

Disease and Immunity

Mark Scheme



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1. The human immune system is a complex network that defends the body against pathogens. Answer the following questions. Circle the letter of the correct answer for each.

- a) The figure below shows one of the ways the body can defend itself against pathogens. What is the name of this immune response?

D – is the only correct answer.	1 mark
	Total: 1 mark

- b) Which are both chemical barriers to the transmission of pathogens?

A – is the only correct answer.	1 mark
	Total: 1 mark

- c) The figure below shows a lymphocyte. What do lymphocytes produce?

A – is the only correct answer.	1 mark
	Total: 1 mark

- d) The immune system identifies and neutralises pathogens. What characteristic of a pathogen allows the immune system to recognise it as foreign?

C – is the only correct answer.	1 mark
	Total: 1 mark

- e) The figure below shows colonies of bacteria growing on two different agar plates. What is the ratio of the area covered by bacterium X to the area covered by bacterium Y?
(The area of a circle = πr^2)

D – is the only correct answer.	1 mark
	Total: 1 mark

(Total for Question 1 is 5 marks)

2. Measles is a highly contagious disease that can cause serious complications, especially in young children. Vaccination programmes have been successful in reducing the incidence of measles in many countries.

a) State the type of microorganism that causes measles.

Virus.	1 mark
	Total: 1 mark

a) Explain how a measles vaccination protects an individual from developing the disease.

An explanation to include any three of the following:	
Vaccine contains inactive / dead / weakened form of the pathogen / virus or antigens (from the pathogen / virus.	1 mark
Accept: attenuated pathogen. Safe version/part of pathogen.	
This stimulates white blood cells / lymphocytes.	1 mark
Lymphocytes produce antibodies.	1 mark
Lymphocytes) become memory cells.	1 mark
On re-infection / if the real pathogen enters, antibodies are produced rapidly / faster / in larger quantities.	1 mark
Allow: Secondary response is quicker / greater.	
Pathogen / virus is destroyed / killed quickly (before symptoms develop).	1 mark
	Total: 3 marks

b) Describe **two** ways, other than vaccination, that the spread of measles can be controlled.

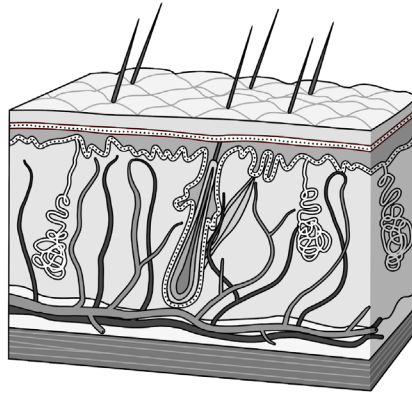
A description to include any two of the following:	
Isolating infected individuals / quarantine.	1 mark
Allow: keeping infected people away from others / Stay at home when ill.	
Good hygiene / sanitation	1 mark
Allow: washing hands frequently.	
Disinfecting / cleaning surfaces.	1 mark
Allow: sterilising equipment / surfaces.	
	Total: 2 marks

c) Suggest why it is important to maintain a high percentage of the population vaccinated against measles.

Any two from:	
Provides herd immunity / achieves herd immunity	1 mark
Reduces the spread / transmission of measles (in the population)	1 mark
Allow "Less likely for the pathogen to pass between people / Less chance of epidemics/outbreaks"	
Protects individuals who are not vaccinated / cannot be vaccinated	1 mark
(Therefore) reduces the overall incidence / cases of the disease	1 mark
	Total: 2 marks

(Total for Question 2 is 8 marks)

3. The human body has multiple methods of defence against pathogens. These defences can be broadly categorised as physical and chemical barriers, and cellular responses.



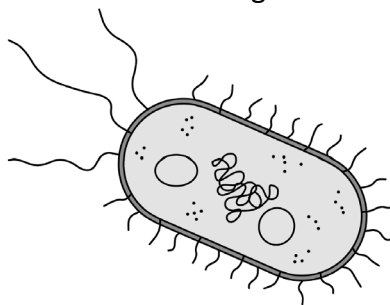
- a) Describe **two** physical or chemical barriers that prevent pathogens from entering the body. For each barrier, explain how it provides protection.

