



EXAM PAPERS PRACTICE

## Immunity, Infection and Forensics -3

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 -3

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

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## Questions

Q1.

The scientific article you have studied is from *Scientific American*.

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

The protein  $\alpha 4\beta 1$  integrin projects out from the cell surface membrane of white blood cells.

Deduce how molecules such as  $\alpha 4\beta 1$  integrin help immune cells cross the blood-brain barrier (paragraph 8).



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(Total for question = 2 marks)

Q2.

Blood clotting is a process that is affected by genes.

Some people are at an increased risk of a condition called deep vein thrombosis (DVT). Blood clots form in the veins of people with DVT.

There are two alleles in a population, a wild type allele and G20210A.

Individuals with a family history of DVT may be offered a genetic test for the G20210A allele.

In this test, a sequence of 345 base pairs (bp) from this gene is amplified using the polymerase chain reaction (PCR).

A specific restriction enzyme is then added to the amplified DNA.

The DNA fragments produced are then separated using gel electrophoresis. The diagram shows the results of gel electrophoresis for three individuals, A, B and C.



(i) Explain the role of DNA primers in the production of the amplified 345bp sequence.

(2)

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(ii) Explain why the amplified DNA fragments for the G20210A allele and the wild type allele are different.

(3)



Q3.

The structure of the cell surface membrane can be explained using the fluid mosaic model.

This model suggests that there are a variety of different proteins and glycoproteins present in a phospholipid bilayer.

\* The ratio of lipid to protein in a cell surface membrane is approximately 1:1.

Scientists have studied the proteins present within human cells. Proteins in a cell are found in several locations.

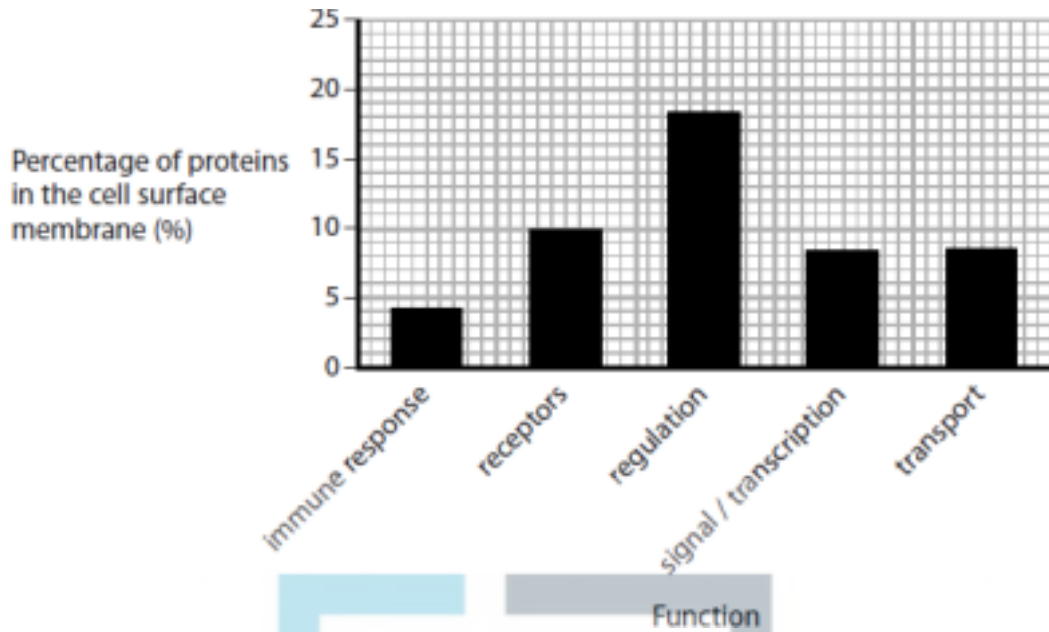
The table shows the percentage of protein found in some locations in a cell.

Location within a cell	Percentage of total protein present (%)
cell surface membrane	68.2
cytoplasm	1.4
endoplasmic reticulum / Golgi apparatus	1.4
nucleus	14.5
other	14.5

The proteins within the cell surface membrane were further analysed for their function. The graph shows some of the results of this analysis.



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Analyse the data to evaluate the following statement.

*'The variety of different proteins present in the cell surface membrane makes them more important than the phospholipid bilayer to the functioning of that cell.'*

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(Total for question = 9 marks)

Q4.

Tuberculosis (TB) is an infectious disease caused by mycobacteria.

Individuals infected with *M. tuberculosis* can be treated with antibiotics.

