St. Stephen's Girls' College

Form 6 **Final Examination 2016-2017**

65 students **Biology Paper 2** KFL & LYL

Time allowed: One hour

Form 6 ___ Class No.: ____ Name: _____

INSTRUCTIONS

1. There are TWO sections A and D in this paper. Answer ALL questions in the 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.

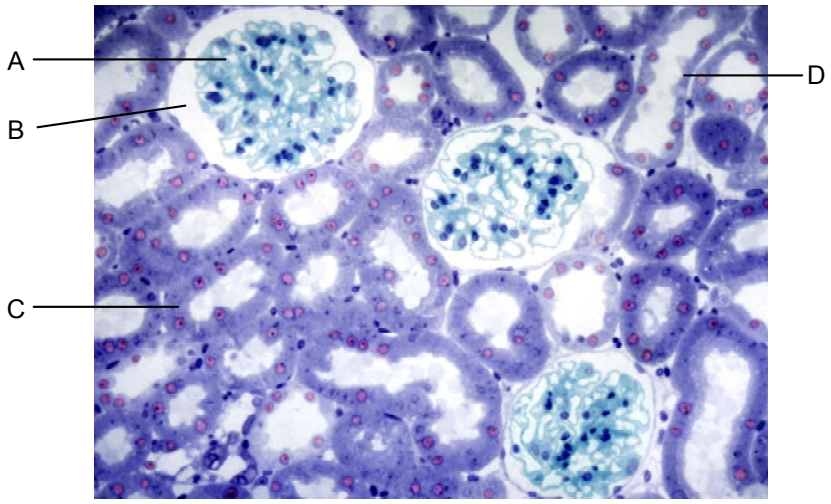
5. The diagrams in this section are NOT necessarily drawn to scale.

6. Supplementary answer sheets will be provided on request. Write your class, class number and name on each sheet.

SECTION A Human Physiology: Regulation and Control

Answer **ALL** parts of this question.

1 (a) The photomicrograph below shows a section through a region of the human kidney.



i Name the region of the kidney from which the photomicrograph was taken. (1 mark)

ii C and D are the same structure. Why do they appear differently under the microscope? (1 mark)

iii Compare the concentrations of glucose and proteins in A and those in B of a healthy person. Explain your answer. (4 marks)

1 (b) The table below shows the rate of water loss in different ways from the human body at rest and during heavy exercise:

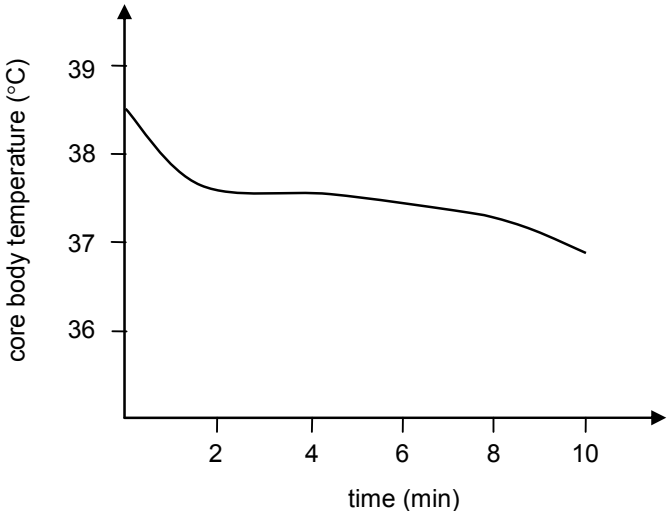
	Rate of water loss (mL h^{-1})		
	Sweat	**Urine**	**Exhaled air**
At rest	4	58	15
During heavy exercise	1,200	10	100

i The rate of sweat production increases during heavy exercise. What is the significance of this? (3 marks)

ii With reference to the action of the anti-diuretic hormone (ADH), account for the decrease in water loss from urine during heavy exercise. (5 marks)

iii Explain why there is an increase in water loss from exhalation during heavy exercise.
(2 marks)

