Module Code: BIO00018C

Examination Candidate Number: __________
Desk Number: __________

BSc and MSc Degree Examinations 2018-9

Department:
BIOLOGY

Title of Exam:
Introduction to Biomedical Sciences I

Time Allowed:
1 hour 30 minutes

Marking Scheme:
Total marks available for this paper: 50
The marks available for each question are indicated on the paper

Instructions:
Answer all questions in the spaces provided on the examination paper

Materials Supplied:
CALCULATOR

For marker use only:
Office use only:

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DO NOT WRITE ON THIS BOOKLET BEFORE THE EXAM BEGINS
DO NOT TURN OVER THIS PAGE UNTIL INSTRUCTED TO DO SO BY AN INVIGILATOR

Page 1 of 8
1. Define the term ‘emerging infectious disease’.  
   (1 mark)
   An emerging infectious disease is an infectious disease whose incidence has increased in the past 20 years and could increase in the near future (1 mark).

   LO1: Using examples, discuss the concept of disease.

   This question was answered well by students.

2. Explain the difference between zoonoses and vector-borne diseases. Provide an example for each type of disease.  
   (3 marks)
   Zoonoses are infectious diseases transmitted to humans from other vertebrates (0.5 mark) while vector-borne infections are transmitted to humans from invertebrates (0.5 mark).
   Examples of zoonoses that were covered in the lectures were influenza and rabies (1 mark).
   Examples of vector-borne infections that were covered in the lectures were malaria and West Nile fever (1 mark). Marks will be awarded for alternative correct examples.

   LO1: Using examples, discuss the concept of disease.

   This question was answered well by students.

3. List 3 mechanisms for how antibiotics can target bacterial cells.  
   (3 marks)
   3 examples maximum from: inhibition of cell wall synthesis (1 mark), inhibition of folate synthesis (1 mark), inhibition of DNA replication (1 mark), inhibition of transcription (1 mark), inhibition of translation (1 mark) Students may provide alternative correct answers.

   LO1: Using examples, discuss the concept of disease.

   This question was answered well by students.

4. Study the data in Table 1:

   **Table 1**: Years of Life Lost (YLL) and Years Lost to Disability (YLD) for people living with, or the consequences of, Myocardial Infarction and Diabetes in the UK in 2017.

<table>
<thead>
<tr>
<th>Cause</th>
<th>YLL (000’s)</th>
<th>YLD (000’s)</th>
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<tbody>
<tr>
<td>Myocardial Infarction</td>
<td>1,342</td>
<td>122</td>
</tr>
<tr>
<td>Diabetes</td>
<td>80</td>
<td>652</td>
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</table>
(a) Describe the differences in YLL and YLD between the two diseases and suggest a reason for these differences. (2 marks)

For Myocardial Infarction, YLL is greater than YLD while for diabetes, YLD is greater than YLL (1 mark). Myocardial Infarction is an acute, life-threatening condition; whereas diabetes is a chronic disease that can cause many complications (1 mark).

Some answers did not mention the terms ‘chronic’ and ‘acute’

(b) Calculate the Disability-adjusted life years (DALYs) for Myocardial Infarction and Diabetes. (1 mark)

\[
DALY = YLL + YLD. \text{ Therefore,}\n\]
\[
DALY \text{ for MI} = 1,342,000 + 122,000 = 1,464,000 (1.46 million; 0.5 mark)\n\]
\[
DALY \text{ for Diabetes} = 80,000 + 652,000 = 732,000 (0.732 million; 0.5 mark)\n\]

LO1: Using examples, discuss the concept of disease.
LO5: Acquire, analyse, interpret and write up/present experimental data.

Some answers did not take into account that the values in the Table are in thousands

5. Describe the main structural and functional features of a gomphosis joint. Where in the body would you find this joint? (3 marks)

Gomphosis is an immovable (synarthroses) fibrous joint which connects a tooth to its socket (1 mark).

LO2: Describe basic aspects of human anatomy and the function and regulation of the major physiological systems in the healthy human body.

Quite mixed. Some answers achieved full marks (a few missed a mark for not stating that it is a fibrous joint) but some answers scored zero.

