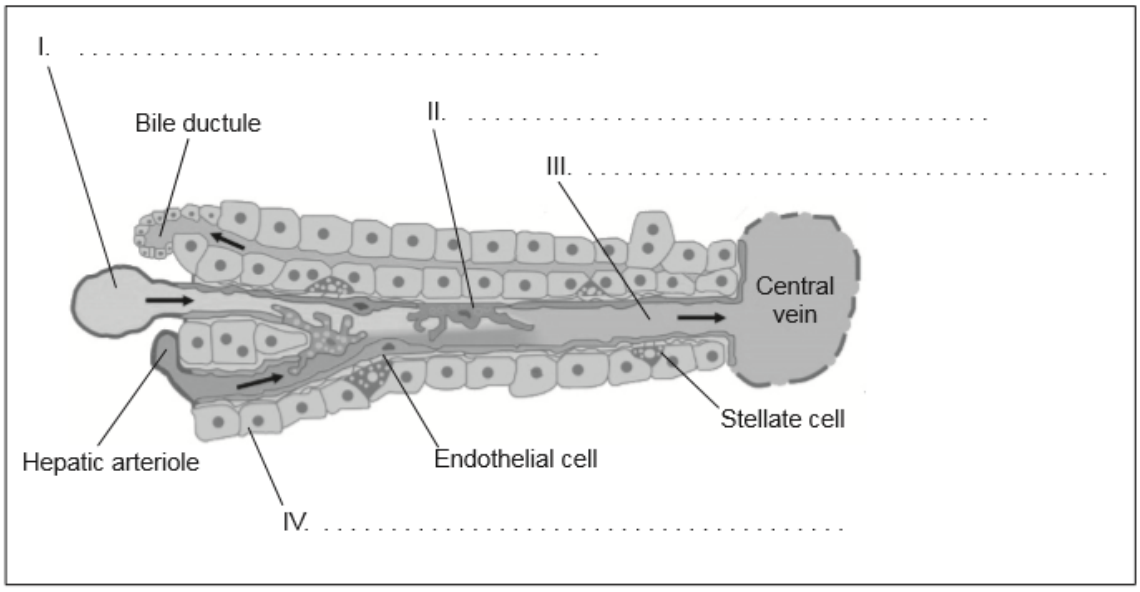
a. The liver's unique blood supply and system of ducts allow proper functioning of its hepatocytes and Kupffer cells. These cells are found throughout the liver in functional units called liver lobules. The image shows a cross section of the blood and bile paths in a liver lobule. [2]

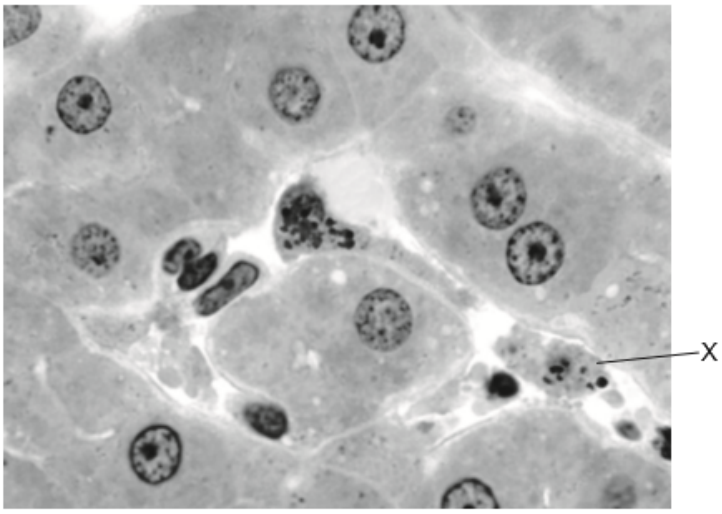


[Source: Ute Frevert, Sabine Engelmann, Sergine Zougbédé, Jörg Stange, Bruce Ng, Kai Matuschewski, Leonard Liebes, Herman Yee. Intravital observation of Plasmodium berghei sporozoite infection of the liver. *PLoS Biol.*: 2005, 3(6);e192 PubMed 15901208]

Label the structures I, II, III and IV.

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

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]

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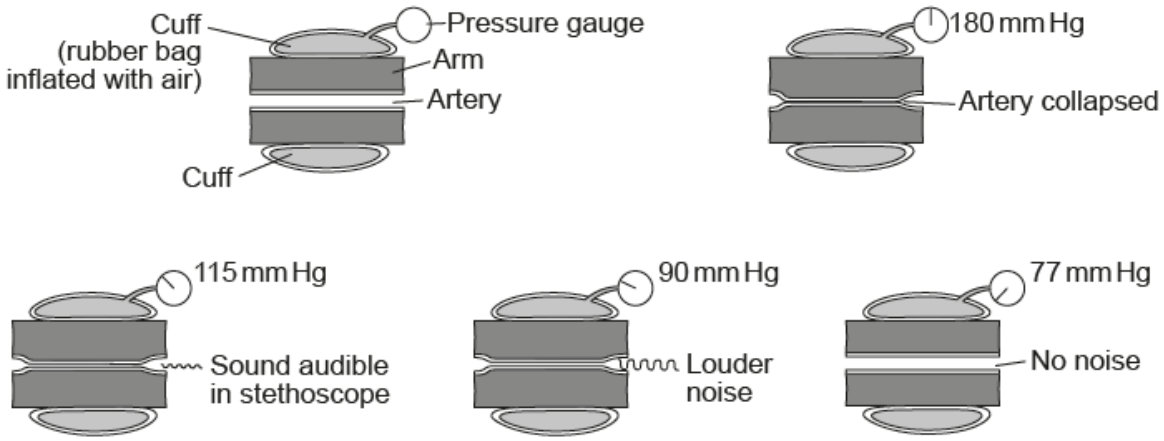
a. The diagram shows the use of a sphygmomanometer in the measurement of blood pressure. [1]



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

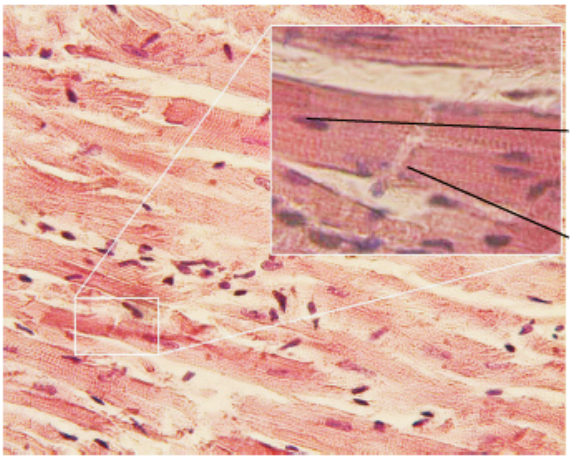
Identify the systolic pressure and diastolic pressure for this adult male.

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]