Q1.

(a) Disinfectants are used to kill microorganisms on non-living surfaces. A student investigated the effect of different concentrations of disinfectant **X** on the growth of *Bacillus subtilis*.

The student:

- added 5 cm^3 of a different concentration of disinfectant **X** to 5 different test tubes
- added 5 cm^3 of distilled water to another test tube
- added 2 cm^3 of a culture of *B. subtilis* to all 6 test tubes
- incubated the test tubes at 25 °C for 24 hours
- used a colorimeter to record the percentage of light absorbed by the contents of each tube.

The table below shows the student's results.

Percentage concentration of disinfectant X	0	20	40	60	80	100
Percentage light absorbance	100	100	87	52	10	10

The student prepared the different concentrations of disinfectant **X**.

Describe how the student made 5 cm^3 of the 60% concentration using distilled water and undiluted disinfectant.

_____

_____

_____

(1)

(b) The student used a sterile pipette with 0.1 cm^3 graduations to transfer 2 cm^3 of *B. subtilis* into each test tube.

What is the uncertainty in measuring 2 cm^3 with this pipette?

Calculate the percentage uncertainty of this 2 cm^3 measurement.

Uncertainty _____ cm^3

Percentage uncertainty _____

(2)

(c) Use the table above to evaluate the effectiveness of disinfectant **X** at killing microorganisms on non-living surfaces.

(4)

(Total 7 marks)

Q2.

(a) Describe the hydrolysis reactions involved in the digestion of triglycerides.

Do **not** write about the activity of lipase.

_____

_____

_____

_____

_____

_____

(2)

(b) All mammals produce a lipase called CEL.

CEL digests triglycerides.

CEL is activated by bile salts binding to the enzyme.

Describe **two** other functions of bile salts.

1 _____

_____

_____

2 _____

_____

_____

(2)

(c) Mammals feed their young on milk. CEL digests the triglycerides in milk. The ability to produce CEL occurred due to a gene mutation.

Describe how natural selection may have led to all mammals in a population producing CEL.

(4)

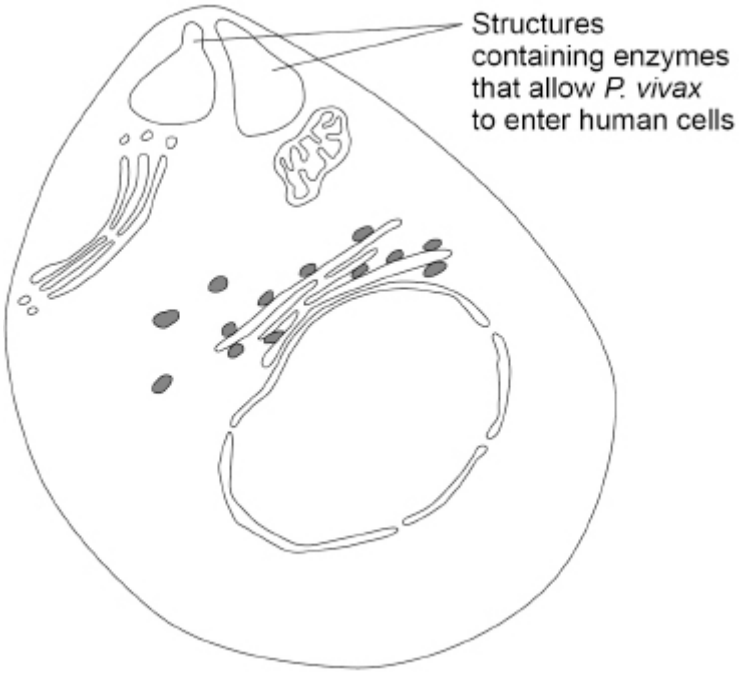
(Total 8 marks)

Q3.

(a) The human disease, malaria, is caused by infection with a single-celled eukaryotic organism.

Figure 1 shows a diagram of *Plasmodium vivax*, one of the species that can cause malaria.

Figure 1



Other than the Golgi apparatus, name **one** structure in **Figure 1** which shows that *P. vivax* is a eukaryote.

_____

_____

(1)

(b) Describe **two** functions of the Golgi apparatus in a eukaryotic cell.