Four of the antibiotics used to treat TB are shown in the table.

Antibiotic	Mechanism of action
Isoniazid	Inhibits the synthesis of a fatty acid needed to make bacterial cell walls
Rifampicin	Inhibits bacterial RNA polymerase
Streptomycin	Binds to bacterial ribosomes to prevent the binding of tRNA
Pyrazinamide	Not yet known, but not the same mechanisms as the other three antibiotics

In one clinical trial lasting six months, the effect of treating TB with these antibiotics was investigated.

All patients were treated with all four antibiotics for two months. Then they were treated with different pairs of antibiotics or isoniazid alone for a further four months.

All patients were free of any signs of active TB at the end of the clinical trial.







Q5.

Tuberculosis (TB) is an infectious disease caused by mycobacteria.

The graphs show the number of cases of TB and the number of deaths from TB worldwide from 2000 to 2015.



In 1993 the World Health Organisation (WHO) declared TB a global public health emergency. Since then, there has been a programme to reduce the impact of this disease.

Analyse the data to deduce the effectiveness of this programme.

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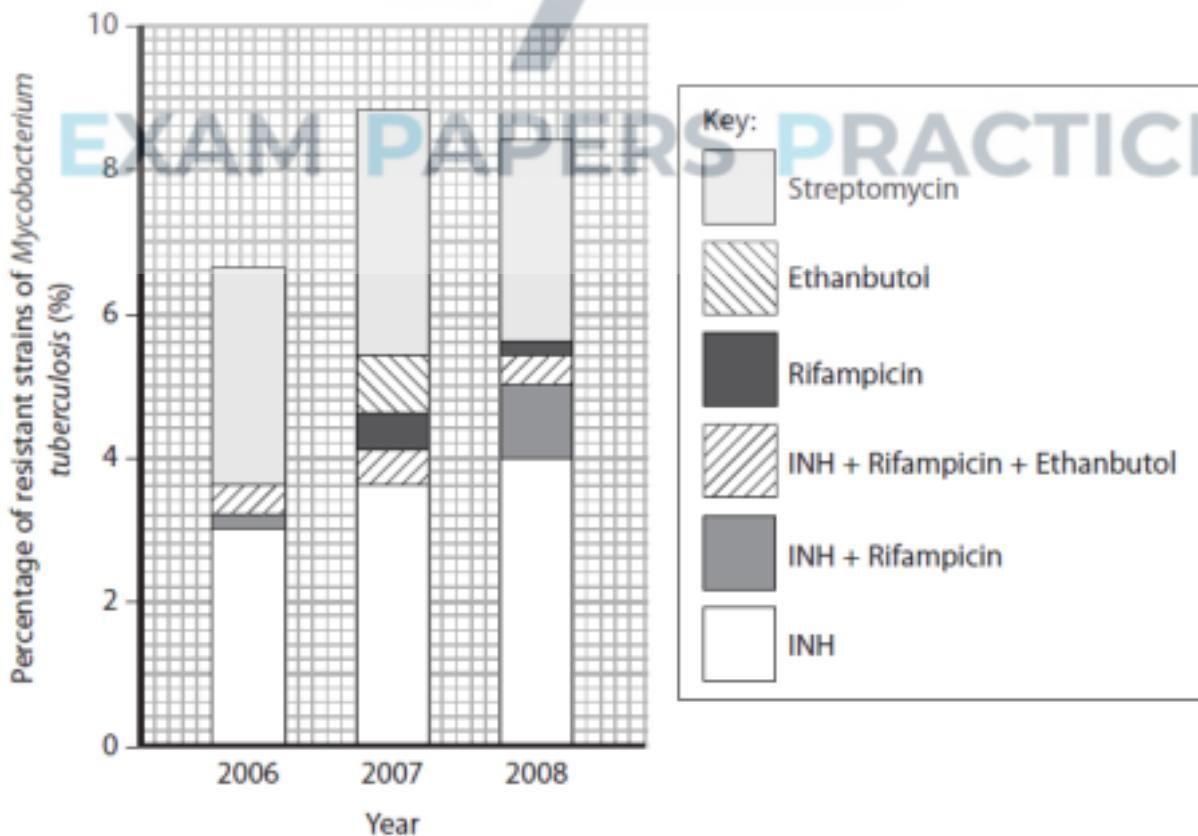
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Q6.

Treating *Mycobacterium tuberculosis* infections can be a problem, as the bacteria are resistant to many antibiotics.