A description to include any four of the following:	
Physical barrier 1: <u>Skin</u> Explanation of protection: • Acts as a physical barrier / stops pathogens getting in. • Produces antimicrobial secretions / sebum. • Outer layer consists of dead cells (making entry difficult) / Blood clotting / scab formation.	1 mark
Physical barrier 2: <u>Mucus</u> Explanation of protection: Traps / catches pathogens / microorganisms / particles.	1 mark
Chemical barrier 1: <u>Stomach acid / Hydrochloric acid (in stomach).</u> Explanation of protection: • <u>Kills / destroys pathogens / bacteria / microorganisms (due to low pH / being acidic).</u> • <u>Denatures the enzymes of pathogens.</u>	1 mark
Chemical barrier 2: <u>Tears / Saliva</u> Explanation of protection: • Contain enzymes / lysozyme. • Must identify enzyme/lysozyme for chemical barrier aspect. • (Which) kill / destroy / break down bacteria / pathogens.	1 mark
Total: 4 marks	

- b) Explain how phagocytes defend the body against pathogens that have entered the tissues.

An explanation to include any four of the following:	
Phagocyte detects / recognises / is attracted to the pathogen / microorganism / foreign cell	1 mark
Phagocyte surrounds / engulfs the pathogen.	1 mark
Allow: Ingests / takes in the pathogen.	
(Pathogen is enclosed) within a vesicle / vacuole / phagosome.	1 mark
Enzymes digest / break down / destroy the pathogen.	1 mark
Allow: Pathogen is killed by enzymes	
Total: 4 marks	

Many bacteria that cause disease produce toxins. The figure below shows a typical bacterial cell.

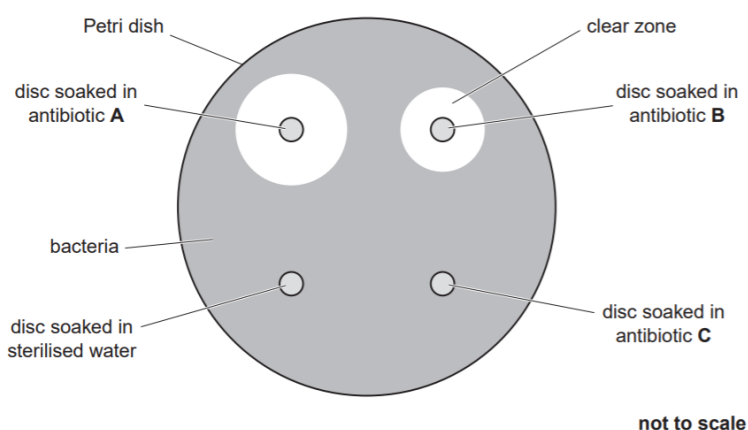


c) Describe **one** way that the body can neutralise these toxins.

A description to include any one of the following:	
Lymphocytes / specific white blood cells produce antitoxins.	1 mark
Antitoxins neutralise / counteract the toxins.	1 mark
Allow: Antitoxins bind to toxins (making them harmless)	
	Total: 2 marks

A student is investigating the effectiveness of different antibiotics on a species of bacteria.

The student set up a sterile petri dish as shown below with four paper discs soaked in four different antibiotics and one disc soaked in distilled water.



d) What is the purpose of the paper disc soaked in distilled water?

The following linked points:	
Acts as a <u>control</u> / for <u>comparison</u> .	1 mark
To show that the water (itself) does not kill / inhibit the bacteria OR to show that the paper disc (itself) does not kill / inhibit the bacteria	1 mark
	Total: 2 marks

e) Calculate the area of the clear zone for Antibiotic B. Use the formula πr^2 .

Give your answer to three significant figures.

Radius = $1.2 \div 2 = 0.6 \text{ cm}$	1 mark
Area = $\pi \times (0.6)^2$	
Area = 1.13 cm^2	1 mark
	Total: 2 marks

(Total for Question 3 is 14 marks)

4. Malaria is a serious disease caused by a parasite transmitted to humans through the bite of infected mosquitoes.

a) Name the type of pathogen that causes malaria.

Protist.	1 mark
	Total: 1 mark

b) Describe the role of mosquitoes in the transmission of malaria.

A description to include any two of the following:	
Mosquitoes are <u>vectors</u> for malaria / the pathogen.	1 mark
The mosquito feeds on / bites / takes blood from an infected person.	1 mark
The mosquito feeds on / bites an uninfected person; (Mosquito) injects / passes / transmits the protist / parasite / Plasmodium	1 mark
	Total: 2 marks

c) Explain **two** different methods used to control the spread of malaria.

