

OCR A-LEVEL BIOLOGY B • H422

BIOLOGY



EXAM QUESTION PACK

3.2.1 PATHOGENIC MICROORGANISMS

SCORE

/118

PERCENTAGE

%

STEMUP

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- 1(a) Please refer to the Advance Notice article 'Do Pathogens Gain Virulence as Hosts Become More Resistant?' in Insert H422-02 October 2021.

The myxoma virus (MYXV) is a pathogen that causes myxomatosis in its hosts.

- (i) Describe how a virus replicates.

----- [2]

- (ii) Explain why myxomatosis could not be described as endemic in Australia before 1950.

----- [1]

- (iii) Explain why the myxomatosis outbreak in the 1950s could be described as an epidemic.

----- [1]

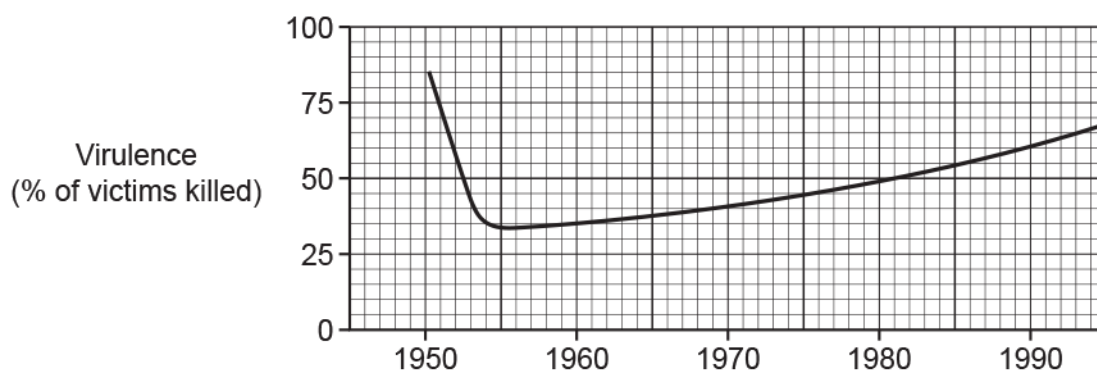
- (b) HIV is a retrovirus but MYXV is not.

Use this information and your knowledge to complete the following table by placing a tick (✓) if the feature is found in HIV or MYXV.

Feature	HIV	MYXV
Genetic material is RNA		
Virus particle contains reverse transcriptase		
Virus has a protein capsid		

[3]

- (c) The graph shows how the virulence of MYXV changed over the period from 1950 to 1990.



Describe how the virulence of MYXV strains varied during the period 1950 to 1990.

[2]

[2]

2(a) Please refer to Fig. 5.1 in the Insert H422-02 November 2020, which shows an image of a culture of bacteria growing on agar in a petri dish.



Fig. 5.1

(i) A student concluded that there were two different species of bacteria in the culture.

Evaluate the student's conclusion.

[3]

- (ii) * Outline a practical procedure to obtain pure cultures of the bacterial species growing on the plate in Fig. 5.1.

In your answer you should include the steps you would take to avoid contamination and confirm the purity of the cultures produced.

Blank lined paper for writing.

(b) Please refer to Fig. 5.2 in the Insert H422-02 November 2020, which shows a photomicrograph of bacteria that have been stained with Gram stain.

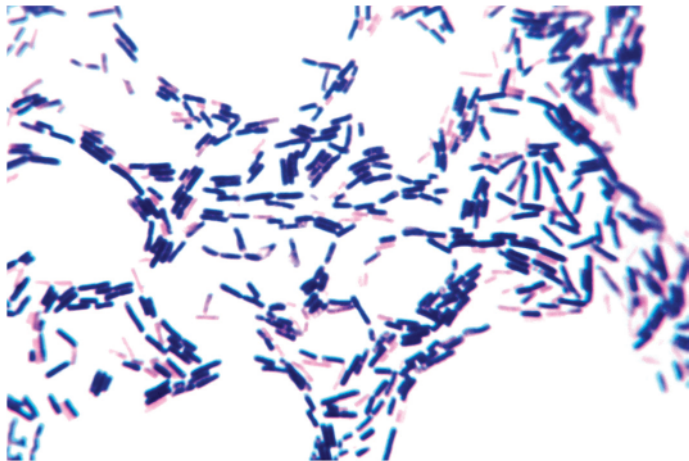


Fig. 5.2

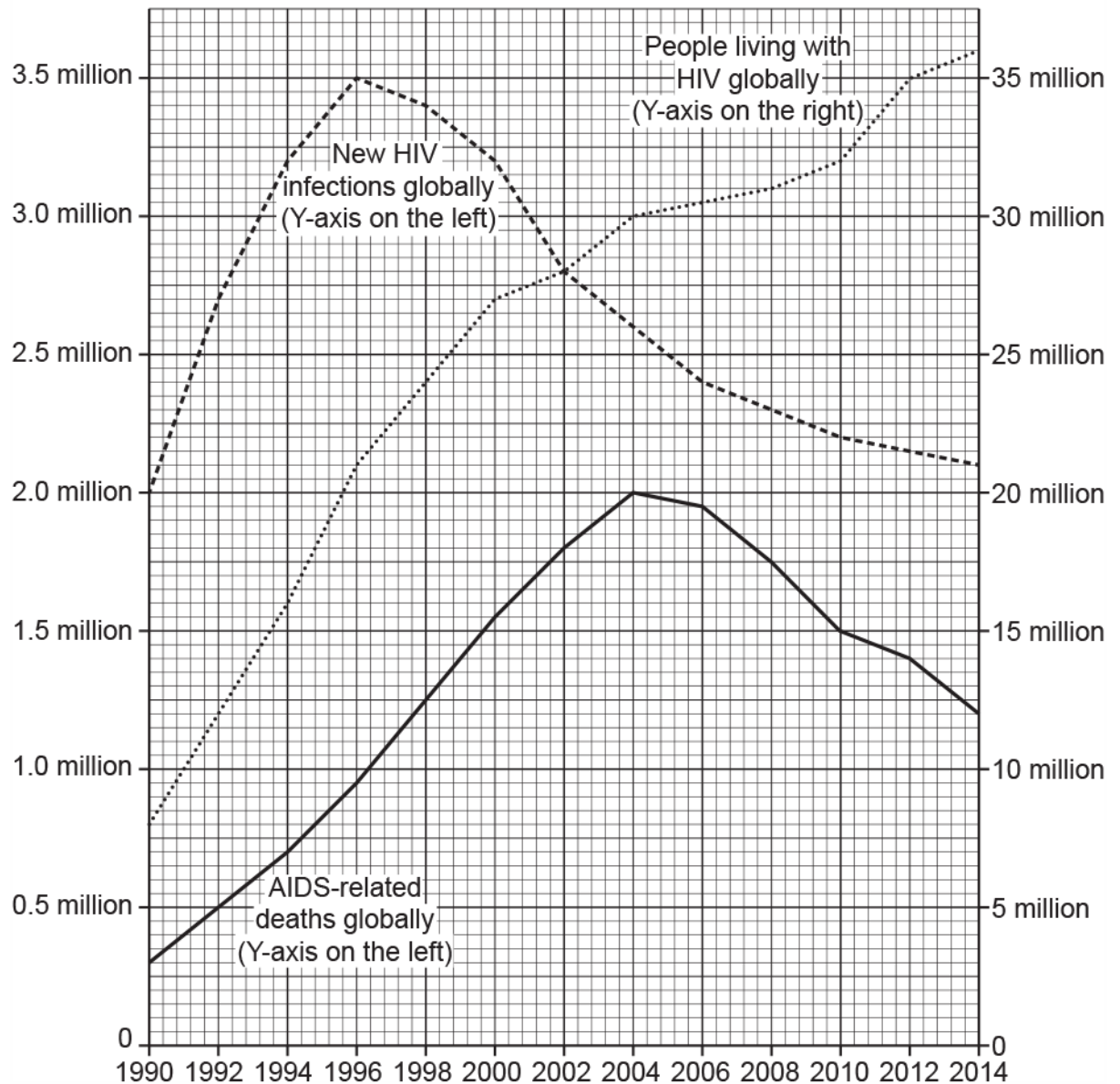
(i) Explain what can be concluded about the types of bacteria present in this culture.

[2]

(ii) Describe how Gram stain changes the colour of bacterial cells.

3 Acquired immune deficiency syndrome (AIDS) is caused by the Human Immunodeficiency Virus (HIV).

The graph shows the estimated global number of AIDS-related deaths, new HIV infections and the number of people living with HIV between 1990 and 2014.



(i) Calculate the rate of increase in people living with HIV globally between 1990 and 1998.

rate of increase = ...yr⁻¹ [2]

- (ii) Some scientists believe the rise in people living with HIV globally is proof that HIV has become a bigger problem since 1990.

Using only the information in the graph, explain why this may **not** be the case.

[2]

- (iii) Suggest why the data given in the graph is an estimate of the number of deaths and not the actual value.

[1]

- 4 Which of the components, **A** to **D**, is **not** present in the human immunodeficiency virus?

