



EXAM PAPERS PRACTICE

Immunity, Infection and Forensics -1

Name: _____

Class: _____

Date: _____

Time:

Total Marks Available:

Total Marks Archived:

Level: Edexcel A level Biology

Subject: Biology

Exam Board: Pearson Edexcel Level 3 GCE AS and A level Biology A (Salters-Nuffield) and also Pearsons Edexcel AS and A Level Biology B (9BI0) - Is however suitable for use by AS and A level Biology Students of other Boards

Topic: Immunity, Infection and Forensics -1

Type: Topic Question

To be used by all students preparing for Edexcel AS and A level Biology A and Biology B - Students of other Boards may also find this useful

Questions

Q1.

Histamine and the proteins interferon and lysozyme are involved in the non-specific responses to infection.

(a) (i) Describe how the production and action of interferon differs from the production and action of lysozyme.

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(ii) Suggest why the protein structure of lysozyme is important to the way in which it acts against pathogens.

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(b) Following a bite by an insect, the area around the bite may show signs of inflammation as histamine is released.

(i) Explain why an insect bite, which breaks the surface of the skin, may lead to inflammation around the injury.

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(ii) In order to reduce inflammation, a cream containing antihistamines might be applied to the skin, around an insect bite.

Suggest why applying this cream might be better than taking tablets containing antihistamines.

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(Total for question = 13 marks)



Q2.

The polar bear, *Ursus maritimus*, preys on seals and fish. Polar bears are adapted to live in cold Arctic regions.



Polar bear
Magnification $\times 0.04$

A recent study has shown that all polar bears are descended from populations that diverged from the Irish brown bear, *Ursus arctos*, approximately 120 000 years ago.

In this study, DNA from modern polar bears, the remains of historic polar bears and the remains of Irish brown bears was analysed.

(a) The first part of the study involved the amplification of DNA to give large enough samples for analysis.

(i) Describe how small samples of DNA can be amplified.

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(ii) Name **one** technique that could be used to analyse the amplified DNA samples.

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(b) Suggest how the scientists who conducted the study had their results accepted by other scientists.

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(c) Suggest how each of the following may have contributed towards the divergence of polar bears and Irish brown bears into two separate species.

(i) Separation of the Arctic and Irish regions by sea

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(ii) Genetic mutation

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(Total for question = 11 marks)

Q3.

Peat bogs are formed over millions of years from the remains of plants and animals.

Waterlogging and acidic conditions prevent the decomposition of plants and animals in peat bogs.

The photograph shows peat being cut from a peat bog.



(Source: © Reimar/Shutterstock)

(i) State how the age of the layers in a peat bog can be determined.

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(ii) Explain why the conditions in peat bogs prevent decomposition.

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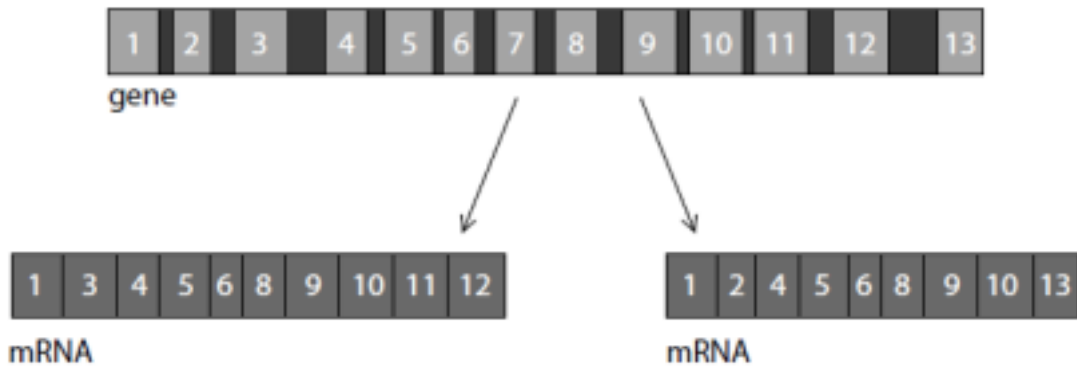
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Q4.

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A central idea in biology is that DNA codes for the synthesis of proteins from amino acids. The instructions for making proteins are in the form of mRNA.

The diagram below shows a method by which mRNA can be produced.





An initial estimate of the number of genes, based on the number of proteins found in humans, was in the region of 100 000. It is now known that the number of genes is around 25 000.

Explain how the formation of mRNA, shown in the diagram, might account for this.

