UNIT 1 ANSWERS

CHAPTER 1

1 ▶ Diagram should show each part of an animal cell and its function, i.e.
- cytoplasm – where metabolism / reactions take place
- nucleus – controls activities of the cell
- cell membrane – controls movement of substances into and out of the cell
- mitochondria – respiration.

2 ▶ a i base / thymine **ii** base / cytosine **iii** deoxyribose / sugar **iv** phosphate **v** nucleotide

b A always pairs with T, while C always pairs with G

3 ▶ a Flow diagram should have boxes showing the stages in order, i.e.
- 1: The two strands of the DNA separate.
- 2: Each strand acts as a template for the formation of a new strand.
- 3: DNA polymerase assembles nucleotides alongside the two strands.
- 4: Two DNA molecules are formed.

b i Addition, duplication or deletion of a base will result in all triplets of bases after the mutation being different. This will mean that different amino acids are coded for.

ii Substitution or inversion affect only one base in a triplet. That triplet will code for a different amino acid, but triplets after the mutation are not altered so subsequent amino acids will not be affected.

4 ▶ a Five

b AUG GAG CCA GUA GGG

c ATG GAG CCA GTA GGG

d translation; codon; start codon; stop codon; ribosome

5 ▶ a Chromosomes align themselves along the equator of the cell, attached to the spindle fibres.

b The spindle fibres shorten, pulling the chromatids towards opposite poles of the cell.

c The chromosomes reach the opposite poles of the cell and the nucleus begins to re-form.

6 ▶ a A cell that can divide several times but remain undifferentiated.

b Embryonic stem cells are found in the early stage of development of an embryo and can differentiate to form any type of cell. Adult stem cells are found in certain adult tissues such as bone marrow and skin. They can differentiate to form a limited number of specialised tissues only.

c Leukaemia can be treated by chemotherapy but a side effect of this treatment is that it destroys healthy blood cells. Stem cell therapy involves a bone marrow transplant. This provides stem cells which can divide and differentiate to replace the blood cells lost during chemotherapy.

7 ▶ a 1: restriction endonuclease / restriction enzyme; 2: (DNA) ligase

b The plasmid is a vector, used to transfer the gene into the bacteria.

c The bacteria would be cultured in fermenters.

d It is identical to human insulin and so allows better control of blood glucose levels.

CHAPTER 2

1 ▶ a Diffusion is the net movement of particles (molecules or ions) from a region of high concentration to a region of low concentration. It does not need energy from respiration. Active transport uses energy from respiration to transport particles against a concentration gradient.

b Any three from: concentration gradient; surface area to volume ratio; distance; temperature.

c i surface area = $2 \times 2 \times 6 = 24\,cm^2$

volume = $2 \times 2 \times 2 = 8\,cm^3$

$\frac{\text{surface area}}{\text{volume}} = \frac{24}{8} = 3:1$

ii surface area = $3 \times 3 \times 6 = 54\,cm^2$

volume = $3 \times 3 \times 3 = 27\,cm^3$

$\frac{\text{surface area}}{\text{volume}} = \frac{54}{27} = 2:1$

d The surface area to volume ratio decreases as the size of the cube increases. As a cell becomes larger, the exchange of substances by diffusion will become less efficient, because the surface area will be smaller in proportion to the overall size of the cell.

2 ▶ a They carry out most of the reactions of respiration in the cell, providing the cell with energy.

b Active transport; this uses the energy from the mitochondria.

c Diffusion. The removal of glucose at A lowers the concentration of glucose inside the cell, so the concentration at B is higher than inside the cell. This means that glucose can diffuse down a concentration gradient.

d Increases the surface area for absorption.

3 ▶ a B

b A = no cells (just a red solution); B = red blood cells with a normal appearance; C = shrunken red blood cells with crinkly edges

c A: Water has a higher water potential than the cell contents, so water enters the cells by osmosis. The cells burst and release their haemoglobin, forming the red solution.

B: 0.85% salt solution has the same water potential as the cell contents, so there is no net movement of water into or out of the cells. As a result, the cells retain their normal appearance.

C: 3% salt solution has a lower water potential than the cell contents, so water leaves the cells by osmosis. The cells shrink and become crinkly at the edges.

d 0.85% salt solution has the same water potential as blood, so there will be no net movement of water into or out of blood cells by osmosis (and no damage to blood cells). If water was used, the blood cells would absorb water by osmosis and burst.

CHAPTER 3

1 ▶

Biological molecule	'Building blocks' of the molecule	Chemical elements in the molecule
carbohydrate	*simple sugars (monosaccharides)*	carbon, hydrogen, oxygen
lipid	fatty acids and glycerol	*carbon, hydrogen, oxygen*
protein	amino acids	carbon, hydrogen, oxygen, nitrogen

2 ▶ a Add iodine solution to the sample. If starch is present, the iodine will change from yellow-brown to blue-black.

b Add Benedict's solution to the sample and boil. If glucose is present, a brick-red precipitate will form.

3 ▶ a A protein that acts as a biological catalyst.

b Diagram should be similar to Figure 3.5, with active site, reactants and products labelled and annotated.

c A competitive inhibitor is a molecule with a shape that is similar to the shape of the substrate. It fits into the active site of the enzyme, stopping the substrate from entering and, as a result, slowing the reaction. Using the lock and key model, the competitive inhibitor prevents the 'key' (the substrate) from entering the 'lock' (the enzyme's active site).

d Test the effect of the inhibitor at different concentrations of substrate. The results will be different depending on whether the inhibitor is competitive or non-competitive:

- Competitive inhibitor: At a low concentration of substrate, the inhibitor will have a large effect. At a high concentration of substrate, the inhibitor will have no effect on the rate of reaction.
- Non-competitive inhibitor: The concentration of substrate will not affect the action of the inhibitor.

4 ▶ a Points to include:

- Use two or more speeds of flow of milk (adjust the flow rate using the clip)
- Use the same milk / same type of milk / same age of milk
- Use the same (batch of) lactase / same concentration of lactase
- Use the same mass of beads / same size of beads
- Keep the temperature constant
- Measure the rate of production of glucose (or galactose)
- Suggested method for measuring rate of production of glucose / galactose (e.g. using a glucose sensor or test strip)
- Repeat measurements at each flow rate (for reliability)

b Independent variable = speed of flow of milk; dependent variable = rate of breakdown of lactose

c Any three advantages from:

- The enzymes are more stable at high temperatures and less likely to denature
- The enzymes are more resistant to changes in pH
- The enzymes are less likely to be broken down by organic solvents
- The products are uncontaminated by enzyme and can be collected more easily
- The enzyme can be kept and re-used
- An industrial process can use columns of immobilised enzyme, allowing large-scale production

END OF UNIT 1 QUESTIONS

1 ▶ D **2 ▶** C **3 ▶** A **4 ▶** B

5 ▶ C **6 ▶** A **7 ▶** D **8 ▶** A

9 ▶ C **10 ▶** B **11 ▶** D **12 ▶** A

13 ▶ DNA / deoxyribonucleic acid; nucleus; chromosomes; thymine; guanine; messenger RNA / mRNA **[1 mark for each correct term]**

