

ST. PAUL'S COLLEGE

FORM 6 INTERNAL EXAMINATION 2019-2020

BIOLOGY PAPER 2

Name: _____

Class: **F.6** _____

Class No: _____

Teacher: **KCA / KCW** _____

Time allowed: 1 hour

This paper must be answered in English.

INSTRUCTIONS

- (1) There are **THREE** sections, A, B and C in this Paper. Attempt **ALL** questions in any **TWO** sections.
- (2) Write your answers in the Answer Book provided. Start each question (not part of a question) on a new page.
- (3) Present your answers in paragraphs wherever appropriate.
- (4) Illustrate your answers with diagrams wherever appropriate.
- (5) The diagrams in this paper are **NOT** necessarily drawn to scale.

SECTION A Human Physiology: Regulation and Control

Answer **ALL** parts of the question.

1. (a) Kidney function can be assessed by the glomerular filtration rate (GFR). The GFR is the volume of blood filtered by the kidneys per minute. We can measure the GFR by the rate of clearance of creatinine by the kidneys. Creatinine is a breakdown product of a substance found in muscle cells and is produced at a relatively constant rate. Normally it passes from the blood in the glomerulus into the Bowman's capsule and is entirely excreted by the kidneys.

(i) Explain why creatinine passes from the blood in the glomerulus into the Bowman's capsule.

(2 marks)

(ii) If a healthy person with normal range of GFR drank a large amount of water the next morning, how would the volume of urine produced and the concentration of creatinine in the urine change? Explain your answers.

(6 marks)

(iii) Some athletes like to drink a protein-rich drink after doing exercise to help muscle repair. Explain why people may excrete a large amount of urea in their urine after drinking a protein-rich drink.

(2 marks)

1. (b) In an investigation, the volumes of blood received by different organs or tissues of a marathon runner per hour when he was at rest and running were studied. The table below shows the results.

Organ or tissue	Blood volume received ($\text{dm}^3\text{hr}^{-1}$)	
	At rest	Running
Brain	0.7	0.75
Heart	0.2	1
Kidney	1.1	0.25
Liver	1.4	0.5
Skin	0.3	4
Skeletal muscle	1	17
Others	0.3	1.5

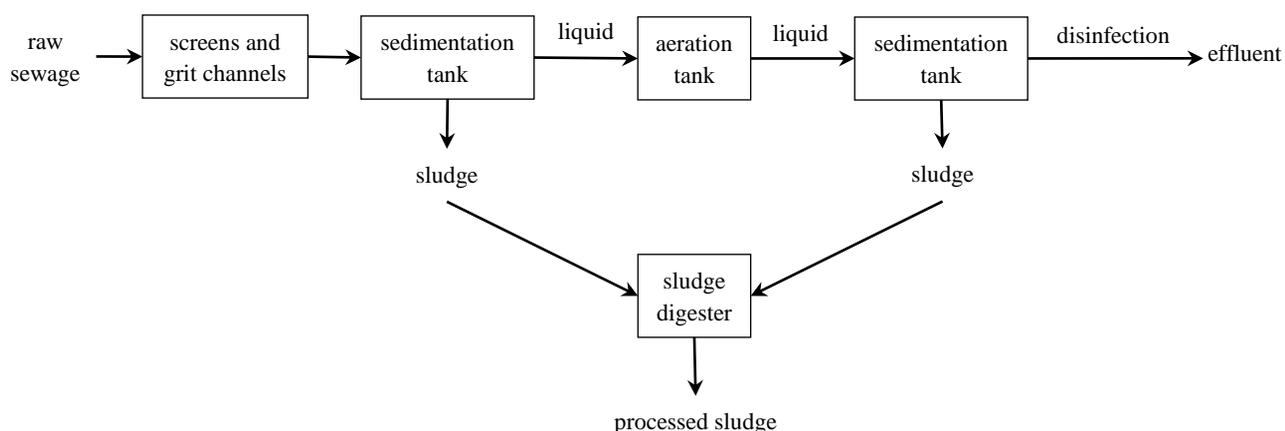
- (i) The increase in the volume of blood received by the skeletal muscle was the greatest during running. Calculate the percentage increase in the volume of blood received by the skeletal muscle during running. (1 mark)
- (ii) Describe the change in the volume of blood received by the skin during running. Explain why. (4 marks)
- (iii) Describe how the sympathetic nerve brings about the change in the cardiac output during running. (2 marks)
- (iv) After finishing the run, the breathing rate of the man remained high for a short while. State and explain the importance of this phenomenon to the body. (3 marks)

SECTION B Applied Ecology

Answer **ALL** parts of the question.

2.

