

## Immunity, Infection and Forensics -2

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 -2

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.

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.

*M. tuberculosis* bacteria can remain dormant in the body after infection.

Explain why these dormant bacteria are not destroyed by the immune system.

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(Total for question = 3 marks)

Q2.

A deer was found dead on National Trust land. Some people thought that the wounds that led to the deer's death could have been caused by a big cat such as a black panther.





Samples of DNA from the wounds of this deer were collected.

Investigators used the polymerase chain reaction (PCR) to increase the quantity of DNA in the samples.

(i) Describe how one PCR cycle would increase the quantity of DNA present.

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(ii) One PCR cycle takes two minutes.

Show that the quantity of DNA would have been amplified over one million times after 40 minutes.

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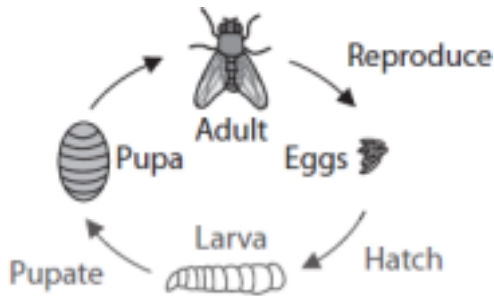
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**(Total for question = 5 marks)**

Q3.

Blowflies are found in many parts of the world, including Africa.

The diagram shows the life cycle of one species of blowfly (species A) found in Africa.



An investigation was carried out to find the temperature at which 50% of the larvae of this species survive. This investigation was repeated for a further six species of African blowfly larvae, B to G. All other variables were kept constant.

In another investigation, the temperature of sand that the larvae selected when ready to pupate was recorded.

A student used the data from these investigations to find out if there is a statistically significant correlation between the two sets of temperatures.

To do so, a Spearman's rank correlation coefficient can be calculated.

(i) Complete the table to rank all the data and to calculate  $d$  and  $d^2$  for species E to G.

(3)

(ii) Calculate the Spearman's rank correlation coefficient ( $r_s$ ) using the equation:

(3)

$$r_s = 1 - \frac{6 \sum d^2}{n(n^2 - 1)}$$

where  $\sum d^2 = 34$  and  $n$  is the number of blowfly species.

Answer .....



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Blowfly species	Mean temperature at which 50% of larvae survive / °C	Rank for mean temperature for 50% larvae survival	Mean temperature of sand selected / °C	Rank for mean temperature of sand selected	Difference in rank (d)	Difference in rank squared (d <sup>2</sup> )
A	49.0	5	26.1	7	-2	4
B	47.5	2	23.2	3	-1	1
C	48.5	3	24.7	6	-3	9
D	42.9	1	16.6	1	0	0
E	48.8		23.6			
F	50.1		24.2			
G	49.2		23.1			

(iii) The table shows critical values for  $r_s$ .

n	Probability		
	0.10	0.05	0.01
5	0.900	1.000	1.000
6	0.829	0.886	1.000
7	0.714	0.786	0.929
8	0.643	0.738	0.881
9	0.600	0.683	0.833

Deduce whether the data showed a statistically significant correlation.

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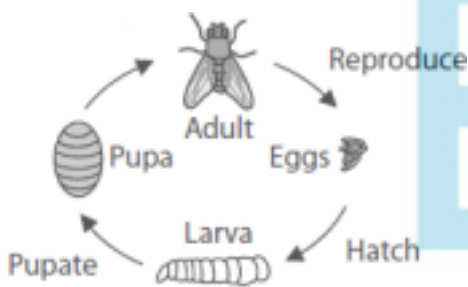
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(Total for question = 8 marks)

Q4.

Blowflies are found in many parts of the world, including Africa.

The diagram shows the life cycle of one species of blowfly (species A) found in Africa.



An investigation was carried out to find the temperature at which 50% of the larvae of this species survive. This investigation was repeated for a further six species of African blowfly larvae, B to G. All other variables were kept constant.