14 ▶ a 50 base pairs **[1]**

b 30 G bases **[1]**

c 20 T bases **[1]**

d 20 A bases **[1]**

e 100 deoxyribose sugar groups **[1]**

15 ▶ [1 mark for each correct row]

Feature	Active transport	Osmosis	Diffusion
particles must have kinetic energy	×	✓	✓
requires energy from respiration	✓	×	×
particles move down a concentration gradient	×	✓	✓

16 ▶ a 75°C **[1]**

b At 60°C, the molecules of enzyme and substrate have more kinetic energy / move around more quickly **[1]**. As a result, there are more frequent collisions between enzyme and substrate molecules **[1]** so more reactions are likely to take place **[1]**.

c This microorganism lives at high temperatures **[1]** so it needs 'heat-resistant' enzymes with a high optimum temperature / the enzymes must not be denatured at high temperatures **[1]**.

d It is denatured / the protein structure is broken down **[1]**. This changes the shape of the active site so the enzyme no longer catalyses the reaction **[1]**.

UNIT 2 ANSWERS

CHAPTER 4

1 ▶ a Starch: Place a sample of the water on a spotting tile and add a drop of iodine solution. If starch is present, the colour will change from orange to blue-black.

Glucose: Place a sample of the water in a test tube

and add blue Benedict's solution. Place the tube in a water bath and heat it until the solution boils. If glucose is present, a brick-red precipitate will form.

b Starch molecules are too large to pass through the holes in the Visking tubing. Glucose molecules are smaller, so they can pass through the tubing into the water.

c The blood

d Large, insoluble food molecules are broken down into small, soluble ones.

2 ▶ a It is body temperature.

b It had been broken down into smaller molecules called peptides (short chains of amino acids), forming a clear solution.

c The enzyme pepsin is denatured in alkaline conditions.

d Tube B remained cloudy because there was no enzyme. The egg white does not break down by itself. (This tube was the Control: all other factors were the same, but the enzyme was not added. The result shows that it is the enzyme that breaks down the protein.)

e The enzyme works more slowly at a lower temperature, because the enzyme and substrate molecules have less kinetic energy so there are fewer collisions between them.

f Hydrochloric acid kills bacteria in the food entering the stomach.

g By alkaline secretions in the bile and pancreatic juice.

3 ▶

Enzyme	Food on which it acts	Products
amylase	starch	maltose
trypsin	protein	peptides
lipase	fats	*fatty acids and glycerol*

4 ▶ Any four of the following:

- length – increases time and surface area for absorption
- folds in lining – increase surface area
- villi covering lining – increase surface area
- microvilli on lining cells – increase surface area
- capillary networks in villi – for absorption of products
- lacteals in villi – absorb fats

5 ▶ The account should include full descriptions of most of the following points:

- digestion of starch to maltose in the mouth
- action of saliva in moistening food
- mechanical digestion by the teeth
- movement through the gut by peristalsis (diagram useful)
- digestion of protein by pepsin in the stomach
- the role of hydrochloric acid in the stomach
- emulsifying action of bile from the liver on fats
- pancreatic enzymes (amylase, trypsin, lipase) and their role in digestion of starch, protein and fats
- adaptations of the ileum for the absorption of digested food (see answer to Q4)
- role of the colon in absorption of water.

6 ▶ a

Deficiency disease	Nutrient that is lacking in the diet
kwashiorkor	protein
scurvy	*vitamin C*
anaemia	iron
night blindness	vitamin A

b Description should include the following points:

- Add, drop by drop, a 1% solution of DCPIP to a fixed volume (e.g. 2 cm^3) of the fruit juice until the blue colour of the DCPIP does not disappear. Note the volume of DCPIP used.
- Repeat using the same volume (e.g. 2 cm^3) of a 1% solution of vitamin C instead of the fruit juice. Again, note the volume of DCPIP used.
- Use the two measured volumes of DCPIP to calculate the amount of vitamin C in the juice. For example, if the juice decolourises twice as much DCPIP as the 1% vitamin C solution, the juice must contain twice the concentration of vitamin C (2%).

c Answer should include the following points:

- Use (juice from) two or more ages of orange / suggested age difference (between 1 day and 1 month)
- Use same type / variety / species of orange
- Measure the amount of vitamin C in the juice using decolourisation of DCPIP
- Compare with standard vitamin C solution
- Use the same volume of juice
- Other controlled variable, e.g. temperature
- Repeat measurements on juice from several oranges (for reliability)

7 ▶ Any three from:

- Salting (covering in salt): high salt concentration kills bacteria by osmotic loss of water
- Pickling (bottling in vinegar): low pH inactivates microorganisms by affecting enzyme activity
- Canning (heating to high temperatures and packing in cans): high temperatures kill bacteria, canning prevents more bacteria entering the food
- Freezing (rapid cooling and storage below –12°C): low temperature prevents bacteria from reproducing

CHAPTER 5

1 ▶ a $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$ (+ energy)

b ATP is the energy 'currency' in the cell. It transfers energy between the process that releases energy (respiration) and the processes in a cell that use this energy. To supply energy, ATP is broken down into ADP and phosphate. ATP is built up from ADP and phosphate during respiration.

c Three differences from:

- aerobic respiration uses oxygen, anaerobic respiration does not
- aerobic respiration produces carbon dioxide, anaerobic respiration does not
- aerobic respiration produces water, anaerobic respiration does not

- aerobic respiration produces more energy than anaerobic respiration
- anaerobic respiration produces lactate, aerobic respiration does not

d During a 100-metre race, the runner's muscles respire anaerobically and lactate builds up in the runner's muscles and bloodstream. When the race is over, this lactate must be removed from the athlete's body. Lactate is broken down by aerobic respiration into carbon dioxide and water. The oxygen debt is the volume of oxygen needed to completely oxidise the lactate that has built up during the race. The debt is 'repaid' by breathing and aerobic respiration after the race.

2 ▶

	Action during inhalation	Action during exhalation
external intercostal muscles	*contract*	relax
internal intercostal muscles	relax	contract
ribs	move up and out	*move down and in*
diaphragm	contracts and flattens	relaxes and becomes dome-shaped
volume of thorax	increases	decreases
pressure in thorax	decreases	increases
volume of air in lungs	increases	decreases

3 ▶ When we breathe in, the external intercostal muscles between our ribs contract, pulling the ribs up and out. The diaphragm muscles contract, flattening the diaphragm. This increases the volume in the chest cavity, lowering the pressure there, and causing air to enter from outside the body, through the nose or mouth. This is called ventilation.

In the air sacs of the lungs, oxygen enters the blood. The blood then takes the oxygen around the body, where it is used by the cells. The blood returns to the lungs, where carbon dioxide leaves the blood and enters the air sacs.

When we breathe out, the external intercostal muscles relax and the ribs move down and in. The diaphragm muscles relax, and the diaphragm returns to a dome shape. These changes decrease the volume of the chest cavity, increasing the pressure in the cavity and pushing the air out of the lungs.

