BSc Degree Examinations 2018-9

Department:
BIOLOGY

Title of Exam:
Advanced Topics in Immunology

Time Allowed:
2 Hours

Marking Scheme:
Total marks available for this paper: 100
Section A: Short Answer / Problem / Experimental Design questions (50 marks)
Section B: Essay question (marked out of 100, weighted 50 marks)
The marks available for each question are indicated on the paper.

Instructions:
Section A: Answer all questions in the spaces provided on the examination paper
Section B: Answer either question A or question B. Write your answer in the green answer booklet provided and attach it to the back of the question paper using the cable tie provided.

Materials Supplied: Green Answer Booklet

For marker use only:  
Office use only:

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>A</th>
<th>B</th>
<th>Total as %</th>
</tr>
</thead>
</table>

DO NOT WRITE ON THIS BOOKLET BEFORE THE EXAM BEGINS

DO NOT TURN OVER THIS PAGE UNTIL INSTRUCTED TO DO SO BY AN INVIGILATOR
1. Describe the similarities and differences between central tolerance of B cells and T cells. (5 marks)
2.

a) Explain the concept of macrophage heterogeneity, and give two examples of this. (3 marks)

b) Identify the three types of immune cells (A, B and C) whose characteristics are listed in the table below. (3 marks)

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Originate from yolk sac</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Able to stimulate naïve T cells</td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Migrate to draining LN following antigen uptake</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Self-maintaining</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>

Cell A:

Cell B:

Cell C:
3. Assessment of the bronchus-associated lymphoid tissue (BALT) from three patients gave the following results:

<table>
<thead>
<tr>
<th></th>
<th>Patient 1</th>
<th>Patient 2</th>
<th>Patient 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Th1 cell numbers</td>
<td>low</td>
<td>high</td>
<td>low</td>
</tr>
<tr>
<td>Th2 cell numbers</td>
<td>high</td>
<td>low</td>
<td>high</td>
</tr>
<tr>
<td>Treg cell numbers</td>
<td>normal to high</td>
<td>normal</td>
<td>low</td>
</tr>
<tr>
<td>IgE concentration</td>
<td>high</td>
<td>low</td>
<td>high</td>
</tr>
</tbody>
</table>

a) Which patient has the highest risk of developing asthma? Explain your reasoning. (4 marks)

b) You suspect that one patient is suffering from an allergy, and speculate that this patient will have enhanced serum levels of a member of the C-type lectin superfamily. Name this molecule and explain its role in the allergic response. (4 marks)
4. You have been given two samples of B cells isolated from either the follicular or the marginal zone of the spleen of vaccinated mice. Following \textit{in vitro} re-stimulation of these B cells with the vaccine antigen, you collect supernatants containing immunoglobulins. Design an ELISA assay to determine which B cells came from the follicular region and which came from the marginal zone. Explain the rationale behind your design. (6 marks)
5. You have been given naive CD4+ T cells, and you wish to induce their differentiation into Th1, Th2, and Th17 cells.

a) Describe an experimental protocol that would allow you to generate Th1, Th2, and Th17 cells. (5 marks)

b) How would you determine if your protocol has worked? (3 marks)
6. Describe four characteristic features of the mucosal immune system. (4 marks)

THE SPACE ABOVE THIS LINE SHOULD BE SUFFICIENT FOR YOUR ANSWER
7. The dot plots below depict flow cytometry data of cells from a primary lymphoid tissue and a secondary lymphoid tissue of a normal mouse.

Dot plot A                    Dot plot B

a) What tissues are shown? Explain how you came to your conclusions.  

Dot plot A:

Dot plot B:

b) Describe the main function of the primary lymphoid tissue depicted.  

(2 mark)  

(3 marks)
c) The picture below shows the same lymphoid tissue from three different strains of mice (A-C). Strain A is a wild-type mouse. What strains are shown in B and C? Explain your reasoning. (4 marks)

Mouse strain A                Mouse strain B                Mouse strain C

The space above this line should be sufficient for your answer.
8. Cytokine X is thought to be linked to a new autoimmune disease. The transcription factor (Tf) necessary for its induction has been identified. In addition, you know that the cytokine can bind to two different receptors, XR1 and XR2, on the target host cell. You decide to take a gene-knockout approach to confirm the contribution of cytokine X in the autoimmune disease. Comparing each of the knockout models with wild-type control mice, you obtain the following data:

<table>
<thead>
<tr>
<th>Mouse</th>
<th>Pups born</th>
<th>Disease phenotype</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tf knockout</td>
<td>No</td>
<td>-</td>
</tr>
<tr>
<td>Cytokine X knockout</td>
<td>Yes</td>
<td>Accelerated disease</td>
</tr>
<tr>
<td>XR1 knockout</td>
<td>Yes</td>
<td>Accelerated disease</td>
</tr>
<tr>
<td>XR2 knockout</td>
<td>Yes</td>
<td>Protected from disease</td>
</tr>
</tbody>
</table>

a) Give an explanation for the fate of Tf knockout mice. (1 mark)

b) What can you conclude about cytokine X signalling in the autoimmune condition? Explain your reasoning. (3 marks)
SECTION B: Essay question
Answer one question in the green answer booklet provided.

Remember to write your candidate number on the front of the answer booklet and indicate whether you have answered question A or B at the top of the page.

Mark total for this section: 50

EITHER

A. Discuss how different aspects of the host immune response may lead to either protective immunity or tissue damage during infection with intestinal pathogens.

OR

B. Using specific examples, debate whether antigen-specific immunotherapy has the potential to be more effective than non-antigen-specific immunotherapy approaches.