There are many strains of *Mycobacterium tuberculosis*. Different strains are resistant to different antibiotics or combinations of antibiotics.

The chart below shows the percentage of resistant strains of *Mycobacterium tuberculosis* to six different antibiotics, or combinations of antibiotics, in 2006, 2007 and 2008.







(iii) Suggest how hospitals could prevent an increase in the percentage of strains of *Mycobacterium tuberculosis* resistant to antibiotics.

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Q7.

Antibiotics are used in the treatment of bacterial infections.

(a) (i) Cephalosporins are antibiotics that inhibit the production of bacterial cell walls. Suggest why cephalosporins are **bactericidal** antibiotics.

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(ii) Quinolones are antibiotics that inhibit the synthesis of DNA in bacterial cells.

Suggest why quinolones are **bacteriostatic** antibiotics.

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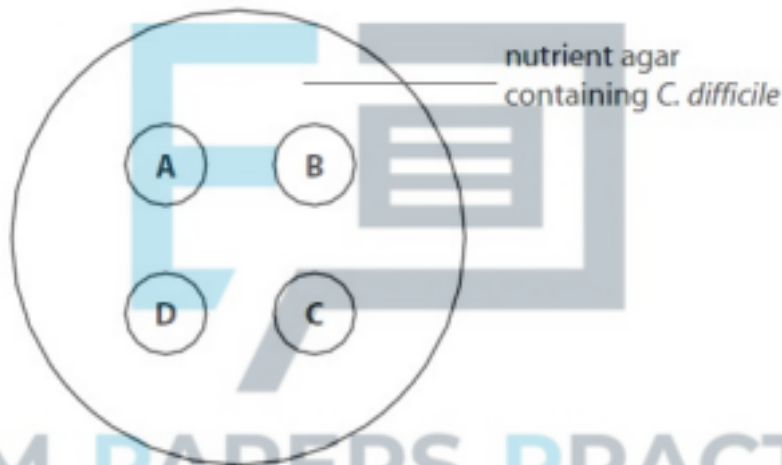
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(b) An investigation of the effectiveness of different antibiotics on *Clostridium difficile* was carried out by a hospital laboratory. Several nutrient agar plates, containing *C. difficile*, were prepared.

Four discs, A, B, C and D, were placed on the surface of each plate. Each disc contained the same concentration of a different antibiotic.

The diagram below shows the position of the four discs on each agar plate, before being incubated.



After incubation, the scientists in the laboratory concluded that *C. difficile* was completely resistant to antibiotics A and C. They also concluded that antibiotic D was more effective against *C. difficile* than antibiotic B.

(i) Explain how the appearance of the nutrient agar plates, after incubation, would have enabled the scientists to reach these conclusions.

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For each of the statements below, put a cross ( ✖ ) in the box next to the term that completes each statement.

(ii) In this investigation, several nutrient agar plates were used for

(1)

**A** accuracy

**B** precision

**C** reliability

**D** validity

(iii) In this investigation, each disc had the same concentration of antibiotic for

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(1)

**A** accuracy

**B** precision

**C** reliability

**D** validity

(c) Hospital-acquired infections caused by bacteria can be a major problem for patients.

In a study in a London hospital, it was found that pillows contaminated with bacteria could spread infections between patients.

Suggest how this hospital could improve the prevention and control of the spread of infections.

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(Total for question = 12 marks)

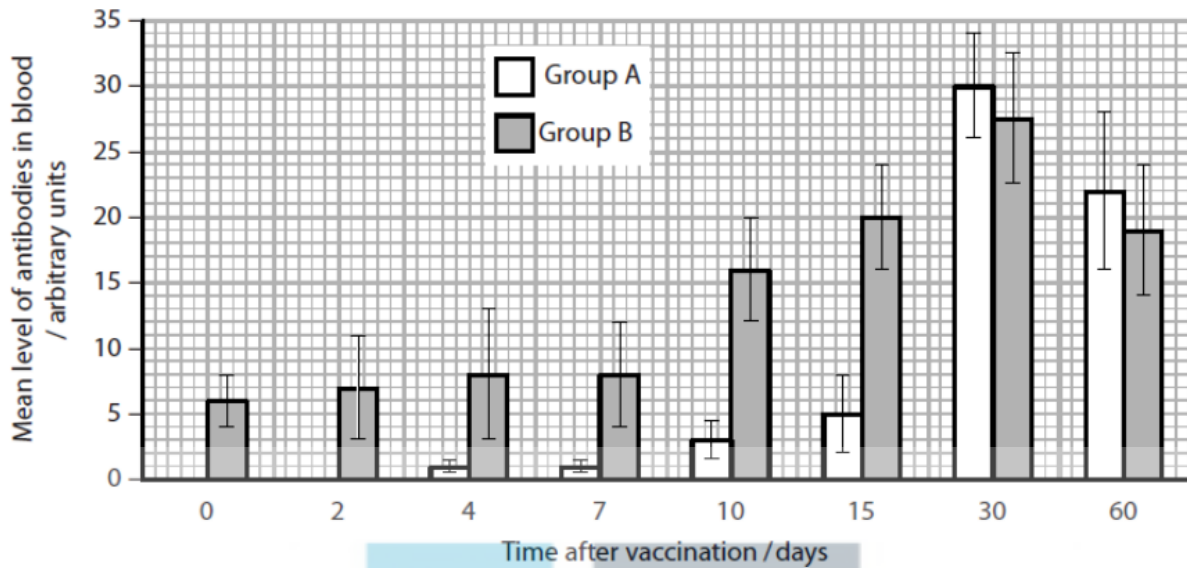
Q8.

