41(a). The English elm tree, *Ulmus procera,* was once widespread in Britain. The English elm is much less common now because of a disease known as Dutch elm disease.

- The disease is caused by a fungus that first arrived in Britain in 1967.
- Beetles living under the bark pick up fungal spores while feeding.
- Within a few years approximately 25 million trees were dead.

Suggest two reasons for the **rapid** spread of the fungus in the elm population.

1

2

---

[2]

(b). Malaria is a disease that affects many millions of people.

Identify one similarity in the way malaria is transmitted compared with the way Dutch elm disease is spread.

---

[1]

(c). Complete the passage using the most appropriate terms.

The pathogen that causes malaria is called …… . This organism belongs to the kingdom …… . The pathogens that cause malaria and Dutch elm disease are both in the domain …… .

[3]

42. Plague is caused by the bacterium, *Yersinia pestis.*

i. The bacterium is a rod-shaped cell that is approximately 3 μm long.

Yersinia pestis is viewed using a light microscope with a magnification of 1250.
What would be the length of the cell in the image produced by this microscope?

Answer……mm **[2]**

ii. Photographs taken of the image obtained by the light microscope could be further enlarged using a projector.

Why might the enlarged image be unable to tell us more about the structure of *Yersinia pestis?*

---**[1]**

iii. Outbreaks of plague still occur occasionally. Plague is transmitted by several methods including droplet infection, close contact between people and fleas moving between infected rats and people.

Suggest **two** ways to minimise the spread of an outbreak of plague.

---**[2]**

43. Pathogens cause disease and are transmitted from individual to individual in a variety of ways.

Which of the rows, **A** to **D**, in the table below is correct?

	Disease	**Type of pathogen**	**Means of transmission**
A	Athlete's foot	Fungus	Direct and indirect contact
B	HIV/AIDs	Virus	Indirect contact
C	Malaria	Bacterium	Vector
D	Tuberculosis	Protoctist	Direct contact

Your answer ☐

[1]

44. The potato plant, *Solanum tuberosum*, is a staple food plant in many parts of the world.
Potatoes are susceptible to infection by a pathogen called *Phytophthora infestans*, which causes a disease known as potato late blight. The most visible sign of the disease is a brown discolouration of the leaves.
Some varieties of potato are resistant to infection by *P. infestans*.

The resistance of different varieties of *S. tuberosum* to infection by *P. infestans* was investigated.

- Three different clones, A, B and C, of S. *tuberosum* were used.
- The clones were grown in adjacent fields over the same time period.
- The percentage of leaf area affected by the disease was estimated at regular intervals.

The results are shown in Fig. 18.

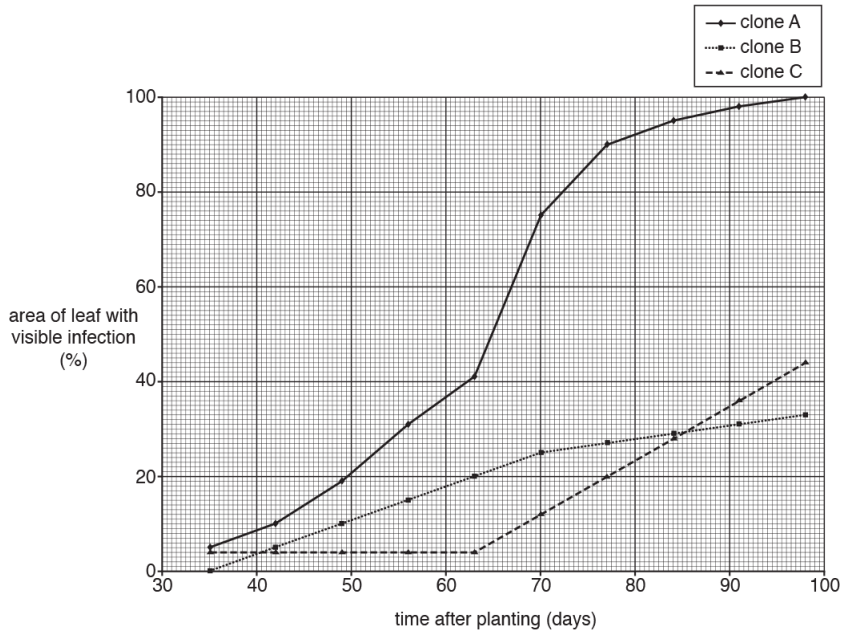

Fig. 18

i. Suggest why it is important to use clones in an investigation such as this.

