

Molecules, Transport and Health practice questions

40 questions • 138 marks • mark scheme at the back

For Pearson Edexcel International AS Biology XBI11 and International A Level Biology YBI11. **A Level only** is IA2 content (Units 4 to 6), not needed for the International AS.

Name

Total / 138

Water, carbohydrates and lipids Spec 1.1-1.5

1 UNIT 1 STYLE [1 mark]

Which property of a water molecule explains why sodium ions dissolve in water?

- A. ☐ Water molecules are non-polar
- B. ☐ Water molecules are dipoles, with charged ends attracted to ions
- C. ☐ Water molecules are small enough to fit between the ions
- D. ☐ Water molecules have an overall positive charge

2 UNIT 1 STYLE [3 marks]

Explain why water is important as a solvent in the transport of substances in the blood.

3 UNIT 1 STYLE [1 mark]

Lactose is a disaccharide. Which pair of monosaccharides is joined to make lactose?

- A. ☐ Glucose and glucose
- B. ☐ Glucose and fructose
- C. ☐ Glucose and galactose
- D. ☐ Fructose and galactose

4 UNIT 1 STYLE

[4 marks]

Explain how the structure of glycogen makes it suitable as an energy store in animal cells.

5 UNIT 1 STYLE

[3 marks]

Compare and contrast the structures of amylose and amylopectin.

6 UNIT 1 STYLE

[3 marks]

Describe how maltose is formed from glucose and how it can be broken down again.

7 UNIT 1 STYLE

[4 marks]

Describe how a triglyceride is formed from glycerol and fatty acids.

8 UNIT 1 STYLE [3 marks]

Compare saturated and unsaturated lipids.

9 UNIT 3 STYLE [5 marks]

A student is given a solution of unknown glucose concentration. Describe how the student could use Benedict's reagent and colour standards to estimate its concentration.

10 UNIT 3 STYLE [3 marks]

A student has a 1.0 % starch stock suspension. Calculate the volume of stock and the volume of distilled water needed to make 20 cm³ of a 0.25 % starch standard. Show your working.

Answer = ...

The heart, blood vessels and haemoglobin Spec 1.6-1.9

11 UNIT 1 STYLE [1 mark]

Which statement best explains why a large mammal needs a circulatory system?

- A. ☐ Its surface area to volume ratio is large
- B. ☐ Its diffusion distances are short
- C. ☐ Its surface area to volume ratio is small, so diffusion alone is too slow
- D. ☐ Its cells do not respire aerobically

12 UNIT 1 STYLE

[4 marks]

A scientist models two organisms as cubes. Organism A has sides of 2 mm and organism B has sides of 8 mm. Calculate the surface area to volume ratio of each organism and explain why organism B would need a transport system but organism A would not.

Answer = ...

13 UNIT 1 STYLE

[4 marks]

Explain how the structure of an artery is related to its function.

14 UNIT 1 STYLE

[3 marks]

Explain how the structure of a capillary makes it suitable for exchange of substances between blood and tissue cells.

The table shows pressures in the left side of the heart at different times during one cardiac cycle. Use the data to deduce whether each valve is open or closed at the time stated, giving a reason. (i) the atrioventricular valve at 0.1 s (ii) the atrioventricular valve at 0.3 s (iii) the aortic valve at 0.3 s (iv) the aortic valve at 0.4 s

Pressure in the left side of the heart			
Time / s	Left atrium / kPa	Left ventricle / kPa	Aorta / kPa
0.0	0.7	0.4	10.7
0.1	1.1	0.9	10.4
0.2	0.9	5.0	10.0
0.3	0.6	16.0	15.5
0.4	0.8	11.0	12.5
0.5	1.0	0.7	12.0

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A person's heart beats 90 times per minute. Calculate the time for one cardiac cycle. Ventricular systole lasts 0.3 s. Calculate the percentage of the cycle spent in ventricular systole. Give your answers to two significant figures.