4 ▶ a When the volume of the patient's chest was increased by the movements of the ribs and diaphragm, the drop in pressure in the chest cavity drew air into the pleural cavity through the puncture in the chest wall, rather than drawing air through the mouth or nose into the lung.

b Each lung is in a separate pleural cavity, so it is isolated from the other lung. This means a pneumothorax on one side will not affect the lung on the other side.

c A tube is inserted through the chest wall into the pleural cavity on the side of the injured lung. This stops ventilation in that lung, while the other lung is ventilated normally.

5 ▶ a The rings support the trachea so it does not collapse during inhalation. The gap in the 'C' allows food to pass down the oesophagus (which runs next to the trachea) without catching on the rings.

b The short distance allows easy diffusion of oxygen into the blood, and easy diffusion of carbon dioxide out of the blood.

c The mucus traps bacteria and dirt particles. The cilia beat backwards and forwards to sweep the mucus and trapped bacteria/particles towards the mouth, preventing them entering the lungs.

d Smoke contains carbon monoxide, which displaces oxygen from the haemoglobin in the smoker's red blood cells.

e The addictive drug in tobacco smoke is nicotine. Smokers who are trying to give up can use patches or gum to provide the nicotine they would usually get from cigarettes. This reduces the craving to smoke.

f The large surface area (provided by the alveoli) allows for efficient diffusion of oxygen into the large blood supply, and efficient removal of the waste product, carbon dioxide.

6 ▶ Bronchitis is a lung disease caused by irritation of the linings of the airways to the lungs. It may be made worse by bacteria infecting the bronchial system.

Emphysema is a lung disease in which the walls of the alveoli break down and then fuse together, reducing the surface area of the alveoli.

(Both diseases may be caused by smoking.)

7 ▶ a Tidal volume is the volume of air breathed in and out during a normal breath.

Tidal volume on the graph = 0.5 dm^3.

b C

c Points to include:

- Collect data from a group of boys and girls (minimum six of each)
- Collect data from boys and girls of the same age / same health / same physical fitness / non-smokers (or other suitable controlled variable)
- Measure the vital capacity of each person (vital capacity = difference between maximum inhalation and maximum exhalation)
- Repeat measurements for each person (for reliability)

8 ▶ a Answers may refer to the following points:

- non-smokers have a low death rate from lung cancer at all ages
- the death rate from lung cancer among smokers increases with age
- the death rate increases with the number of cigarettes smoked per day.

Numbers from the graph should be used to illustrate the points made.

b For 55-year-olds smoking 25 a day: about 4.5 per 1000 men (or 45 per 10 000 men)

c For 55-year-olds smoking 10 a day: about 1 per 1000 men

d Probably this investigation. The graph shows a direct relationship between the number of cigarettes smoked and the incidence of lung cancer, in one particular type of person (middle-aged male doctors): in other words, a more controlled group. In Table 5.2, the patients were matched for age, sex etc. but were from more varied backgrounds, so there could be other reasons for the correlation. However, both investigations show a strong link between lung cancer and smoking.

9 ▶ The leaflet should not be too complicated or have too much information so that it puts the reader off. It must have a clear message.

CHAPTER 6

1 ▶ a A = pulmonary vein; B = aorta; C = right atrium; D = left ventricle; E = renal vein

b X (artery) has narrow lumen / muscular wall; Y (vein) has large lumen / little muscle

c Hepatic vein

2 ▶ a A red blood cell:
- has a large surface area compared with its volume
- contains haemoglobin
- has no nucleus, so more space is available for haemoglobin.

b i Oxygen dissolves in the liquid lining the alveoli and then diffuses down a concentration gradient through the walls of the alveoli and capillaries into the plasma and into the red blood cells.

ii Oxygen dissolves in the plasma and then diffuses down a concentration gradient through the walls of the capillaries into the muscle cells.

c Dissolved in plasma, mainly as hydrogencarbonate ions

3 ▶ a Any two from:
- small diameter – to fit between cells
- walls only one cell thick – to provide a short distance for diffusion
- narrow lumen (just wider than a red blood cell) – to provide a short distance for diffusion of oxygen.

b Blood pressure causes fluid to leak out of the capillaries through the thin epithelial cells of the capillary wall. This forms tissue fluid, which is similar in composition to blood plasma, except that it does not contain proteins.

c Tissue fluid forms a pathway for the diffusion of substances between the capillaries and the cells of the body.

4 ▶ a A = left atrium; B = (atrioventricular) valves; C = left ventricle; D = aorta; E = right atrium

b To ensure blood flows in one direction only / to prevent backflow of blood

c i A

ii E

5 ▶ a i C (phagocyte) – identified by colour (white), irregular shape and lobed nucleus

ii A (red blood cell) – identified by colour (red) and biconcave disc shape

iii B (lymphocyte) – identified by colour (white) and large round nucleus

b Platelets – involved in blood clotting

6 ▶ a C – heart rate is increasing so more blood can be pumped to the muscles

b E – brief jump in heart rate

c A – lowest heart rate

d B – heart rate increases from minimum to a steady rate

7 ▶ a i Low rate (75 bpm) because the body is at rest so the need for oxygen is low.

ii Heart rate increases so more blood (carrying oxygen for respiration) can be pumped to the muscles.

iii Heart rate decreases as the need for oxygen is reduced / lactate produced during exercise is removed (repaying the oxygen debt).

b A fitter person has a shorter recovery period.

c Any four from:
- reduces blood pressure
- strengthens the heart muscle
- prevents coronary heart disease
- maintains a healthy body weight / prevents obesity
- builds skeletal muscle
- reduces the level of lipids / cholesterol in the blood
- improves the strength of tendons and ligaments
- increases lung capacity / vital capacity
- stimulates the immune system
- helps to maintain the level of glucose in the blood / prevents type 2 diabetes
- reduces the risk of contracting some cancers
- reduces the likelihood of getting depression.

8 ▶ a (Long-term) high blood pressure

b Physical exercise that depends on a supply of ATP from aerobic respiration. It consists of light to moderate activities that can be performed for extended periods of time, such as walking, jogging, swimming or cycling.

c A normal diet (not low energy and low fat), with no periods of aerobic exercise

d Systolic blood pressure is the blood pressure in the arteries to the body caused by the contraction of the left ventricle of the heart. Diastolic blood pressure is the pressure in the arteries when the ventricles relax. Systolic blood pressure is higher than diastolic blood pressure.

e i Exercise alone reduces systolic blood pressure by about 10 mmHg and diastolic blood pressure by about 6 mmHg.