---

[2]

ii. State how a clone of potatoes could be produced for this investigation and explain why it is important to carry out this procedure under aseptic conditions.
procedure

Asepsis is important because

---**[2]**

iii. The extent of infection is estimated by comparing the area under the curve from the graph. The area under the curve for clone **B** is 1250. (Units can be ignored in this instance.)
Using Fig. 18, calculate the approximate area under the curve, between day 35 and day 98, for clone **C**.

Answer ---**[3]**

iv. Calculate the area under the curve for clone **C** as a proportion of the area under the curve for clone **B**.

Answer ---**[1]**

v. **Using Fig. 18**, suggest why the area under the curve is used as a measure of infection rather than the area of leaf that is visibly affected on a given day.

_____

_____

_____

_____ [2]

vi. The clones were planted in adjacent fields in order to control variables such as temperature, wind speed and rainfall.
Suggest two other abiotic variables that this precaution was intended to control.
1

_____

_____

2

_____

_____ [2]

45. In West Africa during 2015 there was a serious outbreak of the viral disease Ebola which spread by contact with infected bodily fluids.

- At the start of the outbreak there was a severe lack of trained health workers in the affected areas and much of the nursing was carried out in the family home or at local clinics.
- Many residents lived in close proximity to one another and sanitation was often of a poor standard.
- In times of illness it was common for people to travel to stay with close relatives, often in nearby villages or towns.
- As the outbreak spread, some residents left their villages to flee from the disease.
- Local mourning and burial practices involved gathering at the family house to pay respects to the deceased. Prior to burial the deceased was usually bathed by close family members.

A number of common factors affect the spread of communicable diseases in humans and some of them are relevant to the spread of Ebola. From the information above, discuss these factors and suggest what actions could have been put in place to address them.

[6]

46. The sweet potato is a plant that is a staple food in countries such as China. The sweet potato is susceptible to a group of viruses known as potyviruses.

i. It is difficult for the virus to enter the sweet potato cell.

Suggest a barrier that makes it difficult for potyviruses to enter the sweet potato cell.

_____ **[1]**

ii. Suggest how the potyviruses enter the sweet potato cell.

_____

_____ **[1]**

47. Some microorganisms can be used by humans in industry. Some microorganisms are pathogenic.

Pathogenic microorganisms are transmitted in various ways.

Complete the following passage about the transmission of pathogenic microorganisms using the most appropriate terms.

Some pathogens are carried between host organisms by animals, which are often insects. These animals suffer no symptoms of the disease and are known as ..... . Other pathogens, such as *P. infestans* that causes potato blight, produce reproductive structures called ..... , which can be carried on air currents to infect other hosts.

[2]

48(a). Different types of pathogen cause communicable diseases in plants and animals.

Complete the table by adding the correct type of pathogen for each communicable disease.

The first one has been done for you.

Type of Pathogen	Communicable Disease
bacterium	tuberculosis (TB)
.....	potato late blight
.....	malaria

[2]

(b). People with malarial pathogens generate distinct odours on their skin. Scientists in Gambia have carried out trials using dogs that have been trained to identify malarial infection in children. The dogs sniff clothing worn by the children. The dogs were trained to sniff each sample and to freeze if they detected malaria, or move on if they did not.

- In one trial the dogs sniffed the socks from 175 children
- 17% of these children had malaria
- The dogs correctly identified 70% of children with malarial infection by sniffing their socks.

i. Calculate how many of the children who were suffering from malaria were correctly identified by the dogs.

number of children = ... **[2]**

ii. Suggest **one** limitation of this trial.

_____

_____ **[1]**

49(a). Callose production reduces the spread of pathogens in plants. The table below lists pathogens that infect plants together with features of the pathogens and examples of the diseases they cause.

