RIVER VALLEY HIGH SCHOOL
YEAR 6
PRELIMINARY EXAMINATION

CANDIDATE NAME											
CENTRE NUMBER	S					CLASS		INDEX NUMBER			

BIOLOGY **9744/03**

Paper 3 Long Structured and Free-response Questions **14 Sep 2018**

2 hours

Candidates answer on the Question Paper.
No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, index number and name in the spaces at the top of this page.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Section A
Answer **all** questions in the spaces provided on the Question Paper.

Section B
Answer any **one** question in the spaces provided on the Question Paper.

The use of an approved scientific calculator is expected, where appropriate. You may lose marks if you do not show your working or if you do not use appropriate units.

At the end of the examination, fasten all your work securely together. The number of marks is given in brackets [ ] at the end of each question or part question.

For Examiner's Use	
Section A	
1	**/ 25**
2	**/ 25**
Section B	**/ 25**
Total	**/ 75**

This document consists of **19** printed pages and **1** blank page.

Section A

Answer **all** the questions in this section.

1 Plant tissue culture is a technique to produce an entire plant using undifferentiated meristem cells. A cluster of meristem cells can be extracted and stimulated with growth hormones to differentiate to form different types of cells that give rise to an entire plant.

(a) Suggest why meristem cells from any part of a plant can be used to produce the entire plant in plant tissue culture. [2]

In plant tissue culture, plant hormones are added to the meristem cells to regulate growth and differentiation to form roots and shoots. These hormones include auxin and cytokinin. The experiment set up is shown in Fig. 1.1

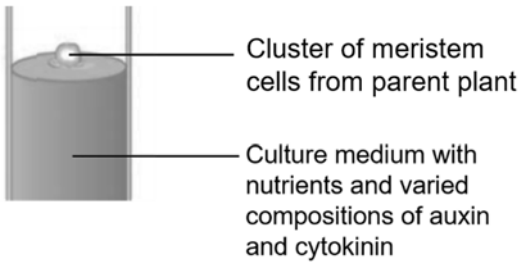
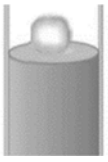
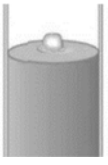


Fig. 1.1

The effects of various compositions of auxin and cytokinin on the cluster of meristem cells are summarised in Table 1.1.

Table 1.1

Concentration of auxin / mg L^{-1}	Concentration of cytokinin / mg L^{-1}	Observation
0	0	
10	0	
8	4	
6	6	
4	8	
0	10	

(b) With reference to Table 1.1, state three conclusions on the effect of auxin and cytokinin on plant growth and differentiation. [3]

The plant hormone auxin plays a key role in growth and differentiation in plants by altering the expression of selected genes. Genes that are activated or repressed by the presence of auxin are known as auxin-responsive genes (ARGs).

ARG expression is controlled by two transcription factors, auxin response factor and auxin repressor. Binding of auxin response factor to ARE recruits the auxin repressor. Fig. 1.2 shows how auxin controls the expression of an ARG.