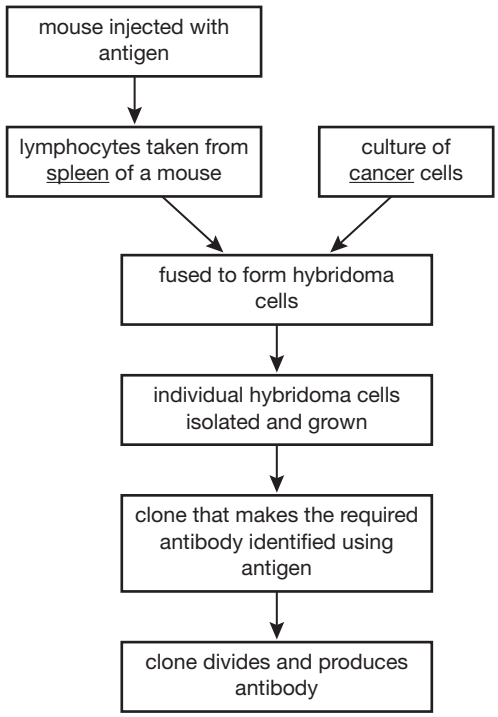
ii Diet alone reduces systolic blood pressure by over 11 mmHg (11.5 mmHg) and diastolic blood pressure by over 7 mmHg (7.5 mmHg).

f Increase the number of patients in the study: a larger sample of patients may show a significant difference in the mean values / anomalous values will have less effect on the results.

9 ▶ a Atherosclerosis is a build-up of fatty substances (such as cholesterol) in the walls of the coronary arteries supplying blood to the heart muscle. If the coronary arteries become completely blocked, no blood (and therefore no oxygen) will reach the heart muscle. This leads to a heart attack.

b A stent is an expandable mesh tube around an inflatable balloon. It is inserted into the coronary artery using a thin tube called a catheter. The catheter is inserted into a blood vessel in the arm or leg and the stent is guided to the coronary artery using a guide wire. Once the stent is in place, the balloon is inflated and the mesh tube is pushed outwards, widening the coronary artery. The balloon is then deflated and removed, while the stent is left in place, holding the artery open.

10 ▶ a



b To detect a cancer, monoclonal antibodies are produced using antigens from the cancer cells. The antibodies can then be used to detect that antigen in tissue samples from other patients.

END OF UNIT 2 QUESTIONS

1 ▶	D	**2 ▶**	B	**3 ▶**	B	**4 ▶**	B
5 ▶	C	**6 ▶**	A	**7 ▶**	B	**8 ▶**	B
9 ▶	B	**10 ▶**	D	**11 ▶**	C	**12 ▶**	A

13 ▶ a Energy supplied in joules = $(39 - 21) \times 20 \times 4.2 = 1512\,J$ **[1]**

Energy supplied in kilojoules = $\frac{1512}{1000} = 1.512\,kJ$ **[1]**

b Energy per g of pasta = $\frac{1512}{0.22} = 6.87\,kJ$ per g **[1]**

c Any three from the following **[maximum 3 marks]**:
- heat lost to air
- heat lost to test tube
- heat lost to thermometer
- heat lost when lighting pasta
- heat lost during transfer of burning pasta

d Any valid suggestion to reduce heat loss (e.g. insulating the tube by putting a metal box around it). **[1]**

e Peanuts contain lipid / oil, while pasta contains carbohydrate **[1]**. Lipid contains more energy than carbohydrate **[1]**.

14 ▶ Answer may include the following points **[maximum 6 marks]**:
- Add the solution containing ATP to some muscle fibres **[1]**
- Control – add the same solution (e.g. water or salt solution) without ATP to some different muscle fibres **[1]**
- Use the same source of meat / same meat / same species / same age / same sell-by date (etc.) **[1]**
- Repeat to improve reliability – minimum 6 sets in ATP solution, 6 in control solution **[1]**
- Measure the change in length of the fibres / starting and final length **[1]**
- Calculate the % change in length **[1]**
- Two controlled variables from: same volume of solution(s); (approximately) same length of muscle; (approximately) same thickness of muscle; same temperature; same length of time before measuring muscle, etc. **[2]**

15 ▶ a Reasonable diagram of cell with nucleus **[1]**
Two labels from: (lobed) nucleus; cytoplasm; cell membrane **[2]**

b Any one of the following for 1 mark:
- phagocyte has a nucleus, red blood cell does not
- red blood cell contains haemoglobin, phagocyte does not
- red blood cell is biconcave disc shape / can't change shape; phagocyte has variable shape / can change shape

c Phagocytes change their shape, producing extensions of their cytoplasm / pseudopodia **[1]**. The extensions / pseudopodia surround and enclose a microorganism (in a vacuole) **[1]**. The phagocyte secretes enzymes into the vacuole to break down the microorganism **[1]**.

d Lymphocytes **[1]** produce antibodies **[1]** against antigens **[1]** and form memory cells **[1]**.

[maximum 3 marks]

16 ▶ a Any three of the following points:
- Removal of carbon dioxide from the body reduces the concentration of carbon dioxide in the blood **[1]**
- Fall in carbon dioxide in the blood is detected by receptors in the medulla (of the brain) / aorta / carotid arteries **[1]**
- This decreases stimulation of the respiratory centre (in the medulla) **[1]**
- This decreases stimulation of the diaphragm / intercostal muscles **[1]**

[maximum 3 marks]

b i Blood will carry more oxygen **[1]** to offset the low level of oxygen in the air (at altitude) **[1]**

ii Increased blood flow to muscles / more oxygen will reach muscles **[1]**

iii Mitochondria carry out aerobic respiration **[1]** so more efficient use of available oxygen [or words to that effect] **[1]**

iv Right ventricle pumps blood to the lungs **[1]** so more blood can be oxygenated [or words to that effect] **[1]**

c $\frac{1750}{1000} \times 11.4$ **[1]** = 19.95 days **[1]**

UNIT 3 ANSWERS

CHAPTER 7

1 ▶ a i brain

ii spinal cord

iii heart and lungs

b Cartilage is a tough but flexible tissue, so the discs of cartilage act as a cushion between the vertebrae, preventing them being damaged when the body moves.

c bone cells / osteocytes; calcium salts / calcium phosphate; protein fibres

2 ▶
- synovial membrane – secretes synovial fluid
- synovial fluid – acts as a lubricant, reducing friction between the ends of the bones
- ligaments – hold the joint together, allowing movement but preventing the bones becoming dislocated

3 ▶ a The bones lose calcium salts and become porous and less dense. As a result, they break easily.

b i Osteoporosis in women increases with age. Between the ages of 18 and 44, only 1.2% of women have the condition. By 45–64, this percentage has risen to 9.4% (an increase of 7.8 times) and 27.4% of women aged 65 or more have osteoporosis.

ii Osteoporosis is much less common in men than in women. It occurs in only 0.3% of men aged 18–44, increases to 1.2% in men aged 45–64, and increases again to 4.3% in men aged over 65. Around 6.4 times more women than men aged 65 and over have osteoporosis.

c Any two from: good diet; taking calcium and vitamin D supplements; hormone treatment.

4 ▶ a A = biceps (muscle); B = scapula; C = triceps (muscle); D = tendon; E = ligaments; F = ulna; G = radius

b Antagonistic muscles are pairs of muscles that work together: one contracts while the other relaxes.

c i Ligaments (E) hold the elbow joint together. They allow movement but prevent the arm bones becoming dislocated.

ii Ligaments have great tensile strength (to resist stretching) but they also have some elasticity so they allow movement.

d The biceps muscle (A) relaxes to lower the forearm. (The triceps muscle contracts at the same time to help control the movement.)