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(Total for question = 5 marks)

Q5.

A student carried out an investigation to compare the antibacterial effect of a garlic extract with that of three antibiotics, all at the same concentration.

(a) (i) To obtain the extract, a clove of garlic was cut into lots of small pieces and soaked in 0.1% ethanol for a long time.

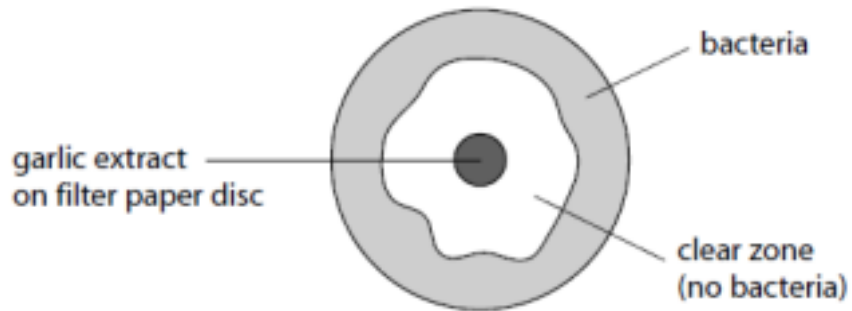
Explain why this is an effective method of extraction.

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(ii) The diagram shows the effect of the garlic extract on bacteria growing on an agar plate.



The area of the clear zone was calculated by assuming it is a circle and estimating the diameter. The estimate made was 4.3 cm.

Calculate the estimated area of the clear zone.

(2)

Answer

(b) The results of the investigation are shown in the table.



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Sample number	Estimated area of clear zone / mm ²			
	Antibiotics			Plant extract
	Chloramphenicol	Tetracycline	Streptomycin	Garlic
1	28	16	15	20
2	26	19	13	28
3	29	11	14	18
4	28	21	12	25
5	26	7	14	27
6	29	11	15	26
7	22	8	9	25
8	25	21	14	25
9	29	10	12	29
Mean	27	14	13	25
Standard deviation	2.37	5.54	1.90	3.60

These data were analysed using *t*-tests.

(i) Several statistical tests were available to the student to analyse these data, including the *t*-test, Chi squared and the correlation coefficient.

Explain why the *t*-test was chosen to analyse these data, rather than the other two tests.

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(ii) Calculate the t value for the data to compare garlic with chloramphenicol, using the formula:

$$t = \frac{|\bar{x}^1 - \bar{x}^2|}{\sqrt{\left(\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}\right)}}$$

(3)

Answer

(iii) The table shows the critical values of t with 16 degrees of freedom.

Significance level (p)	0.20	0.10	0.05	0.01	0.001
Critical value of t	1.34	1.75	2.12	2.92	4.02

Use your value of t to test the validity of a stated null hypothesis.