Complete the table below by writing the correct answers in the empty boxes.

Type of pathogen	Pathogen has membrane-bound organelles	Pathogen has a cell wall	Example of a plant disease caused by the pathogen
	yes	yes	black sigatoka
			ring rot
virus	no	no	

[3]

(b). Plants produce callose in response to pathogenic infection, injury and changes in environmental temperature. Scientists wanted to investigate the effect of temperature on callose production.

Outline a valid plan that could be used to investigate the effect of temperature on callose production in plants.

You should include a suggestion for how callose production could be observed.

_____

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_____ **[6]**

50. When their bark is damaged, trees in the genus *Boswellia* release the aromatic resin frankincense which soon hardens to cover the wound.

i. Suggest **two** ways in which frankincense contributes to defending the tree from pathogens.

_____

_____

_____

_____

_____ **[2]**

Frankincense is collected by cutting the bark of a tree and allowing the resin released to harden.

It can be used to relieve the pain of rheumatoid arthritis.

Frankincense works by blocking receptors for molecules called leukotrienes which cause inflammation. Leukotrienes are released by cells from the immune system.

ii. What type of disease is rheumatoid arthritis?

_____ **[1]**

iii. Trees that are overused for harvesting frankincense do not live long and are becoming increasingly rare.

Explain how traditional remedies, such as the use of frankincense, provide a strong argument for conservation of biodiversity.

_____

_____

_____

_____

_____ **[2]**

51. The potato plant, *Solanum tuberosum*, is a staple food plant in many parts of the world.
Potatoes are susceptible to infection by a pathogen called *Phytophthora infestans*, which causes a disease known as potato late blight. The most visible sign of the disease is a brown discolouration of the leaves.
Some varieties of potato are resistant to infection by *P. infestans*.

State **two** ways in which an individual *S. tuberosum* plant could respond to infection by *P. infestans.*

1 _____

_____

_____

2 _____

_____

_____ [2]

52. The sweet potato is a plant that is a staple food in countries such as China. The sweet potato is susceptible to a group of viruses known as potyviruses.

Sweet potato cells have a mechanism that recognises and destroys incorrectly formed mRNA or non-functional mRNA.

i. The nucleic acid in potyviruses is RNA.
Suggest why this mechanism in sweet potato cells is able to counteract infection by a potyvirus.

_____

_____

_____

_____

_____ **[2]**

ii. An enzyme is involved in this process.
Name the bond that is broken by this enzyme.

_____ **[1]**

iii. Suggest an advantage to a **non-infected** cell of having this process.

_____

_____

_____

_____ **[2]**

53. The human body is able to protect itself from disease in a variety of ways.

The table shows a list of cells and structures.

Letter	Cell or structure
A	antigen-presenting cells
B	erythrocytes
C	goblet cells
D	lymphocytes
E	lysosomes
F	mucous membranes
G	neutrophils
H	phagosomes
I	platelets
J	skin

i. Which letter or letters indicate cells or structures involved in preventing the entry of pathogens into the body?

_____ **[1]**

ii. Which letter or letters indicate cells or structures that act as a **physical barrier** to the entry of pathogens?

_____ **[1]**

iii. Which letter or letters indicate cells or structures that are involved in phagocytosis?

_____ **[1]**

iv. Which letter or letters indicate a tissue?

Explain your answer.

_____

_____

_____ **[1]**

54.

i. Mucus is present in goblet cells as condensed granules.

Some studies reveal that when secreted, the mucus expands to 500 times its volume in 20 ms.

40 cm^3 of mucus is held in condensed granules.

Calculate the volume of mucus in these granules **one** second after secretion, assuming a constant rate of expansion.

volume of mucus = ... cm^3 **[2]**

ii. Sjogren's syndrome is a rare condition that can reduce the production of mucus.

Suggest how the upper respiratory tract of a person with Sjogren's syndrome might be affected.

---**[1]**

55. A cytoskeleton is present in all eukaryotic cells. One of its functions is to control the movement of organelles.

Epithelial cells in the airways of mammals play an essential role in defences against pathogens.

Explain the function of epithelial cells in the airways of mammals in the defence against pathogens and suggest the importance of the cytoskeleton in carrying out this function.