Answer = ...

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17 UNIT 1 STYLE**[4 marks]**

Describe how the structure of the heart ensures that blood flows in one direction only and that oxygenated and deoxygenated blood do not mix.

18 UNIT 1 STYLE**[4 marks]**

Describe how carbon dioxide is transported in the blood from respiring tissues to the lungs.

19 UNIT 1 STYLE**[1 mark]**

During vigorous exercise the concentration of carbon dioxide in muscle tissue rises. What is the effect on the oxygen dissociation curve of haemoglobin?

- A. ☐ It shifts to the left, so less oxygen is released
- B. ☐ It shifts to the right, so more oxygen is released
- C. ☐ It shifts to the left, so more oxygen is released
- D. ☐ It does not change

20 UNIT 1 STYLE**[5 marks]**

The table gives the percentage saturation of adult and fetal haemoglobin with oxygen at different partial pressures of oxygen. (i) Describe the differences between the two sets of data. (2) (ii) Explain the significance of the oxygen affinity of fetal haemoglobin compared with adult haemoglobin. (3)

Percentage saturation with oxygen (rounded values)		
pO ₂ / kPa	Adult haemoglobin (%)	Fetal haemoglobin (%)
2	17	33
4	57	76
6	80	90
8	90	95
10	94	97
12	96	98

21 UNIT 1 STYLE**[3 marks]**

Explain why the oxygen dissociation curve of haemoglobin is S-shaped.

Cardiovascular disease and its causes Spec 1.10-1.14

22 UNIT 1 STYLE**[1 mark]**

Which is the first event in the development of atherosclerosis?

- A. ☐ Formation of a blood clot
- B. ☐ Damage to the endothelium of the artery
- C. ☐ Narrowing of the lumen by calcium salts
- D. ☐ Formation of foam cells from macrophages

23 UNIT 1 STYLE

[5 marks]

Describe the course of events that leads to atherosclerosis.

24 UNIT 1 STYLE

[4 marks]

Describe the blood clotting process.

25 UNIT 1 STYLE

[4 marks]

Explain how atherosclerosis in a coronary artery can lead to a myocardial infarction (heart attack).

26 UNIT 1 STYLE

[3 marks]

Explain how smoking increases the risk of cardiovascular disease.

27 UNIT 1 STYLE

[1 mark]

How might antioxidants in the diet reduce the risk of cardiovascular disease?

- A. ☐ By neutralising free radicals that oxidise LDL
- B. ☐ By converting LDL into HDL in the blood
- C. ☐ By inhibiting thrombin, so less fibrin forms
- D. ☐ By lowering blood pressure through dilating the arteries

28 UNIT 1 STYLE

[3 marks]

Studies show that people who eat a lot of fruit and vegetables have a lower risk of CVD, but trials of antioxidant tablets show little benefit. Suggest reasons for these conflicting results.

29 UNIT 3 STYLE

[5 marks]

A student wants to compare the vitamin C content of fresh orange juice and orange juice that has been stored for a week. Describe how the student could do this using DCPIP solution.

A student used DCPIP to measure vitamin C in a fruit juice. A 1.0 mg cm^{-3} ascorbic acid standard needed 0.6 cm^3 to decolourise 1 cm^3 of DCPIP. The table shows the volume of juice needed. (i) Calculate the mean volume for each juice. (2) (ii) Calculate the vitamin C concentration of each juice, in mg cm^{-3} . (2) (iii) Calculate the percentage change in concentration caused by boiling. (1) (iv) Explain the change. (1)

Volume of juice needed to decolourise 1 cm^3 of DCPIP			
Treatment	Repeat 1 / cm^3	Repeat 2 / cm^3	Repeat 3 / cm^3
Fresh juice	1.5	1.6	1.4
Juice boiled for 10 minutes	2.0	2.1	1.9

Answer = ...