5 ▶ a latent phase = 10 ms; contraction phase = 35 ms; relaxation phase = 50 ms

b For 35 ms: muscles can only exert a force when they contract (i.e. during the contraction phase).

c i To bend the arm at the elbow, the biceps contracts and the triceps relaxes. The biceps pulls on the radius.

To straighten the arm, the biceps relaxes and the triceps contracts. The arm falls under its own weight or is pulled straight by the triceps pulling on the ulna.

ii To keep the body upright and straight, the (rectus) muscles either side of the vertebrae are always in a state of partial contraction called muscle tone.

d i Many type I fibres, fewer type IIa and type IIb fibres

ii Many type IIb fibres, fewer type IIa and type I fibres

e A marathon runner needs to run for a long time at a relatively slow speed, using aerobic respiration. Their muscles do not need to contract quickly or produce a high tension but they do need to be resistant to fatigue. These are all properties of type I fibres.

A weightlifter needs to perform a 'burst' activity – using their muscles quickly and getting energy from anaerobic respiration. Their muscles must produce a high tension to lift the weight. These are properties of type IIb muscle fibres.

Each athlete will have all three types of fibre, but in different proportions.

CHAPTER 8

1 ▶ a

Function	Letter
refracts light rays	G
converts light into nerve impulses	A
contains pigment to stop internal reflection	B
contracts to change the shape of the lens	E
takes nerve impulses to the brain	D

b i H

ii The iris muscles contract or relax to adjust the diameter of the pupil.

iii To protect the eye from damage by bright light, and to allow vision in different light intensities.

2 ▶ a A = eardrum; B = malleus / hammer; C = auditory nerve

b The bones transmit vibrations from the eardrum across the middle ear to the oval window of the cochlea. They also amplify the vibrations.

c Vibrations of the fluid in the outer canal cause sensory hairs of receptor cells to be stretched. The receptor cells respond by producing nerve impulses.

d The Eustachian tube connects the middle ear with the throat, and allows the air pressure to be equalised either side of the eardrum.

e i The brain determines the frequency (pitch) of sounds by detecting which hair cells are being stimulated. The hair cells nearest to the oval window are sensitive to high-frequency sounds, while those nearest the round window are sensitive

to low-frequency sounds.

ii The loudness of sounds is determined by the amplitude (size) of vibrations of the hair cells. Loud sounds produce high-amplitude vibrations, which result in more nerve impulses per second in the sensory neurones.

3 ▶ Answers should include the following points:

- Test the hearing of people of different ages
- Suggested age range, e.g. 8 to 80 years in 10-year intervals
- Suggested number of people in each age group (minimum 6)
- Change frequency of sound / use signal generator
- Use same loudness / amplitude of sound
- Controlled variables, e.g. same distance from sound source, same sex, all participants have good hearing (not deaf)
- Record range of frequencies that each person can hear
- Repeat measurements on each person (for reliability)

CHAPTER 9

1 ▶ a i sensory neurone

ii relay neurone

iii motor neurone

b The sensory neurone carries impulses from sensory receptors towards the central nervous system. The motor neurone carries impulses out from the CNS to effector organs (muscles and glands). The relay neurone links the sensory and motor neurones in the CNS.

c X = white matter; Y = grey matter; Z = dorsal root ganglion

d electrical impulses

e The gap between one neurone and another is called a synapse. An impulse arrives at the end of an axon and causes the release of a chemical called a neurotransmitter into the synapse. The neurotransmitter diffuses across the synapse and attaches to the membrane of the next neurone. This starts an impulse in the second nerve cell.

2 ▶ a i cerebellum

ii medulla / brain stem

iii cerebrum / cerebral hemispheres

b i motor area of the cerebrum / cerebral cortex

ii sensory (smell) area of the cerebrum / cerebral cortex

c i Diseased and damaged blood vessels in the brain. The blood vessels become blocked or may leak, reducing the supply of oxygen and nutrients to the brain cells so that they die.

ii Drugs to reduce high blood pressure or lower blood cholesterol, to lower the risk of strokes.

3 ▶ a **Hormones** are chemical messenger substances, carried in the blood. If a substance is **secreted**, it is produced by a cell, tissue or organ and then passes to the outside of that structure. **Endocrine glands** are organs that secrete hormones into the blood.

b A = insulin; B = adrenaline; C = testosterone; D = progesterone

4 ▶ a The thyroid gland makes the hormone thyroxine. Thyroxine increases the metabolic rate, which is needed to control body temperature in cold conditions.

b Iodine is needed to make thyroxine. Lack of iodine in the diet causes a goitre.

5 ▶ a Glucose has been absorbed into the blood following a meal (lunch).

b The high concentration of glucose in the blood is detected by the pancreas, which secretes the hormone insulin into the blood. Insulin stimulates the uptake of blood glucose into the liver, where it is converted into an insoluble storage carbohydrate called glycogen.

c i Untreated diabetes leads to weakness, loss of weight, and eventually coma and death.

ii Coloured test strips to detect glucose in the urine, or direct measurement of blood glucose using a sensor.

iii Reduce the amount of carbohydrate in the diet, or inject insulin.

6 ▶ a During negative feedback, a change in the conditions in the body is detected and this starts a process to return conditions to normal.

b If the level of glucose in the blood falls, this stimulates the pancreas to release glucagon. Glucagon causes the liver to change glycogen into glucose. The glucose is released by the liver, raising the blood glucose levels.

7 ▶ a The men's reaction times increased as the amount of alcohol in their blood increased.

b 0 units reaction time = 0.24 s
8 units reaction time = 0.50 s
Increase = 0.50 – 0.24 = 0.26 s

c A driver may need to react to an emergency situation (by braking suddenly). Alcohol in the bloodstream increases reaction times, which may be dangerous – e.g. the driver may not be able to react quickly enough to avoid an accident if, for instance, a child runs into the road in front of them.

d It causes the disease cirrhosis, where the liver cannot perform its functions properly and toxins in the blood build up to high levels. The disease is usually fatal.

CHAPTER 10

1 ▶ a Homeostasis = maintaining constant conditions in the (internal environment of the) body

b Excretion = removal of waste products of metabolism from the body

c Ultrafiltration = filtration of different sized molecules under pressure (as in the Bowman's capsule)

d Selective reabsorption = reabsorption of different amounts of different substances by the kidney tubule

e Endotherm = an animal (mammal or bird) that generates internal (metabolic) heat to maintain a constant body temperature

2 ▶ a X = glomerulus; Y = Bowman's capsule (or renal capsule); Z = loop of Henlé

b A = water, urea, protein, glucose, salt
B = water, urea, glucose, salt
C = water, urea, salt
D = water, urea, salt

3 ▶ Description should include:
- Increase in blood concentration
- stimulates receptors in the hypothalamus of the brain
- causing the pituitary gland to release more ADH.
- ADH travels in the blood to the kidneys.
- ADH causes collecting ducts of tubules to become more permeable to water
- so more water is reabsorbed into blood.
- Blood becomes more dilute: its concentration returns to normal.
- This is an example of negative feedback – a change in the body is detected and starts a process to return conditions to normal.
- This is negative feedback because an increase in blood concentration is detected and the action of ADH returns blood concentration to normal.