For each method, explain **how** it reduces the number of cases.

Award one mark for identifying a valid method, and one mark for a linked explanation of how it reduces cases/transmission.	
Method 1: mosquito nets / bed nets. Linked explanation: Prevents mosquitoes biting people (at night) / barrier / kills mosquitoes / stops pathogen being passed on / entering blood.	2 marks
Method 2: Spraying insecticides / pesticides Linked explanation: Kills (adult) mosquitoes / reduces vector population.	2 marks
Method 3: Preventing mosquito breeding. Linked explanation: Mosquitoes cannot lay eggs / larvae cannot develop / kills larvae / reduces vector population.	2 marks
	Total: 4 marks

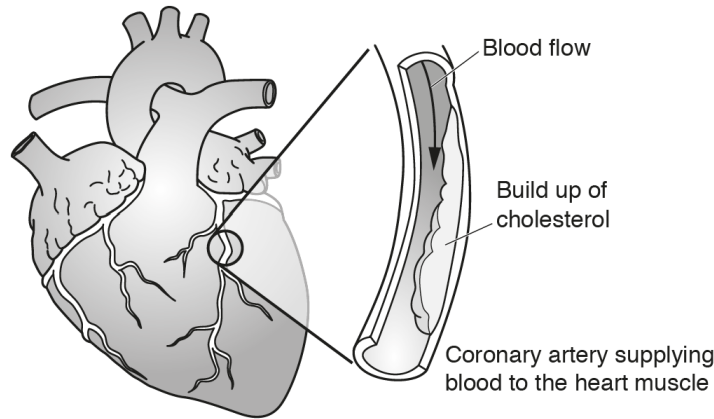
d) Scientists are constantly developing new drugs to treat malaria.

Explain why it is important to continue developing new drugs, even if effective treatments already exist.

Award one mark for identifying a valid reason, and one mark for a linked explanation of how it is beneficial.	
Reason: The pathogen / parasite / Plasmodium can develop resistance (to existing drugs) / mutate to become resistant. Linked explanation: existing / current drugs become less effective / ineffective / stop working. Therefore, new drugs are needed to treat the infection	2 marks
Reason: new drugs could be improved or work more effectively. Linked explanation: new drugs might be more effective or work faster than existing ones against certain strains or stages of the parasite.	2 marks
Reason: new drugs could have reduced side effects. Linked explanation: new drugs could be developed with fewer or less severe side effects, making them safer.	2 marks
Reason: new drugs could cost less. Linked explanation: new drugs could be cheaper to manufacture, making treatment more accessible in low-income countries where malaria is most prevalent.	2 marks
	Total: 2 marks

(Total for Question 3 is 14 marks)

5. Coronary heart disease (CHD) is a condition that affects the heart and can lead to serious health complications. The figure below of a heart shows a section through a coronary artery.



- a) Describe how coronary heart disease develops and explain how lifestyle choices can increase the risk of developing this condition.

Marking guidance		
Level	Marks	Descriptor
Level 1	1 - 2	Identifies at least one lifestyle factor linked to heart disease but provides little or no explanation of how it increases risk.
Level 2	3 - 4	Explains how at least one or two lifestyle factors increase the risk, with some attempt to link the factor to the disease process, although the link may not be fully developed or clear.
Level 3	5 - 6	Clearly explains how multiple relevant lifestyle factors (e.g., diet, smoking, lack of exercise) increase the risk, linking the factor to the mechanism (e.g., high saturated fat leading to cholesterol deposition).

Indicative content:	
Development of CHD: - Coronary arteries supply the heart muscle with oxygenated blood / oxygen / glucose. - Layers of fatty material / deposits / plaque (atheroma) build up inside the coronary arteries. - These deposits contain cholesterol. - This process is called atherosclerosis. - The build-up narrows the lumen / passageway of the artery. - This restricts / reduces blood flow to the heart muscle. - Reduced blood flow means less oxygen reaches the heart muscle cells. - This can cause chest pain (angina). - If a piece of plaque breaks off or a blood clot forms, it can completely block the artery. - This leads to a heart attack (myocardial infarction) as heart muscle cells die due to lack of oxygen. Lifestyle Factors Increasing Risk (with explanations): Poor Diet: High intake of saturated fats / cholesterol leads to increased blood cholesterol levels, contributing to plaque formation. High salt intake can increase blood pressure, straining the heart and damaging artery walls.	

