BA, BSc, MSc Degree Examinations 2019-20
SECURE EXAM

Department:
BIOLOGY

Title of Exam:
Introduction to Biomedical Sciences Part 1

Time Allowed:
1 hour and 30 minutes

Allocation of Marks:
Total marks available for this paper: 50
The marks available for each question are indicated on the paper.

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

Materials Supplied:
CALCULATOR

For marker 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
1. What does the acronym DALY stand for and how is it calculated?  
   
   Disability Adjusted Life Years (1 mark)  
   
   DALY = YLL (years of life lost due to mortality) + YLD (years lived with disability)  
   (1 mark for each term)  

   LO1. Using examples, discuss the concept of disease.  
   Most students answered this question well.

2. Explain how antibiotic resistance is propagated between different bacteria.  
   (3 marks)  
   
   Bacteria have plasmids that contain genes conferring resistance to antibiotics (1 mark).  
   Bacteria may obtain plasmids from the surrounding environment through transformation (1 mark) or from other bacteria through conjugation (1 mark).  
   Alternative correct answers will be given credit. Diagrams may also be awarded marks.  

   LO1. Using examples, discuss the concept of disease.  
   Most students answered this question well.

3. Name a disease that has been globally eradicated through vaccination. (1 mark)  
   
   Smallpox (1 mark).  

   LO1. Using examples, discuss the concept of disease.  
   Most students answered this question well.

4. a) What is another term for the posterior (back) surface of the human body in the anatomical position? (1 mark)  
   
   Dorsal (1 mark).  
   Some mixed responses. Some named it as a plane, rather than a region.  

   b) What is the name of the spinal curve disorder which results in a ‘humpback’, and in which plane is the condition best visualised? (2 marks)
Kyphosis (1 mark). Sagittal (or median) plane (1 mark)

Answered reasonably well. Most got the correct plane. Only accepted very minor spelling mistakes.

c) Osteoporosis is a disease characterised by increased bone loss. Which bone cell type is likely to be overactive in these patients and why? (2 marks)

Osteoclasts (1 mark) as this cell type is involved in bone breakdown/resorption (1 mark).

Mostly answered well. Most answers showed an understanding of the question but some mixed up bone cell type.

LO2. Describe basic aspects of human anatomy and the function and regulation of the major physiological systems in the healthy human body.
5. Shortly after death, skeletal muscles enter a state of continuous and maximal contraction, a process known as rigor mortis. Using the data in the figure below, explain the mechanism of rigor mortis. (4 marks)

Figure. [Figure legend title redacted]. Skeletal muscle samples were taken from a deceased patient at 0, 2, 4 and 6 hours after death. (A) Myocyte calcium concentration. (B) Myocyte ATP concentration. (C) Rigor Index (which reflects whole muscle tension).

After death, calcium levels rise, which would allow cross-bridge formation (1 mark).

ATP can no longer be synthesised - graph shows declining levels (1 mark).

ATP is required for dissociation of actin and myosin (1 mark).

Without ATP the cross-bridges cannot be broken, thus tension (rigor index) arises (1 mark).
Some answers were just a general description of muscle contraction rather than specifically linked to answering the question. Many answers failed to recognise the role of ATP in the dissociation/breakage of cross-bridges.

6. How do muscles in the eye produce small highly controlled contractions?  
(2 marks)

Muscle fibres are grouped into motor units (1 mark) which vary in size.

Muscles that require light delicate contractions have more smaller motor units (1 mark).

Answered were mixed. Some answers stated that there are fewer motor units recruited (or not many motor neurons), but this is incorrect. It is likely that there are more motor units (and motor neurons) as each motor unit will be smaller. No marks if didn't mention motor unit size.

7. a) Draw a diagram of the hepatic lobule, labelling all of the vessels and ducts present.  
(5 marks)

Answer:

1 mark for hexagon with portal triads, 1 mark each for hepatic vein, hepatic artery, portal vein & bile duct.

b) How does the organization of the liver's circulatory system achieve detoxification?  
(2 marks)

The major blood input to the liver (75%) is via the hepatic portal vein which drains the digestive tract (1 mark) …
meaning anything absorbed into the blood from these tissues must pass through the liver first (1 mark).

