1. Scarlet fever is one of a number of notifiable diseases.

   Using an example **other than** scarlet fever, explain what you understand by the term *notifiable disease*.

   -- [2]

2. 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]

3(a). * Describe the means of transmission of the human immunodeficiency virus (HIV) and how the spread of the virus can be controlled.



----------------- **[6]**

(b). Highly active antiretroviral therapy (HAART) is a treatment used for patients infected with HIV. This therapy involves multiple drugs which reduce the viral count and prevent opportunistic infections.

(i) Explain, using an example, what is meant by the term *opportunistic infection* when related to acquired immunodeficiency syndrome (AIDS).

----------------- **[2]**

Fig. 4.2 shows the trends in the incidence of AIDS, the number of AIDS-related deaths, and the prevalence of AIDS in the USA from 1985 to 2003.
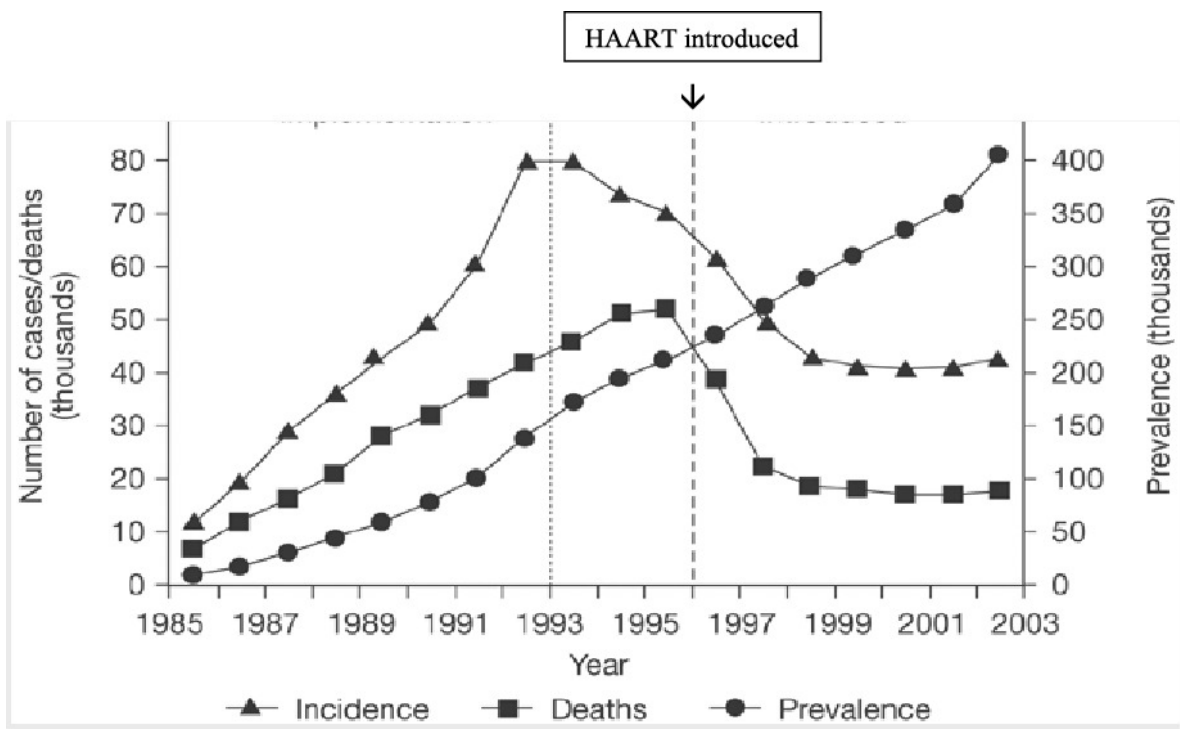
Fig. 4.2

(ii) Compare the trends in incidence of AIDS and AIDS-related deaths between 1988 and 1995.

---[3]

(iii) HAART was introduced in 1996.

Evaluate the effectiveness of the introduction of HAART on the prevalence of AIDS and the number of AIDS-related deaths.

---[3]

4(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]

5(a). Ebola is a viral disease that was first described in human populations in 1976.

Several thousand cases of the disease were recorded in 2014.

Table 5.1 shows the estimated number of Ebola cases and deaths that resulted from the disease.
Figures are shown for the world population and for nations located in West Africa.

Number of Ebola cases		Number of deaths from Ebola	
World	West Africa	World	West Africa
21 364	21 358	8 459	8 458

Table 5.1

Use the data to evaluate the validity of the following statements:

- the Ebola outbreak was a pandemic
- Ebola was more likely to result in deaths in West Africa than the rest of the world.

---[3]

(b).

(i) In 2014, the world's population was estimated to be 7.2 billion.

The total population of the West African nations that experienced Ebola was 231.4 million.

Using the information in Table 5.1, calculate the Ebola mortality rate (deaths per 100 000) for the world and for the West African nations.

World = _____

West Africa = _____

[2]

(ii) Suggest **one** reason for the difference in mortality rates calculated in **(b)(i)**.

_____

_____

_____**[1]**

(c).

    (i) What problems will medical professionals need to overcome when treating diseases caused by pathogens such as the Ebola virus, which has only recently evolved to infect humans?

_____

_____

_____

_____

_____

_____

_____ **[2]**

    (ii) A patient diagnosed with Ebola in the UK was treated with blood plasma from a person who had recently recovered from the disease.

     This is known as convalescent plasma therapy (CPT).

     Suggest why CPT can be effective in the treatment of patients with Ebola.

_____

_____

_____

_____

_____ **[2]**

    (iii) Suggest **one** precaution that must be taken when using CPT.

_____

_____

_____ **[1]**

(d). Ebola is an example of a notifiable disease.

    What is meant by a *notifiable disease*?