• Smoking: Chemicals in smoke (e.g., nicotine, carbon monoxide) damage the lining of arteries, making plaque formation more likely. Nicotine increases heart rate and blood pressure. Carbon monoxide reduces the oxygen-carrying capacity of the blood. Smoking also increases the risk of blood clots. • Lack of Exercise: Leads to higher blood pressure, higher cholesterol levels, and increased risk of obesity/type 2 diabetes, all of which are risk factors for CHD. Regular exercise helps maintain healthy weight and blood pressure. • Obesity: Increases strain on the heart, often associated with high blood pressure, high cholesterol, and type 2 diabetes. • High Blood Pressure (Hypertension): Damages artery walls over time, making them more prone to atherosclerosis. (Can be linked to diet/obesity/lack of exercise/smoking). • Stress: Can contribute to high blood pressure and unhealthy lifestyle choices (e.g., poor diet, smoking). • Excessive Alcohol Consumption: Can raise blood pressure and contribute to weight gain.	
	Total: 6 marks

b) Female 1 has a mass of 80 kg and a height of 1.65 m.

Calculate the BMI of female 1. Give the answer to 3 significant figures.

A description to include any two of the following:	
$80 \div (1.65)^2$	1 mark
29.4	1 mark
	Total: 2 marks

(Total for Question 5 is 8 marks)

6. Measles is a disease caused by a virus. The death rate from measles is 0.15%.
In 2023, 107,500 people died from measles. Deaths were mostly of unvaccinated children under five.

- a) Calculate the number of people infected with measles in 2023.

Give your answer in standard form.

Correct understanding that 0.15 % corresponds to 107,500 people OR Correctly converts percentage to decimal: $0.15\% = 0.0015$	1 mark
Correct calculation of the total number of infected people: $(107\,500 \div 0.0015) = 71\,666\,666.6\dots$	1 mark
Standard form = 7.16×10^7	1 mark
Accept: 7.17×10^7	
	Total: 3 marks

- b) The spread of measles is prevented by herd immunity.

Describe herd immunity.

A description to include any two of the following:	
When a large proportion / high percentage / sufficient number of the population is vaccinated / immune (against a disease).	1 mark
This reduces / prevents the spread of the pathogen / disease (within the population) / provides protection for unvaccinated / non-immune individuals.	1 mark
	Total: 2 marks

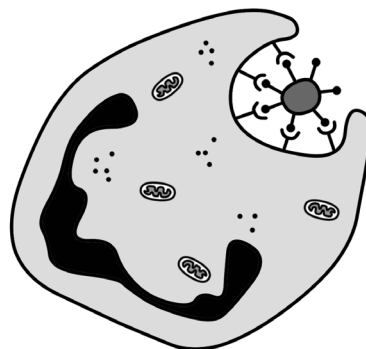
(Total for Question 6 is 5 marks)

7. The human immunodeficiency virus (HIV) can, if left untreated, lead to the development of acquired immunodeficiency syndrome (AIDS). When HIV infects the body it begins destroying cells.

- a) Which type of cell is destroyed by the HIV virus?

White blood cells called <u>T helper cells</u> / <u>helper T lymphocytes</u> / <u>T lymphocytes</u> .	1 mark
	Total: 1 mark

The figure below shows a phagocyte engulfing a microorganism.



- b) Name the process shown in the diagram.

Phagocytosis.	1 mark
	Total: 1 mark

c) Explain why this process is important for the body.

An explanation to include any two of the following:	
Carried out by phagocytes which engulf / ingest / surround / destroy pathogens / microorganisms / bacteria / viruses / foreign material / dead cells.	1 mark
This prevents or removes infection or disease. It could also removes dead / damaged cells / debris (from the body).	1 mark
	Total: 2 marks

d) Describe how the phagocyte destroys the bacterium after it has been engulfed.

A description to include any three of the following:	
Once engulfed, the bacterium is enclosed within a vesicle / vacuole / membrane-bound sac (inside the phagocyte).	1 mark
(Other) vesicles containing digestive enzymes move towards and fuse / join with the vesicle containing the bacterium.	1 mark
The enzymes break down / digest / destroy the bacterium.	1 mark
	Total: 3 marks

e) Phagocytes are part of the non-specific immune response. What is meant by the term "non-specific immune response?"