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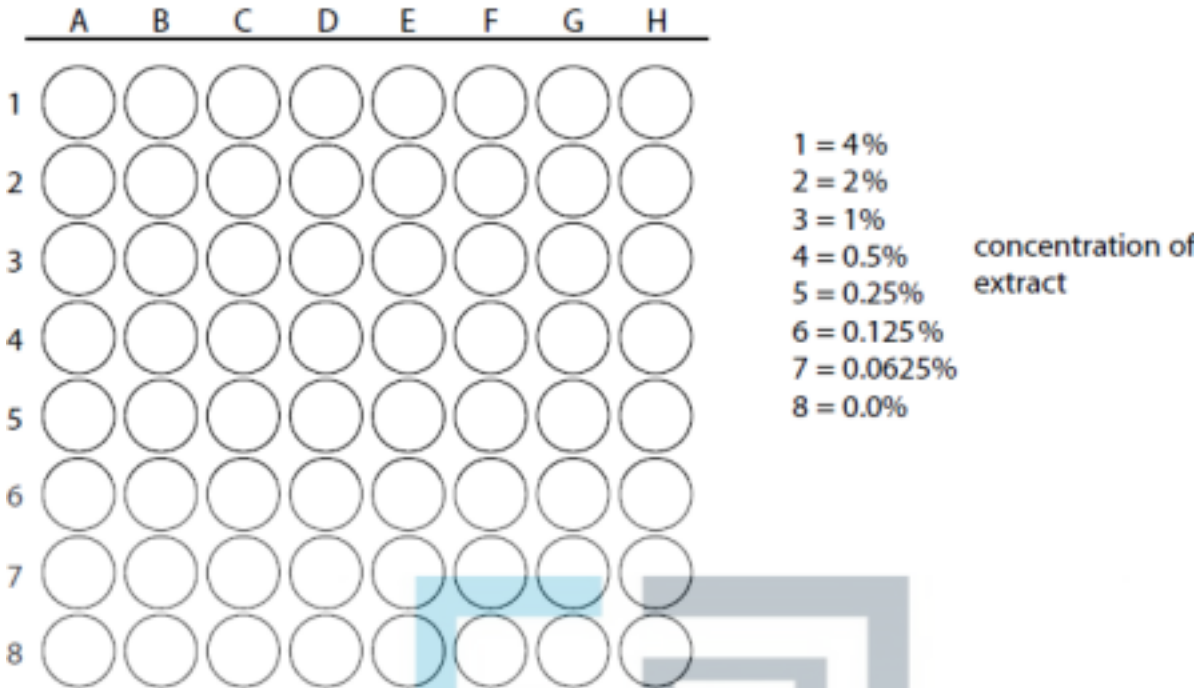
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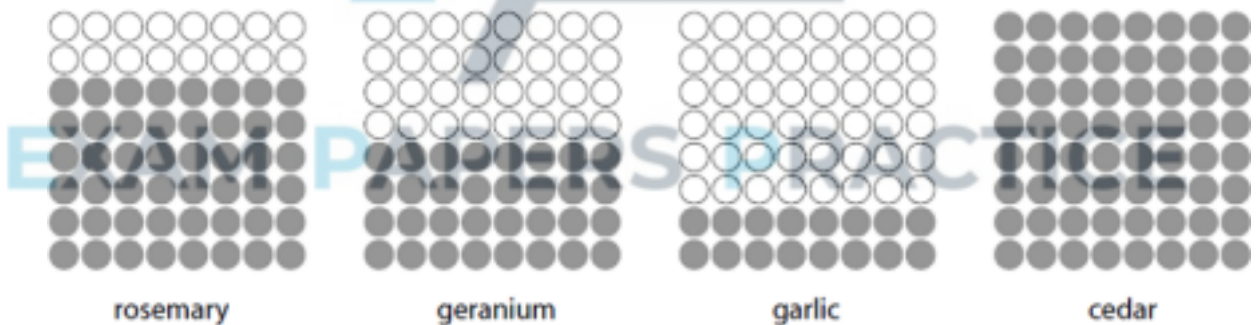
(c) The size of the clear zone depends on variables other than the antibacterial properties of the substances used, such as size and solubility of the antimicrobial molecules in the extract.

A new method was developed in which the minimum concentration of extract that causes inhibition of bacterial growth (Minimum Inhibitory Concentration, MIC), was found.

Samples of extract, bacteria (*E. coli*) and a respiration indicator were placed in a micro-titre tray.



The diagrams show the results obtained. The tubes are black when respiration occurs and clear when no respiration occurs.



(i) Analyse the data to explain the results of this experiment.

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(ii) Give **two** changes that can be made to the procedure to get a more accurate measure of MIC.



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(iii) It was concluded that plant extracts inhibit respiration of bacteria. This conclusion may not be valid because the investigation has limitations.

Describe how the investigation could be modified to reduce the effect of two named limitations.

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(Total for question = 20 marks)

Q6.

The scientific article you have studied is adapted from an article from *'The Scientist'*.

Use the information from the scientific article and your own knowledge to answer the following questions.

Explain how the production of antibiotics by *Streptomyces* species can reduce interspecific competition (paragraph 20).

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(Total for question = 3 marks)

Q7.

Penicillin is an antibiotic. It was discovered in 1928. Since then many antibiotics have been identified and are widely used in the treatment of bacterial infections.

Scientists have recently discovered a new class of antibiotics that bind to ribosomes.

(i) Explain why these antibiotics could affect the production of proteins in bacteria.

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(ii) These new antibiotics attach to a site on the ribosome not affected by any known antibiotics.

Deduce why these new antibiotics might be used to treat bacteria that are resistant to other antibiotics.

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* (iii) Scientists have isolated these new antibiotics and tested their effectiveness against bacteria that are resistant to other types of antibiotic.

Devise a laboratory procedure to compare the effectiveness of penicillin with one of the new antibiotics.

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(Total for question = 11 marks)

Q8.

Human papilloma virus (HPV) is a DNA virus.

Cervarix and Gardasil have been used in national vaccination programs.

A person who has been vaccinated becomes infected with HPV-16. Explain the role of the T cells in the body of this person.