_____

_____

_____ **[1]**

6. *Mycobacterium tuberculosis* causes the infectious disease tuberculosis.

Strains of *M. tuberculosis* have evolved that are resistant to several antibiotics.

Explain how *M. tuberculosis* can evolve resistance to antibiotics **and** describe how hospital staff and medical professionals can help to prevent the spread of these resistant strains.

In your answer, you should provide a balanced account of both aspects of the question.

-- [8]

7. Respiratory syncytial virus (RSV) is a major cause of bronchiole infections in small children.

(i) RSV contains the enzyme reverse transcriptase.

What type of nucleic acid will be found in RSV?

_____ [1]

(ii) Currently, no vaccines have been developed for preventing RSV infection.

Suggest one **biological** problem in developing a vaccine for RSV.

_____

_____

_____ [1]

8.

(i) *Streptococcus pneumoniae* is a Gram-positive bacterium commonly found in the throat of humans. These bacteria can spread from person to person and may cause pneumonia.

What name is given to a disease that is spread between different individuals?

---[1]

(ii) A sample of *S. pneumoniae* was prepared for viewing under a light microscope by Gramstaining a sample taken from a colony on an agar plate.

Suggest **three** steps that should have been taken to make sure that the procedure was carried out **aseptically**.

1

2

3

----

[3]

9. 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]

10(a) TB is sometimes described as a social disease because it can spread easily among people living in deprived communities.

TB is found mainly in deprived communities in developing countries, where the disease can be endemic.

(i) Distinguish between the terms *endemic* and *epidemic*.

-- **[2]**

(ii) State **two** reasons why TB spreads easily in deprived communities.

1

2

-- **[2]**

(b). In the case study you were told that TB claims the lives of many people infected with Human Immunodeficiency Virus (HIV).

Explain why people who test positive for HIV are at a much greater risk of developing TB than people who test negative for HIV.

-- **[3]**

(c). Table 1.2 lists some structural features that can be seen in HIV, or in *Mycobacterium tuberculosis*, or in both.

Complete Table 1.2 by placing ticks or crosses in the boxes.

✓ = feature present

✗ = feature absent

Structural feature	HIV	*Mycobacterium tuberculosis*
Genetic material is RNA only		
Membrane present		
Cell wall present		

Table 1.2

[3]

11(a) Tuberculosis (TB) and Coronary Heart Disease (CHD) cause millions of deaths each year.
.

TB is described as an infectious disease, whereas CHD is described as a non-infectious disease.

(i) What is meant by the term *infectious disease*?

---[1]

(ii) Give **one** other example of an infectious disease and **one** other example of a non-infectious disease.

Infectious disease

Non-infectious disease

----

[1]

(b). Table 5.1 below shows the 2013 global mortality rates for Tuberculosis (TB) and Coronary Heart Disease (CHD) and the two diseases and the mortality rates in two countries: the United Kingdom (UK) and The Gambia, in Africa.

In 2013, the United Nations (UN) ranked the UK 26th and The Gambia 165th in the Human Development Index. This Index is a measure of standards of living and levels of poverty.

Disease	Mortality (per 100000)		
	Global	UK	The Gambia
TB	24.0	0.5	48.0
CHD	138.6	122.0	108.5

Table 5.1

For TB **and** CHD:

- compare the mortality rates of the UK and The Gambia
- compare the mortality rates of the UK and of The Gambia with the global mean averages.

Suggest reasons for the differences in mortality rates.

Your answer should contain a balance of descriptions of the data and explanations of the data.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____ [8]

12. The prevalence of bowel cancer has increased in the UK over the last 40 years.

Benzopyrene is a molecule that has been linked to an increased risk of bowel cancer. It can be produced in cigarette smoke and burned food. Research indicates that benzopyrene may affect the p53 gene.

(i) Define the term *prevalence.*

--[1]

(ii) Suggest how benzopyrene may affect the p53 gene, leading to an increased risk of cancer.

--[3]

(iii) Benzopyrene is a chemical carcinogen. Exposure to chemical carcinogens increases the risk of developing cancer.

State **two** other factors that increase the risk of developing cancer.

1

2

----

[2]

(iv) Some forms of cancer are described as acute.

State what is meant by *acute.*

_____

_____

_____[1]

13. Tuberculosis (TB) is caused by the bacterium *Mycobacterium tuberculosis.*

Isoniazid is one of the antibiotics used to treat TB.

Isoniazid works by inhibiting the production of mycolic acid, a fatty acid required for the synthesis of some bacterial cell walls.

(i) Explain how isoniazid causes the death of *M. tuberculosis* cells.

_____

_____

_____

_____

_____

_____

_____

_____ [3]

(ii) Isoniazid kills bacterial cells but has no effect on human cells.

Explain why.

_____

_____ [1]

14(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).
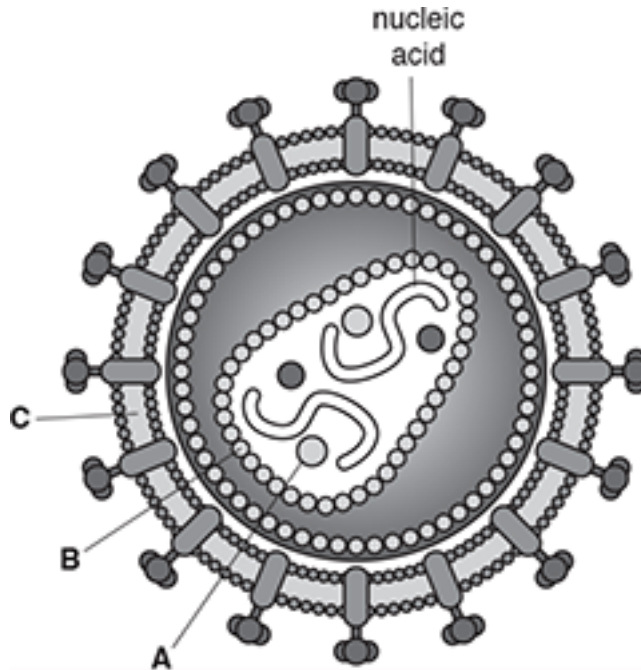
Fig. 3

(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]

15(a) It is essential to the functioning of the human body to maintain the correct balance of water and dissolved
. nutrients.

