Form Six Mock Examination 2019-2020

DSE BIOLOGY PAPER 2

Date: 24th Feb. 2020
11:25 am – 12:25 am (1 hour)
This paper must be answered in English

INSTRUCTIONS

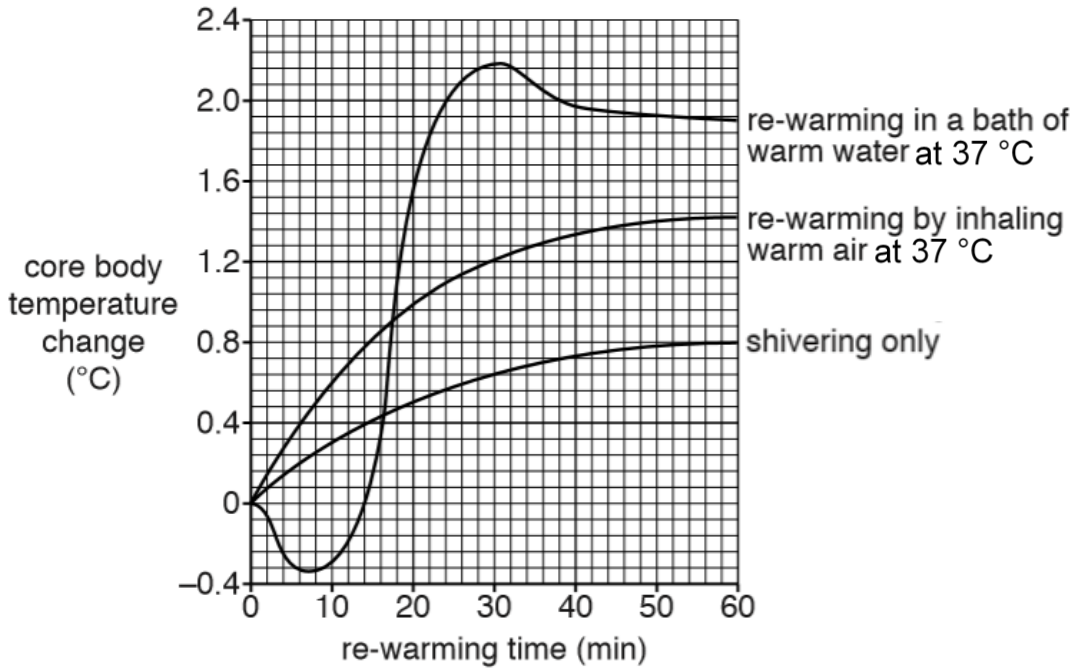
1. There are **TWO** sections, A and B in this Paper. Attempt **ALL** questions in these **TWO** sections**.**
2. Write your answers in the Answer Book provided. Start each question (not part of a question) on a new page.
3. Present your answers in paragraphs wherever appropriate.
4. Illustrate your 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** questions

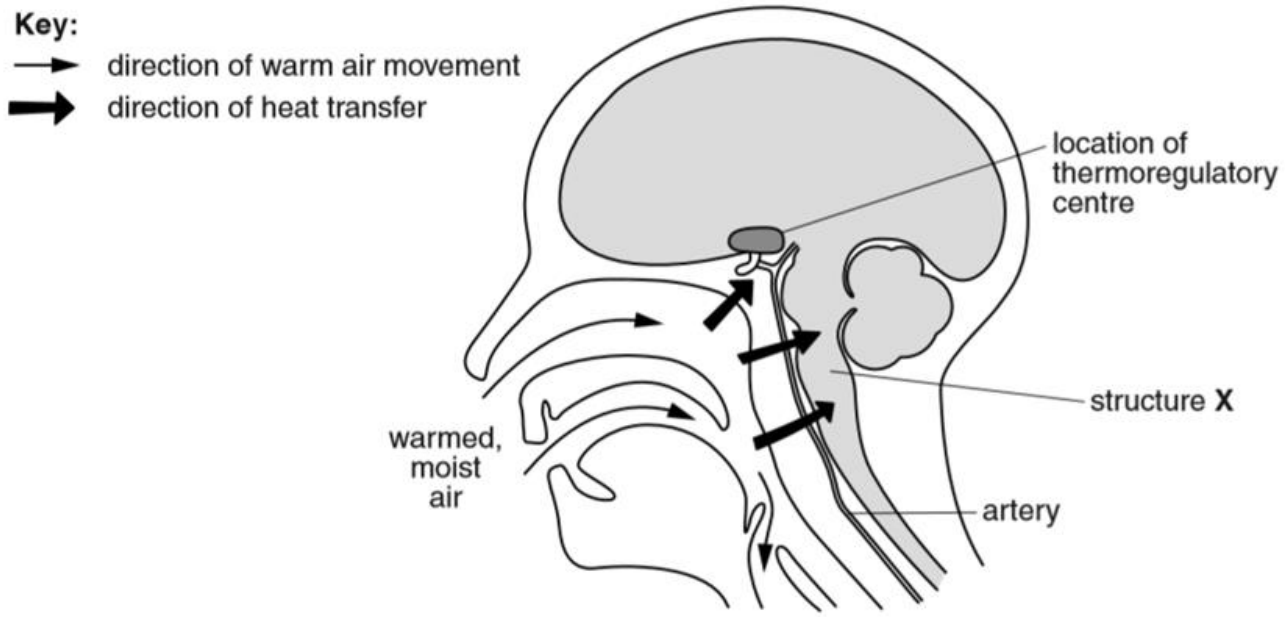
1. Body temperature control is an important aspect of homeostasis especially during high altitude training to increase athletic performance. Conditions such as hypothermia can be fatal if not treated while training.