In another investigation, the temperature of sand that the larvae selected when ready to pupate was recorded.

A number of observations were made about a dead rhinoceros:

- adults of all seven species of blowfly (A to G) were observed near the rhinoceros
- large numbers of living larvae of species F were present inside the rhinoceros
- mean temperature in this group of larvae was  $49 \pm 1.1$  °C
- mean temperature of the air surrounding the rhinoceros was  $33 \pm 3.0$  °C.

(i) Determine how the mean temperature of 49 °C was found.

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(ii) It was observed that all the living larvae in the rhinoceros belonged to species F.  
The metabolic activity of the larvae of species F increases the temperature within the dead rhinoceros.

Explain the advantages for this species of blowfly of increasing the temperature within the dead rhinoceros.

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**(Total for question = 5 marks)**



Q5.

A newborn baby can respond to infections.

Interferon is involved in the response to viral infections.

(i) The influenza virus can be lethal to mice.

The effects of interferon on influenza infection in mice was investigated.

Mice were infected with influenza virus and then given interferon.

The results of the investigation are shown in the table.

Interferon dose / units per mouse	Median survival time / days
No dose	3.3
$8 \times 10^3$	4.4
$8 \times 10^4$	8.5
$8 \times 10^5$	>42

Explain these results.

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(ii) Interferon can be used to treat people with viral hepatitis.

Interferon can be made by animal cells or by genetically modified bacteria.

The table shows information about interferon made by these animal cells and genetically modified bacteria.

Source of interferon	Type of molecule	Folding	Antiviral activity
Animal cells	Glycoprotein	Correctly folded	High
Genetically modified bacteria	Protein	Incorrectly folded and needs to be refolded before it can be used	Low

Explain why the interferon made by genetically modified bacteria is different from the interferon made by animal cells.

(2)

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(iii) Glycoproteins made in animal cells are released into the extracellular fluid by

(1)

- A endocytosis
- B exocytosis
- C facilitated diffusion
- D phagocytosis

(Total for question = 6 marks)

Q6.

The chart shows a Henssge nomogram.

The steps below need to be followed to estimate the time of death using the Henssge nomogram:

**Step 1**

Draw a straight line between the core temperature of the body and the ambient temperature ( = line 1)