Cyclospora cayetanensis and *Campylobacter jejuni* are microorganisms that cause diarrhoea in humans leading
to excessive water loss.

Fig. 23.2 shows some of the data recorded for infections caused by these microorganisms in a human
population during the year 2014.
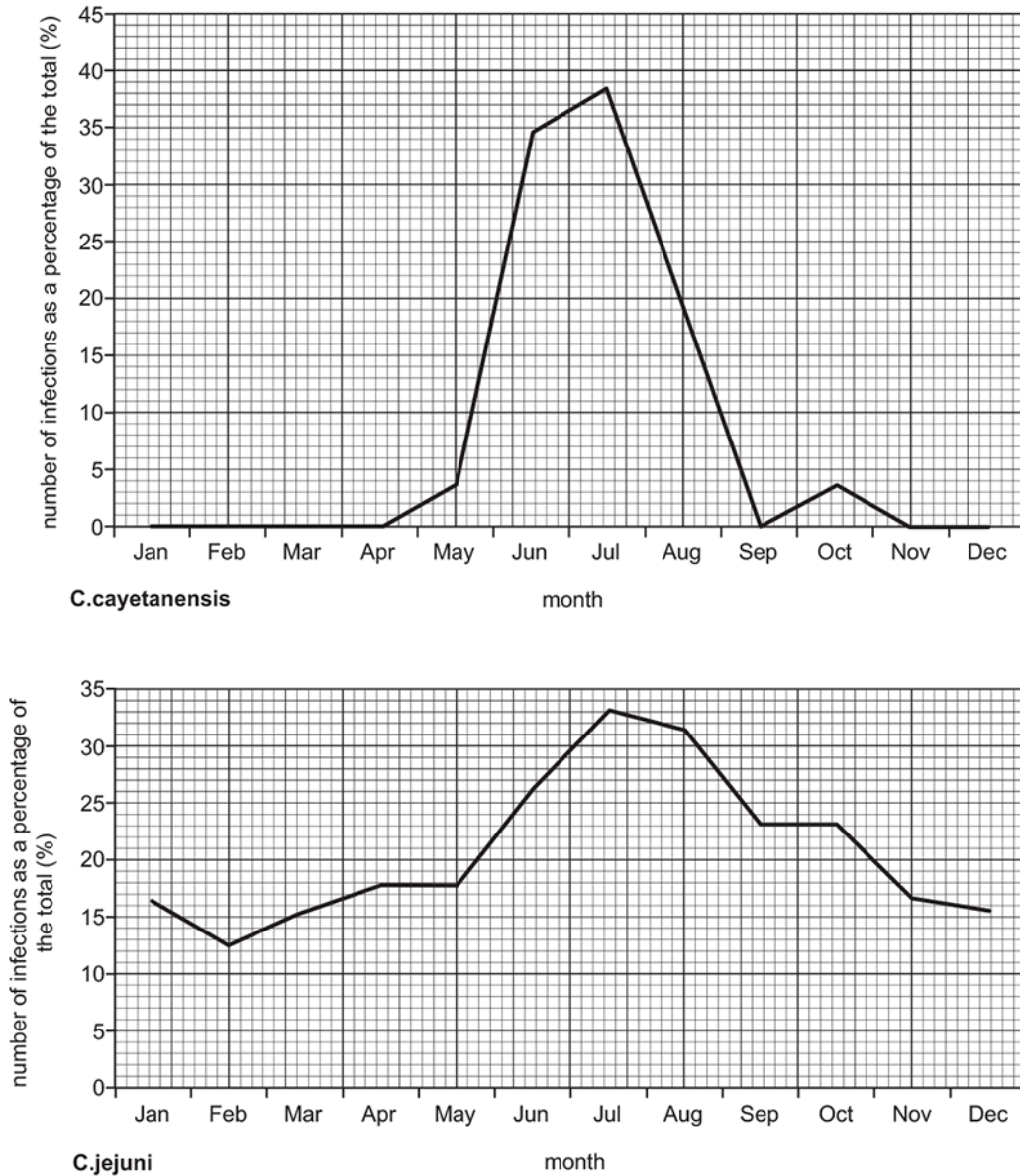
Fig. 23.2

(i) Comment on the trends shown by the data in Fig. 23.2 for the infection caused by *C.jejuni*.

-- [2]

(ii) The data for the infection caused by *C.cayetanensis* suggests that an epidemic occurred between the months of May and August.

Comment on the validity of this suggestion.

-- [2]