- A glycoprotein
- B helicase
- C reverse transcriptase
- D RNA

Your answer

[1]

5(a) The human immunodeficiency virus (HIV) is spread through direct contact with body fluids.

Untreated HIV infection causes progressive destruction of the immune system. This leads to acquired immunodeficiency syndrome (AIDS).

The graph in Fig. 31.1 summarises yearly epidemiological data relating to HIV infection and AIDS in the USA between 1981 and 2008.

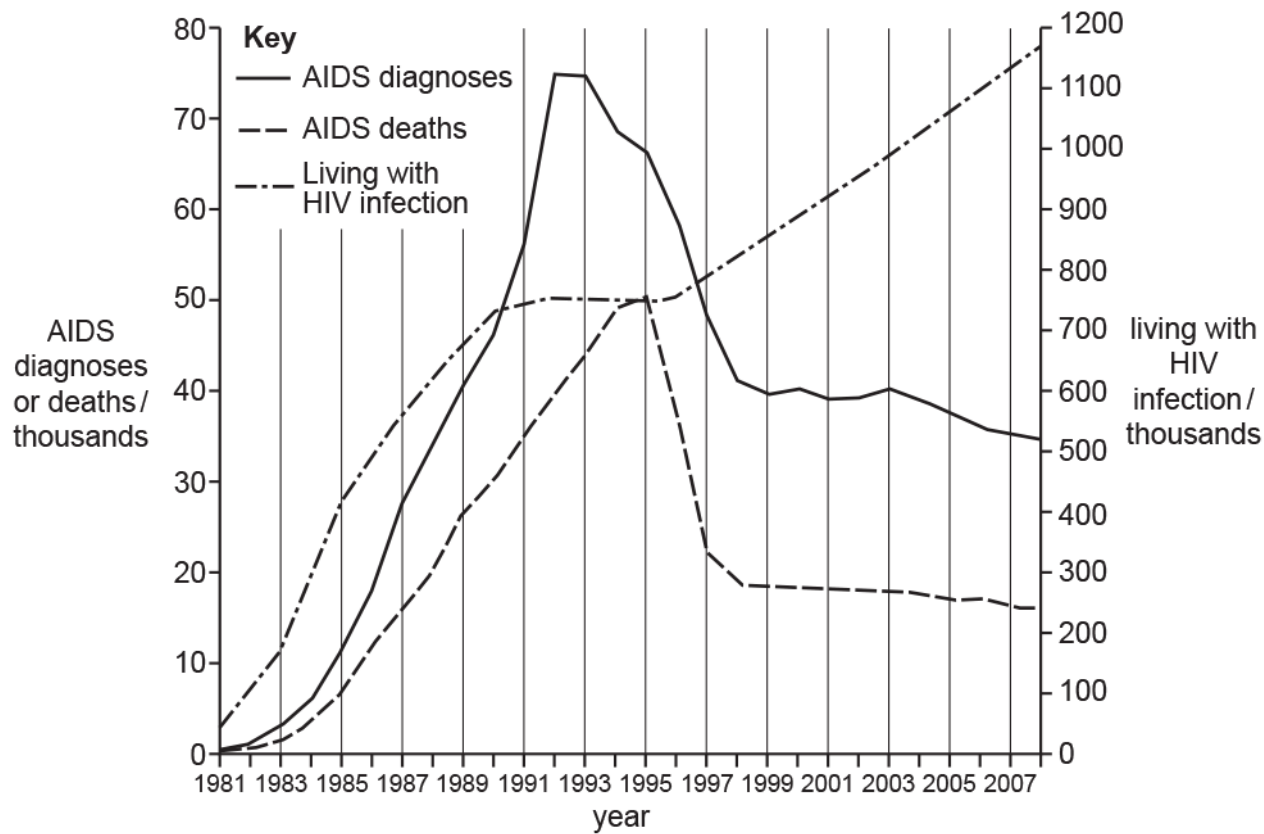


Fig. 31.1

(i) The population of the USA in 1993 was 260 million.

Estimate the mortality rate of AIDS in the USA in 1993.

mortality rate = ... deaths per 100 000 population [2]

- (ii) Patients with HIV/AIDS are managed with highly active antiretroviral therapy (HAART), which was introduced in 1996.

Discuss the effectiveness of HAART as a treatment for patients with HIV/AIDS. Use the data in Fig. 31.1 to support your answer.

[4]

- (b) HIV testing can prevent the spread of infection. In the UK, HIV testing must be carried out with consent from the patient. The results must be treated in a confidential manner.

Suggest **two** other ethical or social concerns associated with receiving an HIV positive test result.

1 -----

2 -----

[2]

(c) Vaccines against HIV are currently being developed:

- to protect individuals from contracting HIV
- to boost the immune response in HIV-positive individuals.

Explain why it is difficult to produce an effective vaccine for HIV.

[3]

(d) HIV destroys the immune system by infecting and killing a type of T helper cell known as a CD4 cell. Therefore, blood levels of CD4 cells can indicate strength of the immune system in patients with HIV.

A clinical trial was conducted to evaluate the safety and effectiveness of a new HIV vaccine in patients with HIV receiving HAART.

(i) The vaccine contains a purified viral protein known as Tat, which is required for transcription of the HIV genome.

State **one** advantage of using purified Tat protein instead of a live, attenuated (weakened) virus.

[1]

(ii) Fig. 31.2 shows CD4 cell levels over time in patients immunised with 7.5 µg or 30 µg Tat protein.

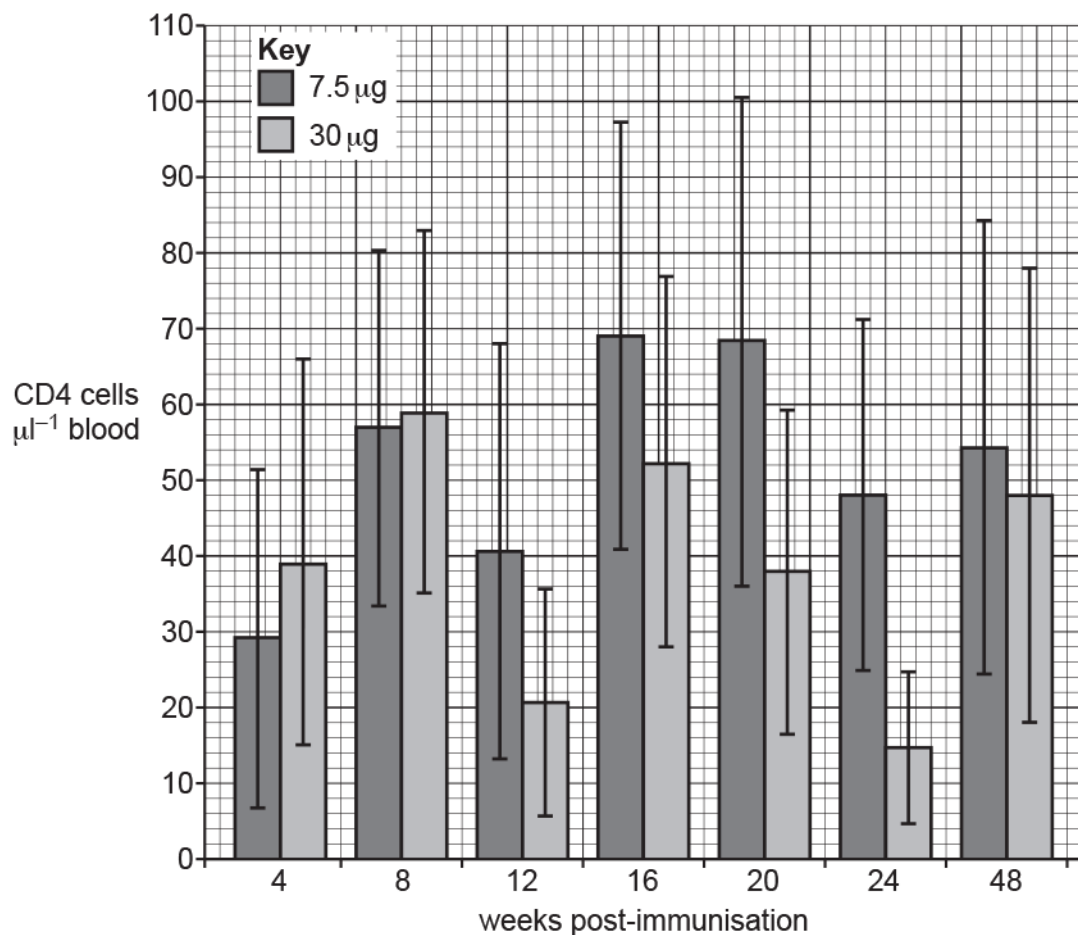


Fig. 31.2

Suggest **two** reasons why the effectiveness of the vaccine can **not** be determined from the data in Fig. 31.2.

- 1 _____
- _____
- 2 _____
- _____

[2]

(e) AIDS is an advanced stage of HIV infection that is defined by the occurrence of opportunistic infections, such as tuberculosis (TB) and hepatitis B and C. TB is the most common opportunistic infection in patients with HIV.