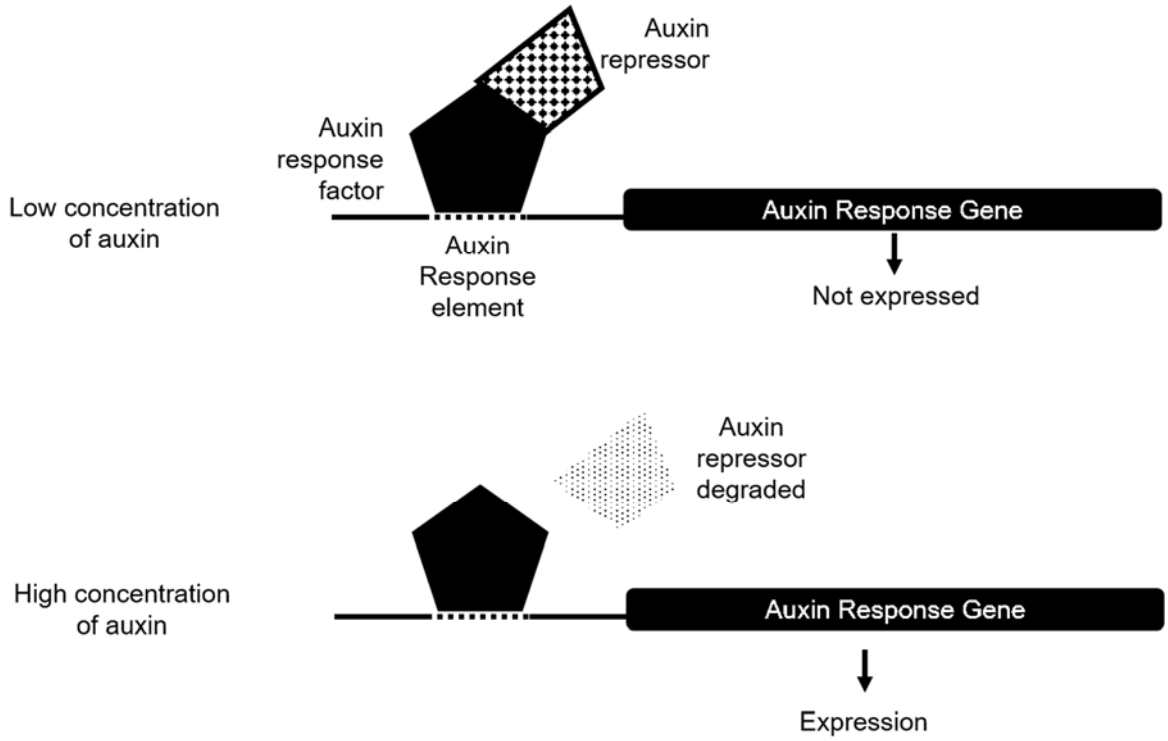


Fig. 1.2

(c) Explain why auxin repressor interacts specifically with auxin response factor. [2]

(d) With reference to Fig. 1.2, state the level at which the gene expression of the following proteins are controlled. [2]

(i) Protein product of ARG

(ii) Auxin repressor

(e) Describe the role of an enzyme involved in each level of control stated in **(d)**. [4]

For many years, bacteria have been genetically manipulated to produce therapeutic proteins for human diseases.

In recent years, plant molecular farming, the practice of using plants to produce human therapeutic proteins, has gained the attention of many pharmaceutical companies. Plants are modified by introducing human gene sequences into their genomes, which serve as templates for protein synthesis.

(f) Describe how protein synthesis in bacteria cells differ from plant cells. [3]

Plant molecular farming produces therapeutic proteins such as clotting factor XIII.

Individuals suffering from haemophilia A cannot produce functional clotting factor XIII due to a point mutation. They suffer from severe bleeding and need injections of clotting factor XIII throughout their life.

(g) Describe how a point mutation can lead to the production of clotting factor XIII with reduced function. [3]

A study investigates the presence of plant-derived blood clotting factor XIII after injection into a patient suffering from haemophilia A. Blood plasma is extracted from the patient and the proteins in the sample are separated by a technique known as sodium dodecyl sulfate - polyacrylamide gel electrophoresis (SDS-PAGE).

In SDS-PAGE, proteins are first treated with the chemical SDS before they are inserted into wells in a polyacrylamide gel for gel electrophoresis. The proteins are then separated on the basis of size, using the same principle as agarose gel electrophoresis. SDS-PAGE is illustrated in Fig. 1.3.