(b). Fig. 23.3 is a transmission electron micrograph (TEM) of a *C.jejuni* bacterium.
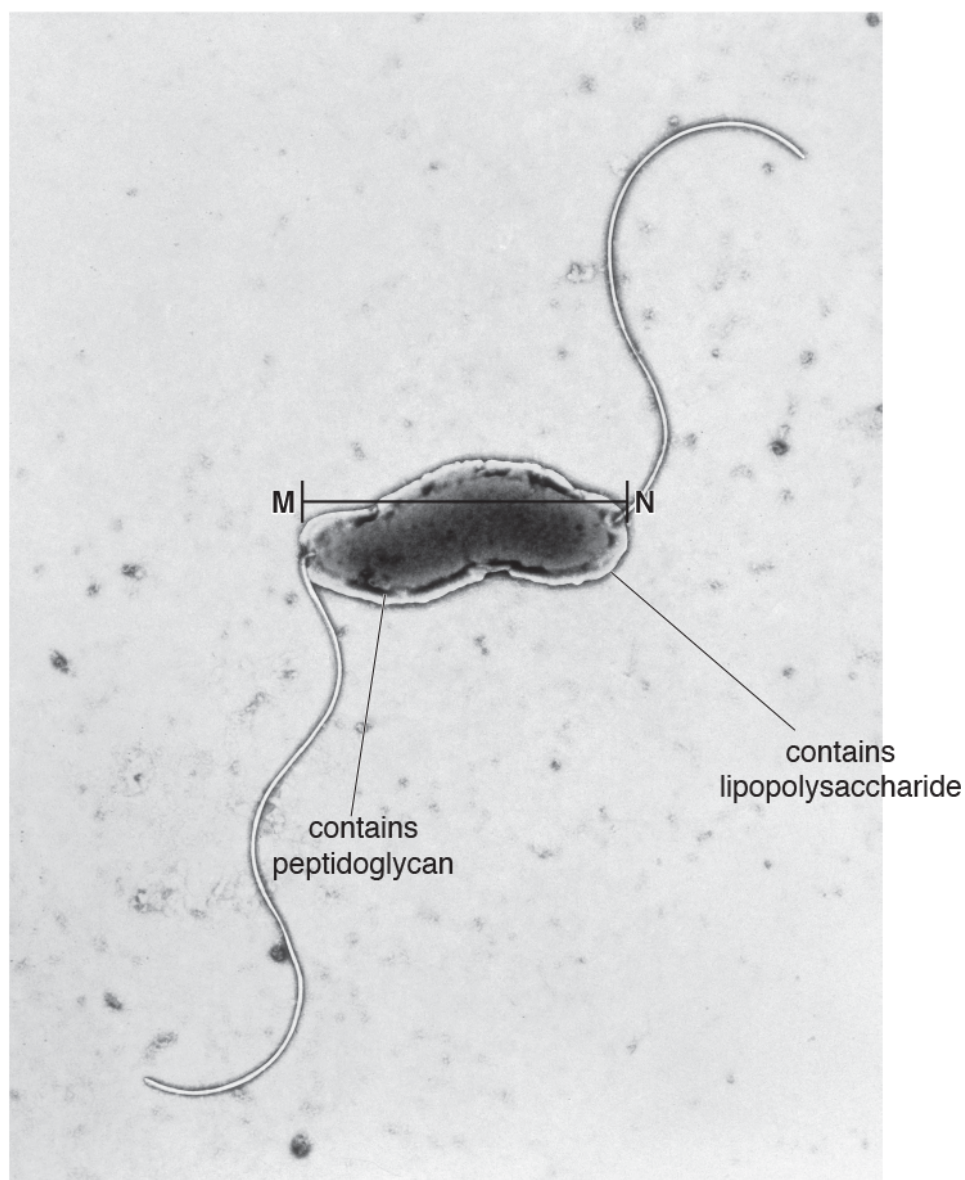
Fig. 23.3

(i) The actual length of the bacterium shown in Fig. 23.3 between points **M** and **N** is 4 μm.

Calculate the magnification of the micrograph.

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

Answer = ... x [2]

(ii) Using the information in Fig. 23.3 comment on **and** explain the results that would be obtained following Gram staining of a culture of *C.jejuni*.

-- [3]

END OF QUESTION PAPER

Question			Answer/Indicative content	Marks	Guidance
1			example of notifiable disease (1) *idea of*, statutory / legal / AW, obligation to inform, health protection team / HPT / competent authorities / AW (1)	2	Examples could include but are not limited to, Anthrax, Botulism, Brucellosis, Cholera, Diphtheria, typhoid or paratyphoid fever, Food poisoning E.coli O157 infection, Legionnaires' disease, Leprosy, Malaria, Measles, Meningococcal septicaemia (meningitis), Mumps, Plague, Polio, Rabies, Rubella Severe Acute Respiratory Syndrome (SARS),Tetanus, Tuberculosis, Typhus, Whooping cough, Yellow fever
			Total	2	
2		i	Any 2 from: *idea that* Gram stain is removed by, ethanol / AW, rinses (due to) peptidoglycan (layer) being thin *idea that* 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 *idea that* (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	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
3	a		***Level 3 (5–6 marks)** The means of transmission is clearly understood and described in detail, using an example. How the spread can be controlled is discussed in detail and the learner considers more than one measure of control. *There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.* **Level 2 (3–4 marks)** The means of transmission is described. At least one good suggestion of how to control the spread of the virus is given. *There is a line of reasoning presented with some structure. The information presented is in the most-part relevant and supported by some evidence.* **Level 1 (1–2 marks)** Relevant comment about the means of transmission or control of spread. *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.* **0 marks** No response or no response worthy of credit.	6	Examples of relevant material could include the following: *means of transmission* - spreads from person to person in body fluids - named example e.g. from mother to baby in uterus - once in blood virus enters T lymphocytes - may remain dormant for long period *controlling the spread* - screening donated blood - education - named example e.g. giving sterile needles to drug users - epidemiological testing - access to means of prevention e.g. condom clinics
	b	i	*idea of* breakdown / lack of T lymphocytes leading to further infection (1) example of infectious agent with the relevant disease (1)	2	

Question			Answer/Indicative content	Marks	Guidance
		ii	**Any 3 from:** incidence **and** deaths both increase between 1988 and 1992 (1) between 1992 to 1993 incidence stays the same (1) between 1993 to 1995 incidence decreases (1) between 1993 to 1995 deaths continue to increase (1) greater difference between incidence and deaths in 1995 (or 1993) than in 1988 (1)	3	
		iii	prevalence and deaths both increased before introduction of HAART (1) *prevalence continued to increase after HAART* (because) more people with AIDS surviving longer (1) *deaths decreased after HAART* (because) HIV infected people responding to treatment (1)	3	
			Total	14	