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Spec 1.15-1.20

[6 marks]

region E. (2) (iii) Explain why these data do not prove that smoking causes CHD. (2)

[illegible]

[3 marks]

[illegible]

33 UNIT 1 STYLE**[4 marks]**

A researcher recruited 30 volunteers from one gym and asked them to recall what they had eaten in the past month. The researcher concluded that a low-fat diet prevents CVD. Evaluate the design of this study.

34 UNIT 1 STYLE**[3 marks]**

Explain why many people underestimate the risk of developing heart disease from their diet and lifestyle.

35 UNIT 1 STYLE**[5 marks]**

The table shows blood cholesterol results for four people. (i) Identify the person with the highest risk of CVD and justify your choice. (3) (ii) Explain why a high concentration of HDL is associated with lower risk of CVD. (2)

Blood cholesterol results / mmol dm ⁻³			
Person	Total cholesterol	HDL	LDL
A	4.5	1.6	2.2
B	6.8	0.9	4.9
C	5.4	1.4	3.3
D	6.2	1.8	3.8

36 UNIT 1 STYLE**[4 marks]**

Describe the evidence for a causal relationship between blood LDL cholesterol and cardiovascular disease.

37 UNIT 1 STYLE**[4 marks]**

A woman has a mass of 92 kg and a height of 1.80 m. Her waist is 104 cm and her hips are 100 cm. Calculate her BMI to one decimal place and her waist-to-hip ratio. Comment on what the waist-to-hip ratio suggests about her risk of CVD.

Answer = ...

38 UNIT 1 STYLE**[4 marks]**

Explain how people can use scientific knowledge about diet, exercise and smoking to reduce their risk of coronary heart disease.

39 UNIT 1 STYLE**[1 mark]**

Which is the main way statins reduce the risk of cardiovascular disease?

- A. ☐ They reduce the stickiness of platelets
- B. ☐ They lower blood pressure by relaxing artery walls
- C. ☐ They lower blood LDL cholesterol
- D. ☐ They prevent fibrinogen forming

Discuss the benefits and risks of using statins and platelet inhibitors to treat cardiovascular disease.

Mark scheme

One mark for each point unless a maximum is given. Words in brackets are not needed for the mark.

1. [1]

B B: water molecules are dipoles, with charged ends attracted to ions

2. [3]

- water molecules are dipoles / polar / have slightly positive and slightly negative ends (1)
- ions and polar molecules (such as glucose and amino acids) are attracted to the charged ends of water and are surrounded by water molecules / dissolve (1)
- dissolved substances can be carried in blood plasma / moved around the body (1)
- lipids / non-polar substances do not dissolve (so need other transport) (1)
- Max 3

3. [1]

C C: glucose and galactose (A is maltose, B is sucrose)

4. [4]

- a polymer / polysaccharide of α -glucose, so hydrolysed to glucose for respiration (1)
- insoluble / large molecule, so does not affect water potential / cannot leave the cell (1)
- highly branched / coiled, so compact and stores a lot of glucose in a small space (1)
- many branches give many free ends, so enzymes hydrolyse glucose rapidly / more quickly (1)
- Max 4

5. [3]

- both are polymers of α -glucose / both joined by α -1,4 glycosidic bonds (1)
- amylose is unbranched but amylopectin is branched (1)
- amylopectin has α -1,6 glycosidic bonds (at branch points), amylose does not (1)
- amylose coils into a helix / amylopectin is less tightly coiled (1)
- Max 3. Answer must include at least one similarity and one difference.