4 ▶

Changes taking place	Hot environment	Cold environment
sweating	Increased sweat production: evaporation of more sweat removes more heat from the skin	Decreased sweat production: evaporation of less sweat removes less heat from the skin
blood flow through capillary loops	Vasodilation increases blood flow through surface capillaries so more heat is radiated from the skin	*Vasoconstriction decreases blood flow through surface capillaries so less heat is radiated from the skin*
hairs in skin	Hairs lie flat due to relaxed muscles, trapping less air next to the skin	Hairs are pulled erect by muscles, trapping a layer of insulating air next to the skin
shivering	No shivering occurs	Shivering occurs; respiration in muscles generates heat
metabolism	Metabolism slows down (e.g. in organs such as the liver) reducing heat production	Metabolism speeds up (e.g. in organs such as the liver) generating heat

5 ▶ a All chemical reactions taking place in cells can continue at a steady rate: metabolism does not slow down in cold conditions.

b i Arterioles constrict: blood remains in the core of the body so less heat is lost by radiation from the surface of the skin.
Less sweat is formed: no heat is lost in evaporating the sweat.
Shivering: increases heat production by respiration.

ii They have a lot of muscle fibres in their walls.

c i antidiuretic hormone / ADH

ii More water has been lost as sweat.

iii As the concentration of water in the blood decreases, ADH is released from the hypothalamus. ADH causes reabsorption of more water in the kidney tubules.

6 ▶ a A membrane that has holes in it which will let small molecules pass through but not larger ones.

b Starch: add iodine solution. If starch is present, the colour will change from yellow-brown to blue-black.
Reducing sugar: add Benedict's solution and boil. If reducing sugar is present, a brick-red precipitate will form.
Protein: add potassium hydroxide solution and copper sulfate solution. If protein is present, a pale purple solution will form.

c Amylase (an enzyme) is a protein. He is testing to see if the amylase can pass through the membrane into the water.

d The amylase and the starch molecules are too large to pass through the Visking tubing. The amylase broke down the starch into reducing sugar / maltose; these smaller molecules were able to pass through the membrane into the water, producing a positive test with Benedict's solution.

END OF UNIT 3 QUESTIONS

1 ▶ B	**2 ▶** C	**3 ▶** D	**4 ▶** C
5 ▶ B	**6 ▶** C	**7 ▶** C	**8 ▶** C
9 ▶ D	**10 ▶** D	**11 ▶** B	**12 ▶** B
13 ▶ D	**14 ▶** A	**15 ▶** C	**16 ▶** C

17 ▶ antagonistic **[1]**; biceps **[1]**; triceps **[1]**; respiration **[1]**; glucose (or oxygen) **[1]**; oxygen (or glucose) **[1]**; carbon dioxide **[1]**

18 ▶ a A condition where the lens of the eye becomes cloudy / opaque (so the person is unable to see). **[1]**

b Changes that take place in the eye **[1]** and allow us to focus on objects at different distances **[1]**.

c The operation removes the lens of the eye and replaces it with an artificial lens **[1]**. The artificial lens is a fixed shape **[1]** so accommodation is not possible.

d Glasses with convex lenses **[1]** which will help to focus the light from a nearby object (the book) **[1]**.

19 ▶ a P = cell body **[1]**; Q = dendrite **[1]**; R = axon **[1]**

b speed = $\frac{1.2}{0.016}$ = 75 metres per second **[1]**

c mitochondrion **[1]**

d i Insulates the axon / stops axons 'short circuiting' / increases the speed of the impulse **[1]**

ii Uncontrolled muscle contractions / wrong muscles contract (or words to that effect) **[1]**

20 ▶ a Before the water was drunk, the volume of urine collected was about 80 cm^3 **[1]**. After the water was drunk, the volume increased **[1]**, reaching a peak of about 320 cm^3 after 60 minutes **[1]**. After this, the volume decreased **[1]** until it returned to the volume produced before drinking the water at about 180 minutes **[1]**.

[maximum 3 marks]

b At 60 minutes, the concentration of ADH in the blood was low **[1]**. This made the collecting ducts of the kidney tubules less permeable to water **[1]**, so less water was reabsorbed into the blood / more water was excreted in the urine **[1]**, forming a large volume of urine **[1]**. By 120 minutes, the secretion of ADH had increased **[1]**, causing the collecting ducts to become more permeable **[1]**, so more water was reabsorbed into the blood / less water entered the urine **[1]**.

[maximum 4 marks]

c The volume of urine collected would be less **[1]**. More water would be lost as sweat **[1]** so there would be less water in the blood for the production of urine **[1]**.

[maximum 2 marks]

d 150 cm^3 of urine is produced in 30 minutes: this is $\frac{150}{30} = 5\,cm^3$ per minute **[1]**

The filtration rate is 125 cm^3 per minute

Therefore, 125 – 5 = 120 cm^3 is reabsorbed per minute **[1]**

The percentage reabsorption is $\frac{120}{125} = 96\%$ **[1]**

UNIT 4 ANSWERS

CHAPTER 11

1 ▶ a B. The number of chromosomes is reduced from 46 to 23 in the new cells.

b Human body cells have 46 chromosomes. Meiosis produces gametes (eggs and sperm) with 23 chromosomes. At fertilisation, the chromosomes from the mother and father come together in the zygote, producing a cell with 46 chromosomes again. The zygote divides repeatedly by mitosis, producing an embryo (and later a baby and then an adult) with 46 chromosomes in all its cells. The life cycle then repeats.

c Any three differences from:

	mitosis	meiosis
number of cell divisions	1	2
number of daughter cells produced	2	4
daughter cells haploid or diploid	diploid	haploid
genetic variation in daughter cells	no	yes

2 ▶ a A = placenta; B = umbilical cord; C = amnion; D = amniotic fluid; E = uterus (womb)

b The function of the placenta is to transfer oxygen and nutrients from the mother's blood to the embryo / fetus, and to remove waste products (such as carbon dioxide and urea) from the fetus to the mother.

c Just before birth, contractions of the muscle of the uterus (E) cause the amnion to rupture, allowing the amniotic fluid (D) to escape. This is known as the 'breaking of the waters'.

d During birth, the cervix (F) becomes fully dilated, and strong contractions of the muscles of the uterus (E) push the baby out.

3 ▶ a i A **ii** B

iii D **iv** A

b i oestrogen

ii Approximately 29–30 days (count the number of days from the start of the first menstruation (day 0) to the start of the next menstruation).

iii Fertilisation is most likely to have taken place about 15 days after the day when the last menstruation started. The last menstruation started on about day 57, so fertilisation probably took place around day 72. (Note: this is very approximate.)