Doesn't distinguish between different types of pathogens.	1 mark
Does not involve recognising specific antigens / does not involve (specific) antibodies / does not provide immunological memory	1 mark
	Total: 2 marks

f) Describe how the specific immune system defends the body against disease.

Marking guidance		
Level	Marks	Descriptor
Level 1	1 - 2	Provides a limited or simple description, mentioning some components like white blood cells or antibodies.
Level 2	3 - 4	Provides a generally correct description of the specific immune response, including some key stages. Mentions lymphocytes/white blood cells producing antibodies in response to pathogens/antigens.
Level 3	4 - 5	Provides a detailed, logical, and sequential description of the specific immune response. Clearly explains the role of lymphocytes (specifically mentioning B lymphocytes/cells) recognising specific antigens on pathogens. Describes the production of specific antibodies that match the antigens.

Indicative content:	
- Pathogens (or foreign cells/toxins) have specific molecules on their surface called antigens. - Specific lymphocytes (white blood cells) recognise specific antigens. (B) lymphocytes are stimulated/activated (often mentioning role of T-helper cells is high level but not essential).	

• (B) lymphocytes divide / clone themselves. • (B lymphocytes differentiate to) produce/release antibodies. • Antibodies are specific to the antigen / have a complementary shape to the antigen. • Antibodies attach/bind to antigens on the pathogen. • This can cause pathogens to clump together (agglutination). • This makes it easier for phagocytes to engulf/destroy them OR marks them for destruction by phagocytes. • Some antibodies may neutralise toxins directly. • Memory (lymph) cells are also produced. • Memory cells remain in the blood/body for a long time. • If the same pathogen/antigen enters the body again, memory cells recognise it. • This leads to a faster / stronger / greater secondary response / antibody production. • This prevents the person from becoming ill / provides immunity. • (Higher level: T-killer/cytotoxic lymphocytes can destroy infected body cells).	
	Total: 5 marks

(Total for Question 7 is 14 marks)

8. Tuberculosis (TB) is a disease caused by a bacterium called *Mycobacterium tuberculosis*. It primarily affects the lungs, but can also affect other parts of the body. TB is spread through the air when an infected person coughs or sneezes.

a) State the type of pathogen that causes TB.

Bacterium/ bacteria.	1 mark
	Total: 1 mark

Tuberculosis (TB) is a communicable disease.

b) State **two** ways that communicable diseases are different from non-communicable diseases.

Cause: Communicable diseases are caused by pathogens / microorganisms / specific organisms (e.g., bacteria, viruses). Non-communicable diseases are not caused by pathogens (often linked to lifestyle/genetics/environment).	1 mark
Transmission: Communicable diseases can be spread / transmitted (from one organism/person to another) / are infectious. Non-communicable diseases cannot be spread / are not infectious.	1 mark
	Total: 2 marks

c) Explain one way that the spread of tuberculosis (TB) can be reduced or prevented.

An explanation to include one of the following:	
Vaccination: (BCG) Vaccinate people / give BCG vaccine. This prevents individuals from developing the disease / becoming infected / builds immunity, so they cannot spread the bacteria.	1 mark
Treatment with Antibiotics: Infected people treated promptly with antibiotics. Kills the bacteria / cures the infection, meaning the person is no longer infectious / cannot pass the bacteria on.	1 mark
Improved Hygiene / Containment: Infected individuals cover mouth/nose when coughing/sneezing / dispose of tissues correctly. Reduces the release of droplets containing bacteria into the air.	1 mark
	Total: 2 marks

d) Describe the trend shown in the graph.

A description to include any two of the following:	
Overall, the number of cases decreased / fell between 2000 and 2014/2018.	1 mark
Then remained constant / stayed the same / plateaued (between 2014 and 2018) OR Then increased / rose (between 2018 and 2020) / at the end of the period.	1 mark
	Total: 2 marks

e) Suggest **two** reasons why the number of TB cases might have increased slightly after 2018.

Award one mark for each valid suggested reason:	
- Antibiotic-resistant strains of TB increasing. - Reduced effectiveness of drugs. - Decrease in BCG vaccination rates. - Reduced funding for / effectiveness of TB screening / control programmes. - Increased movement of people / migration from areas with higher TB prevalence.	2 marks
	Total: 2 marks

f) TB can be treated with antibiotics. However, antibiotic resistance is becoming an increasing problem. Explain how antibiotic resistance can develop in bacteria.