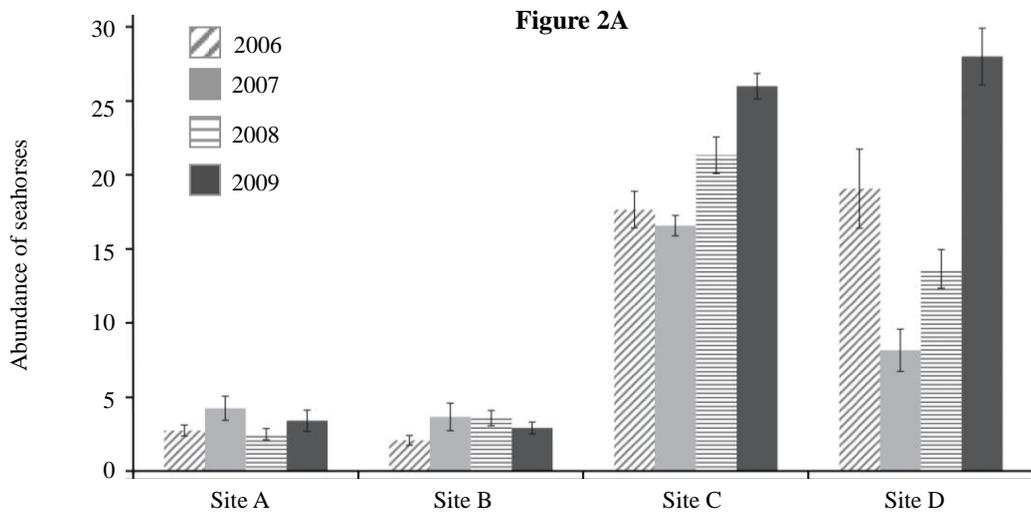
(a) The flowchart below outlines the main stages in a sewage treatment works:



- (i) Decomposition of substances occurs both in the aeration tank and the sludge digester.
Give *two* differences in the biological processes involved. (2 marks)
- (ii) When the effluent is released into a river, it can have an environmental impact similar to the leaching of chemical fertilisers.
- (1) Suggest why the release of the effluent can have this impact. (2 marks)
- (2) Describe and explain the harmful effects of the direct release of the effluent on the river organisms. (4 marks)
- (iii) Suggest how the above sewage treatment works applies the concept of 'Recycle' in waste management. (2 marks)

2.

(b) Marine Protected Areas (MPAs) are areas of the seas, oceans or large lakes where human activity is restricted for conservation. A study was carried out to investigate the effectiveness of MPA on the conservation of a species of seahorse, White's Seahorse (*Hippocampus whitei*). The study was undertaken at four sites in a selected Marine Park in Australia. Two of the sites (A and B) are located within the sanctuary zone where all forms of fishing have been banned since the 1980s. The other two sites (C and D) are located in a habitat protection zone, where local fishing is allowed but destructive fishing methods are banned. Figure 2A shows the number of individuals of White's Seahorse recorded in the four sites from 2006 to 2009.



(Data source: Harasti D, Martin-Smith K, Gladstone W (2014) Does a No-Take Marine Protected Area Benefit Seahorses? PLoS ONE 9(8): e105462. doi:10.1371/journal.pone.0105462)

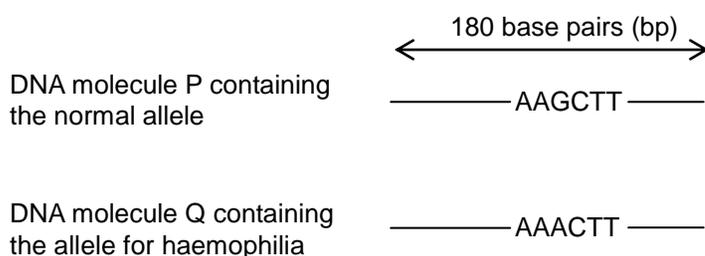
- (i) How does the abundance of seahorse individuals in the sanctuary zones differ from that in the habitat protection zones from 2007 to 2009? (2 marks)
- (ii) Do you think the banning of fishing is effective in conserving seahorses in sites A and B? Support your answer with reference to the graph. (2 marks)
- (iii) It is found that the sanctuary zones can preserve a higher abundance of fish species. Deduce a reason that further supports your answer in part (ii). (2 marks)
- (iv) Suggest *two* reasons why millions of seahorses are traded globally every year. (2 marks)
- (v) What can the government do to conserve the habitat and life of seahorses? (2 marks)

SECTION C Biotechnology

Answer **ALL** parts of the question.

3.