1 _____

_____

_____

2 _____

_____

_____

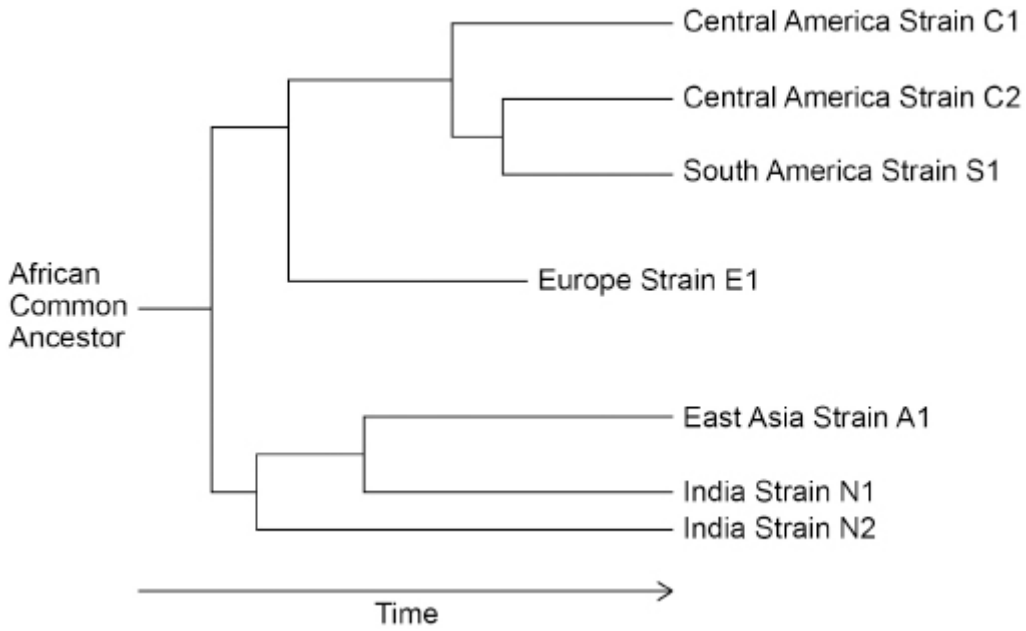
(2)

P. vivax evolved from a common ancestor in Africa. As humans migrated around the world, new strains of *P. vivax* evolved.

P. vivax is now extremely rare in Africa but there are several different strains of *P. vivax* in other parts of the world.

Figure 2 shows a phylogenetic diagram of the evolution of these different strains.

Figure 2



(c) What does **Figure 2** suggest is the order of human migration out of Africa?

Tick ✓ **one** box.

- Europe, India, East Asia, Central America, South America ☐
- India, East Asia, Europe, South America, Central America ☐
- India, Europe, East Asia, Central America, South America ☐
- South America, Central America, East Asia, Europe, India ☐

(1)

(d) There are an estimated 229 million cases of human malaria worldwide per year. 94% of these cases are found in Africa, but are not caused by *P. vivax*. *P. vivax* does cause 61% of the cases of human malaria outside Africa.

Use this information to calculate the number of cases worldwide caused by *P. vivax* each year.

Answer _____ cases of malaria

(1)

(e) In Africa today, most of the human population are resistant to malaria caused by *P. vivax*.

Use your knowledge of natural selection to explain why this resistance is so common in Africa.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(Total 9 marks)

Q4.

(a) Below are **four** statements about the structure of prokaryotic cells.

1. No prokaryotic cell has DNA that is associated with proteins.
2. No prokaryotic cell has membrane-bound organelles.
3. All prokaryotic cells have one or more flagella.
4. All prokaryotic cells have smaller ribosomes than eukaryotic cells.

Which statements about the structure of prokaryotic cells are correct?

Tick (✓) **one** box.

A	statements **1**, **2** and **3**	☐
B	statements **1**, **2** and **4**	☐
C	statements **2**, **3** and **4**	☐
D	statements **1**, **2**, **3** and **4**	☐

(1)

A student investigated the effect of **two** antibiotics on the growth of the bacterium *Micrococcus luteus*.

During the investigation, the student:

- transferred 9 cm^3 of a liquid culture of *M. luteus* into each of **three** bottles
- added the antibiotic chloramphenicol to the first bottle
- added the antibiotic novobiocin to the second bottle
- added no antibiotic to the third bottle.

After 24 hours, he diluted the contents of each bottle by 1 in 100 000 (10^{-5}). He then transferred 0.25 cm^3 samples from the first bottle onto each of 3 separate agar plates. He repeated this with 0.25 cm^3 samples from the second bottle and the third bottle, resulting in 9 agar plates in total.

He incubated the plates for 48 hours.