(i) In the UK, TB is a notifiable disease.

State **two** possible consequences of the reporting of a notifiable disease.

1 -----

2 -----

[2]

(ii) Active TB infection is treated with a combination of antibiotics.

The cell wall of the TB pathogen *Mycobacterium tuberculosis* is strengthened by complex lipid molecules.

What term is given to describe antibiotics that inhibit cell wall synthesis?

[1]

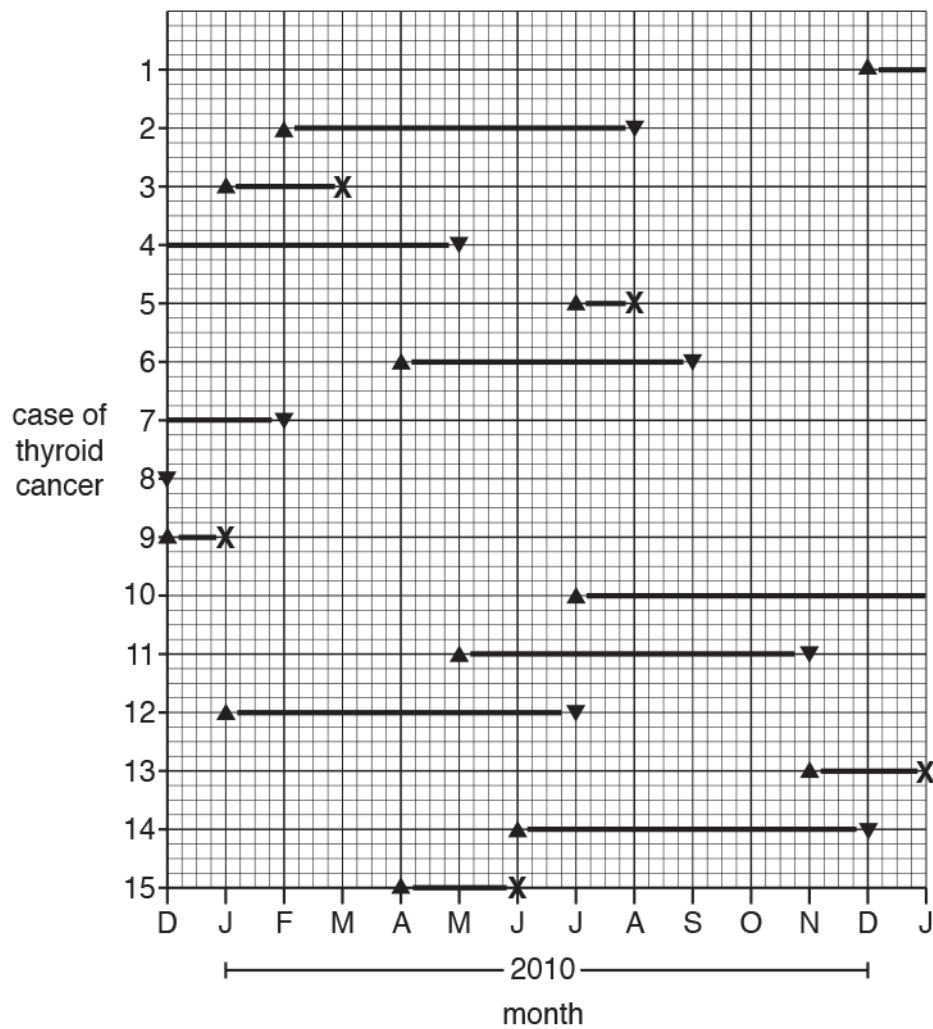
(iii) Multi-drug resistance is a major challenge in the treatment of patients with TB.

Outline how a population of *M. tuberculosis* may become resistant to antibiotics.

[3]

6 15 cases of thyroid cancer were recorded in Iceland between December 2009 and January 2011.

The graph below shows, for each case, the month of diagnosis (▲) and month of recovery (▼) or death (X) from the disease.



Iceland has a population of 330 000 people.

Which of the options, A to D, was the incidence rate (per 100 000) of thyroid cancer in 2010?

- A 2.1
- B 2.7
- C 3.3
- D 4.2

Your answer

[1]

7(a)

The NHS has published the following advice about tuberculosis (TB) on its website:

If you're diagnosed with active pulmonary TB (TB that affects your lungs and causes symptoms), you will be given a six-month course of a combination of antibiotics. The usual course of treatment is:

- two antibiotics (isoniazid and rifampicin) for six months
- two additional antibiotics (pyrazinamide and ethambutol) for the first two months

It is important to take some basic precautions to stop TB spreading to your family and friends. You should:

- always cover your mouth – preferably with a disposable tissue – when coughing, sneezing or laughing
- open windows when possible to ensure a good supply of fresh air in the areas where you spend time
- not sleep in the same room as other people.

(i) State the name of one organism that causes TB.

-----[1]

(ii) Explain why patients with pulmonary TB are advised to cover their mouths when coughing, to open windows when possible and not sleep in the same room as other people.

-----[2]

(iii) Most bacterial infections are treated with a single antibiotic for 7–10 days.

Explain why TB requires treatment with a combination of antibiotics for a much longer period.

-----[2]

(b) Fig. 3 shows the structure of the human immunodeficiency virus (HIV).

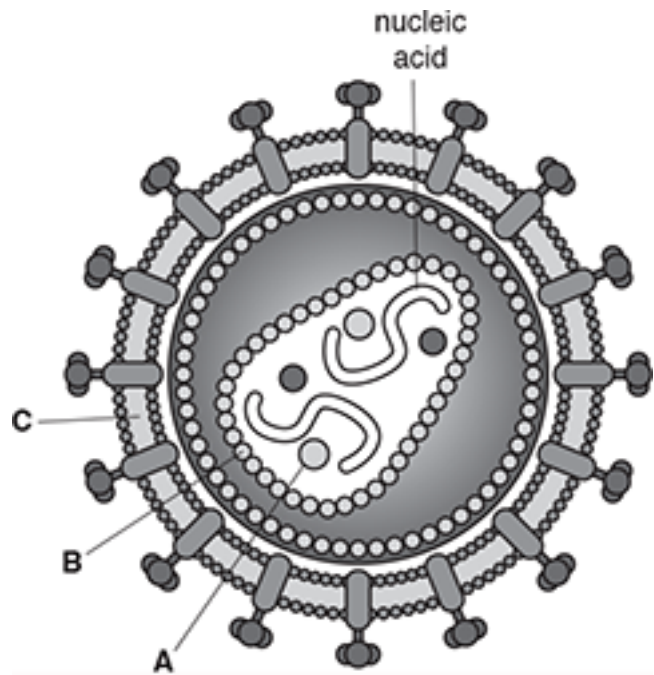


Fig. 3

(i) State the type of nucleic acid that forms the genetic material of HIV.

-----[1]

(ii) Identify the structures labelled B and C in Fig. 3.

B -----

C -----

[1]

(iii) State the name and describe the function of the enzyme labelled A in Fig. 3.

name

function

.....

.....

[2]

(c) Acquired immunodeficiency syndrome (AIDS) refers to a series of symptoms and illnesses caused by HIV.

Describe how the life cycle and method of infection of HIV explains the following features of HIV/AIDS.

(i) There can be a long period (up to ten years) between infection and the onset of symptoms.

.....

.....

.....

.....

[2]

(ii) A person infected with HIV becomes more susceptible to infections such as candidiasis, pneumonia and TB.

.....

.....

.....

.....

[2]



[6]

9 Which of the options, **A** to **D**, could cause a genetic bottleneck?

- Your answer

11

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10 A population of *Escherichia coli* was grown in the laboratory from a single cell.

In a laboratory, *E. coli* divides once every 15 minutes.

Which of the options, A to D, is the theoretical size of the *E. coli* population after 2 hours?

- A 8 cells
- B 16 cells
- C 225 cells
- D 256 cells

Your answer

[1]

11 The frequency of the sickle cell allele in human populations has been found to be higher in areas of the world such as India and the west coast of Africa. In these regions, malaria is said to be endemic.

(i) State what is meant by the term *endemic*.

----- [1]

(ii) Explain why the frequency of the sickle cell allele is higher in areas such as India and the west coast of Africa.

----- [4]

12(a) A horse being treated by a vet appears to have pneumonia caused by a bacterial infection.

- Antibiotics will be used to treat the horse, but the vet must first find out which species of bacterium is causing the pneumonia.
- A sample of fluid containing the bacteria is taken from the horse and sent to a laboratory for analysis in a small lidded bottle.

* Write a method for **safely** obtaining a pure culture of the bacteria from the fluid sample.

You should name any equipment needed and justify your choice of equipment.

Your method must be based on the assumption that you are provided with school or college resources.

[9]

- (b) The vet discovers that two different species of bacteria are present which may be causing the pneumonia.

Once suitably prepared and stained using the Gram staining technique, a sample of the bacteria are observed using the high power lens of a light microscope.

In one of the bacterial species, the cells are seen to be stained red / pink.