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(Total for question = 3 marks)



Q9.

The scientific article you have studied is adapted from the book called *The Immortal Life of Henrietta Lacks* by Rebecca Skloot. Published by Pan Books in 2011.

(a) Explain what is meant by the term **mitosis** (paragraph 7).

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(b) The genome makes sure that cells 'do their jobs, whether that's controlling your heartbeat or helping your brain understand the words on this page' (paragraph 10).

Describe how cells in the sino-atrial node (SAN) are involved in controlling heart rate.

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(c) Henrietta's cells have 'been used to study lactose digestion' (paragraph 16).

Suggest how her cells may have digested lactose.

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(d) 'Like guinea pigs and mice, Henrietta's cells have become the standard laboratory workhorse' (paragraph 16).

Suggest **two** reasons why it is preferable to use Henrietta's cells in medical research, rather than using guinea pigs and mice.

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*(e) 'By the end of 1951, the world was in the midst of the biggest polio epidemic in history' (paragraph 19). This was caused by poliovirus which can lead to paralysis (paragraph 20).

The virus infects motor neurones which can stop skeletal muscles from working.



Suggest how an infection of motor neurones by the virus can stop the transmission of nerve impulses and lead to muscle paralysis.

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(f) Poliovirus, like Human Immunodeficiency Virus, is a retrovirus. Poliovirus was able to infect HeLa cells (paragraph 25).

Give **three** similarities between the structure of the genetic material in poliovirus and the genetic material in HeLa cells.

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(g) Scientists had studied genes by breeding plants 'then breeding their offspring to see how genetic traits are passed from one generation to the next' (paragraph 33).

When this was done using a smooth pea and a wrinkled pea, it was found that in the F₂ generation (second generation of offspring), 75% were smooth.

In the space below, draw genetic diagrams to describe and explain the genotypes of the parents and their offspring in the previous **two** generations.

(4)

(h) Explain what is meant by the term **human genome map** (paragraph 37).

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(i) Suggest how the 'p53 tumor suppressor gene' (paragraph 43) could stop a potential tumour cell forming.

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(j) Using paragraph 46, suggest what the 'specific DNA sequence from a blood cell' coded for.

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(k) A human telomere (paragraph 60) contains 10 000 nucleotides.

Using information from paragraph 58, state the number of telomere nucleotides lost per cell division.

(1)

Answer nucleotides

(Total for question = 30 marks)

Q10.

One role of the skin is to protect the body from infection.

(i) Explain how skin flora protect the body from infection.

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(ii) The skin produces lipids that protect the body from infection.

Place a cross in the box next to the correct explanation of how these lipids protect the body from infection.

(1)

- A** they are alkalis that kill bacteria
- B** they have antimicrobial properties that inhibit the growth of bacteria
- C** they are enzymes that destroy viruses
- D** they are water soluble and prevent viruses from replicating

Q11.

The human gut contains more than a thousand species of bacteria. Only 30 to 40 of these species are found in the stomach.

Explain why there are relatively few species of bacteria in the stomach.

(2)

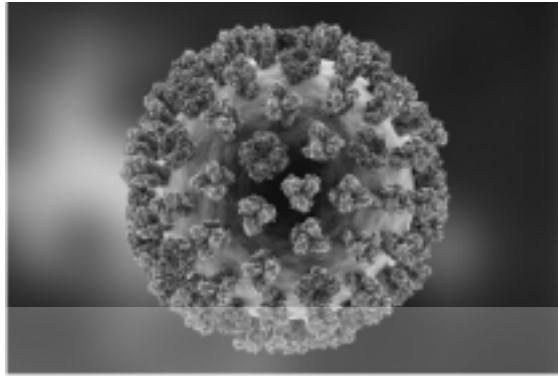
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(Total for question = 2 marks)



Q12.

The diagram shows an RNA virus that causes influenza.



(Source: © Kateryna Kon/Shutterstock)

The surface of this virus capsid is covered with 'spike' proteins.

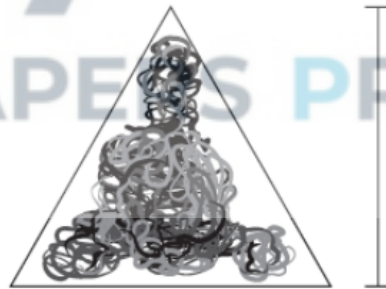
The diameter of the capsid of this virus is 240 nm.