The table below shows the number of colonies of bacteria he counted on each plate after 48 hours' incubation.

Plate	Number of colonies of bacteria		
	with chloramphenicol	with novobiocin	with no antibiotic
1	2	238	276
2	4	263	258
3	6	261	324

(b) Calculate the mean number of bacteria in the **undiluted** bottle of liquid culture containing novobiocin.

Give your answer in standard form. Show your working.

Answer _____ bacteria

(2)

(c) Starting with a single bacterium, calculate how many generations it would take to produce at least the number of bacteria you have calculated for your answer in part (b)

You can assume no bacteria die.

You could use the ln or log button on your calculator to calculate your answer.

Answer _____ generations

(1)

(d) *M. luteus* is **not** resistant to chloramphenicol.

Suggest **two** reasons why the bacteria were able to grow in the culture containing chloramphenicol.

1 _____

_____

_____

2 _____

_____

_____

(2)

(Total 6 marks)

Q5.

A student investigated the effect of two antimicrobial substances, **J** and **K**, on the growth of *E. coli* bacteria.

She transferred *E. coli* cells using a sterilised pipette to make three identical cultures, **1**, **2**, and **3**. She then added:

- no antimicrobial substance to culture **1**
- antimicrobial substance **J** to culture **2**
- antimicrobial substance **K** to culture **3**.

She incubated the cultures for 24 hours, after which she determined the number of cells per mm^3 in each culture.

(a) The student used a sterilised pipette to transfer *E. coli* into each culture.

Suggest why the number of *E. coli* cells per mm^3 in each culture after 24 hours might have been lower if the student had **not** used a sterilised pipette. Explain your answer.

_____

_____

_____

_____

_____

_____

_____

_____

(2)

(b) The student diluted 3 cm^3 of culture **1** with 12 cm^3 of water. She observed a sample of this diluted mixture using an optical microscope and counted 24 cells in 0.000 25 mm^3 of the diluted mixture.

Use this information to calculate the number of cells per mm^3 in **undiluted** culture **1**.

Number of cells = _____ per mm^3

(2)

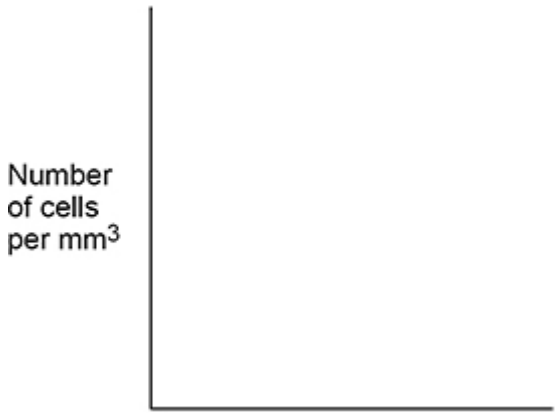
(c) After 24 hours, the student compared the number of cells per mm^3 in cultures **1**, **2** and **3**. She found:

- substance **J** killed 80% of the cells
- substance **J** killed twice as many cells as substance **K**.

Using the axes shown in below figure, **sketch** a bar chart showing the results the student obtained from cultures **1**, **2** and **3**.

Do **not** draw a grid on the chart.

Do **not** include figures for the number of cells per mm^3



(3)

(Total 7 marks)

Q6.

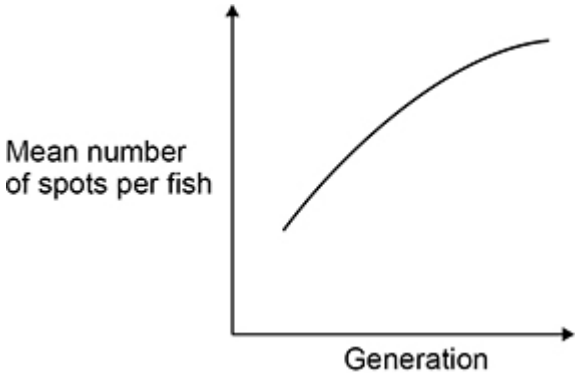
Guppies are small fish with brightly coloured spots on their body.

The number of spots on a guppy is controlled by genes.

A scientist investigated guppy breeding in a large population of guppies in a fish tank. The fish tank contained brightly coloured stones. After each generation of breeding, she counted the number of spots on every guppy.

Figure 1 shows her results.

Figure 1



(a) The scientist concluded that the mean number of spots on the guppies changed in this fish tank because the brightly coloured stones had affected the behaviour of the guppies.