**Step 2**

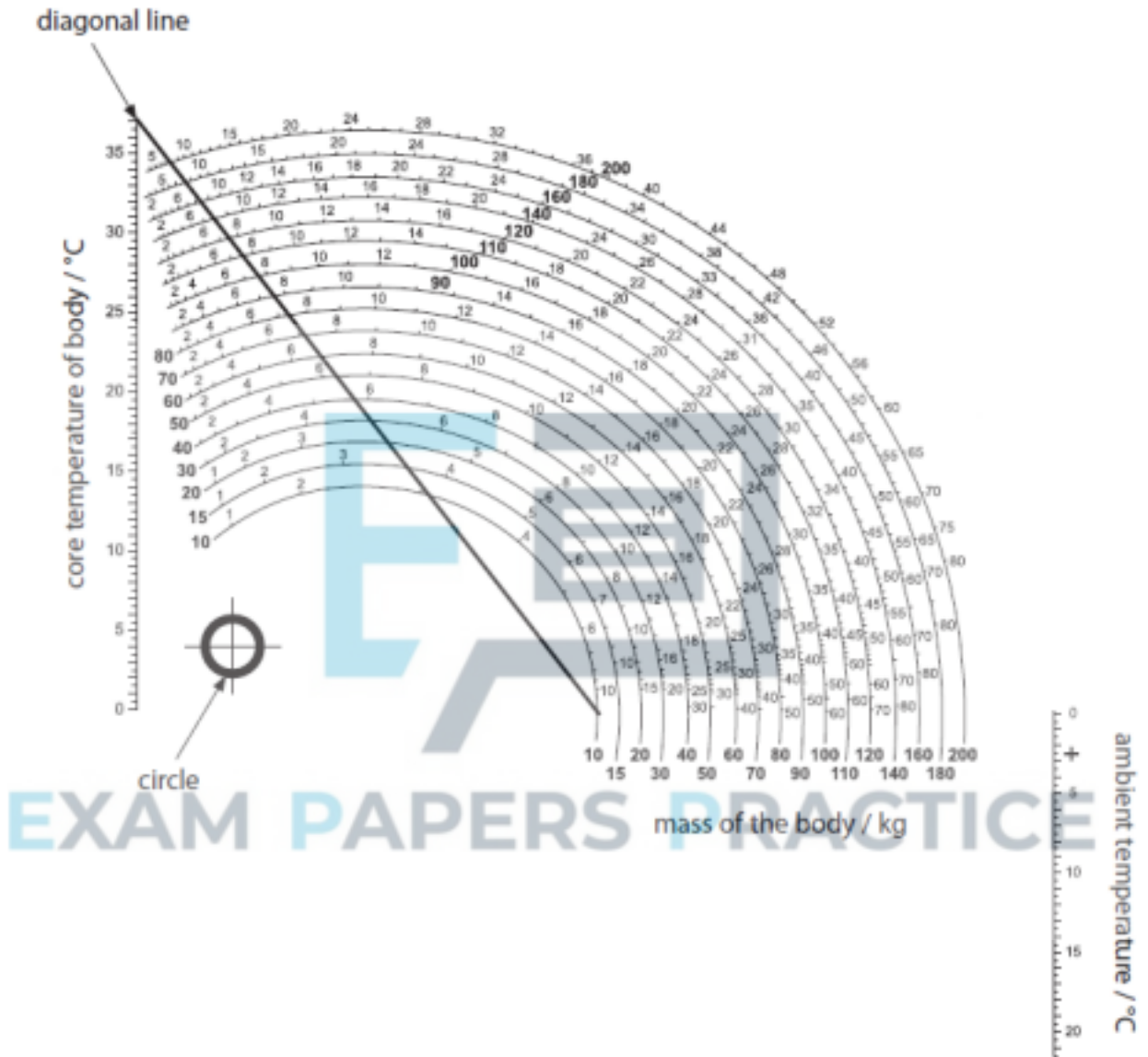
Draw a straight line that extends from the centre of the circle through the diagonal line, at the point where it crosses line 1 ( = line 2)

**Step 3**

Read the time of death from the nomogram at the point line 2 crosses the appropriate semicircle for the mass of the body.



Henssge nomogram



(i) A body was found. The mass of the body was 100 kg and the core temperature of the body was 25°C. The ambient temperature was 15°C.

Use the Henssge nomogram to estimate the time of death.

(3)

time of death = ..... hours ago

\* (ii) The Henssge nomogram is used to estimate the time of death of a naked body, lying stretched out and in still air.

Suggest how a change in each of these three factors could affect the estimated time of death. Give reasons for your answer.