- (i) Why must a high power lens be used to view the bacteria?

----- [1]

- (ii) What does the red / pink colour of the stained bacteria suggest about the structure of the cells?

----- [1]

- (c) Fig. 2.1 is a photomicrograph of the bacterium, *Klebsiella pneumoniae*, the probable cause of the pneumonia.

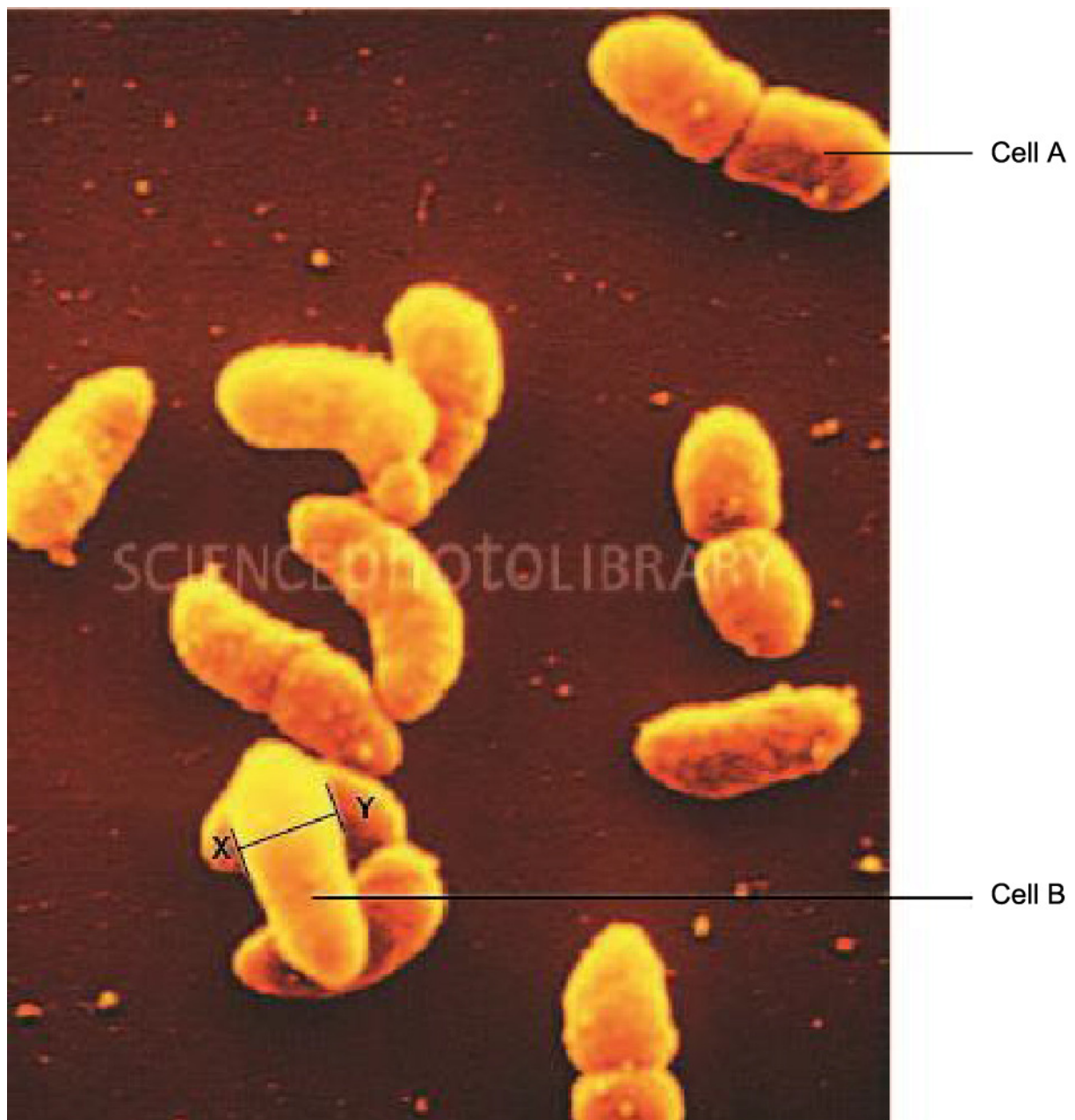


Fig. 2.1

- (i) The cell labelled **A**, in Fig. 2.1, is undergoing cell division by a process called binary fission.

Suggest why these bacterial cells do not divide by mitosis.

[1]

- (ii) The cell labelled **B**, in Fig. 2.1, has a width of $5\ \mu\text{m}$ measured between X and Y.

Calculate the magnification of the photomicrograph.
Show your working. Give your answer to **three** significant figures.

Answer X [2]

Fig. 2.2 shows the results of a test carried out using the *Klebsiella pneumoniae* bacteria cultured from the horse. The bacterial culture was spread on an agar plate and discs containing antibiotics A to D were placed on the agar as shown. The plate was then incubated overnight.

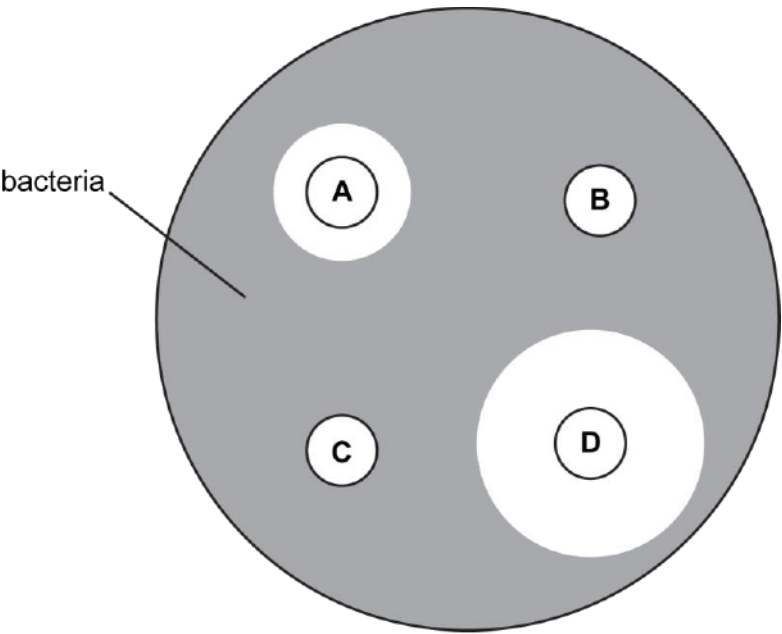


Fig. 2.2

Table 2.1 shows information about the 4 antibiotics used in the test.

Antibiotic	Mode of Action	Notes
A	Inhibits the synthesis of protein by bacteria, leading to cell death	Family of over 20 antibiotics
B	Inhibits bacterial cell wall synthesis	Most widely used antibiotics
C	Inhibits bacterial cell wall synthesis	Resistance evolves rapidly
D	Interferes with bacterial DNA replication and transcription	Common ‘drug of last resort’ used with resistant strains

Table 2.1

(d) The vet chooses to use antibiotic A. Using Fig 2.2 and Table 2.1, justify this decision.

[2]

13(a) Bacteria represent one of two prokaryotic domains.

The Gram staining method allows bacteria to be classified based on the thickness of the peptidoglycan layer in their cell wall.

Outline **one** risk involved in using the Gram staining method.

[1]

(b) * A student wrote the following statement:

Bacteria can be harmful and cause disease, but some bacteria can play important roles in the environment, for example, recycling nutrients. In recent years, scientists have developed techniques to genetically alter bacteria. These genetically modified bacteria have allowed us to produce useful substances.

Using the ideas in the student's statement, outline the relationship between humans and bacteria.

[6]

14(a) Coronaviruses are a large family of viruses, some of which can infect the human respiratory system.

In 2002, a coronavirus caused an outbreak of Severe Acute Respiratory Syndrome (SARS) in China. Within several months, outbreaks were reported in a further 36 countries and the incidence rates were tracked.

Table 37.1 shows data for cases of SARS in four countries between November 2002 and June 2003.

Country	Number of cases	Number of deaths
Canada	251	41
China	5237	349
Singapore	238	33
Taiwan	665	180

Table 37.1

(i) What is meant by the term incidence rate?

----- [1]

(ii) Suggest reasons why **valid** conclusions relating to incidence and mortality **cannot** be made from the data in Table 37.1.

----- [3]

(b) Middle East Respiratory Syndrome (MERS) is caused by another type of coronavirus.

An outbreak of MERS was reported in South Korea in 2015.

Fig. 37.1 shows the cumulative data relating to this outbreak.