Yellow fever is caused by a virus. Infection with this virus causes thousands of deaths every year in people who have not been vaccinated.

The graph below shows the mean levels of antibodies in the blood of two groups of people, group A and group B, after being vaccinated. The same vaccine was used each time.

Group A consisted of eight people. They were given a vaccination against yellow fever and their blood was analysed.

Group B consisted of nine people who had already been vaccinated against yellow fever. They were given a second vaccination and their blood was analysed.



(a) Place a cross ✕ in the box next to the term that describes the type of immunity that results from this vaccination against yellow fever.

(1)

- A artificial active
- B artificial passive
- C natural active
- D natural passive

(b) (i) Compare the changes in the mean levels of antibodies in these two groups of people in the first fifteen days after vaccination.

(2)

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(ii) Explain why the mean levels of antibody in group B are different from group A in the first fifteen days.

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(c) Using the information in the graph, explain the advantage of vaccinating people twice against yellow fever.

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(d) Comment on the reliability of the data shown in the graph.

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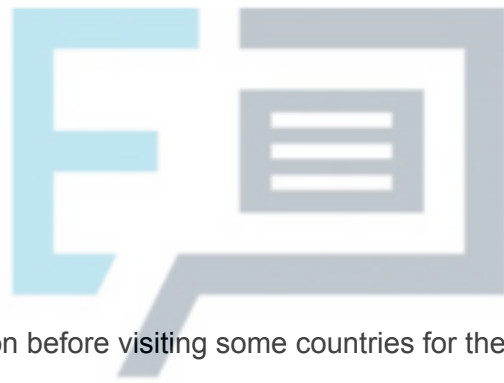
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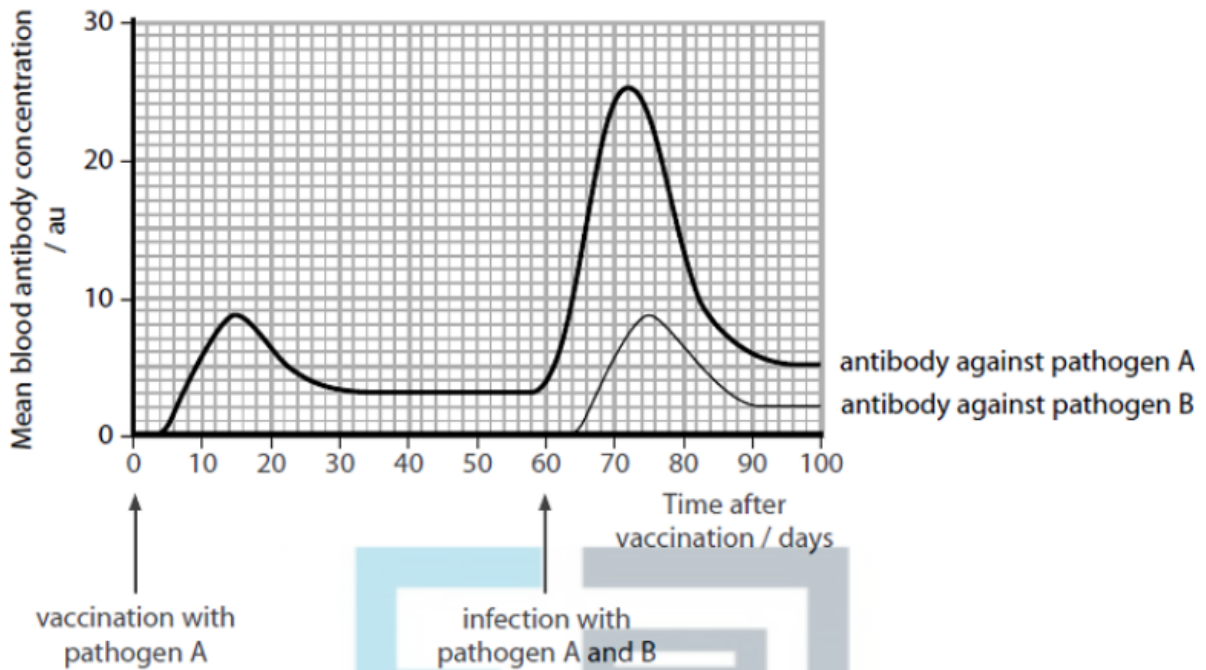
**(Total for question = 11 marks)**