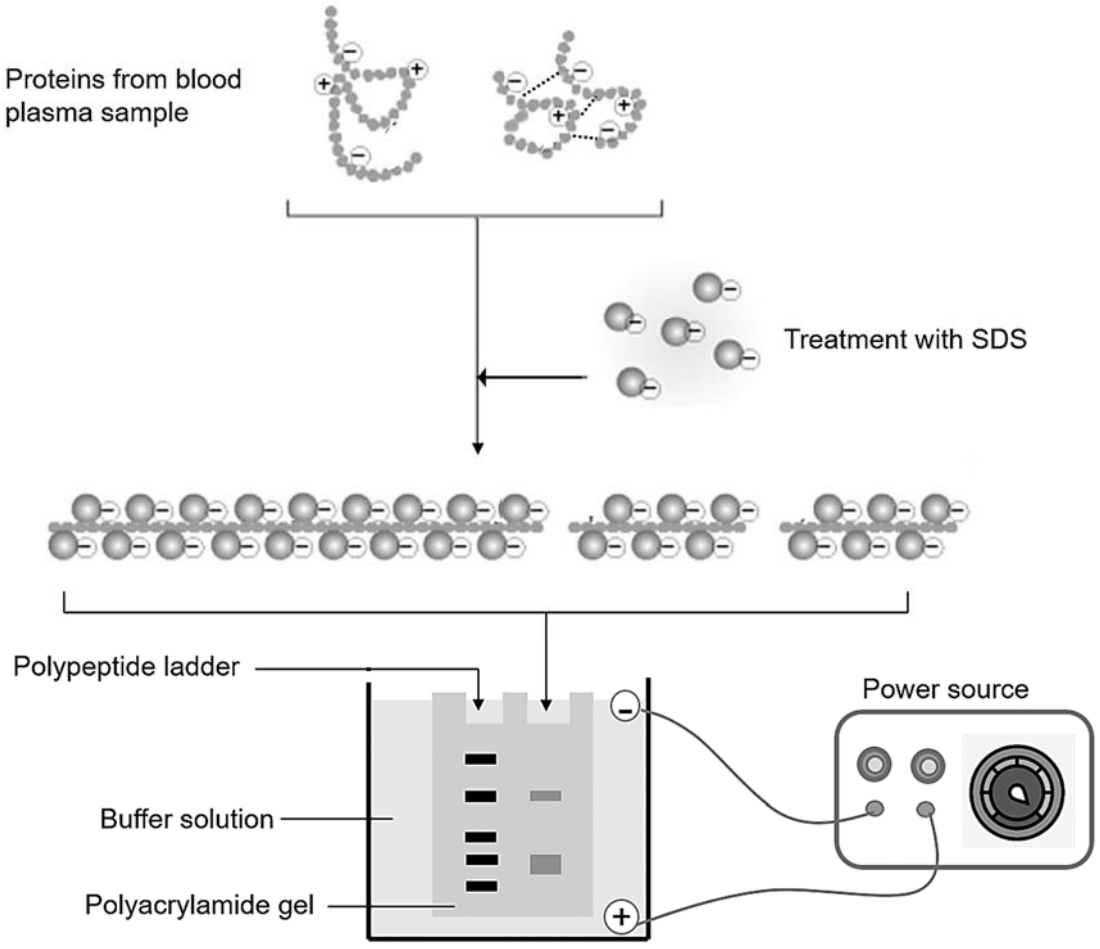


Fig. 1.3

(h) With reference to Fig. 1.3,

(i) describe the effect of SDS treatment on proteins from the blood plasma, and [2]

(ii) describe how polyacrylamide gel electrophoresis is used to separate and determine the length of SDS-treated proteins. [4]

[Total: 25]

2 Rising global temperatures are causing an increase in the frequency and severity of extreme climatic events like heat waves.

A study on heat waves in India tracked the mean summer temperatures from 1960 to 2009 and attributed the temperature changes to greenhouse gas emissions. Scientists warned that if greenhouse gas emissions continue to rise at the current rates, there may be severe impact on crop yield and livestock that can lead to population mortality.

Fig. 2.1 shows the result of this study.

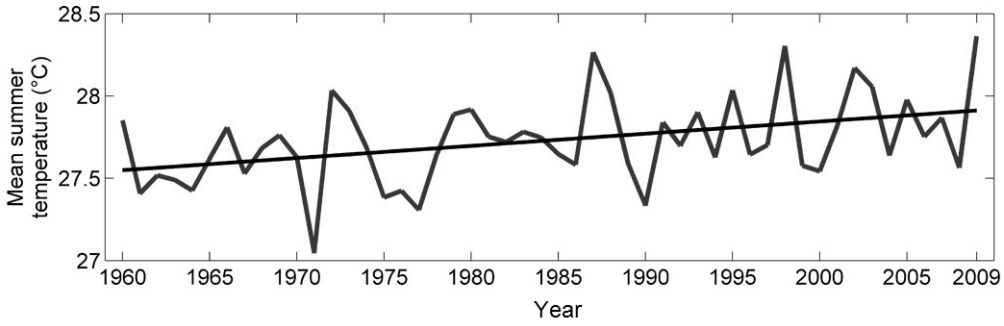


Fig. 2.1

Source: Mora et. al., 2017

(a) With reference to Fig. 2.1, describe the change in summer temperatures since 1960 and explain how this may be attributed to greenhouse gas emissions. [3]

To better understand the impact of heat waves on population mortality, a concurrent study on crop yield was conducted during the same time period. Table 2.1 summarises the yield of wheat and maize plants.

Table 2.1

crop	mass of harvest / million tonnes		change in yield / %
	1960	2009	
Wheat		127.40	+ 30
Maize	78.20		+ 5

(b) (i) Complete Table 2.1. [2]

(ii) Explain the change in wheat yield from 1960 to 2009. [2]

(iii) Scientists attributed the lesser increase in maize yield to decreased viability of maize seeds. Explain why this may be true. [2]

(c) State why such increases in crop yields will not sustain with further increase in temperatures. [2]

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Buffaloes play a major role in sustaining India's agriculture. In another study on heat waves, scientists used buffalo T lymphocytes to investigate the effect of heat stress on livestock's vulnerability to diseases.

The expression of HSP60, a heat-shock protein, is upregulated in response to heat stress. Fig. 2.2 shows the role of HSP60 in PKC signaling. PKC signaling is triggered by the CXCR4 receptor.