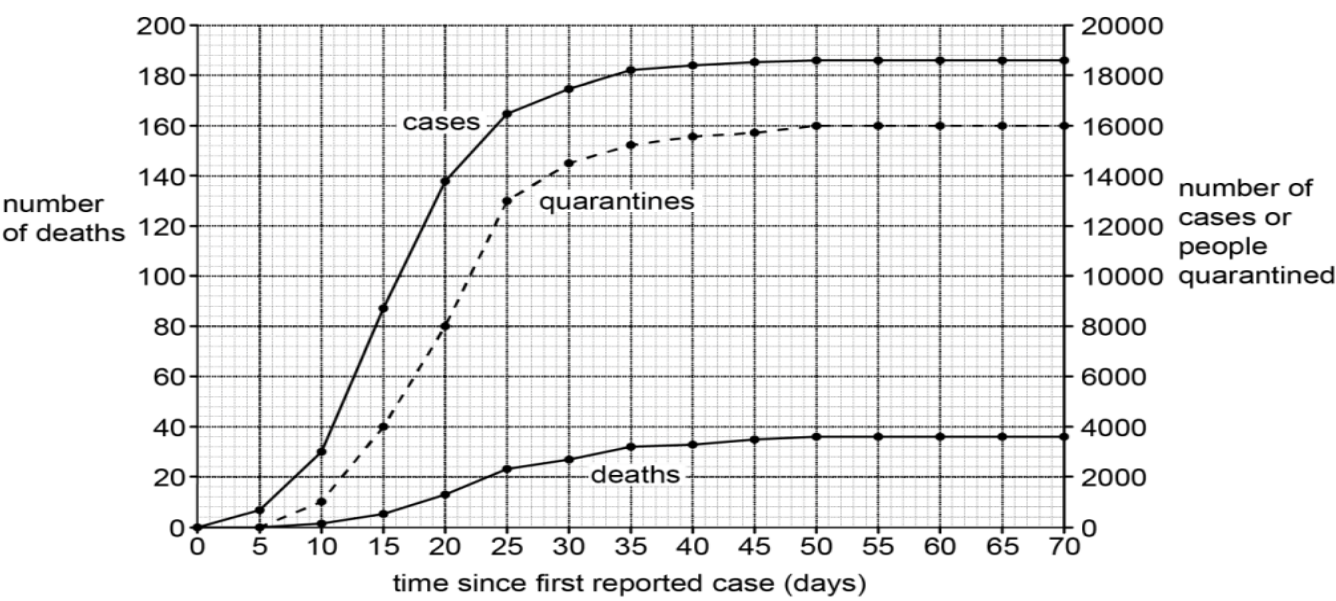


Fig. 37.1

(i) Quarantine data are shown as the dashed line in Fig. 37.1.

Calculate the approximate rate at which people were quarantined between day 10 and day 25.

Answer = _____ people/day [2]

(ii) Analyse the data shown in Fig. 37.1 and evaluate the effectiveness of quarantine on preventing further cases of MERS.

----- [4]

15 Gram staining is a technique used to distinguish between gram-positive and gram-negative bacteria.

Which of the options, **A** to **D**, is correct?

- A gram-positive bacteria stain blue / purple, gram-negative bacteria do not stain
- B gram-positive bacteria stain blue / purple, gram-negative bacteria stain pink / red
- C gram-positive bacteria stain pink / red, gram-negative bacteria do not stain
- D gram-positive bacteria stain pink / red, gram-negative bacteria stain blue / purple

Your answer

☐

[1]

- 16 One mechanism for controlling gene expression in cells uses small, double stranded pieces of RNA known as siRNA.

- 1 siRNA molecules are introduced into the cell.
- 2 The siRNA molecules are combined with a protein complex called the RNA induced silencing complex (RISC) and one of the siRNA strands is destroyed.
- 3 The other strand remains bound to RISC and acts as a guide. RISC is now said to be activated.
- 4 This strand binds to complementary sequences on messenger RNA molecules in the cytoplasm causing them to be destroyed.

Fig. 36.1 shows the sequence of events for this mechanism.

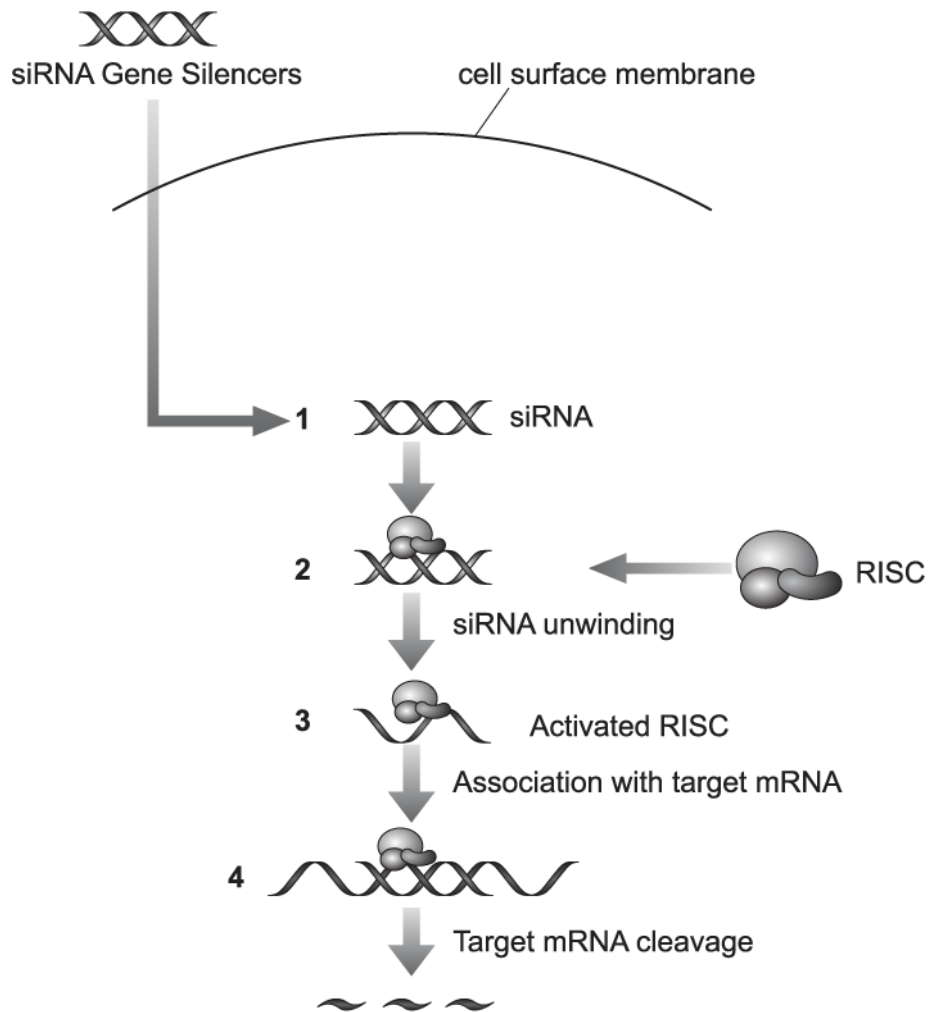


Fig. 36.1

- (i) An RNA strand on an activated RISC has the following sequence.

On the line above, write out the sequence that activated **RISC** would bind to on the mRNA molecule.

[1]

(ii) What type of reaction is carried out by activated **RISC** on the bonds in the mRNA molecule?

[1]

(iii) Clinical trialling is being carried out on the use of siRNA as an anti-viral therapy for the treatment of Hepatitis C infections.

Suggest how siRNA could prevent the spread of a virus within a person infected by the Hepatitis C virus.

----- [3]

17 Penicillin and other antibiotics are widely used to treat bacterial infections. The bacteria are sometimes analysed using stains such as the Gram stain before an antibiotic is prescribed.

- (i) Explain why a counter stain such as Safranin is necessary to identify the presence of Gram negative organisms such as *E.coli*.

----- [2]

- (ii) Some bacteria such as the pathogens *Haemophilus* and *Legionella* are also gram negative. Unlike other Gram negative bacteria, these pathogens do not stain with Safranin.

Instead, medical laboratories use Fuchsin as a counter stain.

Why is the use of Safranin justified as a choice of counter stain in a school laboratory?

----- [2]

END OF QUESTION PAPER

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance																
1	a	i	virus enters (host) cell ✓ viral, DNA / RNA / genetic material, replicates ✓ viral proteins made using cell's mechanisms ✓	max 2(AO1.1)(AO1.1)(AO1.1)	ALLOW takes over host cell metabolism																
		ii	(because it was) not present in the (wild) population ✓ (because it was) only present in test sites ✓ was not present in the population at a baseline level ✓	max 1(AO2.1)(AO2.1)																	
		iii	(because there was a) sudden increase in incidence ✓	1(AO2.1)																	
	b		<table><tr><td></td><td>HIV</td><td>MYXV</td><td></td></tr><tr><td>genetic material is RNA</td><td>✓</td><td></td><td>✓</td></tr><tr><td>virus particle contains reverse transcriptase</td><td>✓</td><td></td><td>✓</td></tr><tr><td>virus has a capsid</td><td>✓</td><td>✓</td><td>✓</td></tr></table>		HIV	MYXV		genetic material is RNA	✓		✓	virus particle contains reverse transcriptase	✓		✓	virus has a capsid	✓	✓	✓	3(AO1.1 x 2)(AO2.1 x 1)	
	HIV	MYXV																			
genetic material is RNA	✓		✓																		
virus particle contains reverse transcriptase	✓		✓																		
virus has a capsid	✓	✓	✓																		
	c		steep / AW, decrease from 1950 to 1955 and gradual / AW, increase to 1990 ✓ use of two pieces of correct data from graph e.g. 85% in 1950 / 35% in 1955 / 60% in 1990 ✓	2(AO2.1)																	
			Total	9																	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
2	a	i	any three from: correct detail of colony morphology differences ✓ <i>agree because...</i> (there is) more than one type of <u>colony</u> ✓ (there is) more than one (colony) <u>morphology</u> ✓ <i>disagree because...</i> (there are) more than two , types of colony / morphologies ✓ (so there are) 3 / 4 / more than two , species present ✓	3 AO 3.2	e.g. 'some colonies are orange, but some are light brown in colour'. 'Three colonies have rough edges, but the others are smooth'.