Q9.

Many people have a vaccination before visiting some countries for the first time.

A person was vaccinated with a weakened form of pathogen six weeks before travelling to a particular country. The person was infected by two different pathogens, A and B, when in this country.

The graph shows what happened to different blood antibody concentrations of the person after vaccination and after infection by the two different pathogens.



(a) The changes to blood antibody concentration occur because vaccination produces

(1)

- A active artificial immunity
- B active natural immunity
- C passive artificial immunity
- D passive active immunity

\*(b) Explain why this person did not become ill from pathogen A but did become ill from pathogen B when visiting this country.

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**(Total for question = 7 marks)**

Q10.

The scientific article you have studied is from *Scientific American*.

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

'The lymphatic vessels also ferry antigens—substances capable of inducing an immune response—from the tissues into tissue-draining lymph nodes, where they are presented to immune cells' (paragraph 15).

Describe how these antigens are presented to immune cells.

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(Total for question = 3 marks)

Q11.  
Humans are surrounded by microorganisms in the air, water and food.  
Some microorganisms are pathogenic.  
The human body has several barriers to prevent infection by pathogens.  
Complete the table by putting a tick (✓) in the box if the type of barrier is correct. If the type of barrier is not correct, place a cross (✗) in the box.

(2)

Type of barrier	Keratin in the skin	Lysozyme in mucus	Hydrochloric acid in the stomach
Physical			
Chemical			

(Total for question = 2 marks)

Q12.  
Human diseases can be caused by many different types of organism, such as bacteria and viruses.  
(a) Give **two** differences between the genetic material of bacteria and viruses.

(2)

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(b) Tuberculosis (TB) is caused when droplets, containing the bacterium *Mycobacterium tuberculosis*, are inhaled into the lungs.

In the lungs, large numbers of the bacterium are formed rapidly. These can be ingested by macrophages. Eventually, tubercles (tissue masses), containing dormant bacteria inside macrophages, may form.

(i) Describe how macrophages ingest the bacteria.

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(ii) Suggest why treatment with antibiotics may not be effective against the dormant bacteria in the tubercles.

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(iii) TB can be prevented by vaccination. Explain how a person can develop artificial active immunity following vaccination.



Q13.

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 vaccine is still undergoing clinical trials, but was given approval for use in recent Ebola outbreaks.

(i) Describe how clinical trials of a vaccine would be conducted.

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(ii) The Ebola vaccine was given to health workers and immediate family of those with the disease. Justify the use of this vaccine, even though the clinical trials had not been completed.

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Q16.

Tuberculosis (TB) is an infectious disease caused by mycobacteria.

Most cases of TB are caused by infection with *Mycobacterium tuberculosis* (*M. tuberculosis*). The ribosomes of bacteria are

(1)

- A** larger than the ribosomes in eukaryotes
- B** smaller than ribosomes in eukaryotes
- C** the same size as ribosomes in animal cells
- D** the same size as ribosomes in plant cells

(Total for question = 1 mark)

Q17.

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.

Give reasons why 'humble microbes', such as bacteria, are considered less complex than eukaryotes (paragraph 4).

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**(Total for question = 2 marks)**

Q18.

The coffee husks, shown in the photograph, are a waste product of coffee plantations.

Composting has been suggested as an environmentally friendly way of decomposing these coffee husks.



The effect of adding cow dung to coffee husks, before they are composted, has been investigated.

The table shows the percentages of organic carbon and nitrogen in two compost heaps at the start of composting and after 90 days.