   The graph below shows the effects of shivering and two other treatments on the core body temperature change of hypothermic patients.



(a) Explain how shivering can increase the core temperature. (2 marks)

(b) Rewarming by inhaling warm air is also known as core- rewarming. The diagram below shows the route taken by the warm air as it is inhaled by the person.



(i) Using the graph provided in (a), compare the effectiveness of changing the core body temperature by using core- warming and rewarming using warm water bath in treating mild hypothermia.

(2 marks)

(ii) Using the diagram above, suggest how core-warming helps restore normal breathing rate from hypothermia. (2 marks)

(c) Blood doping is an illegal practice of boosting the number of red blood cells in the bloodstream. A high dose of recombinant erythropoietin (rhEPO), an artificial hormone, is injected into the athlete's body for stimulating red blood cell production in the blood marrow.

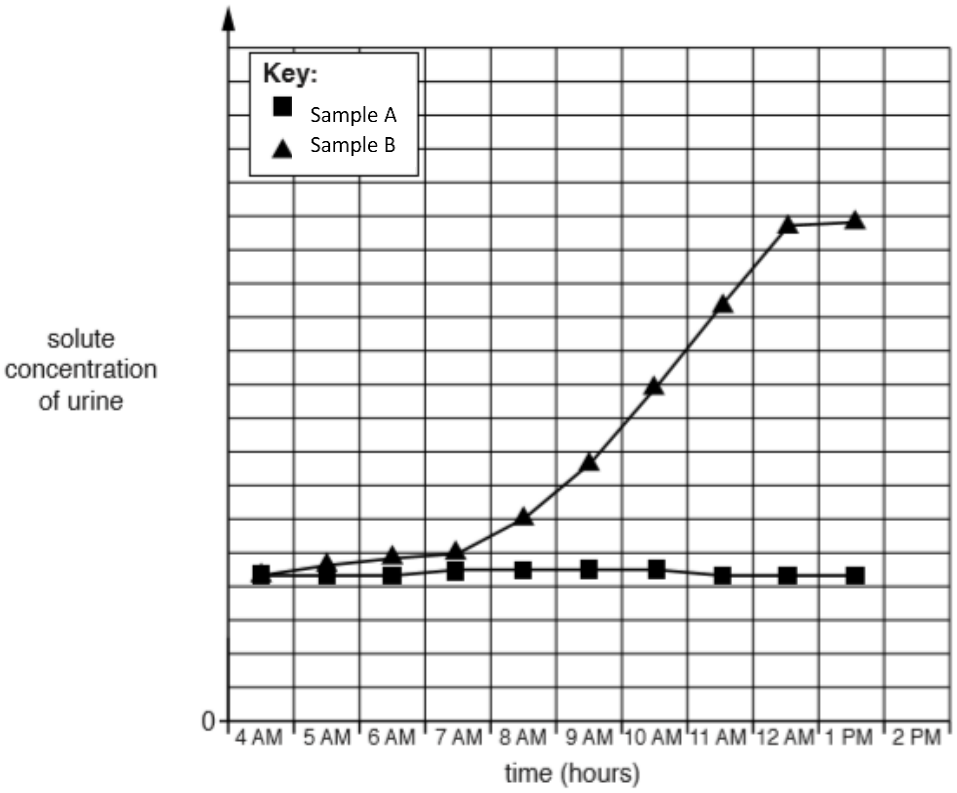
(i) With reference to the physiological process involved, suggest why rhEPO is present in the urine sample of blood-doped athlete. (3 marks)