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
		ii	Level 3 (5–6 marks) A comprehensive description of a method that would produce pure cultures, including selection and culturing techniques, contamination avoidance, and purity confirmation. <i>There is a well-developed line of reasoning which is clear and logically structured and uses scientific terminology at an appropriate level. All the information presented is relevant and forms a continuous narrative.</i> Level 2 (3–4 marks) A description of a method that would produce pure cultures, including selection and culturing techniques, and either contamination avoidance or purity confirmation. <i>There is a line of reasoning presented with some structure and use of appropriate scientific language. The information presented is mostly relevant.</i> Level 1 (1–2 marks) An outline of a method that would produce a culture of bacteria, with proper aseptic technique but few other details. <i>The information is communicated with only a little structure. Communication is hampered by the inappropriate use of technical terms.</i> 0 marks No response or no response worthy of credit.	6 AO 3.3	Indicative scientific points may include <i>Selection & culturing techniques:</i> • Select different colonies based on morphology • Culture on agar plates / in nutrient broth • Plate each colony on different plate / container of broth • Incubate at suitable temperature / 25°C <i>Avoiding contamination:</i> • Use of sterile containers and media • Use aseptic technique to avoid contamination (e.g. disinfection of work surfaces; flaming of wire loops and bottle necks; limit exposure of samples; do not put lids or caps down on work surfaces) • Avoid selecting colonies that overlap <i>Confirming purity:</i> • Examine under microscope • Use of Gram or other staining An answer that just describes aseptic technique (no matter how detailed) will only achieve Level 1
	b	i	there are gram-negative and gram-positive bacteria present ✓ (because) some cells are stained pink and some are stained , purple / violet ✓	2 AO 3.1	ALLOW at least 2 species / types of bacteria present ALLOW because they are stained differently

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
		ii	Gram positive bacteria have , thick /AW , peptidoglycan wall ✓ (that) takes up / binds to , crystal violet stain ✓ outer (stained) layer is not washed away by alcohol ✓	max 2 AO 1.2	ALLOW 'they' for 'Gram positive bacteria' ALLOW Gram negative bacteria have thin wall ALLOW stain washed away in Gram negative allowing (named) counter stain to bind
			Total	13	
3		i	2 million (per year) ✓✓	2 AO2.1	ALLOW 1 mark for (8-24) = 16 ALLOW 1 mark for Answer/ 8
		ii	deaths falling (since 2004) ✓ new diagnoses falling (since 1996) ✓	2 AO2.1	
		iii	not all countries have accurate records on cause of death ✓	1 AO2.1	
			Total	5	
4			B	1 AO2.1	
			Total	1	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
5	a	i	17 ✓✓	2 AO2.2	$(43\ 000/260\ 000\ 000) \times 100\ 000$ OR $(44\ 000/260\ 000\ 000) \times 100\ 000 = 1\ \text{mark}$ ALLOW 16.5 or 16.9 <u>Examiner's Comments</u> Candidates who didn't score full marks either made an error in reading the data from the graph or they did not realise that the question asked for mortality rate in deaths per 100,000 of the population. A horizontal line at the intersect of 1993 and AIDs deaths gives a value of 43 or 44 thousand. Many candidates were careless with the reading of the data or gave their answer in deaths per million.

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
		ii	use of the data to support any of the marking points ✓ rapid / sudden, reduction in AIDS deaths after introduction of HAART ✓ AIDS diagnoses/deaths already reducing before introduction of HAART ✓ increase in prevalence of HIV infection after introduction of HAART, (following plateau reached ~ 1990) ✓ additional valid points, e.g. reduction in AIDS deaths may be due to reduction in AIDS diagnoses (before introduction of HAART) ✓	max 4 AO3.1 3.2	DO NOT ALLOW 'reduction' alone ALLOW AIDS diagnosis reducing from 1993 / AIDS deaths reducing from 1995 Examiner's Comments This question clearly states the HAART was introduced in 1996 and answers that gave information relating to different dates did not gain credit. Unintended errors such as writing 1966 instead of 1996 were common. Candidates also frequently quoted figures in deaths per thousand rather than deaths in thousands. The most commonly awarded correct answer was the increase in the number of people living with HIV after HAART was introduced. Many candidates did not pick up on the idea that the AIDS deaths were decreasing before 1996 which may have been due to the decline in diagnoses. Exemplar 1 data in Fig. 31.1 to support your answer. * in 1996 It proved effective ~~as~~ because after 1996, number of people living with HIV increased from 700,000* to 1,750,000 in 2007. This showed treatment was effective as people living longer. As a result number of deaths due to AIDS also decreased. However deaths were decreasing before treatment was introduced. Also AIDS diagnoses also decreased. However HAART may not be as effective as thought A good answer which achieved 3 marks. If the decrease in deaths from AIDS had been described in more detail, this would have been awarded full marks.

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
	b		stigma/responsibility associated with informing, sexual partner(s) / children / health professionals ✓ discrimination from insurers / employers ✓ distress caused by false positive result ✓ conflict for health care professionals between confidentiality and right for sexual partner to be protected from infection ✓ affects decision to have children/continue with pregnancy ✓ additional valid points, e.g. restriction to travel to some countries ✓	max 2 AO2.1	ALLOW reference to any individual that may have been infected. <u>Examiner's Comments</u> In this question candidates should be referring to specifically social or ethical concerns about a positive test. Any form of discrimination that might occur would be credited as would the idea of the responsibility of the patient/health carers to inform others who might be at risk. Candidates did however need to develop their answers e.g. discrimination alone would not be credited but discrimination from insurance companies would.
	c		high mutation rate ✓ variability of antigens (on pathogen surface) ✓ antibodies no longer, complimentary / bind, to antigen ✓ ref to delay between emergence of new strain and development of new vaccine ✓ recombination of / hybrid, strains ✓	max 3 AO1.1 1.2	<u>Examiner's Comments</u> While this question is asking about the issues of vaccine development such as high mutation rates and antigen variability; several candidates restricted their answer to the idea that HIV reproduces within body cells making it inaccessible.
	d	i	live virus may, revert / mutate / become pathogenic ✓	1 AO1.1	ORA e.g. purified protein cannot mutate
		ii	no data at, baseline / week 0 ✓ large error bars ✓ no overall trend (over time) ✓ CD4 cell level not the only indicator of immune health ✓ trial period not long enough (given longevity of the virus) ✓ no control ✓	max 2 AO3.4	ALLOW large standard deviations ALLOW idea of no pattern <u>Examiner's Comments</u> Several candidates stated that the error bars overlapped which was too vague, given that overlapping error bars often occurred between the two doses (although there was no overlap at 24 weeks), but not always between weeks e.g. 30mg at 8 weeks and 30mg at 24 weeks. The key point about the data is the fluctuations (so large error bars/standard deviations was acceptable) and lack of overall trend.

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
	e	i	publishing of data which monitors trends ✓ educate/inform ✓ improve vaccination ✓ initiate contact tracing ✓ ensures availability of vaccine ✓ isolation of affected individuals ✓	max 2 AO1.1	ALLOW ring vaccination <u>Examiner's Comments</u> This question was generally well answered although some candidates suggested consequences which would not be practical and thus were not credited. For example, isolation of affected individuals would be accepted but it would be impractical to isolate a human population.
		ii	bacteriocidal ✓	1 AO1.1	
		iii	genetic variation / mutations, are present ✓ acquisition of new mutations over time ✓ antibiotics provide <u>selection pressure</u> ✓ (resistant/most adapted) bacteria survive and multiply ✓ advantageous mutation / allele passed on ✓	max 3 AO1.2	<u>Examiner's Comments</u> Most candidates scored at least one mark on this question, most commonly for identifying that a mutation may give rise to resistance. A few candidates mistakenly suggested that the use of antibiotics caused mutations to arise rather than identifying the antibiotics as the selection pressure that causes the population to evolve.  OCR support OCR's delivery guide on controlling communicable disease offers support in the development of antibiotic resistance: https://www.ocr.org.uk/qualifications/as-a-level-gce-biology-b-advancing-biology-h022-h422-from-2015/delivery-guide/module-bb03-module-3-cell-division-development-and-disease-control/delivery-guide-bbdg017-controlling-communicable-disease-323
			Total	20	
6			C	1	
			Total	1	