The guppies did **not** behave aggressively towards each other and their feeding behaviour did **not** change.

Suggest **one** type of guppy behaviour that could be affected by the presence of brightly coloured stones.

_____

_____

_____

(1)

(b) Suggest:

- a further investigation the scientist could do to confirm that the brightly coloured stones had affected guppy behaviour
- a null hypothesis for the new investigation.

Further investigation _____

_____

_____

_____

Null hypothesis _____

_____

_____

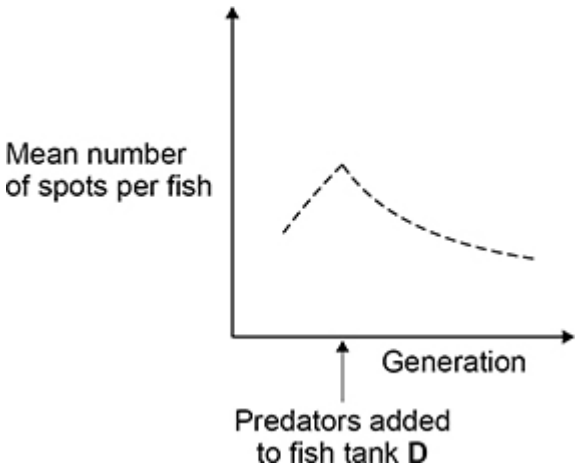
_____

(2)

(c) The scientist repeated the investigation of guppy breeding in an identical fish tank, but added predators of the guppies into the fish tank at the fourth generation of breeding.

Figure 2 shows her results.

Figure 2



Name the type of selection the scientist investigated in this fish tank.

Explain why this selection affected the frequency of alleles in the population of guppies in this fish tank.

Type of selection _____

_____

Explanation _____

_____

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(Total 7 marks)

Q7.

(a) *Clostridium difficile* is a bacterial species that causes disease in humans.

Antibiotic-resistant strains of *C. difficile* have become a common cause of infection acquired when in hospital.

Explain how the use of antibiotics has led to antibiotic-resistant strains of bacteria becoming a common cause of infection acquired when in hospital.

(3)

(b) Scientists suggested that factors, other than antibiotic use, led to the increase in antibiotic-resistant *C. difficile* infections. One suggested factor is people eating more trehalose in their diet.

Trehalose is a disaccharide formed from two glucose molecules.

Name another disaccharide formed from two glucose molecules.

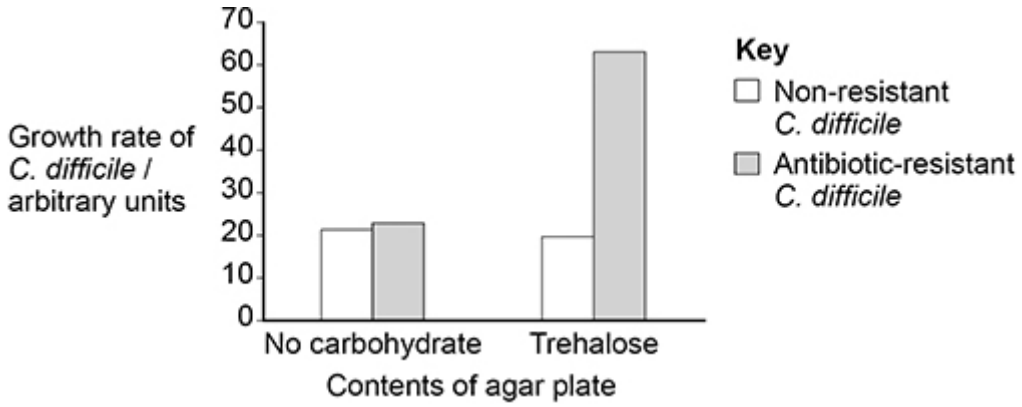
(1)

Scientists investigated the effect of trehalose on the growth rate of *C. difficile*. They grew populations of non-resistant and antibiotic-resistant *C. difficile* on separate agar plates with:

- no carbohydrate added
- trehalose added.

They measured the growth rate of the *C. difficile*.

The graph below shows the scientists' results.



(c) Describe how the scientists could use aseptic techniques to transfer 0.3 cm^3 of *C. difficile* in liquid culture from a bottle onto an agar plate.

(3)

(d) Use the graph above to evaluate whether more trehalose in the diet could be a factor in the increased number of antibiotic-resistant *C. difficile* infections.

(3)

(Total 10 marks)