Question			Answer/Indicative content	Marks	Guidance
4	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 *idea that* 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. *There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.* 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. *There is a line of reasoning presented with some structure. The information presented is in the most-part relevant and supported by some evidence.* Level 1 (1–2 marks) Simple comments about humans and bacteria made with connections not always made. Little exemplification. *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.* 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	

Question			Answer/Indicative content	Marks	Guidance
5	a		not pandemic; only 6 cases / few cases, originating outside West Africa; use of data to show that probability of dying from Ebola is greater in West Africa; *idea of* data too limited for validity statement;	3 max	**e.g.** 39.6% **and** 16.7% or 1 in 2.5 **and** 1 in 6 (die) **Examiner's Comments** This question required analytical skills on very topical, epidemiological data and thus centred around AO2 with maths. Many candidates understood why the first statement was not valid and could also develop their response further by commenting on the data, but very few were able to gain more than two marks as they could not manipulate the data to support their answer. Some candidates did not appreciate that the World data included the data from West Africa.
	b	i	*The world* 0.1 (per 100,000); *West Africa* 3.7 (per 100,000);	2	**ACCEPT** 0.12 or 0.117 **ACCEPT** 3.66 **Examiner's Comments** Very few candidates knew how to calculate the mortality rates and of those who did complete the calculation there were some who used an inappropriate number of decimal places. Clearly candidates struggled with working out the values per 100,000.
		ii	*idea of* differences in access to therapies and medical care **OR** spread of disease contained within West Africa **OR** *idea that* infected people / contaminated material, not isolated in West Africa;	1	**ACCEPT** ref to remote areas in West Africa having no hospitals **Examiner's Comments** The majority of candidates answered this in terms of less health care facilities in West Africa although a few candidates felt the difference was solely due to the difference in population size, not appreciating the relevance of calculating a mortality rate and not relating it to the previous part question.

Question			Answer/Indicative content	Marks	Guidance
	c	i	no (reliable or fully-tested), cure / treatment; no vaccine; (so) no herd immunity; *Idea of* how, pathogen / virus, is transmitted; *idea that* identification of, virus / pathogen / symptoms, might be difficult;	2 max	<u>Examiner's Comments</u> There were some good responses seen which demonstrated that candidates were aware of the problems such as the need to create new treatments and vaccines. Answers included a need to know how the virus was spread and how to prevent contaminating others. However weaker candidates considered this simply in terms of wearing protective clothing which was not credited. A few candidates were distracted by the 'recently evolved' part of the question and discussed their answer in terms of the virus constantly evolving and showing antigenic shift/drift.
		ii	antibodies against Ebola (virus) present; passive immunity; AVP;	2 max	e.g. *idea that* lack of blood cells avoids the need to match blood groups <u>Examiner's Comments</u> Although many candidates stated that antibodies would be present in the plasma they also stated that memory cells would be present and did not appreciate that this is passive immunity. Some candidates felt that memory cells would be present and then would form antibodies when injected into the recipient.
		iii	*idea of* screening for, other (named) pathogens / red blood cells / ABO antibodies;	1	IGNORE disease <u>Examiner's Comments</u> Screening for other pathogens was the most commonly seen correct response. Candidates need to be aware of not stating that we are 'screening for the disease' which could not be credited.

Question			Answer/Indicative content	Marks	Guidance
	d		disease for which cases are reported to the, local / health, authority;	1	**Examiner's Comments** Examiners saw wide variation in what is considered to be a 'local authority' and credit was given to suitable suggestions. Many candidates read notifiable as noticeable, stating that it is a disease that has clear, definable symptoms or can be spotted quickly.
			Total	12	

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Question			Answer/Indicative content	Marks	Guidance
6			*evolve resistance* 1. mutation; 2. (mutated) gene gives resistance to antibiotics; 3. resistance genes found on plasmids; 4. example of resistance; 5. resistant bacteria survive and reproduce; 6. resistance gene, passed on to offspring / transferred between bacteria / transferred by conjugation; *prevent spread* 7. isolation of patients (with resistant *M. tuberculosis*); 8. disinfecting hands / wearing disposable gloves; 9. cleaning, equipment / bedding / clothing; 10. regular cleaning of surfaces (on wards);	7 max	**ACCEPT** gene variant / allele e.g. enzyme that metabolises the antibiotic
			QWC	1	**AWARD QWC** if candidate scores 2 marks from mps 1-6 **and** 2 marks from mps 7-10 <u>Examiner's Comments</u> This related to antibiotics and antibiotic resistance. This tested AO1 and AO3. This differentiated well and good candidates gave clear descriptions of the development of antibiotic resistance and could describe the electron micrograph of M. tuberculosis. The majority of candidates were able to describe how to prevent the spread of resistant strains but there were few good responses for how the resistance evolved. However, many candidates were still able to achieve QWC as they understood that 'mutations' were often involved and that resistant bacteria would 'survive and reproduce'. A few candidates confused antibiotic resistance with antibodies and antigens, seemingly reading antibiotics as antigens, and their answers followed through with the bacteria producing specific antibodies to the antigens. Many candidates discussed the prevention of spread in terms of DOT and not over prescribing antibiotics.