(ii) Explain how blood doping can enhance athletic performance of a 10000m runner more effectively than a 100m sprinter. (4 marks)

(d) Patient X with diabetes insipidus, a disease caused by inability of the nephron in responding to the changes in ADH in the blood, took part in a water deprivation test. The procedure of the test is as followed.

1. Patient does not drink for the duration of the test. 2. Urine samples are collected at regular intervals over a period of up to 9 hours. 3. The solute concentration of each urine sample is measured.

The test result of patient X was mixed up with another patient and the graph below shows the results of the water deprivation test of 2 samples.



(i) Suggest which sample, samples A or B, belongs to patient X. (1 mark)

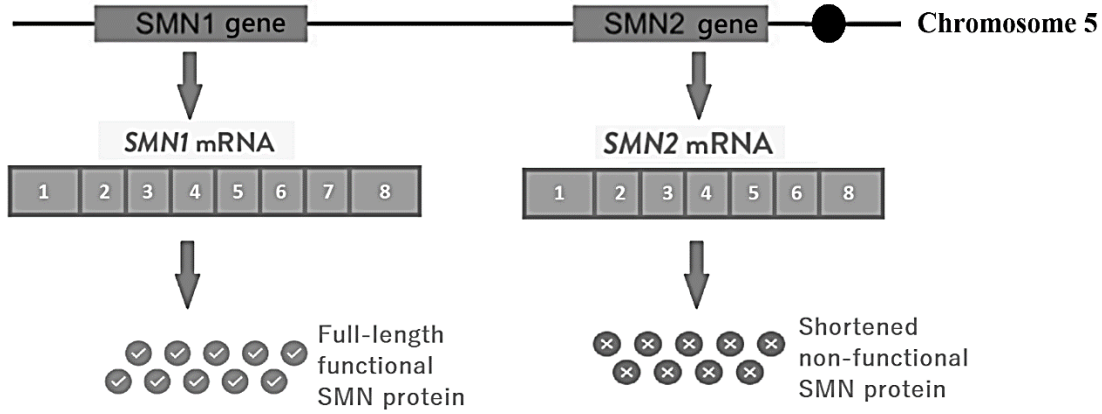
(ii) Suggest how the inability in responding to ADH in patient X leads to the result obtained in the water deprivation test. (4 marks)

(iii) Explain why patient X is advised to avoid vigorous exercise within the duration of the test. (2 marks)

Section B Biotechnology

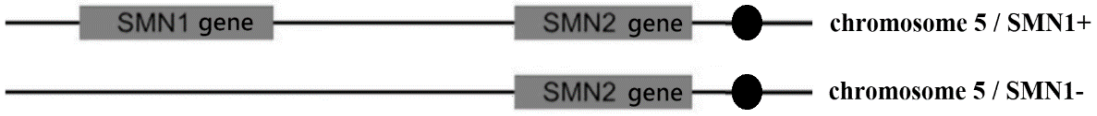
Answer **ALL** questions.

2. Spinal muscular atrophy (SMA) is a genetic disorder caused by mutations in the SMN (survival of motor neurone) genes. A lack of functional SMN proteins causes the death of motor neurones and eventually leads to wasting of skeletal muscles.
   In humans, there are two SMN genes on each chromosome 5, namely SMN1 and SMN2.
   SMN1 gene codes for full-length functional SMN proteins. SMN2 gene, which is basically identical to SMN1 except a few bases difference, is usually incompletely transcribed into shortened mRNA, thus producing non-functional SMN proteins.