6. [3]

- condensation reaction between two glucose molecules (1)
- -OH and -H removed / water molecule released (1)
- α -1,4 glycosidic bond formed (1)
- broken down by hydrolysis, by adding water, to give two glucose molecules (1)
- Max 3

7. [4]

- glycerol joins with three fatty acids (1)
- condensation reaction (1)
- -OH group of glycerol reacts with the -COOH / carboxyl group of a fatty acid (1)
- ester bond formed (three in total) (1)
- water released (three molecules in total) (1)
- Max 4

8. [3]

- saturated have no C=C double bonds but unsaturated have one or more (1)
- saturated chains are straight whereas unsaturated chains are kinked / bent (1)
- saturated pack more closely, so a higher melting point / solid at room temperature (ora) (1)
- both contain ester bonds / both are triglycerides of fatty acids and glycerol (1)
- Max 3. Answer must include at least one similarity and one difference.

9. [5]

- make a range of glucose solutions of known concentration (standards) by diluting a stock solution (1)
- add the same volume of Benedict's reagent to the same volume of each standard and of the unknown (1)
- heat all tubes in a water bath at the same temperature for the same time (1)
- compare the colour of the unknown with the colours of the standards (against a white background) (1)
- concentration of the unknown is that of the closest matching standard (1)
- repeat and compare / use a smaller concentration range to improve accuracy (1)
- wear eye protection / use tongs, as Benedict's reagent is an irritant and the water is hot (1)
- Max 5

10. [3]

- dilution factor = $1.0 \div 0.25 = 4$ (1)
- volume of stock = $20 \div 4 = 5 \text{ cm}^3$ (1)
- volume of distilled water = $20 - 5 = 15 \text{ cm}^3$ (1)

11. [1]

C C: surface area to volume ratio is small, so diffusion alone is too slow

12. [4]

- A: surface area = $6 \times 2^2 = 24 \text{ mm}^2$, volume = $2^3 = 8 \text{ mm}^3$, ratio = 3 : 1 (1)
- B: surface area = $6 \times 8^2 = 384 \text{ mm}^2$, volume = $8^3 = 512 \text{ mm}^3$, ratio = 0.75 : 1 (1)
- B has a much smaller surface area to volume ratio / longer diffusion distance to the centre (1)
- so diffusion alone is too slow to supply all of its cells, whereas in A diffusion is fast enough (1)

13. [4]

- thick wall / collagen, to withstand high pressure / prevent bursting (1)
- elastic fibres stretch and recoil to even out the pressure surge / keep blood flowing smoothly (1)
- smooth muscle can contract to narrow the lumen / control blood flow (1)
- narrow lumen helps maintain high pressure (1)
- smooth endothelium reduces friction (1)
- Max 4

14. [3]

- wall is one cell thick / a single layer of endothelial cells, so short diffusion distance (1)
- very narrow lumen so red blood cells are squeezed close to the wall / flow is slow, giving time for exchange (1)
- large total surface area / dense network close to every cell (1)
- gaps between cells allow small molecules and fluid to pass (1)
- Max 3

15. [4]

- (i) open, as atrial pressure (1.1) is higher than ventricular pressure (0.9) (1)
- (ii) closed, as ventricular pressure (16.0) is higher than atrial pressure (0.6) (1)
- (iii) open, as ventricular pressure (16.0) is higher than aortic pressure (15.5) (1)
- (iv) closed, as aortic pressure (12.5) is higher than ventricular pressure (11.0) (1)

16. [3]

- time for one cycle = $60 \div 90$ (1)
- = 0.67 s (1)
- percentage = $0.3 \div 0.667 \times 100 = 45 \%$ (1)

17. [4]

- septum separates the left and right sides / oxygenated and deoxygenated blood (1)
- atrioventricular valves prevent backflow from ventricles to atria (1)
- tendinous cords stop the valves turning inside out / being forced back (1)
- semilunar valves in the aorta and pulmonary artery prevent backflow into the ventricles (1)
- valves open when pressure behind is higher than in front / shut when pressure in front is higher (1)
- Max 4

18. [4]