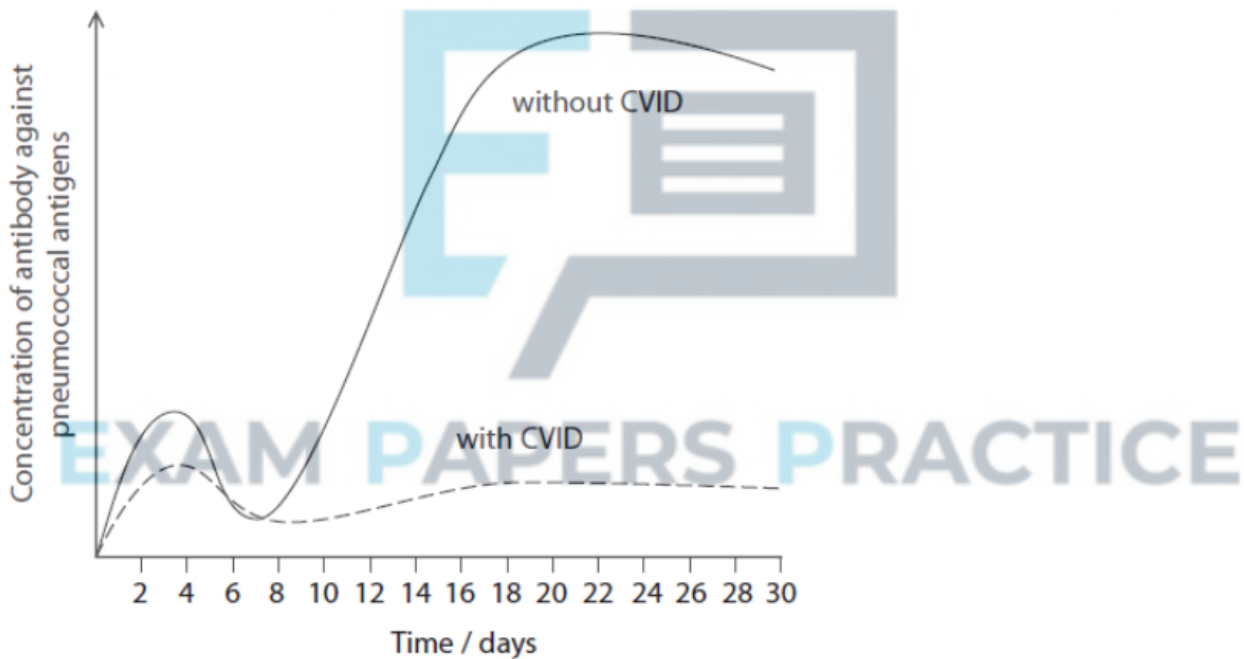




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Type of infection	Characteristics of infection	
	Frequency of infection	Severity of infection
Bacterial	Much more frequent than expected	Effects of infection are more serious than in the general population
Viral	Slightly higher frequency than expected	Effects of infection are comparable to infection in the general population

The average antibody response of two groups, following immunisation with a bacterial pneumococcal vaccine, is shown in the graph.



The distribution of lymphocytes in the blood for the two groups is shown in the table.

Group	Percentage of white blood cells (%)		T helper cell : T killer cell ratio
	B lymphocytes	T lymphocytes	
With CVID	8	78	1.7 : 1
Without CVID	14	80	1.5 : 1

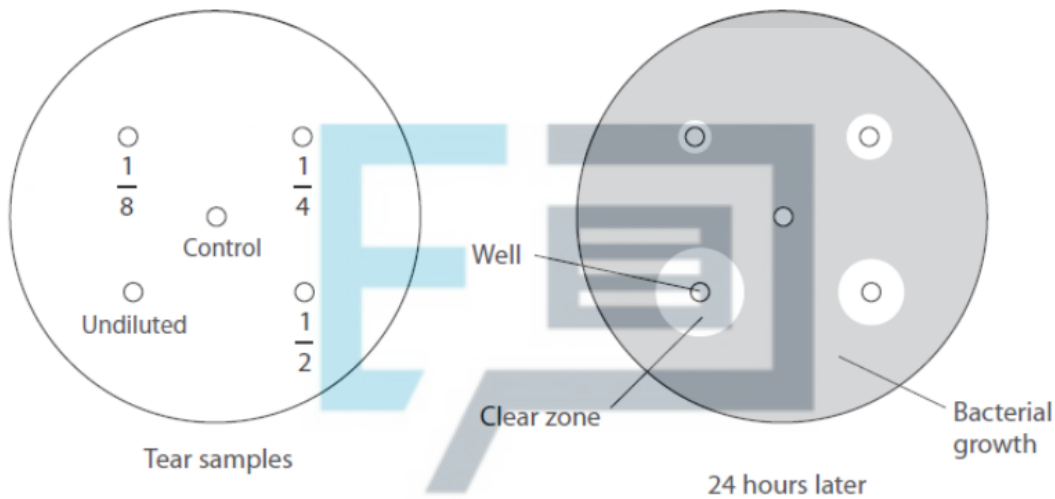


Q20.