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

8. Explain how iodine deficiency causes Goiter. (4 marks)

Goiter as a case of negative feedback problem: In the absence of iodine, there is less T3/T4 (1 mark) … and so there is no negative feedback on pituitary & Hypothalamus (1 mark). Therefore TSH is produced to try and stimulate more T3/T4 production (1 mark). However, TSH doesn’t just cause an increase in T3/T4 secretion – in the longer term it also has a growth factor effect and causes the follicle cells to proliferate (1 mark). This leads to an increase in the size of the thyroid gland.

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.

9. Explain how reduced water intake causes the formation of concentrated urine. (9 marks)

High plasma osmolarity (1 mark) leads to the production of ADH by the pituitary gland (1 mark). ADH increases the water permeability (1 mark) of the collecting duct of the nephrons (1 mark). Water leaves the collecting duct by osmosis (1 mark). In addition, ADH increases the permeability of the collecting duct to urea (1 mark). Urea gets reabsorbed (1 mark), thereby increasing the solute concentration of the interstitial fluid of the inner medulla (1 mark), increasing reabsorption of water by osmosis (1 mark).
10. What are the functions of gastric acid? (3 marks)

- Kills microorganisms that may cause infection (1 mark).
- Denatures proteins (1 mark).
- Activates pepsinogen (1 mark).

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

Many answers were awarded full marks.

11. Explain the importance of haemoglobin in ensuring that the tissues of the human body are supplied with enough oxygen. (2 marks)

- The solubility of oxygen in blood plasma is very low and would be insufficient for transporting enough oxygen to the tissues (1 mark).
- The binding of oxygen to haemoglobin dramatically increases the capacity of blood to carry oxygen (1 mark).

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

Most answers were awarded one mark; often, it was not made clear that the low solubility of oxygen in blood plasma means that without haemoglobin, the blood would not be able to carry enough oxygen.

12. You are the lead researcher in a clinical trial testing the effectiveness of DG-00018C on exercise endurance in adults (aged 40-85) with Chronic Obstructive Pulmonary Disorder (COPD). DG-00018C is a newly invented agonist at β2 adrenoeceptors. Your manager has asked you to review the patient data to confirm that all participants have been correctly diagnosed with COPD. The spirometry results of patient #126 are shown in the table below.
Lung function (spirometry) data for patient #126

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<th>Parameter</th>
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<tr>
<td>FVC (L)</td>
<td>3.90</td>
<td>3.95</td>
<td>3.92</td>
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<tr>
<td>FEV₁ (L)</td>
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<td>2.70</td>
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<td>PEFR (L/s)</td>
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<td>F₂₅ (L/s)</td>
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<td>F₅₀ (L/s)</td>
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<tr>
<td>F₇₅ (L/s)</td>
<td>1.06</td>
<td>1.05</td>
<td>1.00</td>
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a) Has patient #126 been diagnosed correctly? Justify your answer.  

- Maybe yes (1 mark; there needs to a realisation somewhere that it is not certain)
- … because the FEV₁/FVC value is <0.7 (1 mark).
- However, FEV₁/FVC decreases with age in healthy individuals (1 mark).
- We do not know the age of the patient. We may need an age-adjusted threshold to prevent false diagnosis (1 mark).

b) Your assistant has prepared a chart of the final clinical trial results (shown below). Provide a conclusion based on these results and justify any changes you would make to the figure before presenting the data to your manager.  

(3 marks)
Patients with COPD were treated with either placebo or DG-00018C (20 mg/kg) for 5 days. Each group consisted of 100 patients. The next day, the amount of time that patients could spend on an exercise bike at their functional threshold power was determined. Bars represent mean ± SEM. Statistics were performed using t-test.

DG-00018C leads to a significant increase in endurance time in COPD patients (1 mark).

The data is presented in a misleading manner because of the altered y-axis scale. The scale should go down to 0 (1 mark).

It is also not clear whether endurance is higher in all patients treated with the drug, or only some patients. Plot individual data points or box plots (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.

LO4: Acquire, analyse, interpret and write up/present experimental data.