6. a) A study was conducted to determine the impact of creatine on skeletal muscle performance. Using the data in the figure below, describe the effect that creatine has on muscle contraction force and suggest a possible explanation for these findings. (4 marks)
Figure 1: (A) The effect of creatine on contraction force from isolated mouse extensor digitorum longus (EDL) muscle fibres during fatigue and recovery periods. Data represent electromyograph (EMG) force tracings from a muscle fibre during a single twitch and 100-Hz tetanus. (B) Intracellular calcium concentration from isolated EDL muscle fibres (n = 6) during fatigue and recovery. Data represent mean values ± s.e.m * indicates a significant difference (p < 0.05).

Creatine increases both twitch force and tetanic force during fatigue (1 mark) but has little effect in the recovered muscle (1 mark). Creatine likely increases calcium (1 mark) release during fatigue, probably by stimulating the sarcoplasmic reticulum (1 mark).

Most answers received some marks for this question. A mark was not awarded for stating that calcium was higher in the creatine group- only for suggesting that creatine might increase calcium release. Some answers didn’t link to the figure but described calcium handling/ muscle contraction more generally.

b) Explain the role of tropomyosin in the thin-filament in cross-bridge formation. (3 marks)

Tropomyosin covers the myosin-binding sites (1 mark). Upon nervous stimulation, calcium binds to troponin (1 mark) which pulls tropomyosin thereby uncovering the binding sites (1 mark).

LO2: Describe basic aspects of human anatomy and the function and regulation of the major physiological systems in the healthy human body.
LO5: Acquire, analyse, interpret and write up/present experimental data.

Mostly answered well. Some answers confused the functions of troponin and tropomyosin.
Figure 2: Blood glucose measurements were recorded using a glucometer at the indicated times following the ingestion of a drink containing 50 g glucose. The subject was fasted prior to the experiment.

a) Draw a second curve on the graph in Figure 2 to represent the blood glucose response of a Type I diabetic who has ingested the same glucose drink. Justify the features of your curve in terms of physiological mechanisms. (5 marks)

The curve should begin above 7 (1 mark) [diabetics have a fasting blood glucose level of >7 mM] and should remain high (1 mark) [diabetics have a 2 h plasma glucose >11 mM].

Justification: Diabetics have high fasting blood glucose level (>7) because gluconeogenesis in the liver is not inhibited by insulin (1 mark). The graph has a very high peak and does not return to basal because diabetics have an inability to respond to increases in blood glucose (1 mark) due to a lack of pancreatic beta cell function and hence no or drastically reduced insulin secretion (1 mark).

LO1: Using examples, discuss the concept of disease.
LO2: Describe basic aspects of human anatomy and the function and regulation of the major physiological systems in the healthy human body.
LO5: Acquire, analyse, interpret and write up/present experimental data.
b) Why are Type I diabetics more at risk for conditions such as heart disease, stroke, high blood pressure, blindness and nerve damage? (2 marks)

All of these conditions are related to the vasculature. High blood glucose damages the vasculature (1 mark); mechanisms include glycation of blood vessel proteins/lipids or inhibition of vasodilation (1 mark).

8. a) Why does dietary iodine concentrate in the thyroid gland? (2 marks)

The thyroid hormones (T3 and T4) are the only molecules in the body to contain iodine (1 mark) and following synthesis the hormones are stored in the follicles of the thyroid gland (1 mark).

b) Describe the general effects of hyperthyroidism on the body. (2 marks)

Thyroid hormones enhance metabolism (1 mark), which would have the effect of e.g. increasing thermogenesis and cardiac output, and causing weight loss. (1 mark awarded for one of these physiological effects).

LO2: Describe basic aspects of human anatomy and the function and regulation of the major physiological systems in the healthy human body.

9. Describe how the high solute concentration in the interstitial fluid of the inner medulla of the kidney is generated. (7 marks)

NaCl is pumped out of the ascending limb of the loop of Henle (1 mark), leading to an increased concentration in the interstitial fluid (1 mark). The increased NaCl concentration results in reabsorption of water from the water-permeable descending limb of the loop of Henle (1 mark). The reabsorption of water leads to a concentration of the filtrate in the descending limb (1 mark), which eventually reaches the ascending limb (1 mark). A higher concentration of the filtrate in the ascending limb allows for more NaCl to be pumped out, further increasing the concentration and so on (1 mark). Urea released from the collecting duct also contributes to the high solute concentration in the inner medulla (1 mark).