Diagram of the surface of the virus showing each spike protein as a triangle

The diagram shows the area occupied by one spike protein



240 nm



$h = 22.4 \text{ nm}$

$b = 20.0 \text{ nm}$

Calculate the maximum number of spike proteins that can be packed on the surface of one virus particle.

The formula for calculating the surface area of a sphere is $4\pi r^2$

The formula for calculating the area of a triangle is $\frac{h \times b}{2}$

(3)

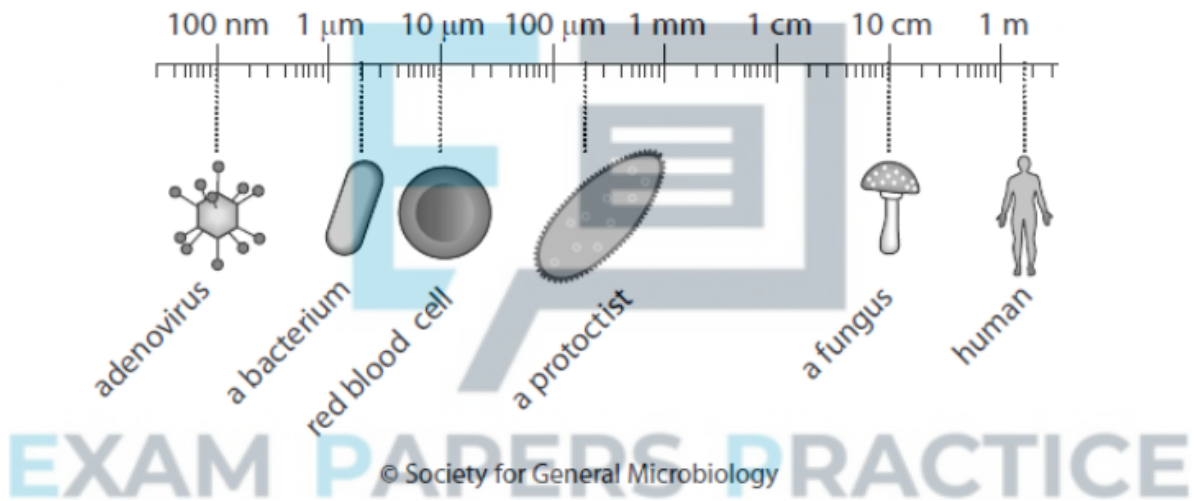


Answer

(Total for question = 3 marks)

Q13.

The diagram compares the size of some microbes with that of a human and a human cell.



(a) Which of the following belong to the domain Eukaryota?

(1)

- A adenovirus, bacterium and protoctist
- B human, bacterium and red blood cell
- C human, red blood cell and protoctist
- D adenovirus, fungus and human

(b) Which of the following do **not** have a nucleus?

(1)

- A bacterium and protocist
- B bacterium and red blood cell
- C fungus and adenovirus
- D protocist and adenovirus

(c) Which of the following shows how many times bigger the bacterium is than the adenovirus?

(1)

- A 45 times
- B 22 times
- C 2 times
- D 10 times

(d) State **one** way in which the structure of a virus is different from that of a bacterium.

(1)

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(Total for question = 4 marks)



Q14.

The scientific article you have studied is adapted from an article from *'The Scientist'*.

Use the information from the scientific article and your own knowledge to answer the following questions.

Describe the structure of the 'protein-synthesis machinery' in bacteria (paragraph 20).

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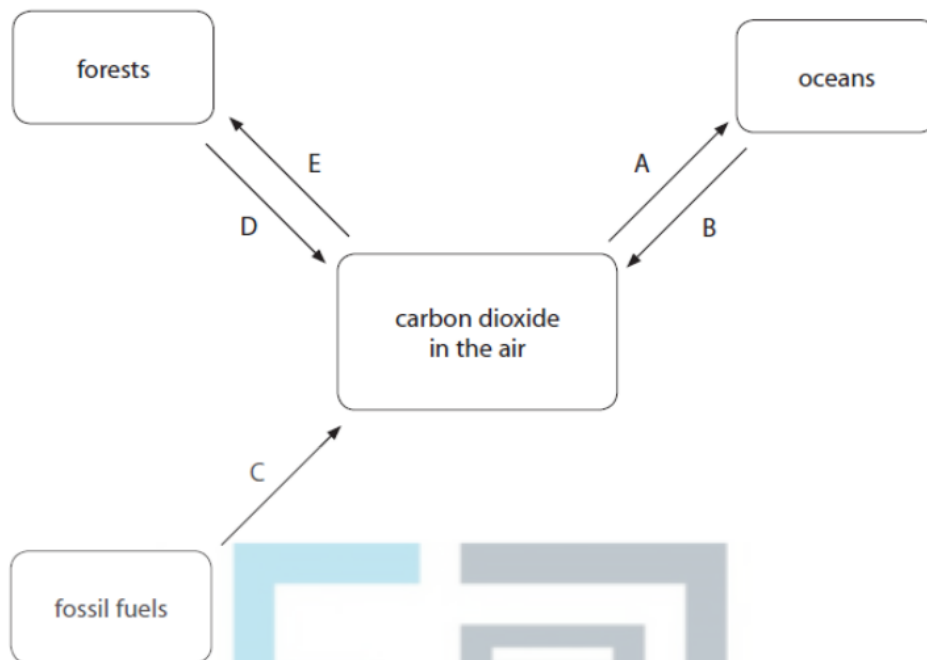
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(Total for question = 2 marks)