---**[4]**

56. Which of the following options, **A** to **D**, is a primary defence mechanism against pathogens?

A. neutralisation
B. agglutination
C. phagocytosis
D. blood clotting

Your answer ☐

[1]

57. Explain how the malarial parasite is able to bypass the body's primary defences.

_____

_____

_____ **[2]**

58. Fig. 19.1 shows a neutrophil responding to a pathogenic bacterium.

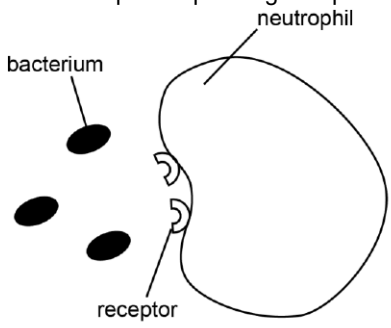


Fig. 19.1a

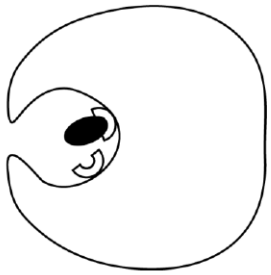


Fig. 19.1b

i. What is the role of an opsonin during this process?

_____

_____ **[1]**

ii. Other than having specific receptors, describe **one** way in which the structure of the neutrophil is specialised.

_____

_____ **[1]**

59(a). Phagocytes are white blood cells that are involved in non-specific immune responses against pathogens.

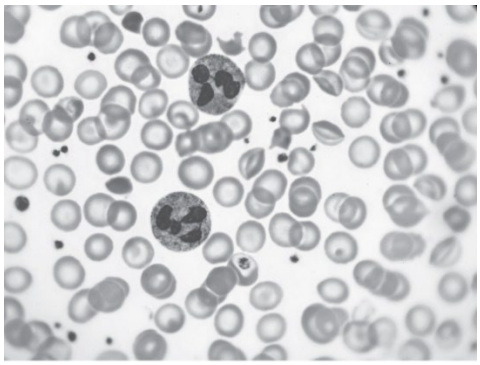
The following passage describes the mode of action of a phagocyte.

Complete the passage using the most appropriate words or phrases.

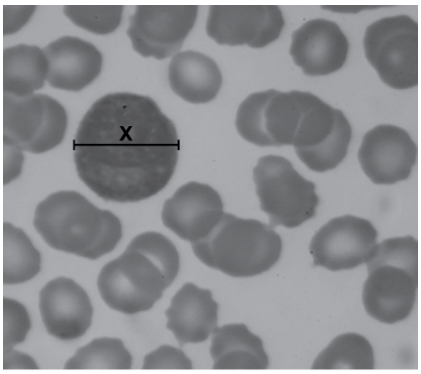
- Receptors on the cell membrane of a phagocyte recognise antibody molecules known as ……, which are bound to pathogens and enhance phagocytosis.
- Once engulfed by a phagocyte, a pathogen is contained in a vacuole called a …… . Organelles called …… produce enzymes that digest the pathogen.

[3]

(b). Fig. 1 shows two blood smears, **A** and **B**.



A



B

Fig. 1

i. Which of the two images, **A** or **B**, shows a non-specific immune response?

Explain your answer.

---

[1]

ii. The actual width of **X** in Fig. 1 image **B** is 15 µm.

Calculate the magnification used to produce image **B** in Fig. 1.

Give your answer to **two** significant figures.

Answer = …… **[2]**

60. Phagocytosis involves cytokines and opsonins.

State the role of cytokines and opsonins in phagocytosis.

cytokines

opsonins

[2]

61.

i. Phagocytes defend the body by engulfing and destroying pathogens in a process called phagocytosis.
A student produced a summary of the stages of phagocytosis, which is shown in Fig. 3.1.
The student made two errors in their summary. Describe what two corrections the student should make.