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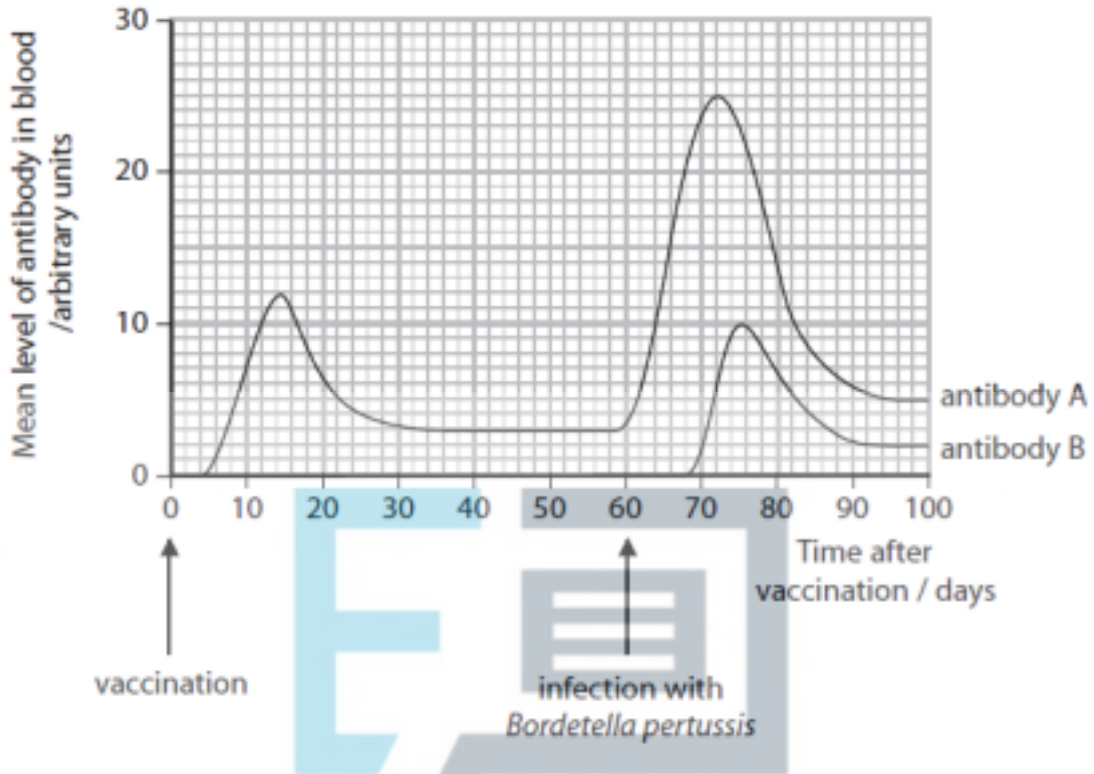
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Q7.

Whooping cough is a disease that is particularly serious in young children. Whooping cough is caused by the bacterium *Bordetella pertussis*. Children may be vaccinated against whooping cough.

In an investigation, a group of rats was vaccinated. Sixty days later these rats were infected with *Bordetella pertussis*. In this investigation, the levels of two antibodies in the blood of the rats were measured.

The graph below shows the mean levels of antibody A and antibody B.



(a) (i) For antibody A, compare the increase in mean level after the vaccination with the increase in mean level after infection with *Bordetella pertussis*.

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(ii) Explain the changes in mean level of antibody A after infection with *Bordetella pertussis*.

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(b) (i) Suggest why antibody B was not present in the blood of these rats until after infection with *Bordetella pertussis*.

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(ii) Place a cross  in the box next to the term that describes the type of immunity that results in the production of antibody B.

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A artificial active

B artificial passive

C natural active

D natural passive

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

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

Q8.

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.

A vaccine has been developed by genetically modifying a virus that infects cattle. In the genetically modified virus, one of the genes was replaced with a gene for a protein found in the Ebola virus.

In a trial of 52 volunteers, 48 developed antibodies against the Ebola virus within 14 days of injection.

(i) The type of immunity given by this vaccine is

(1)

A artificial active immunity

B artificial passive immunity

C natural active immunity

D natural passive immunity

(ii) Explain the role of T cells in the immunity to the Ebola virus that develops following the use of this vaccine.

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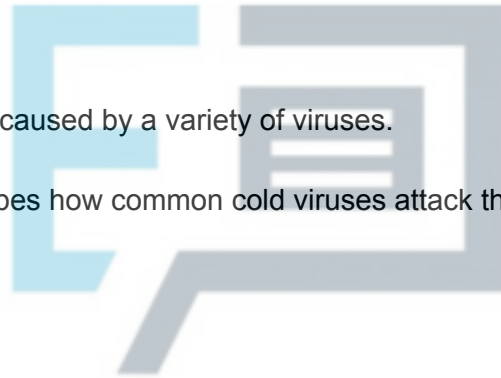
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**(Total for question = 4 marks)**

Q9.