Q15.

The diagram below shows part of the carbon cycle. The processes A, B, C, D and E, transfer carbon.



Suggest how carbon dioxide is returned to the air from the oceans by process B.

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Q16.

The table below shows how much carbon is being transferred by each of the processes in the diagram.

Process	A	B	C	D	E
Mass of carbon transferred / au	338	332	23	444	450

(i) Calculate how much more carbon is entering the air than is leaving it. Show your working.

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Answer

(ii) Suggest why more carbon is entering the air than is leaving it.

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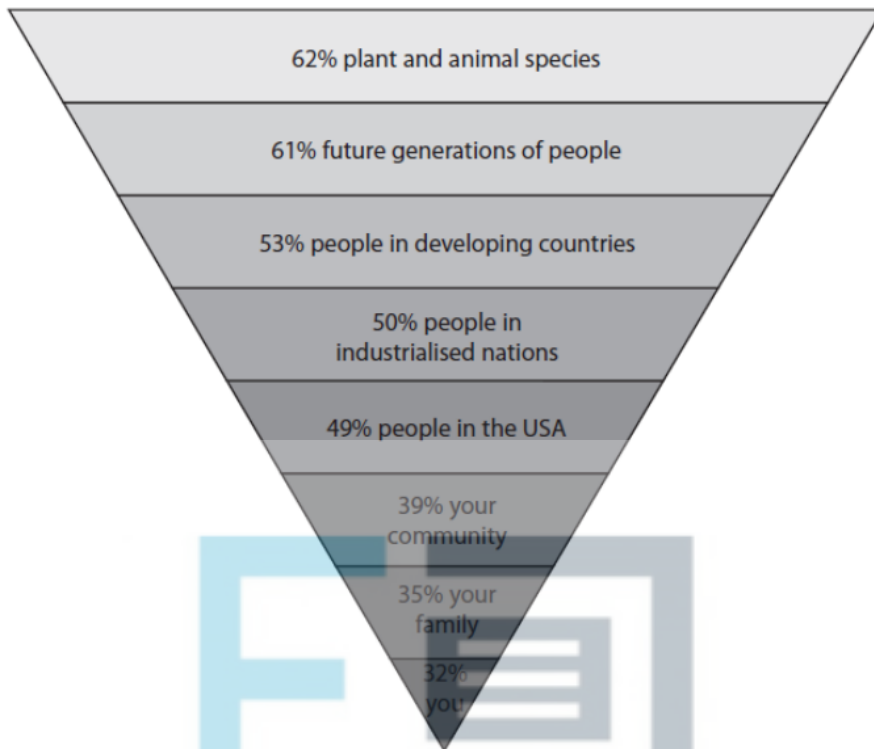
Q17.

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A survey was conducted in the USA to find out what harm people thought global warming could have.

The people were asked if they thought global warming could harm the eight groups shown in the diagram.

The diagram below shows the percentage of people who thought each group would be harmed.



This survey shows that 61% thought future generations of people could be harmed by global warming.

Suggest why the rest of the people surveyed thought that future generations of people would **not** be harmed by global warming.

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Q18.

The scientific article you have studied is adapted from *National Geographic*.

Use the information from the scientific article and your own knowledge to answer the following questions.

Explain how a vaccine developed against human plague can provide lifelong immunity to sylvatic plague in the black-footed ferret (paragraph 33).

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(Total for question = 3 marks)

Q19.

Penicillin is an antibiotic. It was discovered in 1928. Since then many antibiotics have been identified and are widely used in the treatment of bacterial infections.