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
			Total	8	
7		i	RNA ✔	1	IGNORE ref to type of RNA e.g. messenger **Examiner's Comments** This question provided a straightforward end to the question paper with short answers involving AO1 recall or straightforward AO2 'suggest' style questions. Timing issues were the most likely cause of 'no responses' for some of the question parts.
		ii	antigens (on viral coat) constantly change ✔ *idea that* the virus is inside host cell so does not attract antibody ✔ *idea that* frequency of mutation is high ✔	1 max	**Examiner's Comments** This question provided a straightforward end to the question paper with short answers involving AO1 recall or straightforward AO2 'suggest' style questions. Timing issues were the most likely cause of 'no responses' for some of the question parts. Candidates needed to apply their knowledge of HIV as a retrovirus to this question about the RS virus. Many candidates were able to suggest RNA but fewer candidates went on to suggest a correct response for the problem of developing a vaccine for the virus.
			Total	2	

Question			Answer/Indicative content	Marks	Guidance
8		i	communicable / transmissible ✓	1	ACCEPT infectious / contagious **Examiner's Comments** Most candidates got (i) correct and many candidates answered (ii) in a way that suggested that they have carried out the practical work and discussed aseptic techniques a lot. However, three marks was rarely achieved because candidates were giving three general laboratory rules from the first mark point or candidates were writing too generally about tools or equipment being sterilised and not slides or loops.
		ii	example of general lab hygiene ✓ *idea of* work close to, a Bunsen burner / UV light ✓ only lift lid slightly ✓ flame the, spreader / loop ✓ safe disposal of, slides / agar plates ✓ *idea of* prevention of anaerobic conditions ✓	3 Max	e.g. use of disinfectant to wash hands / bench, use sterilised slide, use of lab coats, gloves, goggles ACCEPT use lid as umbrella e.g. hypochlorite / autoclaving / bleach
			Total	4	

Question			Answer/Indicative content	Marks	Guidance
9		i	*Idea that* (disease is) always present in, a population / region;	1	**Examiner's Comments** 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 **Examiner's Comments** 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	

Question			Answer/Indicative content	Marks	Guidance
10	a	i	*Endemic* = a disease always present in, the population / AW (in a region / country / area / prevalence pool); *Epidemic* = a sudden / AW, increase in the, number of cases / incidence (in a region / country / area) ;	2	**IGNORE** Spreads quickly **ACCEPT** 'sudden outbreak' – look for a time reference **DO NOT CREDIT** in the context of a pandemic ('in the world') **Examiner's Comments** This question was based on the pre-release material, and tested a range of abilities. Candidates achieved higher marks if they had thoroughly researched the material provided. This question assessed **AO1**, and **AO2** skills. Most candidates knew the definition of an endemic disease. Several candidates talked about a rapid spread rather than a sudden increase in number of cases for an epidemic, and a few talked about pandemics.

Question			Answer/Indicative content	Marks	Guidance
		ii	overcrowding / AW;	2	IGNORE damp conditions
			unaffordable / unavailable, diagnosis / vaccine / (named) drugs / healthcare;		IGNORE ref to lack of education IGNORE health care unqualified
			weakened immune system / reason for weakened immune system ;		e.g. malnutrition **OR** HIV[+]
			more people with active TB in community;		**CREDIT** hygiene in the context of coughing / sneezing
			poor hygiene qualified;		**Examiner's Comments** This question was based on the pre-release material, and tested a range of abilities. Candidates achieved higher marks if they had thoroughly researched the material provided. This question assessed **AO1**, and **AO2** skills. Most candidates correctly stated overcrowding as a cause of rapid spread. Poor access to health care, or a description, was also a common correct answer. Poor hygiene was often unqualified or incorrectly qualified as 'poor sanitation or drinking water' rather than the idea of spread due to coughing / sneezing. Lack of education was ignored as it is not generally considered to be a major factor in the spread of a droplet transmitted disease such as TB.

Question			Answer/Indicative content	Marks	Guidance
	b		weak(ened) / compromised, immune system; T <u>helper</u> cells, destroyed / infected / numbers fall; (T helper cells normally) activate, other immune cells / B cells; fewer / no, antibodies produced;	3	**CREDIT** reverse argument for immune response in HIV negative people. **IGNORE** no or lower, immune response **ACCEPT** T helper cells infected, attacked, or damaged **ALLOW** description e.g. No cytokines released to trigger clonal expansion **REJECT** if T cells producing antibodies **Examiner's Comments** This question was based on the pre-release material, and tested a range of abilities. Candidates achieved higher marks if they had thoroughly researched the material provided. This question assessed **AO1**, and **AO2** skills. Most candidates identified that HIV weakens the immune system, but then did not focus on the 'explain' command word to develop their answer further. Some candidates identified that T cells were infected but were not precise about the infection of T helper cells. Very few candidates identified the consequence of fewer T helper cells either on stimulation of other cells on the consequence for antibody production as a result of this.

Question			Answer/Indicative content	Marks	Guidance
	c		<table><tr><td>*Structural feature*</td><td>*HIV*</td><td>*Mycobacterium tuberculosis*</td><td></td></tr><tr><td>*Genetic material is RNA only*</td><td>✓</td><td>**X**</td><td>;</td></tr><tr><td>*Membrane present*</td><td>✓</td><td>✓</td><td>;</td></tr><tr><td>*Cell wall present*</td><td>**X**</td><td>✓</td><td>;</td></tr></table>	3	1 mark per correct row ACCEPT 'present' instead of a tick, 'absent' instead of a cross ACCEPT empty boxes instead of crosses if ticks are correct DO NOT CREDIT empty boxes instead of ticks if only crosses are entered. DO NOT CREDIT hybrid ticks or hybrid crosses **Examiner's Comments** This question was based on the pre-release material, and tested a range of abilities. Candidates achieved higher marks if they had thoroughly researched the material provided. This question assessed **AO1**, and **AO2** skills. This question was accessible to most candidates.
		Total		10	

	Question		Answer/Indicative content	Marks	Guidance
11	a	i	*infectious* spread / AW, between, people / organisms, by pathogens / AW;	1	ACCEPT "communicable" for "spread between people". **Examiner's Comments** This question assessed A01, AO2 and AO3 skills. Similar numbers of AO1 and AO3 marks were available. Most candidates correctly stated the meaning of the term 'infectious disease'. Some candidates did not make reference to a pathogen as the cause.
		ii	one correct example of an infectious disease **and** one correct example of a non-infectious disease;	1	e.g. HIV infection, malaria, HPV infection ACCEPT MRSA IGNORE TB e.g. diabetes, emphysema, chronic bronchitis, cancer, asthma, COPD IGNORE CHD **Examiner's Comments** Correct examples of infectious and non-infectious diseases were given by almost all candidates. A few gave the examples already stated in the question stem.