The common cold is a disease caused by a variety of viruses.

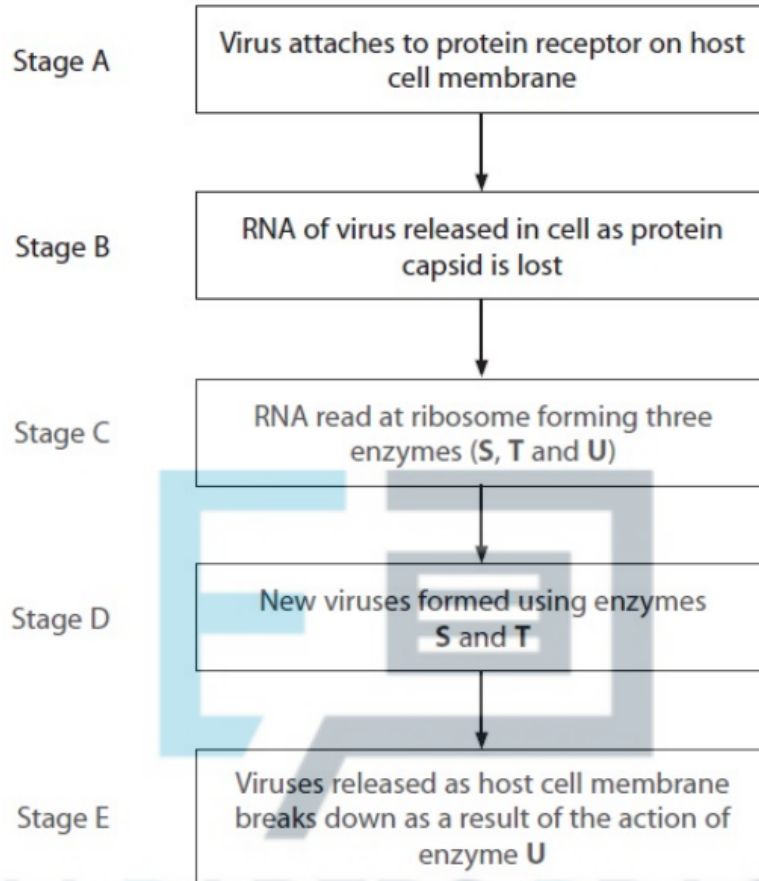
The flow diagram below describes how common cold viruses attack the cells on the inside of the nose.







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(a) Common cold viruses infect only the cells inside the nose.

(i) Suggest why common cold viruses cannot infect cells if they land on unbroken skin.

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(ii) Suggest why common cold viruses cannot infect cells if they enter the blood through a cut in the skin.

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(b) Compare the action of the RNA in the common cold virus with that found in HIV.

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(c) At Stage C, three enzymes are formed.

(i) Suggest why two of these enzymes, **S** and **T**, are needed at Stage D.

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(ii) Suggest how enzyme **U** might catalyse the breakdown of the host cell membrane at Stage E.

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(Total for Question = 11 marks)

Q10.

Eating food that is contaminated with microorganisms can cause food poisoning.

(a) Not all contaminated food causes food poisoning. Suggest explanations for this.

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(b) The norovirus causes a type of food poisoning, commonly called stomach flu. Norovirus is a non-enveloped RNA virus.

The virus stays in the small intestine and causes symptoms approximately 24 hours after eating the contaminated food.

Stomach flu can be caused by eating food containing as few as 20 viral particles.

(i) Suggest how new viral particles are formed inside the host cells.

(4)



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(ii) Suggest why so few viral particles are enough to cause symptoms after 24 hours.

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(iii) The risk of transmitting food poisoning microorganisms can often be reduced by using alcohol-based handwashes.



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Suggest why alcohol-based handwashes do **not** reduce transmission of the norovirus.

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(Total for Question = 11 marks)

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