An explanation to include the following:	
(Within a population of bacteria), <u>variation exists due to random mutation(s)</u> .	1 mark
When exposed to an antibiotic, non-resistant / susceptible bacteria are killed.	1 mark
Resistant bacteria survive and reproduce / multiply (passing on the resistance gene/allele).	1 mark
	Total: 3 marks

g) Explain why people with AIDS are more susceptible to TB.

An explanation to include the following:	
HIV / the virus attacks / damages / destroys / reduces the number of (specific) white blood cells / lymphocytes / T-helper cells.	1 mark
This weakens / damages the immune system (response). Therefore, the body is less able to fight off / defend against / kill the TB pathogen	1 mark
	Total: 2 marks

(Total for Question 8 is 14 marks)

9. The figure below shows the number of people diagnosed with sexually transmitted infections (STIs) in the UK during 2023.

Sexually transmitted infections	Number of diagnosed infections
Syphilis	10000
Chlamydia	195000
Gonorrhoea	85000
Genital warts	26000

- a) Calculate the mean number of sexually transmitted infections diagnosed in 2023.

$10000 + 195000 + 85000 + 26000 = 316000$	1 mark
$316000 \div 4 = 79\ 000$	1 mark
Accept correct answer without any working for full marks.	
	Total: 2 marks

- b) State why chlamydia can be described as a communicable disease.

It can be spread / passed on / transmitted (from person to person).	1 mark
Accept infectious, contagious, it is caused by a pathogen / bacteria that can be passed on. Accept can be caught from someone else. Ignore references to how it is spread.	1 mark
	Total: 1 mark

- c) Give one way the spread of chlamydia can be prevented.

Accept any one of the following:	
- Use barrier contraception / condoms. - Abstinence / refraining from sexual activity / not having sex. - Reducing the number of sexual partners / limiting partners / faithful relationship. - Prompt treatment (of infected individuals / partners).	
	Total: 1 mark

- d) Chlamydia can be cured using antibiotics. Explain how chlamydia can be treated with antibiotics.

An explanation to include the following:	
Chlamydia is caused by <u>bacteria</u> . Accept It is a bacterial infection. Ignore pathogen / microbe / microorganism unless qualified as bacterial. Reject virus / fungus.	1 mark
Antibiotics kill / destroy bacteria OR prevent growth / reproduction of bacteria. Accept Antibiotics disrupt cell wall synthesis of bacteria. Accept Antibiotics damage or destroy bacterial cell walls.	1 mark
	Total: 2 marks

(Total for Question 9 is 6 marks)

10. Developing new medicines is a long and complex process.
It involves several stages, including pre-clinical testing, clinical trials, and regulatory approval.

a) What is meant by the term "pre-clinical testing" in drug development?

Testing (of a potential new drug/medicine) that takes place before it is tested on humans / clinical trials.	1 mark
Accept Testing in a laboratory / using computers / using cells / tissues / organs.	
Accept Testing on animals.	
	Total: 1 mark

b) State **two** reasons why pre-clinical testing is important.

Accept any two of the following:	
- To assess safety / toxicity of the drug. - To assess efficacy / effectiveness of the drug. - To help determine appropriate dosage / dose ranging. - To predict potential effects / reactions in humans. - Ethical reasons / to avoid unnecessary harm to humans.	
	Total: 2 marks

Before it can be made available to the public, it must undergo clinical trials.

c) Describe the steps that should be taken to ensure that the new drug is safe and effective, before it is made available to the general public.

A description to include four of the following:	
Tested on small numbers of healthy volunteers first.	1 mark
Accept initial tests on people without high blood pressure.	
Tested on (small numbers of) patients / people with high blood pressure.	1 mark
Accept testing on people with the condition / illness. Needs to be clear this is a different/later stage than healthy volunteers if both points awarded.	
Tested on large(r) numbers of patients.	1 mark
Accept large scale trials.	
To monitor for safety / side effects / adverse reactions / toxicity (in humans).	1 mark
Accept to check it is safe (for humans). This point must clearly relate to the human testing stage.	
To determine efficacy / effectiveness / check if it works / check it lowers blood pressure.	1 mark
Accept To see if it treats the condition.	
To determine / optimise dosage.	1 mark
Accept To find the correct / safe / effective amount to use.	
	Total: 4 marks

(Total for Question 10 is 7 marks)