- some dissolved in plasma (1)
- some combines with haemoglobin to form carbaminohaemoglobin (1)
- most converted to hydrogencarbonate ions in red blood cells, catalysed by carbonic anhydrase (1)
- hydrogencarbonate ions diffuse out into the plasma, with chloride ions moving in (1)
- H^+ ions produced bind to haemoglobin, acting as a buffer (1)
- Max 4

19. [1]

B B: the curve shifts right (Bohr effect), so more oxygen is released

20. [5]

- (i) fetal haemoglobin is more saturated at every pO_2 (1)
- the difference is greatest at low pO_2 / 4 kPa (19 percentage points) and smaller at high pO_2 (1)
- (ii) fetal haemoglobin has a higher affinity for oxygen / curve is to the left (1)
- in the placenta pO_2 is low, so adult (maternal) haemoglobin unloads oxygen while fetal haemoglobin is still highly saturated / loads it (1)
- so oxygen passes from the mother's blood to the fetus (1)
- Max 5

21. [3]

- at low pO_2 the first oxygen molecule binds with difficulty, so the curve is shallow (1)
- binding of the first oxygen changes the shape of haemoglobin, making it easier for the next ones to bind / cooperative binding, so the curve is steep (1)
- at high pO_2 haemoglobin is almost saturated / few haem groups remain free, so the curve levels off (1)

22. [1]

B B: damage to the endothelium of the artery

23. [5]

- damage to the endothelium / endothelial dysfunction (1)
- LDL cholesterol enters the artery wall (1)
- inflammatory response: white blood cells / monocytes / macrophages enter and take up cholesterol (1)
- plaque / atheroma forms from cholesterol, foam cells, fibres and calcium (1)
- lumen narrows and wall loses elasticity (1)
- blood pressure rises, causing further endothelial damage (1)
- Max 5

24. [4]

- platelets / damaged tissue release thromboplastin (1)
- thromboplastin catalyses conversion of prothrombin to thrombin (1)
- thrombin catalyses conversion of soluble fibrinogen to insoluble fibrin (1)
- fibrin forms a mesh of fibres that traps blood cells / platelets, forming a clot (1)
- Max 4

25. [4]

- plaque may rupture / lumen is narrowed (1)
- clotting is triggered / a thrombus forms on the plaque (1)
- artery blocked / blood flow to part of the cardiac muscle stops (1)
- cardiac muscle cells do not receive oxygen / glucose, so cannot respire aerobically and die (1)
- Max 4

26. [3]

- carbon monoxide binds to haemoglobin, reducing oxygen transport / oxygen supply to heart muscle (1)
- nicotine increases heart rate / blood pressure (1)
- chemicals in smoke damage the endothelium, leading to atherosclerosis (1)
- platelets become stickier / clotting more likely (1)
- Max 3

27. [1]

A A: by neutralising free radicals that oxidise LDL

28. [3]

- people who eat fruit and vegetables may also exercise more / smoke less / eat less saturated fat (1)
- so the lower risk may not be caused by antioxidants (correlation is not causation) (1)
- fruit and vegetables contain other beneficial substances, such as fibre, or antioxidants work in combination (1)
- tablets may give the wrong dose / form / the trials may have been too short (1)
- Max 3

29. [5]

- add a fixed volume of DCPIP (blue) to a test tube (1)
- add the juice drop by drop from a graduated pipette / burette, shaking, until the blue colour just disappears (1)
- record the volume of juice needed; repeat and calculate a mean (1)
- repeat with the stored juice (1)
- the juice needing the smaller volume contains more vitamin C (1)
- control volume and concentration of DCPIP, temperature and the rate of adding juice (1)
- wear eye protection / wipe up spills of DCPIP (1)
- Max 5

30. [6]