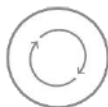
Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
7	a	i	<i>Mycobacterium, tuberculosis / bovis</i> ✓	1	Italics not required <u>Examiner's Comments</u> Candidates struggled with this recall question. Some candidates confused the pathogen with possible vectors e.g. cows, bats and badgers. Spelling was erratic and the correct order of genus and species was rarely given.  Classification and the binomial nomenclature can be explored using Top Trump® cards e.g. predators. The genus and species are stated for each card and candidates can have fun trying to pronounce the Latin names as well as playing the game. It will help to reinforce the order in which genus and species must be written, the capital and lower-case lettering and the importance of spelling. Biological prefixes can also be highlighted where relevant in the course content. Discussions of the prefix 'myco', the Latin for fungus, will help to prevent the use of prefixes that have completely different meanings e.g. 'myo' and 'micro'. Many different Latin, scientific prefixes can be found at: https://www.quia.com/files/quia/users/glysd/Word/APBio/LatinVocab

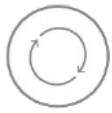
Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
		ii	(cover mouth because) spread by (inhalation of) infected droplets ✓ (open windows) reduce chance of inhalation / removes droplets from, room / air ✓ (not sleep in same room because) long periods of contact required for infection ✓ (not sleep in same room because) cannot, control coughing / cover mouth, when asleep ✓	2max	<u>Examiner's Comments</u> This was well answered for 1 mark, with candidates clearly recalling how TB is spread. Few candidates were able to separate the three pieces of advice to three different aspects of the spread of TB.

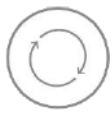
Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
		iii	bacteria are, inaccessible to antibiotics / protected inside tubercles ✓ (many antibiotics required as) bacteria may be resistant to (any) one antibiotic ✓ (longer period required to) stop antibiotic resistance developing ✓	2 max	ALLOW granuloma / macrophage, for 'tubercle' IGNORE general ref to bacteria being antibiotic resistant ALLOW bacteria unlikely to be resistant to all antibiotics 0 <u>Examiner's Comments</u> Well answered with most candidates appreciating the antibiotic resistant possibilities of TB. Some candidates discussed the use of many antibiotics in terms of becoming infected with multiple strains of TB. Few candidates wrote about the difficulty of antibiotics to access mycobacterium, with very few mentioning tubercles or macrophages.  There are some good images of tubercles in lungs to help illustrate the damaging effects these would have on surface area for inhalation as well as a visual illustration of how well mycobacterium can 'hide' from the circulating immune cells. http://www.pathologylearningcentre.uct.ac.za/sites/default/files/image_tool/images/408/primary-pulmonary-tuberculosis.013.jpg
	b	i	(single stranded) RNA / ribonucleic acid ✓	1	<u>Examiner's Comments</u> Well answered with only a few candidates stating DNA or ribose.

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
		ii	B = capsid / capsule proteins / capsomeres AND C = (lipid) membrane ✓	1	ALLOW phospholipid bilayer IGNORE plasma (membrane) <u>Examiner's Comments</u> Candidates struggled to identify structure B. Some candidates referred to B as various organelles e.g. nucleus, which suggests a lack of appreciation as to the acellular nature of viruses.
		iii	<u>reverse transcriptase</u> ✓ creates (double stranded) DNA from, (viral) genome / RNA ✓ OR <u>integrase</u> ✓ Inserts viral, (c)DNA / genome, into host genetic material ✓	2	ALLOW forms cDNA for 'creates DNA ' <u>Examiner's Comments</u> Many candidates correctly stated reverse transcriptase and followed through with a correct function. Some candidates that did name transcriptase confused the function and stated the conversion of DNA to RNA. No candidates referred to integrase.  Integrase has been a 'molecule of the month' and details can be found at: http://pdb101.rcsb.org/motm/135

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
	c	i	Viral (c)DNA becomes part of the host cell, DNA /genome / chromosomes ✓ (integrated cDNA known as) provirus ✓ (provirus) can remain dormant in the, genome / DNA / chromosome / nucleus, for years ✓	2 max	<u>Examiner's Comments</u> Few candidates understood the relevance of HIV as a latent virus. Most answers discussed the time delay in infecting lots of cells and slowly reducing the cells' functions.  The integration of the viral cDNA into the host chromosomes can be easily demonstrated using pipe cleaners of different colours or there are some videos to show this integration; https://www.bing.com/videos/search?q=latent+viruses&&view=detail&mid=BC73F1B8F6F2112B9ECBBC73F1B8F6F2112B9ECB&&FORM=VDRVRV Other viruses could be discussed in this context, particularly in terms of herpes simplex virus which may give a more familiar context http://www.virology.ws/2009/04/03/how-herpes-simplex-virus-exits-latency/
		ii	HIV, infects / targets, helper T / TH / CD4, cells ✓ T (helper) cells decrease ✓ T cells/ phagocytes / immune cells, cannot destroy pathogen ✓	2max	ALLOW patient is, immunocompromised / immunosuppressed / described <u>Examiner's Comments</u> All candidates appreciated that the susceptibility is due to a weakened immune system. Many candidates did relate this weakness to a decline in T helper cells, although some candidates discussed this in terms of macrophages becoming infected.

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
			Total	13	

Mark Scheme

Question	Answer/Indicative content	Marks	Guidance
8	Summary of instructions to markers: <i>Read through the whole answer. (Be prepared to recognise and credit unexpected approaches where they show relevance.) Using a 'best-fit' approach based on the science content of the answer, first decide which of the level descriptors, Level 1, Level 2 or Level 3, best describes the overall quality of the answer.</i> <i>Then, award the higher or lower mark within the level, according to the Communication Statement (shown in italics):</i> ◦ award the higher mark where the Communication Statement has been met. ◦ award the lower mark where aspects of the Communication Statement have been missed. • <i>The science content determines the level.</i> • <i>The Communication Statement determines the mark within a level.</i> Level 3 (5—6 marks) A comprehensive evaluation of the importance of herd immunity in the control of epidemics, including risks and benefits of vaccination. A reasoned conclusion is drawn about the benefits to society and/or the individual resulting from herd immunity including ethical issues. <i>There is a well-developed line of reasoning which is clear and logically structured and uses scientific terminology at an appropriate level. The information presented is relevant and substantiated.</i> Level 2 (3–4 marks) A limited evaluation of the importance of herd immunity, with some reference to risks and/or benefits. An attempt is made to link ethical issues with the benefits of	6	Indicative scientific points may include: Epidemic is a sudden increase in incidence of infectious disease in an area. Herd immunity Successful vaccination programme requires large population to be immune. Can eradicate an infectious disease Reduces chances of pathogen being passed on, so reduces risk of epidemics. Requires 80 – 95% of population to be immune. Depends on how easily pathogen is spread. Reference to ring vaccination Vaccination risks Live-attenuated vaccines may revert and cause disease.

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
			herd immunity. <i>There is a line of reasoning presented with some structure and use of appropriate scientific language. The information presented in the most part relevant and supported by some evidence.</i> Level 1 (1–2 marks) A description of herd immunity and link to epidemics. Little or no mention of risks or ethical issues. <i>There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.</i> 0 marks <i>No response or no response worthy of credit.</i>		Possibility of allergic reaction / anaphylaxis / side effects May not be effective in all individuals due to genetic differences Reference to discredited study of MMR risks. Ethical issues Balance between individual's right to refuse consent and need to establish minimum immunity levels. Herd immunity protects those who cannot be immunised. Helps to eradicate a pathogen so it cannot spread to other countries where immunisation levels low due to socioeconomic reasons Helps to contain the spread so it doesn't reach those who cannot be immunised. Examiner's Comments was generally not well answered with many candidates failing to appreciate the relevance of herd immunity, not mentioning vaccination and just discussing immunity in general with many stating all the population being immune. The candidates that gave a clear description of an epidemic often achieved high marks as they related it well to protecting those un-vaccinated individuals and preventing the spread of a pathogen. Very few candidates discussed the risks of vaccination.
			Total	6	
9			A ✓	1	
			Total	1	
10			D ✓	1	
			Total	1	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
11		i	<i>Idea that</i> (disease is) always present in, a population / region;	1	<u>Examiner's Comments</u> Part (i) was synoptic with F222 and relatively few candidates gained a mark here with most confusing the term endemic with pandemic or epidemic.
		ii	1 malaria acts as a selection pressure; 2 mechanism of resistance described; 3 heterozygotes / carriers / sickle cell trait / Hb^sHb^A (are) less likely to get malaria / more likely to survive / have an advantage; 4 sickle cell / advantageous, allele, is passed on in, reproduction / gametes; 5 homozygous 'normal' individuals / Hb^AHb^A, (more likely to) die from malaria; 6 homozygous for sickle cell / Hb^sHb^s, (more likely to) die from (sickle cell) anaemia;		ACCEPT correct use of 'selection' by malaria / Plasmodium ACCEPT idea that parasite / plasmodium / malaria, stays in the body for longer so immunity is enhanced ACCEPT 'those with (one) sickle cell allele' NOTE 'Those having a sickle cell allele have a selective advantage if malaria is present' = 2 marks (1 and 3) ACCEPT 'those with no sickle cell allele' for homozygous normal <u>Examiner's Comments</u> In (ii), few candidates used the idea of malaria acting as a selection pressure and many candidates were not specific enough in describing the heterozygotes or those with the sickle cell trait having the advantage in terms of survival where malaria is present. Some candidates had clearly not covered the learning outcome in F225 and answered in terms of high birth rates and poverty in these regions meaning access to health care was not available.
			Total	5	