Question			Answer/Indicative content	Marks	Guidance
	b		*For Mark Points 1 and 2, penalise lack of correct units on data once* 1 TB higher in The Gambia (than UK) **and** data with correct units to support **ora**; 2 CHD higher in UK (than The Gambia) **and** data with correct units to support **ora**; 3 UK, below / AW, global (mean) and The Gambia, above / AW for TB; 4 UK and The Gambia both below global (mean) for CHD; 5 Correct manipulation of data in support of mark points **1 - 4**; 6 A correct reason for TB being spread more easily in The Gambia (than in UK) **ora**; 7 A correct reason for CHD (mortality) being higher in UK (than The Gambia) **ora**; 8 *idea of* genetic difference in predisposition for CHD; 9 *idea of* good health care (system) in UK, limits deaths from CHD / keeps CHD deaths below global average;	7	**Disease / Mortality per 100 000** | Disease	Global	UK	Gambia | |---|---|---|---| | TB | 24.0 | 0.5 | 48.0 | | CHD | 138.6 | 122.0 | 108.5 | e.g. "UK mortality from CHD is 13.5 **per** 100,000 greater than The Gambia." gets mp2 and 5 "The Gambia's mortality from TB is 200 % of the global average." gets mp 5 **6.** e.g. overcrowding / poor diet / poor health / less access to health care **7.** e.g. more smoking / less physical activity / diet higher in, saturated fat / cholesterol Award QWC when 2 marks from mp 1-5 are given and 2 marks from mp 6-9 are given.

The Guidance table referenced above:

Disease	Mortality per 100 000		
	Global	UK	Gambia
TB	24.0	0.5	48.0
CHD	138.6	122.0	108.5

Question			Answer/Indicative content	Marks	Guidance
				1	Award QWC when 2 marks from mp 1-5 are given and 2 marks from mp 6-9 are given. **Examiner's Comments** The vast majority of candidates required extra space for this question. Most candidates structured their answer methodically, discussing each disease in turn. Several candidates did not use figures in support of their arguments, or did not use appropriate units. Most were able to give correct reasons for the differences in data, although there was some confusion over the mode of transmission of TB as several answers referred to 'clean water supply', 'poor housing' and 'hand washing'. Some candidates did not compare the mortality rates of the UK and Gambia with the global mean average.
			Total	10	

Question			Answer/Indicative content	Marks	Guidance
12		i	number of (existing) cases of a disease (in a population);	1	DO NOT CREDIT reference to new cases **Examiner's Comments** This question addressed **AO1**, **AO2** and **AO3** skills. Most candidates correctly defined the term 'prevalence'. A few candidates incorrectly answered in terms of new cases or an increase in cases.
		ii	p53 (gene) is a <u>tumour suppressor</u> gene; (benzopyrene causes) <u>mutation</u> (of p53 gene); cell cycle not halted / no detection of DNA damage / AW; no <u>apoptosis</u> (of cells with, damaged/mutated, DNA);	3 max	ACCEPT correct detail of p53 pathway (e.g. P53 (gene) not expressed, p53 (protein) no longer produced / p53 protein cannot bind to DNA / p21(gene) not expressed, P21 no longer produced / CDKs continue to be activated **Examiner's Comments** Most candidates correctly identified that benzopyrene caused a mutation in p53 gene, although some merely wrote about p53 being inactivated or not working. A number of candidates were able to give further detail of the consequences of the mutation, although some failed to discriminate between the gene and the protein, stating that genes will not be produced. Several candidates wrote that p53 is a proto-oncogene rather than a tumour suppressor gene. Few candidates discussed the lack of apoptosis.
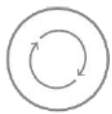
Question			Answer/Indicative content	Marks	Guidance
		iii		2 max	**Mark the first answer** on each line. If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = **0 marks**
					IGNORE references to diet/smoking / alcohol as these factors involve chemical carcinogens.
			heredity / genetic predisposition / family history (of cancer);		**ACCEPT** genetics
			viruses / viral infection;		**CREDIT** weakened immune system / AW
			age / ageing;		
			(exposure to ionising) radiation;		**CREDIT** UV, x-ray, gamma rays **DO NOT CREDIT** radio waves, infrared, microwaves
			lack of exercise / being overweight;		**CREDIT** HRT **Examiner's Comments** This was a well answered question. Some candidates referred to chemical carcinogens, e.g. diet or smoking, indicating that they did not read the question properly.
		iv	rapid onset and short-lived / lasts short time;	1	**Examiner's Comments** Very few candidates were able to give the correct definition as rapid onset and short-lived. Most were able to give only part of the definition. Many talked of it being 'small' or 'non-invasive' or 'curable' or 'in the early stages'.
			Total	7	