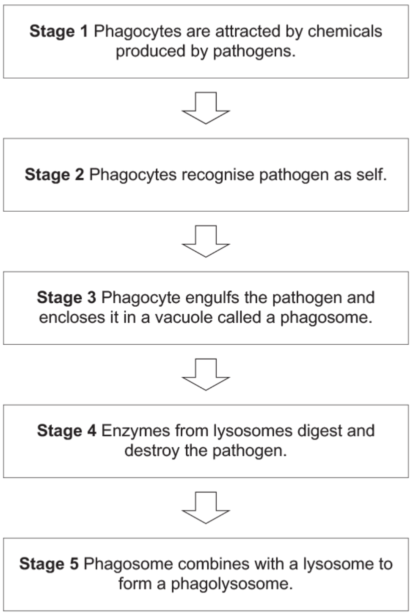


Fig. 3.1

Correction 1

Correction 2

[2]

ii. Antibodies are defensive proteins carried in the bloodstream. Fig. 3.2 shows the simplified, incomplete structure of an antibody.

Complete Fig. 3.2 by **drawing and labelling** the missing part(s) of the antibody.

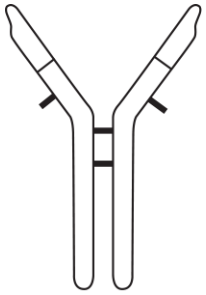
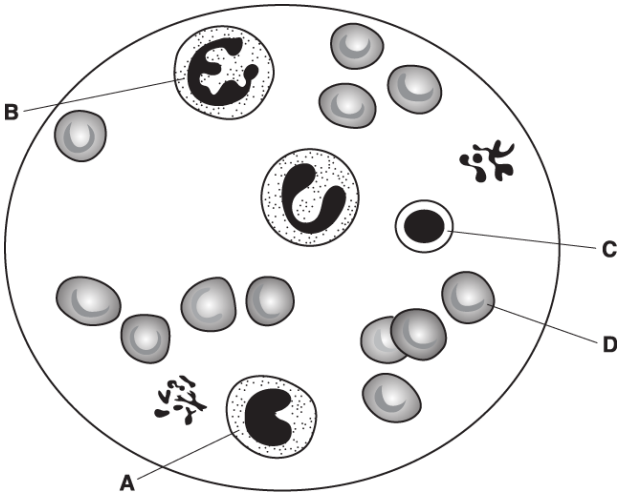


Fig. 3.2

[answer on Fig. 3.2] **[1]**

62. A diagram of a stained blood smear observed under a light microscope is shown below.



Which of the structures labelled **A** to **D** in the diagram is a neutrophil?

Your answer ☐

[1]

63.

i. Outline the processes that lead to the production of antibodies against an unfamiliar bacterium.

_____

_____

_____

_____

_____ **[3]**

ii. Explain how helper T cells act to speed up these processes.

_____

_____

_____

_____ **[2]**

64. * There are a number of different strains of the *Clostridium botulinum* bacterium. Different strains produce immunologically distinct forms of the toxin.

Explain why the toxins produced by the different strains are described as being 'immunologically distinct' and how they will be dealt with by the immune system.

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_____ **[6]**

65. Agammaglobulinemia and Vici syndrome are both genetic diseases.

Agammaglobulinemia results in a lack of mature B lymphocytes in a person's blood.

i. Suggest and explain one symptom of agammaglobulinemia.

_____

_____

_____

_____ **[2]**

ii. Fig. 4 shows the inheritance pattern of agammaglobulinemia in a family.

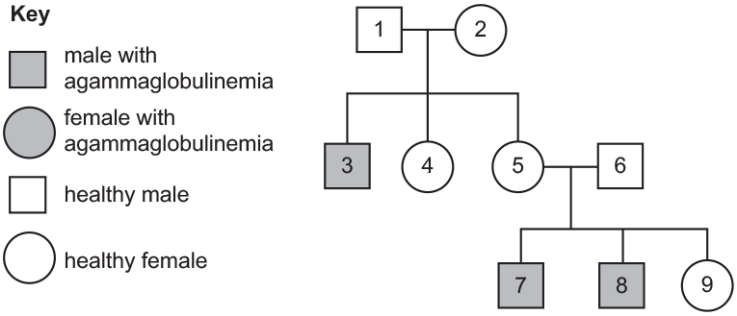

Fig. 4

What conclusions can you draw about the location and nature of the allele responsible for causing agammaglobulinemia? Explain your conclusions.