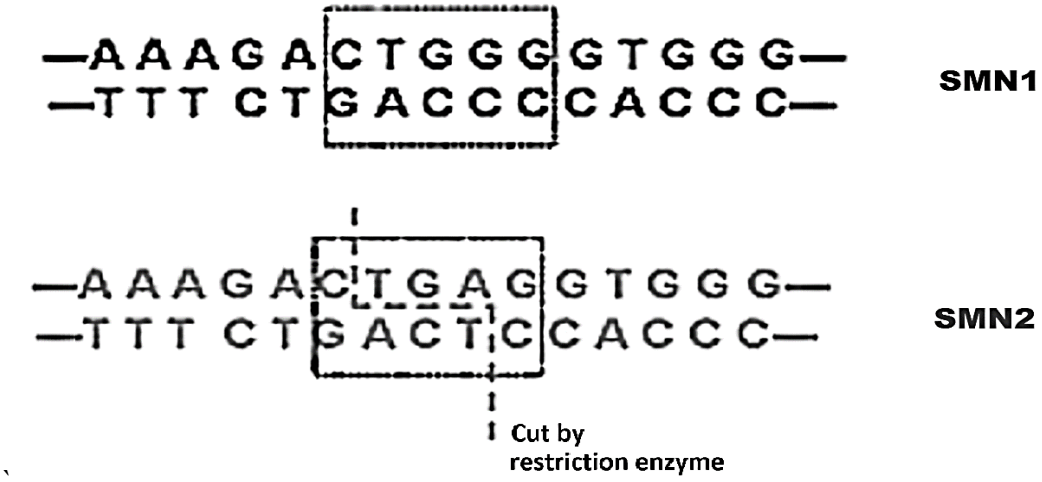
(a) Explain why the shortened SMN2 mRNA leads to formation of non-functional SMN protein. (2 marks)

Gene deletion may occur to SMN1 or SMN2 gene, or both. The diagram below shows two different types of chromosome 5: SMN1+ with the SMN1 gene, and SMN1- with the SMN1 gene deleted.



(b) With reference to the above chromosomes, deduce whether SMA is a dominant or recessive disorder. (3 marks)

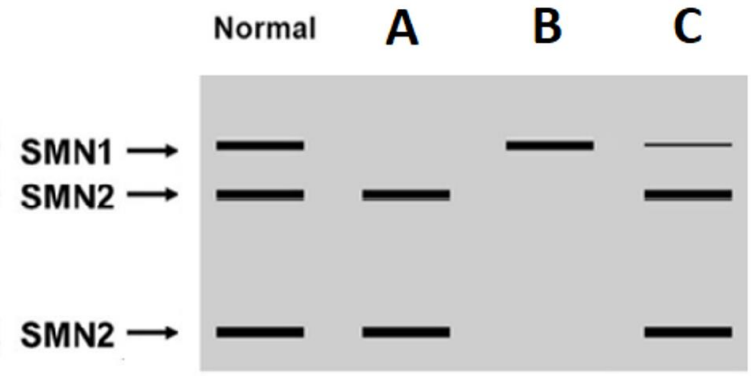
(c) PCR-RFLP analysis can be used for genetic screening of SMA. PCR amplifies the following regions on SMN1 and SMN2 genes. The PCR products will then be subjected to digestion by an appropriate restriction enzyme. With the C-to-T mutation on SMN2 gene, the enzyme cuts only the SMN2 gene but not the SMN1 gene:



(i) Describe the major steps involved in using PCR to amplify the SMN genes. (3 marks)

(ii) Why is it necessary to carry out the restriction digestion before gel electrophoresis during the genetic screening of SMA? (2 marks)

(iii) Here are the results of genetic screening for SMA for individuals A, B and C:



(1) Based on the results, state whether individual A, B or both of them have/ has SMA. (1 mark)

(2) Individual C does not have SMA. Explain why the SMN1 band for individual C is thinner than that of the control. (2 mark)

(d) Currently, there are two types of approved therapies available for treating SMA.

Treatment 1: Gene therapy Treatment 2: Introduce drugs into motor neurones for full transcription of SMN2 gene and hence producing full length functional SMN protein from SMN2 gene

(i) Describe how recombinant DNA technology is applied in gene therapy for SMA. (3 marks)

(ii) Explain why individuals who have already been exposed to delivery viruses in the past will be unable to receive gene therapy. (2 marks)

(iii) Are the above treatments long-term treatment for SMA? Explain. (2 marks)

END OF PAPER