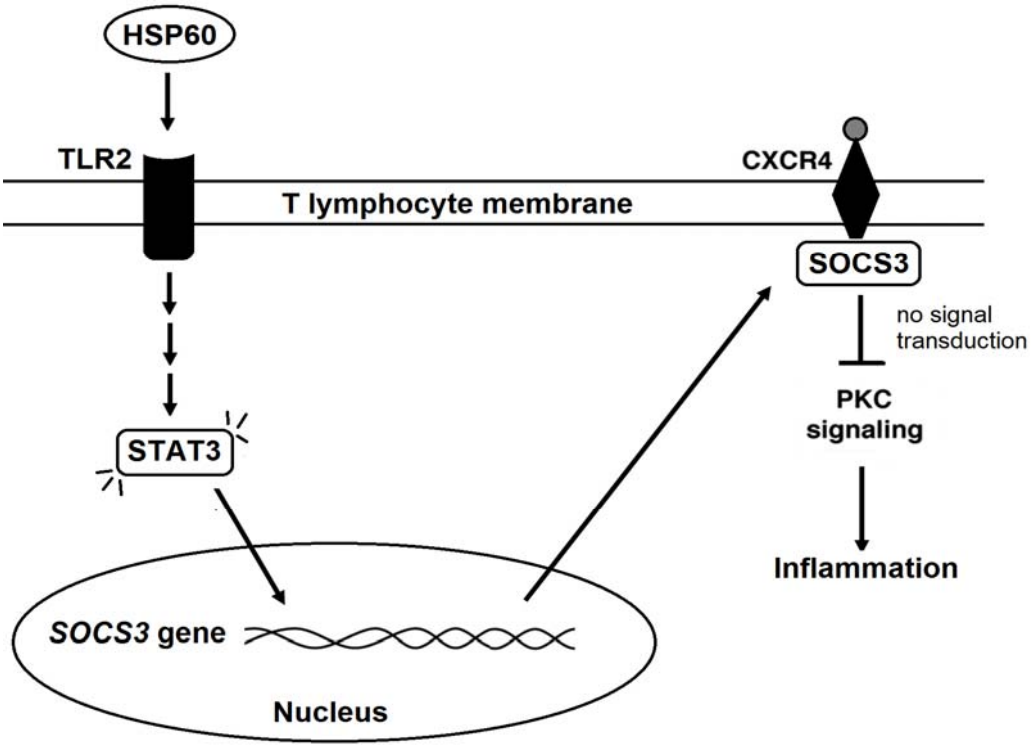

Fig. 2.2

(d) (i) Inflammation is part of the innate immune response.

Describe what is meant by innate immune response. [2]

(ii) With reference to Fig. 2.2, describe how heat stress results in decreased inflammation in buffaloes. [5]

(iii) Suggest how decreased inflammation increases buffaloes' vulnerability to diseases. [2]

Further investigation of HSP60 protein reveals molecular homology across various species of buffaloes.

Fig. 2.3 shows the DNA sequences of the same segment of *HSP60* gene in various buffalo species. Shaded regions indicates similarity with the common ancestor.

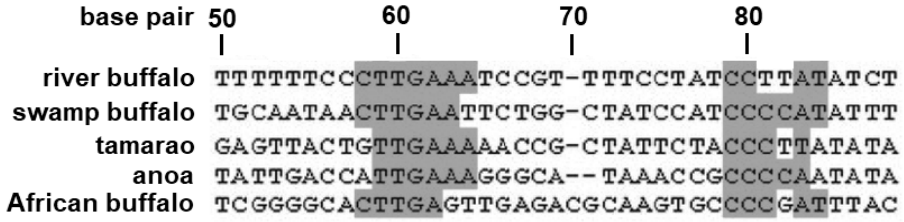

Fig. 2.3

(e) Explain how the molecular data in Fig. 2.3 supports Darwin's theory of evolution. [4]

(f) State which species of buffalo is most closely related to the common ancestor. [1]

[Total: 25]

Section B

Answer **one** question in this section.

Write your answers on the line paper provided at the end of this Question Paper.

Your answers should illustrated by large, clearly labelled diagrams, where appropriate.

Your answers must be in continuous prose, where appropriate.

Your answers must be set out in parts **(a)** and **(b)**, as indicated in the question.

3 **(a)** Describe the polymerisation of different types of biomolecules in a plant and explain how these biomolecules allow plant growth and survival. [15]

(b) All living organisms (autotrophs and heterotrophs) require energy to survive. Outline the processes in which they obtain energy and explain the advantage of each process to the organism. [10]

[Total: 25]

4 **(a)** Cancer is a disease associated with abnormal cell division with the potential to invade other parts of the body. Outline how genetic and environmental factors cause cancer and explain why it is challenging to cure cancer. [15]

(b) Discuss the role of constituent biomolecules of the cell surface membrane in the movement of substances across the membrane. Explain the need for a variety of transport mechanisms. [10]

[Total: 25]