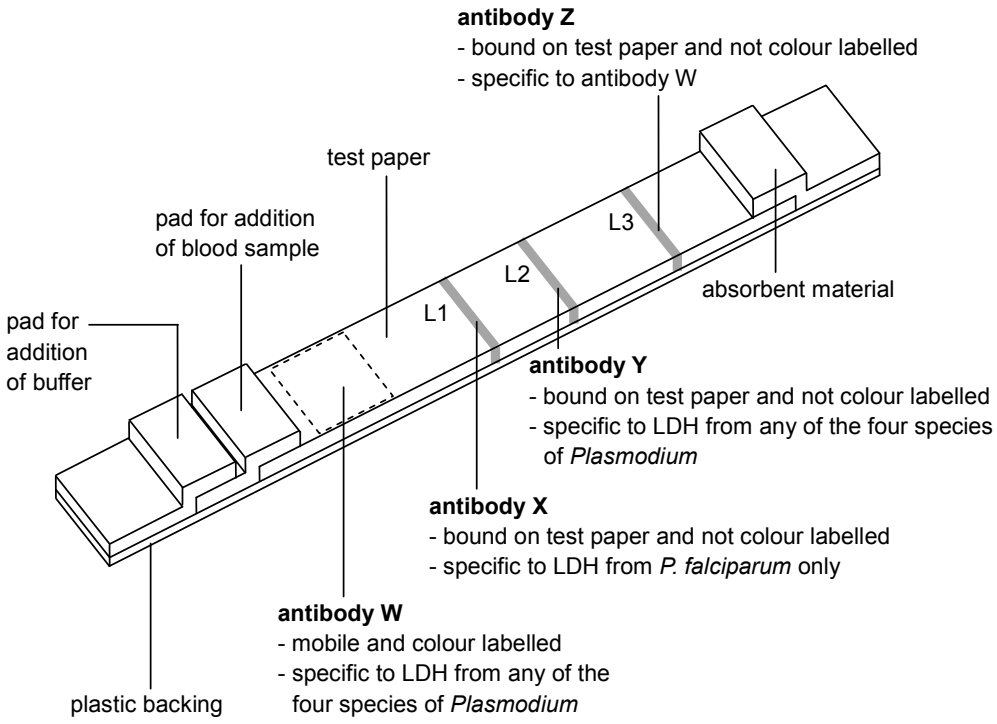
iv After the heavy exercise, the man took a shower with water at 10 °C for 10 minutes. The graph below shows the change in his core body temperature during the shower. Explain the change. (4 marks)



SECTION D Biotechnology

Answer **ALL** parts of the question.

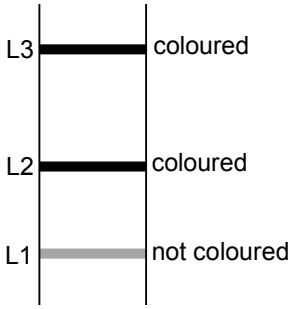
2(a) Malaria in humans is caused by four species of the protist *Plasmodium*. They are *P. falciparum*, *P. vivax*, *P. ovale* and *P. malariae*. A test strip can be used to diagnose malaria rapidly. It works by detecting a specific enzyme called LDH produced by *Plasmodium* in the blood of infected individuals. The diagram below shows the design of the test strip. It contains several types of monoclonal antibodies and each of which is specific to a particular antigen.



i After a drop of blood is put on the test strip, a buffer is added. The blood sample and the buffer will then be drawn towards the absorbent material. Why should the buffer contain an agent that lyses red blood cells?