Mark Scheme

Question		Answer/Indicative content	Marks	Guidance
12	a	<i>* Please refer to the marking instruction point 10 for guidance on how to mark this question.</i> <i>In summary:</i> <i>Read through the whole answer. (Be prepared to recognise and credit unexpected approaches where they show relevance.)</i> <i>Using a 'best-fit' approach based on the science content of the answer, first decide which of the level descriptors, Level 1, Level 2 or Level 3, best describes the overall quality of the answer.</i> <i>Then, award the higher or lower mark within the level, according to the Communication Statement (shown in italics):</i> • <i>award the higher mark where the Communication Statement has been met.</i> • <i>award the middle mark where aspects of the Communication Statement have been missed</i> • <i>award the lower mark where the Communication Statement has not been met.</i> • <i>The science content determines the level.</i> • <i>The Communication Statement determines the mark within a level.</i> Level 3 (7–9 marks) Details of apparatus and a method to produce bacterial colonies are provided. A thorough risk assessment is written which includes most of the high risk hazards and suitable control methods. The importance of aseptic technique is evident and most examples are given. <i>There is a well-developed line of reasoning which is clear and logically structured and uses scientific terminology at an appropriate level. All the information presented is relevant and forms a</i>	9	Indicative scientific points may include: Equipment correctly identified with a reason • container / named container (e.g. Petri dish, flask, bottle, flat) because sterile / easily sterilised / lidded • culture medium because provides food / nutrients / water IGNORE moist • incubator because gives controlled optimum temperature • inoculating loop because allows for, accurate transfer / transfer of a small number / one colony, of bacteria • spreader because enables bacteria to be dispersed across / through medium • nutrient agar plates / broth because supplies the nutrients for bacterial growth ALLOW references to different nutrient agars Aseptic technique • flaming of flask / bottle neck • flaming of inoculation loop / spreader • keeping lids on culture dishes / flasks (when not in use) • keeping Petri dishes upside down • work next to Bunsen flame to carry away contaminating bacteria in convection current / rising hot air OR to stop bacteria in air from falling onto / contaminating plates Method • detail of removal of fluid from bottle and transfer to nutrient plate / broth • detail of streak plating after initial culture • incubation of sample / kept at constant optimum temperature • detail of selecting bacteria with differing colony morphology to separate bacterial species

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
			<i>continuous narrative.</i> Level 2 (4–6 marks) The apparatus and a method to produce bacterial colonies are provided although some details may be missing. There is an outline risk assessment including some control measures. Aseptic technique is evident and some examples are given. <i>There is a line of reasoning presented with some structure and use of appropriate scientific language. The information presented is mostly relevant.</i> Level 1 (1–3 marks) The apparatus and an outline method are suggested which will allow for bacterial culture. A risk assessment is present but incomplete. Information about aseptic technique is limited. <i>There is a logical structure to the answer. The explanation, though basic, is clear.</i> 0 marks No response or no response worthy of credit.		Hazards identified with an appropriate control measure • (zoonotic) bacteria (on surfaces / from fluid touched by hands – wear gloves • (zoonotic) bacteria (on surfaces / from fluid transferred to clothes – wear a lab coat / remove lab coat before exiting lab • flammable liquids / ethanol used (e.g. in irrigating during Gram staining / flaming) – ensure bottles / flasks kept away from ignition sources / Bunsen burner / flame • 100% ethanol used risks intoxication – use at arm's length / use in a well-ventilated space
	b	i	bacteria very small / too small to be seen with low power lens	1	ALLOW because the bacteria are only 5 μm wide / shape of individual bacterium cannot be seen with LP IGNORE bacteria are small / bacteria can't be seen with a low power, lens / microscope
		ii	cells have thin(ner) (peptidoglycan) cell walls	1	
	c	i	Bacteria do not have a nucleus / nuclear membrane	1	ALLOW bacteria only have a single / one chromosome (plus plasmids)
		ii	$\times 3000$ (1) (1)	2	ALLOW one mark for correct working [15 mm $\times$ 1000] / 5 μm

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
	d		D is largest clear zone (diameter) indicates more bacteria killed is not selected because this antibiotic is used as a last resort / with resistant strains (so) A is selected as next largest clear zone (diameter) / next largest number of bacteria killed, and inhibits protein synthesis / prevents bacteria, dividing / reproducing, without risk of selecting antibiotic resistant strains	2	Candidates may describe A being tried and, if found not to work, vet has another antibiotic to choose. ALLOW if correct ref is also given to mode of action (second mark point only)
			Total	16	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
13	a		Any 1 from: crystal violet / methylene blue / iodine / potassium iodide / ethanol, is an irritant crystal violet is toxic / carcinogenic risk of burns when using heat source <i>idea that</i> bacterial species must be identified correctly to ensure they are not pathogenic	1	
	b		* Level 3 (5–6 marks) Candidate addresses all the ideas in the student's statement making clear connections between humans and bacteria and using examples to illustrate their answers. <i>There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.</i> Level 2 (3–4 marks) Candidate addresses some of the ideas in the student's statement making some connections between humans and bacteria and using at least one example to illustrate their answers. <i>There is a line of reasoning presented with some structure. The information presented is in the most-part relevant and supported by some evidence.</i> Level 1 (1–2 marks) Simple comments about humans and bacteria made with connections not always made. Little exemplification. <i>The information is basic and communicated in an unstructured way. The information is supported by limited evidence and the relationship to the evidence may not be clear.</i> 0 marks No response or no response worthy of credit.	6	Examples of relevant scientific points: Benefits from the use of bacteria • nitrogen cycling – including the role of putrefying, denitrifying, nitrogen-fixing and nitrifying bacteria. All benefitting food production • biotechnology – including genetic modification techniques that lead to benefits due to the production of drugs, insulin, the broadening of scientific research. Ideas might include the palindromic nature of recognition sequences for restriction enzymes and the need for reporter genes on plasmids. Challenges from interactions with bacteria • communicable diseases – including general mechanisms of pathogenicity of bacteria, causes, transmission, mode of infection, symptoms, treatment e.g. TB • the use of antibiotics and antibiotic resistance, including reference to TB and MRSA. Examples of technical terms that could be used in answers: Mycobacterium, communicable disease, prevalence, incidence, denitrification, saprotrophs, nitrification, named bacterial taxa, restriction enzymes, palindromic sequence, plasmid.
			Total	7	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
14	a	i	number of new cases, over time / within time period / over a year	1	
		ii	any 3 from: no information on population size (1) different countries have different population size (1) use of correct figures from table in support (1) different reporting procedures (1) accuracy of diagnosis (1)	3	ALLOW 'not given per 100 000' or 'not given as % of population' e.g. 'there are 349 deaths in China but only 41 in Canada but China has a bigger population' gets marking points 2 and 3
	b	i	(13 000 – 1000) / 15 (1) 800 (1)	2	800 = 2 marks ALLOW ecf for marking point 2
		ii	rapid rise in cases in first 25 days (1) no further cases / contained, after 50 days OR idea that outbreak lasted 50 days (1) no deaths after 50 days (1) idea that cases that resulted in death is only a small proportion of all cases (1) figures to support above statement (1) quarantine rate proportional to rate of new cases (1)	4	ALLOW 20–30 days ALLOW 45–50 days ALLOW 45–50 days e.g. 180–190 cases but 35–40 deaths.
			Total	10	
15			B	1	
			Total	1	
16		i	ACGGGAAGGGCCCGAGCACGGA UGCCCUUCCCGGGCUCGUGCCU	1	
		ii	hydrolysis	1	IGNORE 'cleavage'
		iii	Any 3 from: (activated) RISC, cleaves / AW, viral mRNA no viral proteins made no, viral particles / AW, assembled <i>idea that</i> no new cells are infected	3	IGNORE 'virus cannot spread' as this is given in the question
			Total	5	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
17		i	Any 2 from: <i>idea that</i> Gram stain is removed by, ethanol / AW, rinses (due to) peptidoglycan (layer) being thin <i>idea that</i> bacteria would not be visible without the counter stain	2	ALLOW alcohol / ethyl alcohol / acetone / solvent instead of ethanol IGNORE reference to the outer membrane A statement such as 'the Gram stain is washed out of the peptidoglycan within the alcohol wall because the layer is thin' = 2 marks
		ii	justification on cost grounds / justification on stain safety grounds <i>idea that</i> (these) pathogens would not be handled in a school lab / only allowed to handle non-pathogenic bacteria in school	2	e.g. 'it is cheaper than other counter stains', 'it is less toxic than other counter stains'
			Total	4	