

2 Cholera, malaria and tuberculosis (TB) are infectious diseases caused by unicellular organisms.

(a) For each of the diseases listed, state whether the disease is caused by a eukaryotic or prokaryotic organism.

cholera .....  
 malaria .....  
 TB ..... [1]

(b) State the term given to an organism that causes diseases such as cholera, malaria and TB. .... [1]

(c) Malaria is caused by species from the genus *Plasmodium*.

Ring cells are one stage in the complex life cycle of *Plasmodium* that are found within red blood cells. Fig. 2.1 is a scanning electron micrograph showing two ring cells, surrounded by the membrane of a red blood cell, which has just lysed (burst).

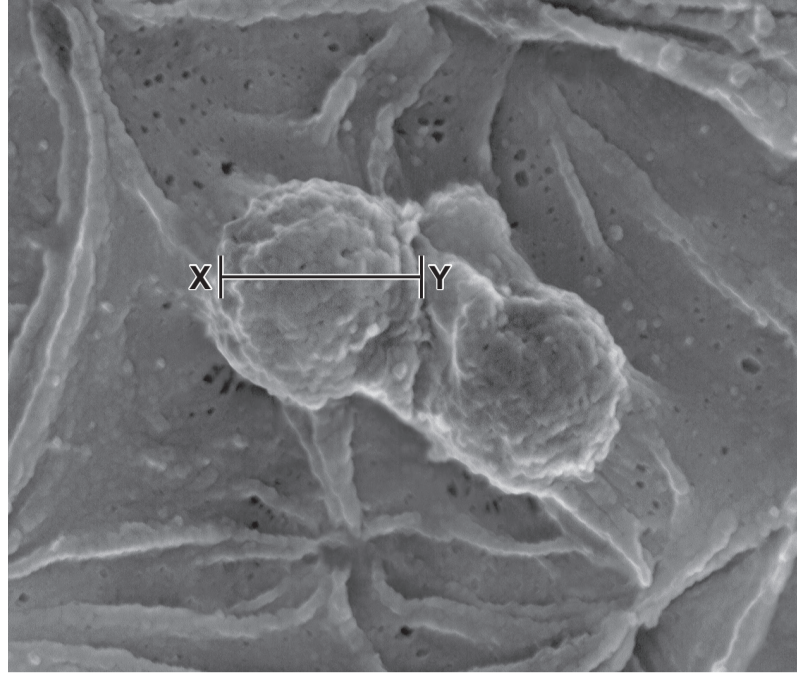


Fig. 2.1

(i) The actual diameter of the ring cell along the length X–Y is 2 μm.

Calculate the magnification of the image shown in Fig. 2.1.

Give your answer to 3 significant figures.

magnification = × ..... [2]

(ii) Describe how *Plasmodium* is transmitted from a person with malaria into the blood stream of an uninfected person.

.....  
 .....  
 .....  
 .....  
 ..... [3]

(d) In a person with malaria, phagocytes destroy infected red blood cells. The phagocytes respond to the presence of particular molecules in the outer phospholipid bilayer of the cell surface membrane.

The cell surface membrane of a healthy, uninfected red blood cell shows an uneven distribution of types of phospholipid making up the bilayer (membrane asymmetry). For example, most of the phospholipid phosphatidylserine (PS) is located in the inner layer, facing the cytoplasm.

(i) After a red blood cell is infected, a much higher proportion of PS is found in the outer layer of the cell surface membrane, facing blood plasma.

Suggest how the presence of PS in the outer layer can cause a response in a phagocytic cell.

.....  
 .....  
 .....  
 ..... [2]

(ii) Suggest why some **uninfected** red blood cells in a person with malaria can also be destroyed by phagocytic cells.

.....  
 .....  
 ..... [1]

(e) Research has shown that *Plasmodium* uses cholesterol from the cell surface membrane of the red blood cell it has infected.

(i) Suggest why cholesterol is needed by *Plasmodium*.

.....  
 ..... [1]

(ii) The use of cholesterol by *Plasmodium* causes a decrease in the quantity of cholesterol in the cell surface membrane of the red blood cell.

Outline how a decrease in cholesterol could affect the cell surface membrane of the red blood cell.

.....  
 .....  
 ..... [2]

(f) To achieve membrane asymmetry, which is an essential feature of a healthy cell, the red blood cell needs a supply of ATP and must maintain a very low concentration of calcium ions (Ca<sup>2+</sup>) within the cytoplasm.

Table 2.1 shows details of three membrane enzymes that are involved in the movement of phospholipids between the inner and outer layers.

Table 2.1

key

PS = phosphatidylserine  
 PE = phosphatidylethanolamine  
 PC = phosphatidylcholine } type of phospholipid

enzyme	enzyme action
flippase	hydrolyses ATP and moves PS and PE from the outer to the inner layer
floppase	hydrolyses ATP and moves PC from the inner to the outer layer
scramblase	after binding Ca <sup>2+</sup> , randomly moves PS, PE and PC between layers

A healthy red blood cell has most PS and PE located in the inner layer and most PC located in the outer layer.

(i) Phospholipids can occasionally move between layers without the action of an enzyme, so the continued activity of flippase and floppase is needed.

With reference to Table 2.1, explain why the action of the enzymes flippase and floppase involves the hydrolysis of ATP.

.....  
 ..... [1]

(ii) Blood plasma has a higher concentration of Ca<sup>2+</sup> than the cytoplasm of red blood cells.

Suggest **one** way in which a red blood cell can have a very low concentration of Ca<sup>2+</sup> when blood plasma has a higher concentration of Ca<sup>2+</sup>.

.....  
 ..... [1]

(iii) The concentration of Ca<sup>2+</sup> within the red blood cell increases when the cell is infected with the malarial parasite. This leads to the loss of membrane asymmetry.

With reference to Table 2.1, suggest **and** explain how membrane asymmetry is lost when the concentration of Ca<sup>2+</sup> within the red blood cell increases.

.....  
 .....  
 ..... [3]