After day 72, there is no menstruation so the uterus lining becomes thicker.

iv To allow implantation of the fertilised egg

4 ▶ There is evidence for and against the involvement of pollutants in lowering human sperm counts (and some disagreement over whether human sperm counts have become lower at all). A good account of the student's findings should be balanced, giving both sides of the argument. It should be illustrated with some tables or graphs of data, and sources should be referenced.

5 ▶

Name of hormone	Place where the hormone is made	Function(s) of the hormone
follicle stimulating hormone / FSH	pituitary (gland)	Stimulates growth of follicles in the ovary Stimulates secretion of oestrogen by the ovary
luteinising hormone / LH	pituitary (gland)	Stimulates ovulation
oestrogen	ovary	Causes repair (thickening) of the lining of the uterus following menstruation
progesterone	ovary (corpus luteum)	Completes the development of the uterus lining and maintains it ready for implantation of the egg Inhibits the release of FSH and LH by the pituitary (and stops ovulation)

6 ▶ a i A diaphragm is a dome-shaped piece of rubber that

a woman inserts into her vagina before intercourse. The cap covers the cervix, preventing sperm from entering the uterus.

ii An intrauterine device is a small plastic or copper object that is inserted through the cervix into the uterus. It works by preventing a fertilised egg from implanting in the lining of the uterus.

iii The combined pill contains a mixture of the hormones oestrogen and progesterone. They prevent the production of FSH and LH by the pituitary gland. This means that the follicles inside the ovary do not develop, and ovulation does not take place. A woman cannot become pregnant unless an egg is released.

b i Advantages: easy to obtain and use; gives protection against sexually transmitted diseases

Disadvantage: may slip off during intercourse

ii Advantages: can be used by people who have religious or moral objections to other forms of contraception

Disadvantages: high failure rate; woman needs to have a regular cycle; woman must keep track of her cycle

7 ▶ a i The whole body grows at a steady (constant) rate between birth and about 20 years, then stops growing. The brain and head grow much more rapidly at first (up to about 5 years of age); then the rate of growth steadily slows until growth stops at about 20 years.

ii The brain is large / well-developed at birth and continues to develop quickly during childhood. It is needed for coordination of body activities and learning.

b Slow growth from birth to age 10–13, followed by rapid growth between about 12 and 20 years. No growth after 20 years.

c There is little growth below the age of about 10–13, because the child is unable to reproduce / they are not sexually mature (because they would not be able to look after children). When a child is around 10–13 years old, puberty takes place. Sex hormones (oestrogen and testosterone) are released and the sex organs grow, becoming ready for reproduction.

CHAPTER 12

1 ▶ a Both parent guinea pigs must be heterozygous. Let S = allele for short hair and s = allele for long hair:

	S	**s**
S	SS	Ss
s	Ss	ss

There is a 1 in 4 chance of two heterozygous short-haired guinea pigs producing long-haired offspring (ss).

b Breed the short-haired guinea pig with a homozygous long-haired guinea pig (ss).

If the short-haired guinea pig is heterozygous (Ss), there will be both long-haired and short-haired offspring (in a 1:1 ratio):

	S	**s**
s	Ss	ss
s	Ss	ss

If the short-haired guinea pig is homozygous (SS), all offspring will have short hair:

	S	**S**
s	Ss	Ss
s	Ss	Ss

2 ▶ a Both 1 and 2 are tasters. If the gene was recessive, all their children would also be tasters, but 4 is a non-taster.

b Individual 3 is Tt: if she was TT, she could not supply a 't' allele to have daughters who are non-tasters.

Individual 7 is tt, because this is the only genotype that produces a non-taster.

c Individual 5 could be TT or Tt: her husband (6) is a non-taster (tt), so she could donate a 'T' allele from either genotype to produce a son (9) with the genotype Tt.

d Individual 3 must have the genotype Tt, while individual 4 must be tt. The cross produces a 1:1 ratio of tasters to non-tasters: the probability that a child is a taster is 0.5 / 50% / 1 in 2.

	T	**t**
t	Tt	tt
t	Tt	tt

3 ▶ a i An allele is an alternative form of a gene. Alleles can give rise to different inherited characteristics.

ii Codominant means that both alleles in a heterozygote are expressed in the phenotype.

b

Blood group	Genotypes
A	I^AI^A, I^Ai^o
B	I^BI^B, I^Bi^o
AB	I^AI^B
O	i^oi^o

c The woman's genotype must be I^Ai^o and the man's must be I^Bi^o: this is the only combination of genotypes that would allow them to have one child who is group A and one who is group O. The genetic cross is:

	I^A	**i^o**
I^B	I^AI^B (group AB)	I^Bi^o (group B)
i^o	I^Ai^o (group A)	I^Ai^o (group O)

4 ▶ a The probability of any child being a boy is always 0.5 or 50%. It makes no difference that they have already had four girls – each time, the probability was 0.5 that a child would be a girl.

This is because sex is determined by the sex chromosomes. Males have the genotype XY and females have the genotype XX.

Men can produce sperm containing either X or Y chromosomes; women only produce eggs with X chromosomes. So a cross looks like this:

	X
X	XX
Y	XY

This means there is a 50% probability that a boy will be produced at any fertilisation of an egg.

5 ▶ a The person's blood does not clot.

b A gene carried on one of the sex chromosomes (usually on the larger X chromosome).

c A change in the nucleotide base sequence of a section of DNA.

d i X^HX^h **ii** X^HY

iii X^hY **iv** X^HX^H

6 ▶ a Individual 8 has cystic fibrosis, but neither of his parents does. This means that both parents must be heterozygous and the allele must be recessive. If the allele was dominant, he would have to have inherited at least one dominant allele from one parent, so that parent would have cystic fibrosis too.

b 3 and 4 must be heterozygous for the gene, as they do not have the disease but their son does. 11 must be homozygous for the gene, since she has the disease.

c i The probability that the next child is male is 1 in 2, or 0.5:

	X
X	XX
Y	XY

ii Let A = the normal allele of the gene and a = the cystic fibrosis gene.

Individual 11's genotype = aa.

Individual 10's genotype could be AA or Aa, so there are two possible outcomes:

1: AA × aa

	A	**A**
a	Aa	Aa
a	Aa	Aa

In this case, there is no chance of the child having cystic fibrosis: the probability is 0.

2: Aa × aa

	A	**a**
a	Aa	aa
a	Aa	aa

In this case, there is a 1 in 2 change (0.5 probability) of the child having cystic fibrosis.

Alternatively, you could argue that, since the genotype of 10 is unknown, the probability of the child having cystic fibrosis is 1 in 4, or 0.25.

CHAPTER 13

1 ▶ a A = chromosome; B = cell wall; C = cell surface membrane

b For swimming – the flagellum moves in a corkscrew motion to propel the bacterium through water

c Most bacteria are not pathogens (i.e. do not cause disease). Most species are free-living, for example in soil or water. Many are decomposers or photosynthesise.

2 ▶ a Diagram should show a core of DNA or RNA surrounded by a protein coat and an outer membrane derived from the host cell

b Virus particles are not living organisms. They do not carry out any of the characteristics of living things except reproduction, and they can only do this parasitically. Viruses can be thought of as on the borderline between living organisms and non-living chemicals.

c A virus reproduces by entering a cell (of a host) and taking over the host cell's genetic 'machinery' to make more virus particles. This is the only way in which viruses can reproduce, so all viruses are parasites.