State what is meant by the term bacteriostatic antibiotic.

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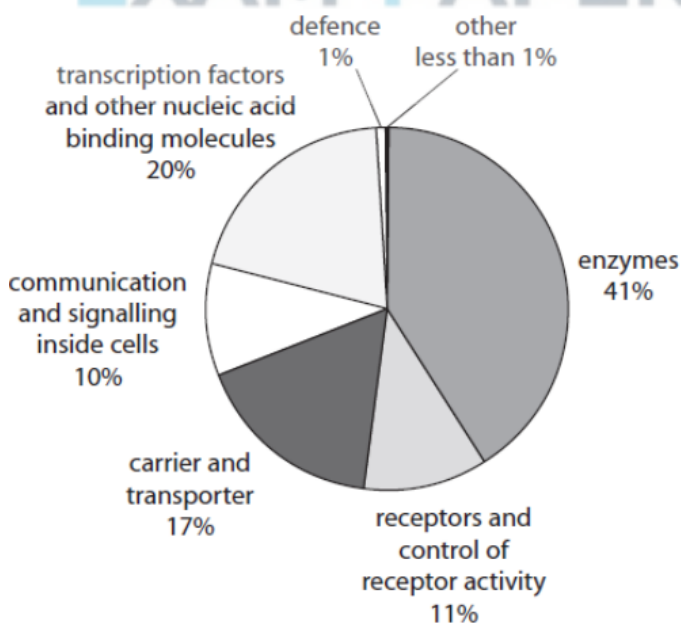
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(Total for question = 1 mark)

Q20.

* The human genome codes for approximately 20 000 different proteins. The pie chart shows the proportion of proteins carrying out different functions.





The 20 amino acids used to make proteins can be classified according to the properties of their side chains (R groups).

Table 1 shows the number of amino acids with these properties.

Property of the side chain group	Number of amino acids with the property
Non-polar	9
Polar, uncharged	6
Negatively charged	3
Positively charged	2

Table 1

Table 2 shows three amino acids, used to synthesise proteins, that have unique properties.

Amino acid	Comment on structure
Cysteine	The side chain contains a thiol group (-S-H) that is chemically reactive.
Glycine	The side chain is a hydrogen atom which is much smaller than any other side chain. This allows tight coiling of polypeptide chains.
Proline	The side chain forms a peptide bond with the nitrogen in the amino group. This makes a polypeptide chain more rigid.

Table 2

Discuss the importance of the amino acid side chain to the structure, function and location of proteins.

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(Total for question = 9 marks)



Q21.

Tuberculosis (TB) is a disease that affects the lungs. It is caused by the bacterium *Mycobacterium tuberculosis*. When these bacteria enter the body an immune response is triggered.

The Human Immunodeficiency Virus (HIV) affects the immune system. People infected with HIV are more likely to develop TB.

A study investigated the relationship between TB infections and HIV status. In 2008, the number of people in the world estimated to have TB was 9.4 million.

The table shows the percentage of these people who were either HIV positive or HIV negative. The estimated number of deaths due to TB is also shown in the table.

HIV status	Percentage of people with TB in 2008 (%)	Estimated number of patients with TB who died in 2008	Percentage of deaths due to TB (%)
HIV positive	15	521 700	
HIV negative	85	1 278 400	16

(i) Calculate the percentage of TB patients infected with HIV who died of TB.

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(ii) Describe the effect of HIV on the number of deaths from TB.