Question			Answer/Indicative content	Marks	Guidance
13		i	cell wall not synthesized ✔ water enters (cells) by osmosis ✔ from higher water potential to lower water potential ✔ cells, lyse / burst ✔	Max 3	**Examiner' Comments** Many candidates mentioned lack of cell wall in and cell lysing **(b)(i)** but very few explained why they lysed.
		ii	human cells do not have cell walls ✔ idea that human cells do not need mycolic acid ✔	Max 1	**Examiner' Comments** There were a lot of vague answers to **(b)(ii)** with many candidates describing why bacterial cells are different from human cells without mentioning the cell wall.
			Total	4	
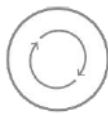
Question			Answer/Indicative content	Marks	Guidance
14	a	i	*Mycobacterium, tuberculosis / bovis* ✓	1	Italics not required **Examiner's Comments** Candidates struggled with this recall question. Some candidates confused the pathogen with possible vectors e.g. cows, bats and badgers. Spelling was erratic 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/glysdi/Word/APBio/LatinVocab
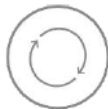
Question			Answer/Indicative content	Marks	Guidance
		ii	(cover mouth because) spread by (inhalation of) infected droplets ✓ (open windows) reduce chance of inhalation / removes droplets from, room / air ✓ (not sleep in same room because) long periods of contact required for infection ✓ (not sleep in 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.
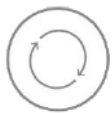
Question			Answer/Indicative content	Marks	Guidance
		iii	bacteria are, inaccessible to antibiotics / protected inside tubercles ✓ (many antibiotics required as) bacteria may be resistant to (any) one antibiotic ✓ (longer period required to) stop antibiotic resistance developing ✓	2 max	ALLOW granuloma / macrophage, for 'tubercle' IGNORE general ref to bacteria being antibiotic resistant ALLOW bacteria unlikely to be resistant to all antibiotics 0 **Examiner's Comments** 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	**Examiner's Comments** Well answered with only a few candidates stating DNA or ribose.

Question			Answer/Indicative content	Marks	Guidance
		ii	B = capsid / capsule proteins / capsomeres **AND** C = (lipid) membrane ✓	1	**ALLOW** phospholipid bilayer **IGNORE** plasma (membrane) **Examiner's Comments** 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 ' **Examiner's Comments** 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

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; <u>https://www.bing.com/videos/search?q=latent+viruses&&view=detail&mid=BC73F1B8F6F2112B9ECBBC73F1B8F6F2112B9ECB&&FORM=VDRVRV</u> Other viruses could be discussed in this context, particularly in terms of herpes simplex virus which may give a more familiar context <u>http://www.virology.ws/2009/04/03/how-herpes-simplex-virus-exits-latency/</u>
		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.

Question			Answer/Indicative content	Marks	Guidance
			Total	13	

Question			Answer/Indicative content	Marks	Guidance
15	a	i	1 (*C.jejuni*) always present (in the population) / AW ✓ 2 increasing infections between 3 February and July ✓ 4 peaks in July ✓ decline in infections from July to December ✓ 5 comparative data quoted ✓	2 max	e.g. peaks at 33% in July dropping to 16% in December = MPs 3,4 and 5 **ALLOW** +/- 0.5 for percentage figures.
		ii	*support suggestion* *idea that there is* no / little , infection present then sudden increase (during these months) ✓ *against suggestion* *idea that* the data does not show number of people with the infection ✓ *idea that* the size of the population would be needed ✓	2 max	**ALLOW** no / little , infection present but rises quickly to 38 % by July e.g. there may only be a small number of people with the infection that year **Examiner's Comments** In parts (c)(i) and (c)(ii) candidates were required to use data provided in the form of graphs showing infections caused by two different bacteria. It is important that candidates refer to data when prompted to do so in the question stem. The majority of candidates gained credit for part (c)(i). There were fewer good responses to (c)(ii) and there were some responses which focussed on the term 'validity' with reference to how the data was collected, rather than on the validity of the suggestion that it was an epidemic. A few candidates chose to describe the trends for *C.cayetanenis* in (c)(i) or used data for *C.jejuni* in (c)(ii) which could not be credited.

Question			Answer/Indicative content	Marks	Guidance
	b	i	*(M-N measured at 43mm)* 10 800 (x) ✓✓	2	**ALLOW** 2 marks for correct calculation if M-N is measured between 42 and 43mm If answer incorrect: **ALLOW** 1 mark for e.g. (using 43mm) 43mm ÷ 4 µm / 4.3cm ÷ 4µm **OR** 43000 ÷ 4 **OR** 10 750 <u>Examiner's Comments</u> Many candidates were credited with two marks for this calculation. Many others gained one mark for a correct calculation because they had not written their response to three significant figures. Most candidates were able to measure the line from M to N as between 42 and 43mm and demonstrated knowledge of the correct calculation for magnification. The challenge for some candidates was then to convert mm into µm, a mathematical skill required to achieve the correct response.

Question			Answer/Indicative content	Marks	Guidance
		ii	*(C. jejuni)* would stain , pink / red (with Gram stain) ✓ (because) peptidoglycan cell wall is covered by lipopolysaccharide layer **OR** (because) the peptidoglycan cell wall is very thin ✓ (so) purple stain / crystal violet, is washed out (by alcohol) ✓ safranin / counter-stain / pink stain, binds to peptidoglycan cell wall ✓	3 max	**ALLOW** *(C. jejuni)* is Gram -ve <u>Examiner's Comments</u> Many candidates gained one mark for recognising *C.jejuni* as being Gram negative or would stain pink using the information in Fig.23.3. Higher ability candidates went on to give detailed explanations to support this comment. There were some unclear or confused responses where candidates could not remember the differences between Gram positive and Gram negative bacteria. Exemplar 3 Gram-negative bacteria/organella stains pink/red whereas Gram-positive bacteria/organelles stain purple/blue. Peptidoglycan is Gram-positive so would stain purple. Lipopolysaccharide is Gram-negative so would stain pink. This response could be improved by applying the information to *C.jejuni* rather than giving a general statement about both types of bacteria. There was also confusion about how the staining technique affected the cell wall and lipopolysaccharide layer surrounding the bacterium, so no marks could be credited.
			Total	9	