(2 marks)

ii Interpret and explain the following result shown on a test strip. (5 marks)

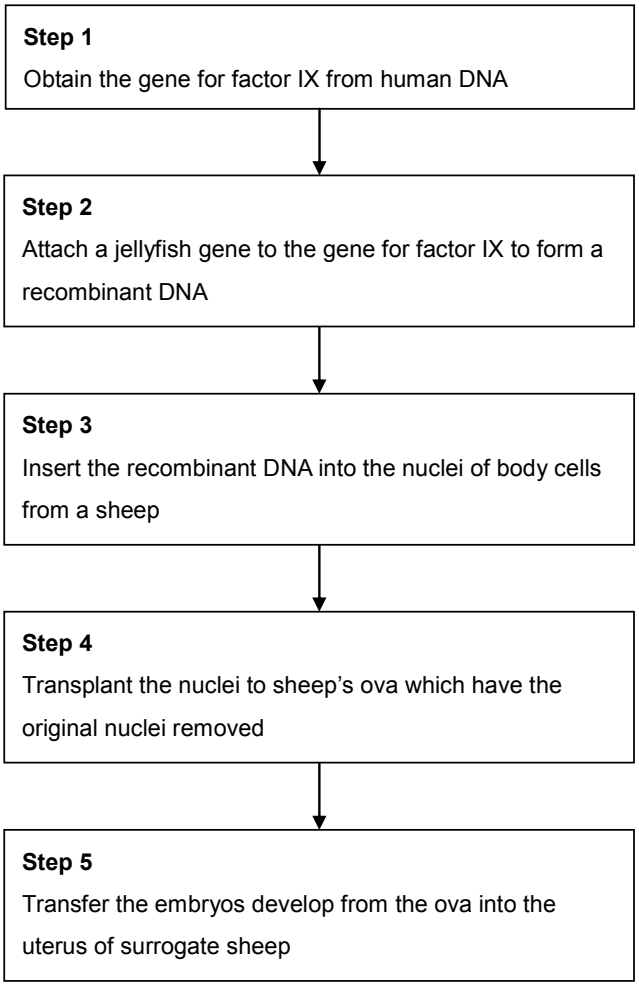


iii Why is a result valid only if line L3 becomes coloured? (2 marks)

iv Traditionally, malaria is diagnosed by looking for the protists in a drop of blood under a light microscope. Besides obtaining a result more rapidly, suggest another advantage of using the test strip over the traditional method for diagnosing malaria.

(1 mark)

2(b) Haemophiliacs whose blood fails to clot can be treated with factor IX extracted from the milk of genetically modified (GM) sheep. The flow chart below shows the process of producing the GM sheep.



i The jellyfish gene used in step 2 codes for a protein which glows green under ultraviolet light. What is the purpose of attaching this jellyfish gene to the gene for factor IX? (2 marks)

ii Describe how enzymes are used in producing the recombinant DNA in the process.

(2 marks)

iii In this process, only a few live births result from the many embryos implanted into the uterus of surrogate sheep. Suggest ***two*** reasons for this low success rate.

(2 marks)

iv After a GM sheep which can secrete factor IX in its milk is produced, the following two methods are considered to produce more sheep with this characteristic.

Method	Description
I	Transplant each nucleus from a body cell of the GM sheep into another sheep's ova which have their original nuclei removed. Then implant the embryos developed from the ova into the uterus of surrogate sheep.
II	Remove an ovum from the GM sheep and fertilize it with a sperm from a male sheep. Allow the zygote to develop into an embryo at the 8-cell stage. Split the embryo into individual cells and allow each cell to grow into an embryo. Then implant the embryos into the uterus of surrogate sheep.

(1) In method II, if a blastocyst instead of an 8-celled embryo was spilt into individual cells, the cells would not develop into embryos. Explain why.