3 ▶ a Any four from:

- droplet infection – e.g. common cold, influenza, tuberculosis, pneumonia
- by drinking contaminated water – e.g. cholera, typhoid, polio
- eating contaminated food – e.g. typhoid, polio, salmonellosis, listeriosis, botulism
- direct contact – e.g. athlete's foot, ringworm, Ebola
- sexual intercourse – e.g. chlamydia, syphilis, AIDS, gonorrhoea
- blood-to-blood contact – e.g. AIDS, hepatitis B
- animal vectors – e.g. malaria, sleeping sickness, typhoid, salmonellosis

b Houseflies are attracted to animal or human faeces and pick up many bacteria and viruses on their bodies or in their saliva. The flies then feed on human food and contaminate it with these pathogens. Humans become infected when they eat the food.

Mosquitoes transmit pathogens (e.g. the protozoan parasite that causes malaria) from one person to another by (the female mosquitoes) feeding on human blood.

c Houseflies

Any two from: use insecticides to kill the insects; cover food to stop flies landing on it; dispose of sewage properly so flies cannot come into contact with human waste, etc.

Mosquitoes

Any two from: use mosquito nets to stop mosquitoes 'biting'; use insect repellents to keep mosquitoes away; use insecticides to kill the insects; drain swamps and pools to prevent mosquitoes breeding; introduce fish to eat the mosquito larvae, etc.

4 ▶ a A virus reproduces by entering a host cell and taking over the host's genetic 'machinery' to make more virus

particles. After many virus particles have been made, the host cell dies and the virus particles are released to infect more cells.

b Sexual intercourse or blood-to-blood contact (or a specific example, such as drug addicts sharing needles or contaminated blood transfusions).

c When the body is infected by the HIV virus, it responds by producing antibodies against the virus. A person who has anti-HIV antibodies in their blood is HIV positive.

d i The (infected) T-helper cells are destroyed by the body's immune system, but are replaced.

ii The (infected) T-helper cells are destroyed by the body's immune system and the body is not able to replace them as quickly as they are being destroyed. As a result, the number of T-helper cells decreases.

e HIV weakens the immune system, so a person with AIDS is less likely to be able to develop an immune response that will destroy the pathogens that cause infections.

5 ▶ a Cholera is mainly transmitted in contaminated drinking water. It can also be passed on if infected people handle food without washing their hands, or in undercooked seafood which was caught in contaminated water.

b Cholera bacteria reproduce in the small intestine, producing a toxin that prevents the epithelium lining the intestine working properly. This causes the loss of water and salts from the blood into the intestine, leading to severe diarrhoea, so the patient becomes dangerously dehydrated.

Oral rehydration therapy restores the osmotic balance in the patient's blood and tissue fluid, so the diarrhoea stops and the person recovers.

6 ▶ a A sexually transmitted disease is one that is passed from person to person during sexual intercourse, such as HIV, syphilis or chlamydia.

b In men, the number of new cases was fairly constant between 1925 and 1939. It fell during World War II (1939–45) but rose dramatically after the war ended, reaching a peak in about 1946. Numbers fell sharply from 1946 until 1955, then rose again until 1973. They then fell again until 1990.

In women, the number of new cases was always lower but the pattern was broadly similar. However, the number of new cases rose during World War II and the peak was in 1977 rather than 1973.

(The answer may not be as detailed as this, but general trends should be given).

c Increase in 'casual' sex outside marriage (or equivalent comment, referring to changes in sexual behaviour); availability of the pill (which does not protect against sexually-transmitted diseases) as a contraceptive

d Awareness of AIDS led to increased use of condoms (which give protection against sexually transmitted diseases such as gonorrhoea); decrease in 'casual' sex; any suitable correct alternative

e i Penicillin interferes with the manufacture of bacterial cell walls. The cell walls of the gonorrhoea bacteria are weakened, so water enters the cells (by osmosis) and they burst.

ii Bacteria may become resistant to the penicillin.

7 ▶ a primary immune response and secondary immune response

b The secondary immune response is faster, produces a higher level of antibodies and lasts longer than the primary immune response.

c B-lymphocytes recognise antigens on the surface of the microorganisms. The lymphocytes have receptor proteins on their surface that bind to the antigens. The lymphocytes are now activated and divide rapidly, producing millions more lymphocytes. These produce antibodies against the microorganism (the primary response).

8 ▶ a A chemical that kills microorganisms, or reduces their growth. Antibiotics are mainly used in medicine to treat bacterial infections.

b Kill microorganisms (bactericidal), or stop them reproducing (bacteriostatic).

9 ▶ a To allow large particles in suspension to settle out.

b Biogas – can be used as a fuel in electricity generators or for heating

Dry solid material – can be used for fertiliser

c Treatment in the filter bed relies on the action of aerobic bacteria, fungi, protozoa and other organisms to digest the sewage.

d Untreated sewage contains high concentrations of nitrates and phosphates, which may lead to eutrophication of water sources.

END OF UNIT 4 QUESTIONS

1 ▶	D	**2 ▶**	D	**3 ▶**	A	**4 ▶**	C
5 ▶	A	**6 ▶**	B	**7 ▶**	D	**8 ▶**	B
9 ▶	A	**10 ▶**	C	**11 ▶**	B	**12 ▶**	D

13 ▶ a A = oestrogen **[1]**; B = progesterone **[1]**

b corpus luteum **[1]**

c To prepare for the implantation of a fertilised embryo **[1]**

d 13 **[1]**

e Progesterone maintains the thickened uterus lining and prevents menstruation **[1]**. It also prevents further ovulation **[1]** by inhibiting the release of FSH and LH **[1]**. **[maximum 2 marks]**

f i Progesterone is secreted by the corpus luteum **[1]**.

ii Progesterone is secreted by the placenta **[1]**.

14 ▶ a i X^aY

ii X^aX^a

iii X^AX^a

b The father must have the genotype X^AY to have normal colour vision. The mother must have the genotype X^AX^a to have normal colour vision herself but still be able to pass on the colour blindness gene. The possible genotypes and phenotypes are:

	X^A	Y
X^A	X^AX^A (girl, normal colour vision)	X^AY (boy, normal colour vision)
X^a	X^AX^a (girl, normal colour vision)	X^aY (boy, colour blind)

[3 marks for correct diagram]

The colour blind child must be a boy **[1]**.

15 ▶ Answer should include the following points:

- Compare garlic juice / different concentrations of juice, with no garlic juice (Control)
- Use the same species of bacterium
- Place paper discs soaked in juice on the bacterial cultures / add garlic juice to agar plates before culturing / other suitable method
- Incubate plates for the same period of time
- Same temperature / stated temperature (20–40°C) / same nutrients / same volume of juice / other controlled variable
- Measure clear areas around discs / count number of colonies / other suitable method of measurement
- Repeat measurements (for reliability)

[maximum 6 marks]