LO2: Describe basic aspects of human anatomy and the function and regulation of the major physiological systems in the healthy human body.

Not many answers were awarded full marks. In many cases, characteristics of the limbs of the loop of Henle were described, but it was not explained how they lead to the generation of the high solute concentration in the inner medulla.


a) What breathing instructions does the doctor need to give the patient to obtain FEV1 (Forced Expiratory Volume at 1 Second) and FVC (Forced Vital Capacity)? (2 marks)
The doctor will ask the patient to inhale fully (1 mark) and then breathe out as fully and quickly as possible (1 mark).

Many correct answers. Several students provided two separate sets of instructions for FEV1 and FVC (in most cases, one of them did not mention the full inhalation).

The doctor compares the measured FEV1 and FVC with the predicted values:

Measured: FEV1 = 2 litres, FVC = 4 litres

Predicted: FEV1 = 4 litres, FVC = 5 litres

b) What type of chronic lung disease might the patient suffer from? Explain how you have reached your conclusion. **(5 marks)**

Obstructive lung disease (1 mark). A characteristic feature of obstructive lung disease is increased airway resistance (1 mark), leading to a reduced FEV1 (1 mark). FVC is also often reduced (1 mark), but to a lesser extent than FEV1. Therefore, FEV1/FVC is reduced (1 mark).

LO2: Describe basic aspects of human anatomy and the function and regulation of the major physiological systems in the healthy human body.

LO5: Acquire, analyse, interpret and write up/present experimental data.

Several good answers. In some cases, the explanation was incomplete.

11. Based on the data in the figure below, and your understanding from the lectures, describe the mechanism by which Salbutamol regulates contractile responses in the trachea. **(5 marks)**

![Figure 3: (A) Tracheal rings were isolated from mice and pre-contracted with methacholine (1 µM; MCh). Changes in contractile force were then measured in response to increasing concentration of Salbutamol in the absence (Salbutamol alone) and in the presence of 8-pCPT-2′-O-Me-cAMP.](image)
or presence of the cAMP inhibitor, 8-pCPT-2’-O-Me-cAMP (100 µM; Salbutamol + 8-pCPT-2’-O-Me-cAMP). Data points represent mean ± s.e.m (n = 4). ** indicates p-value < 0.01 between treatment groups. (B) The extent of myosin light chain (MLC) phosphorylation was determined in tracheal rings under different treatment conditions as indicated in table below chart (+ corresponds to presence of treatment; - corresponds to absence of treatment). Bars represent mean ± s.e.m (n = 4). *** indicates p-value < 0.001 between treatment groups (only statistics required for answer are provided).

- Salbutamol mediates smooth muscle (1 mark) relaxation (1 mark) in the trachea via activation of β2-adrenoceptors (1 mark). [Mark not awarded if β2 not mentioned and/or if it’s not clear that Salbutamol is an agonist]
- Activation of β2-adrenoceptors leads to a decrease in the phosphorylation of MLC (1 mark).
- Both relaxation of smooth muscle and MLC dephosphorylation in response to Salbutamol occur via a cAMP-dependent mechanism (1 mark) [Mark not awarded if students simply state that effect is blocked by 8-pCPT-2’-O-Me-cAMP without mention of what this implies].

LO2: Describe basic aspects of human anatomy and the function and regulation of the major physiological systems in the healthy human body.
LO5: Acquire, analyse, interpret and write up/present experimental data.

All marks were attainable but not many students received full marks. Some students correctly analysed data but did not incorporate it with taught material (e.g. β2-adrenoceptors, smooth muscle). Others relied on some taught material only (all marks could have been achieved based on taught material only). Some students failed to recognise that 8-pCPT-2’-O-Me-cAMP is an inhibitor of cAMP. A few students thought that Salbutamol concentration decreased along the x-axis (concentration if logged). A number of students made no attempt to answer the question.