(1 mark)

(2) Compare the offspring produced in methods I and II. Then decide which method is more suitable for use. (3 marks)

END OF PAPER

Answers:

1 a i The cortex of the kidney 1m

ii C and D are cut at different angles / planes. 1m

iii The concentration of glucose in A (glomerulus) is the same as that in B (Bowman's capsule). 1m

During ultrafiltration, glucose molecules in the blood in A pass through the walls of A and B and enter the capsular space. 1m

The concentration of proteins in A is higher than that in B. 1m

Protein molecules in A are too large to pass through the walls of A and B. They are retained in A. 1m

b i A large amount of heat is generated by the respiration of muscle cells during heavy exercise 1m

Increased sweat production promotes heat loss from the body by evaporation of sweat 1m

To prevent the body from overheating/ heat stroke 1m

ii A large amount of water is lost from the body in the form of sweat during heavy exercise 1m

The hypothalamus detects a decrease in water potential of the blood 1m

The pituitary gland releases more ADH into the blood circulation 1m

As a result, the wall of the collecting ducts of the kidney tubules become more permeable to water 1m

Thus, a greater proportion of water is reabsorbed and a smaller volume of urine is produced 1m

Iii During heavy exercise, the rate and depth of breathing increase 1m

A larger volume of air was exhaled from the lungs per unit time 1m

And hence, water loss in the form of water vapor increases 1m

iv From 0 to 2 minutes, the core body temperature dropped 1m

because body heat was lost to the cold water by conduction. 1m

From 2 to 10 minutes, the core body temperature dropped at a lower rate. 1m

The cold water caused vasoconstriction in the skin. Less blood flowed through the capillaries near the skin surface, resulting in reduced heat loss from the body. 1m

The man might also shiver.

During shivering, the rate of respiration in muscle cells increased, 1m

thus producing more heat. 1m

2 a i *Plasmodium* infects human red blood cells. 1m

The lysing agent helps release *Plasmodium* and the substances (including LDH) produced by it from red blood cells. 1m

ii The result indicates that the test subject is infected with *P. vivax*, *P. ovale* and/or *P. malariae* but not *P. falciparum*. 1m

As LDH from *P. vivax*, *P. ovale* and/or *P. malariae* in the blood sample is drawn towards the absorbent material, it is bound to the colour labelled antibody W, forming a coloured complex. 1m

As the coloured complex is drawn through line L1, antibody X does not bind to the coloured complex because it is specific to LDH from *P. falciparum* only. Thus line L1 is not coloured. 1m

As the coloured complex is drawn through line L2, antibody Y binds to the coloured complex because it is specific to LDH from any of the four species of *Plasmodium*. Thus line L2 becomes coloured. 1m

As the excess colour labelled antibody W or the coloured complex is drawn through line L3, antibody Z binds to the colour labelled antibody W or the coloured complex. Thus line L3 becomes coloured. 1m

iii Line L3 becomes coloured only when antibody Z binds to colour labelled antibody W. 1m

Thus a coloured line L3 indicates that there is a proper flow of the colour labelled antibody W through the test strip. The result is not a false positive or a false negative. 1m

iv Less training for staff is required as the result is easier to read. 1m

b i The jellyfish gene is used as a marker gene to identify which cells have taken up the recombinant DNA. 1m

Cells which have taken up the recombinant DNA glow green under ultraviolet light. 1m

ii Use the same restriction enzyme to cut the gene for factor IX from human DNA and the jellyfish gene from jellyfish DNA to produce complementary sticky ends on the genes. 1m

Use a ligase to catalyse the joining of the gene for factor IX and the jellyfish gene by covalent bonds. 1m

iii The insertion of the recombinant DNA into the DNA of the body cell may have disrupted genes and affected protein synthesis. Thus the embryos fail to grow. 1m

The embryos are rejected or attacked by the immune system of the surrogate sheep. 1m

iv (1) Cells from an 8-celled embryo can differentiate into any types of specialized cells but the cells from a blastocyst cannot. 1m

(2) All the offspring produced in method I are female sheep but some of the offspring produced in method II may be male sheep. 1m

All the offspring produced in method I are genetically identical to the GM sheep but the offspring produced in method II are genetically different from one another and the GM sheep. 1m

Method I is more suitable because all the offspring produced are female sheep which can secrete factor IX in their milk. 1m