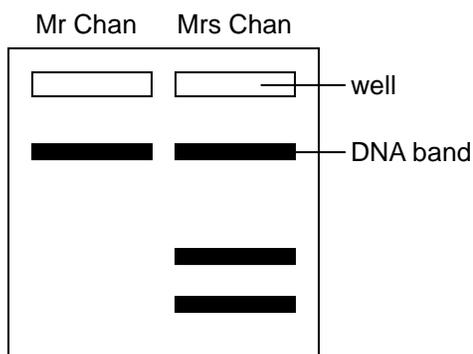
- (a) A certain type of haemophilia is caused by a recessive allele located on the X chromosome. Mr and Mrs Chan underwent a genetic test to estimate the chance of their child having haemophilia. During the test, the doctor obtained some cells from each person and extracted DNA from the cells. He then used polymerase chain reaction (PCR) to amplify the region containing the gene associated with haemophilia in each DNA sample. Two kinds of DNA molecules might be produced in large amounts, DNA molecule P contained the normal allele and DNA molecule Q contained the allele for haemophilia.



After PCR, the doctor treated the DNA samples with a restriction enzyme. The enzyme recognized the sequence AAGCTT and cut within the sequence.

- (i) P and Q gave different products after they were treated with the restriction enzyme. State and explain how the products were different. (4 marks)

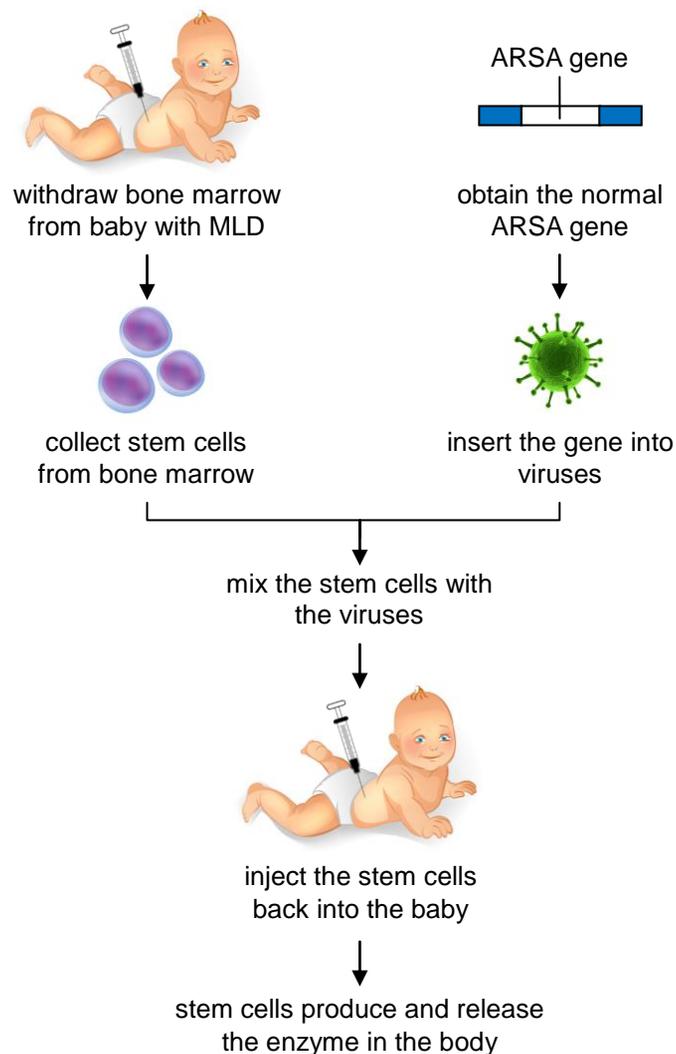
The fragments in each DNA sample were then separated using gel electrophoresis. The diagram below shows the patterns of bands on the gel slab after gel electrophoresis.



- (ii) With reference to her pattern of bands, deduce the phenotype of Mrs Chan. (3 marks)
- (iii) In this genetic test, the pattern of bands formed from the DNA sample of a male usually contains one or two bands. Explain why. (2 marks)
- (iv) What is the chance of Mr and Mrs Chan having a child with haemophilia? (1 mark)

- 3.
- (b) Metachromatic leukodystrophy (MLD) is an inherited disorder caused by a mutation in a gene called ARSA gene. Patients with MLD cannot produce an enzyme in their body. As a result, a toxic substance accumulates in their brain cells. The brain cells degenerate and the patients lose the ability to talk.

In a clinical trial, gene therapy is used to treat three babies with MLD from three different families. The flow chart below shows the process of the gene therapy.



After the gene therapy, the babies were able to talk at an age when their untreated elder brothers and sisters with MLD were unable to talk.

- (i) Explain why the ability of the treated babies to talk was compared with their untreated elder brothers and sisters. (2 marks)
- (ii) Can this gene therapy be used to treat MLD patients who have already lost their ability to talk? Explain your answer. (2 marks)
- (iii) Screening for MLD is recommended for babies who have a family history of MLD. Explain why it is important to screen these babies for MLD. (2 marks)

- (iv) State two potential risks of this gene therapy. (2 marks)
- (v) Apart from using stem cells from the patients, this gene therapy can also be carried out using embryonic stem cells from donors. State two disadvantages of using embryonic stem cells from donors in this gene therapy. (2 marks)

END OF PAPER