_____

_____

_____

_____

_____

_____

_____

_____ **[4]**

66. The specific immune system is based on white blood cells called lymphocytes.

Complete the following passage by using the most appropriate terms from the list. You may use terms once, more than once or not at all.

memory **plasma** **killer T cell** **antigens** **antibodies**

interleukins **phagocyte** **meiosis** **mitosis** **hormones**

When a pathogen enters the body it is recognised due to specific molecules on the surface of its cells called ..... . A phagocyte will engulf the pathogen and process these molecules by displaying them on the surface of the phagocyte. This cell will now interact with a special type of T lymphocyte called a T helper cell. The T helper cells produce ..... that will activate the B lymphocytes. They start to divide by ..... . These cells now differentiate into ..... cells, which synthesise and release ..... .

[5]

67. * The specific immune response involves B and T lymphocytes.

There is variation in specific immune responses between individual animals.

Variation between immune responses can be influenced by genes and the environment.

Using examples, explain how both genes and environment can cause animals to vary in their specific immune responses.

_____

_____

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_____

_____

_____ **[6]**

68. Lymphocytes form an important part of the specific immune system in humans. They can be classified into
B lymphocytes and T lymphocytes.

For each of the statements in the table below, use **ticks or crosses** to identify whether the statement belongs to B lymphocytes, or to T lymphocytes, or to both B and T lymphocytes.

The first one has been done for you.

Statement	B lymphocytes	T lymphocytes
Matured in bone marrow	✓	✗
Form part of immune response		
Differentiate into memory cells		
Produce chemicals that can cause lysis of infected cells		
Form plasma cell clones		

[4]

69. Fig. 16.1 shows the concentration of new antibodies in the blood of a person infected for the first time by a pathogen, on day 0. This is their 'primary response'.

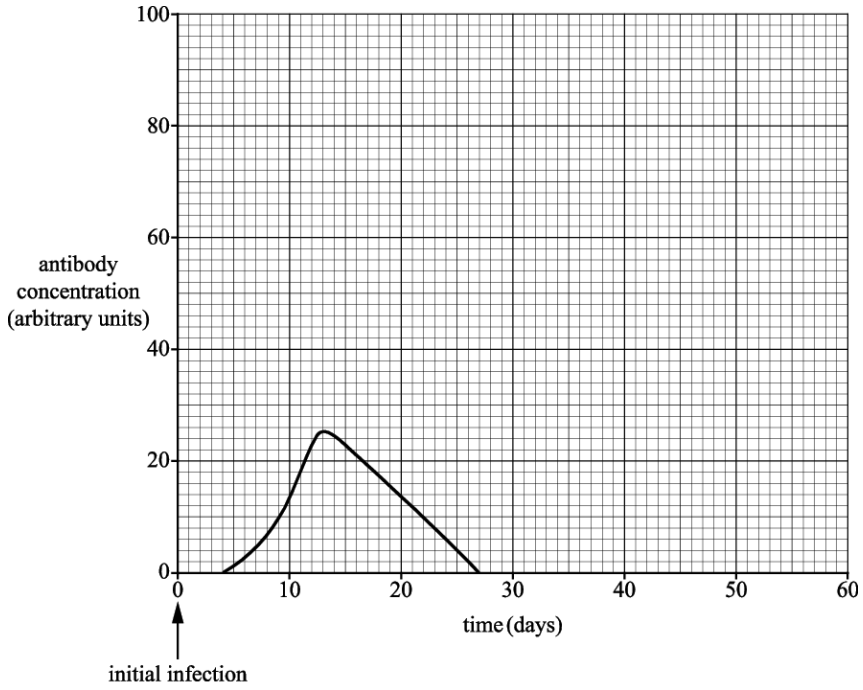

Fig. 16.1

i. On day 30, this individual was again infected with the same pathogen. Sketch a line **on Fig. 16.1** to show the antibody concentration from day 30 onwards.

[2]

ii. Explain how memory cells caused the differences between the two lines on the graph.

_____

_____

_____ **[2]**