- (i) fresh mean = $(1.5 + 1.6 + 1.4) \div 3 = 1.5 \text{ cm}^3$ (1)
- boiled mean = $(2.0 + 2.1 + 1.9) \div 3 = 2.0 \text{ cm}^3$ (1)
- (ii) vitamin C needed = $0.6 \text{ cm}^3 \times 1.0 \text{ mg cm}^{-3} = 0.6 \text{ mg}$ (1)
- fresh $0.6 \div 1.5 = 0.40 \text{ mg cm}^{-3}$; boiled $0.6 \div 2.0 = 0.30 \text{ mg cm}^{-3}$ (1)
- (iii) $(0.30 - 0.40) \div 0.40 \times 100 = -25 \%$ (1)
- (iv) vitamin C is destroyed / oxidised by heating (1)

31. [6]

- (i) positive correlation / as percentage of smokers rises, CHD death rate rises (1)
- quotes figures, e.g. from 95 at 12 % to 215 at 38 % (1)
- (ii) $(215 - 95) \div 95 \times 100$ (1)
- = 126 % (1)
- (iii) correlation does not show causation (1)
- other variables (for example diet, age, exercise, or other differences between regions) could affect death rate / data are for regions not individuals (1)

32. [3]

- different sample sizes / different groups of people studied (age, gender, ethnicity) (1)
- different ways of measuring salt intake (self-reported or measured) (1)
- different lengths of study / different variables controlled (1)
- chance / one study may have had bias (1)
- Max 3

33. [4]

- sample is small, so results are not reliable / more affected by chance (1)
- volunteers from one gym are not representative of the population / are likely to be health-conscious, so bias (1)
- diet recalled from memory / self-reported, so not valid / not accurate (1)
- no control group / other variables (exercise, smoking) not controlled / short duration, so cannot conclude low-fat diet prevents CVD (1)
- Max 4

34. [3]

- the harm builds up over many years / long delay before disease appears, so people feel healthy now (1)
- people enjoy / are used to the behaviour, or think it will not happen to them (1)
- they see relatives or others who did not develop the disease (personal experience) (1)
- media focus on more dramatic risks / statistics are not well understood (1)
- Max 3

35. [5]

- (i) person B (1)
- highest total cholesterol (6.8) and highest LDL (4.9) (1)
- lowest HDL (0.9) / highest total cholesterol : HDL ratio (7.6) (1)
- (ii) HDL carries cholesterol from the tissues / artery walls to the liver (1)
- so less cholesterol is deposited in the artery wall / less atheroma forms (1)

36. [4]

- population studies show higher CVD rates in people with higher total / LDL cholesterol (1)
- people with inherited very high cholesterol develop CVD at a young age (1)
- LDL is found in plaques / the mechanism of foam cell formation is known (1)
- trials show lowering LDL (for example with statins) reduces heart attacks and strokes (1)
- Max 4

37. [4]

- $BMI = mass \div height^2 = 92 \div 1.80^2$ (1)
- $= 28.4 \text{ kg m}^{-2}$ (1)
- waist-to-hip ratio $= 104 \div 100 = 1.04$ (1)
- ratio above the 0.85 commonly used for women, so higher risk (excess abdominal fat) (1)

38. [4]

- reduce saturated fat in the diet to lower LDL cholesterol / less atheroma (1)
- reduce salt to lower blood pressure (1)
- take regular exercise to lower blood pressure / raise HDL / control body mass (1)
- do not smoke, to avoid carbon monoxide / nicotine / endothelial damage (1)
- use BMI or waist-to-hip ratio to monitor body mass (1)
- Max 4

39. [1]

C C: they lower blood LDL cholesterol

40. [6]

- statins lower LDL cholesterol by reducing cholesterol production in the liver (1)
- so slow atheroma formation / reduce the risk of heart attack and stroke (1)
- risks of statins: muscle pain / digestive upset / rarely liver damage (1)
- platelet inhibitors stop platelets sticking together (1)
- so reduce clot formation in arteries / risk of heart attack and stroke (1)
- risks of platelet inhibitors: bleeding / stomach irritation or ulcers (1)
- treatment decided by weighing benefit against risk for each patient, with lifestyle changes (1)
- Max 6