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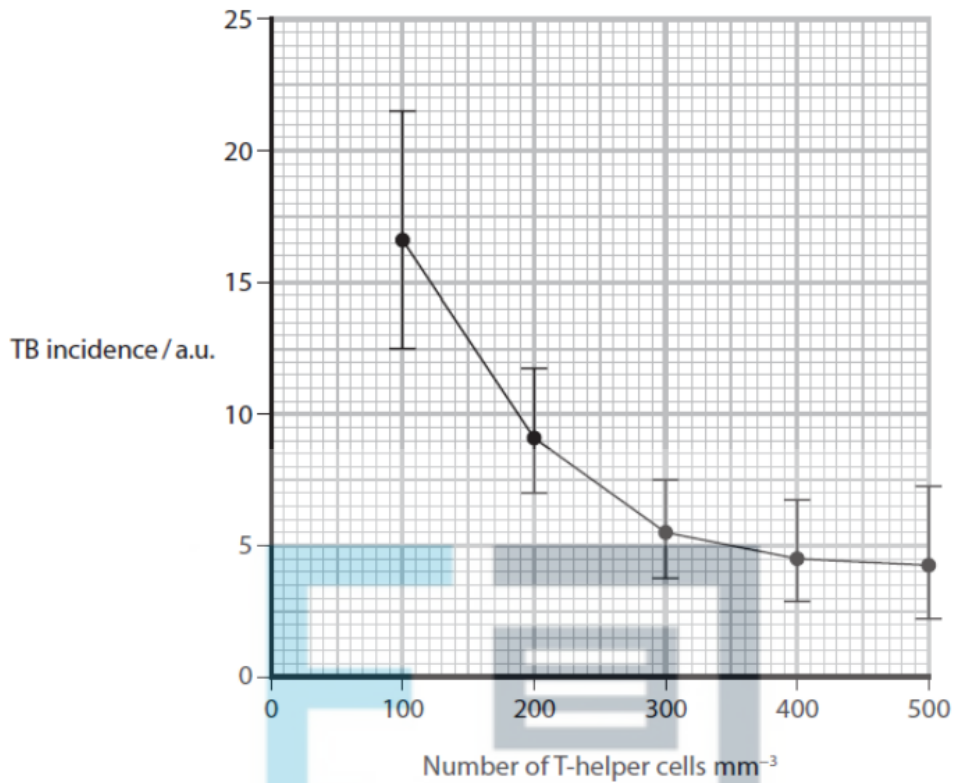
* (iii) There are increased numbers of deaths from TB as a result of HIV infection. The table shows data for deaths worldwide from HIV and TB in 2016.

Type of infection	Number of deaths
TB only	1 300 000
HIV only	826 000
TB and HIV	374 000

Treatment of HIV with anti-viral drugs has reduced the incidence of TB associated with HIV infection.

The replication of HIV reduces the T-helper cell count. These anti-viral drugs reduce the replication of the virus in the body.

The graph shows the effect of this on the incidence of TB.



Explain the effect of using anti-viral drugs to treat HIV on the number of deaths from TB.

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(Total for question = 10 marks)

Q22.

The scientific article you have studied is adapted from *National Geographic*.

Use the information from the scientific article and your own knowledge to answer the following questions.

Explain why some pig genes can cause reactions in the human immune system (paragraph 27).

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(Total for question = 3 marks)

Q23.

Changes in the RNA of influenza produce new strains of the virus with an altered spike protein.

Devise a procedure to determine the similarity of the strains of influenza in saliva samples collected from different people.

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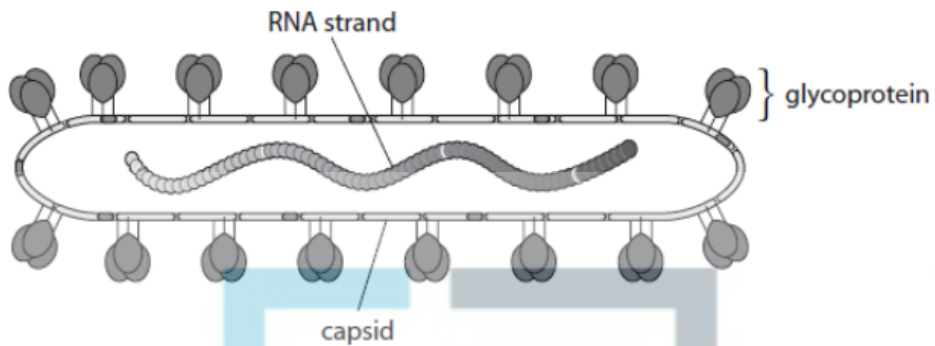
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(Total for question = 4 marks)

Q24.

Ebola virus disease (EVD) is a rare and deadly disease most commonly found in Africa. Following a severe outbreak in 2014, in which 11 000 people died, work has been underway to develop a vaccine.

The diagram shows the structure of an Ebola virus.



Compare and contrast the structure of Ebola virus with that of the human immunodeficiency virus (HIV).

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(Total for question = 3 marks)



Q25.

Tuberculosis (TB) is a disease that affects the lungs. It is caused by the bacterium *Mycobacterium tuberculosis*. When these bacteria enter the body an immune response is triggered.

The initial response when bacteria enter the body is a

(1)

- A non-specific response and bacteria are destroyed by antibodies
- B non-specific response and bacteria are destroyed by phagocytes
- C specific response and bacteria are destroyed by antibodies
- D specific response and bacteria are destroyed by phagocytes.

(Total for question = 1 mark)