Lysozyme is one component of the non-specific response to infection.

A student investigated the activity of lysozyme in tears.

A suspension of bacteria was mixed with molten agar and poured into a Petri dish. After the agar had solidified, wells were cut and different dilutions of tear sample were placed in the wells.



After 24 hours the Petri dish was inspected.

(i) State the relationship between lysozyme dilution and the size of the clear zone.

(1)

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(ii) Calculate the area of the clear zone for the undiluted tear sample.

(Area of a circle =  $\pi r^2$ )

(2)



Q21.

Bacteria are involved in the decomposition of organic matter.

(a) Place a cross **X** in the box next to the type of chemical reaction that takes place in decomposition.

(1)

- A** condensation
- B** esterification
- C** hydrolysis
- D** polymerisation

(b) An investigation was carried out to study the rate of decomposition of leaves from ash trees and beech trees.

Five piles of each type of leaf were placed outside on the ground and each pile was covered with a heavy bucket. Each pile of leaves had a mass of 10 grams.

Every few weeks, one pile of each type of leaf was removed and weighed. The table below shows the results of this investigation.

Time after falling from the tree / weeks	Mass of pile of ash leaves / g	Mass of pile of beech leaves / g
0	10.0	10.0
4	4.9	9.1
8	2.0	8.4
16	1.1	6.0
32	1.2	2.8
64	0.8	2.4



(i) Place a cross **X** in the box next to the reason for using five piles of ash leaves in this investigation.

(1)

- A** to calculate a mean
- B** to give a range of values for the independent variable
- C** to make the investigation valid
- D** to produce reliable data

(ii) A student made the following conclusions from these results.

Decomposition of beech leaves is faster than ash leaves.

Bacteria are needed for the decomposition of beech and ash leaves.

There is a correlation between decomposition and time.

Place a cross **X** in the box next to the number of correct conclusions made by this student.

(1)

- A** none
- B** one
- C** two
- D** three

(iii) Explain why there is a decrease in mass of the leaves.

(4)



Q22.

Blowfly larvae can be used by a forensic scientist to help determine the time of death of a body.

The diagram shows a Petri dish used by a student to investigate whether young and old blowfly larvae show a preference for light or dark conditions.



In the first trial, the left side was dark and the right side was light.

Five blowfly larvae were added to each side of the chamber.

After five minutes, the number of larvae on each side of the Petri dish was recorded.

In the second trial, the same experiment was repeated but this time the right side was dark and the left side was light.

The table shows the results of the trials.

Trial	Number of young blowfly larvae		Number of old blowfly larvae	
	Left side dark	Right side light	Left side dark	Right side light
1	9	1	2	8
2	2	8	9	1

(a) Give a null hypothesis for this investigation.

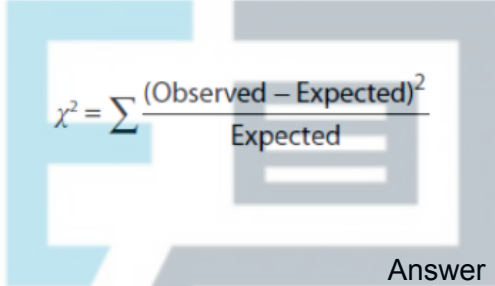
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(b) The Chi squared test can be used to determine whether the results of this investigation indicate a significant difference in the distribution of young larvae between the light and the dark side.

(i) Use the formula to calculate the Chi-squared value for young larvae.

(3)



$$\chi^2 = \sum \frac{(\text{Observed} - \text{Expected})^2}{\text{Expected}}$$

Answer .....

(ii) The table below gives some critical values for Chi-squared.

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p value			
0.15	0.1	0.05	0.025
2.07	2.71	3.84	5.02

Use your calculated value to determine whether the difference between the observed and expected results is significant.

(1)

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(c) Forensic scientists measure the length of larvae found in the tissues of a dead person to help them



determine time of death. Older larvae are longer than younger larvae.

The growth of insect larvae can be affected by a number of factors including toxins.

Explain a procedure that you could use to find out if the presence of a toxin in a sample of dead tissue could affect the accuracy of estimating time of death.

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Q23.

The decomposition of leaves depends on the content of the leaves, the presence of certain microorganisms and a number of abiotic factors.

Leaves consist of a number of organic molecules, including lignin and cellulose.

(a) Place a cross **X** in the box next to the groups of microorganisms that all cause decomposition.

(1)

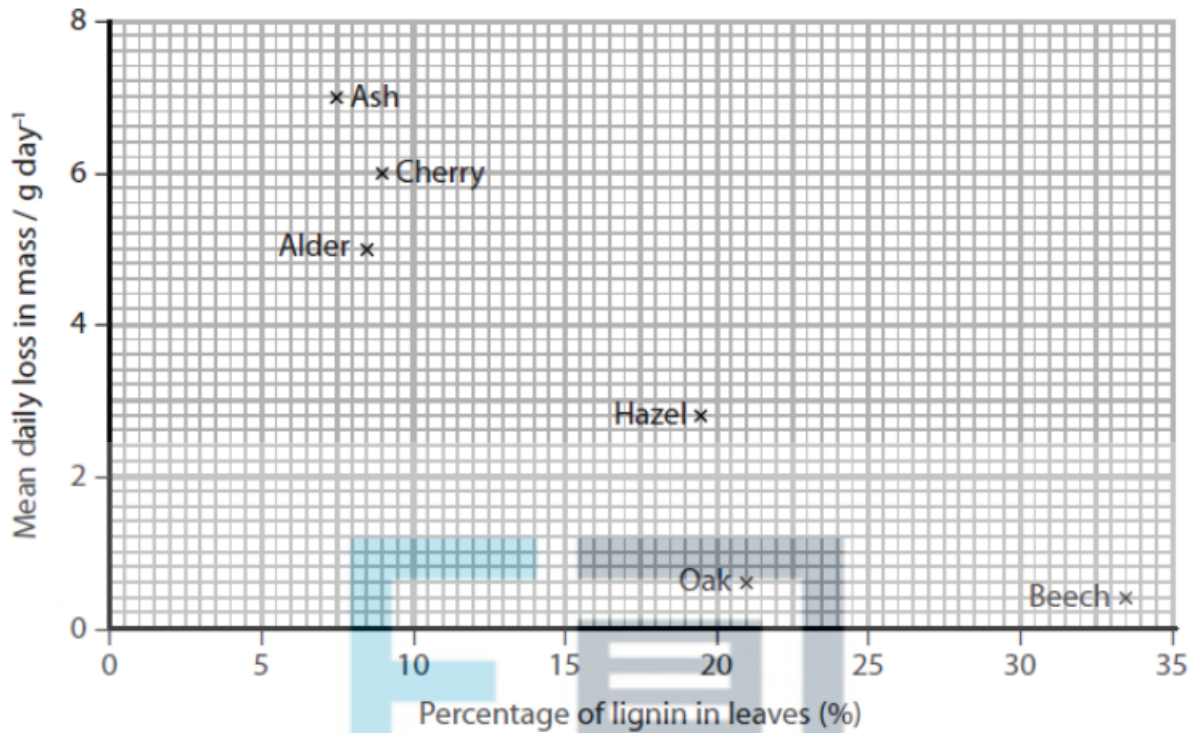
- A** bacteria and fungi
- B** bacteria and viruses
- C** fungi and viruses
- D** bacteria, fungi and viruses

(b) An investigation was carried out into the effect of lignin content on the decomposition of leaves from different types of tree.

The lignin content of leaves from an ash tree was determined. A pile of ash leaves was collected and weighed. The leaves were left for 40 days and reweighed. The mean daily loss in mass was calculated.

This was repeated for leaves from five other species of tree. All six piles of leaves had the same starting mass.

The results of this investigation are shown in the graph below.



(i) A student made the following conclusions from the data.

Beech leaves decompose faster than cherry leaves.

Microorganisms are needed for the decomposition of these leaves.

There is a causal relationship between lignin content and decomposition.

Place a cross  in the box next to the number of correct conclusions made by the student.

(1)

A none

B one

C two

D three

(ii) Place a cross  in the box next to the term that completes the following statement. Each pile







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**(Total for question = 11 marks)**

Q24.

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.

Deduce how PERVs present in pig tissues could infect human cells (paragraph 25).

(2)

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**(Total for question = 2 marks)**

Q25.

Body farms use the bodies of pigs to study the changes in insect species on a body after death.

(i) Describe how this study could be carried out.

(3)

