UNIVERSITY OF CAMBRIDGE

NATURAL SCIENCES TRIPOS Part 1A

Tuesday 5 June 2012 9 to 12

BIOLOGY OF CELLS - THEORY

*Answer **Question 1** (Section A) **and three questions** from Section B.*

Section A carries 33% of the marks and Section B carries 67% of the marks for this paper.

*Write on **one** side of the paper only.*

***Answers** from **Section A** must be tied up in a **single bundle** with a blue coversheet.*
***Each answer** from **Section B** must be **tied individually** with a blue coversheet, on which the question number is written clearly.*
Enter the numbers of the 3 questions you have answered from Section B on the yellow coversheet and leave this loose on top of your pile of answers.

Candidates should write their examination number on each coversheet.

STATIONERY REQUIREMENTS
Script paper
Plain paper
Rough work pad
Blue coversheets
Yellow coversheet
Tags

SPECIAL REQUIREMENTS
Approved calculators allowed

You may not start to read the questions printed on the subsequent pages of this question paper until instructed that you may do so by the invigilator

SECTION A

(Suggested time: not more than one hour. Lengthy answers are not required. Answer all parts of Question 1. Parts a–o of Question 1 carry equal marks.)

Question 1.

(a) With the aid of a diagram, describe the differences between Gram-positive and Gram-negative bacteria. How might these differences be important in the treatment of human disease?

(b) What is the molecular basis for the differences between starch, glycogen and cellulose?

(c) Why is the peptide bond planar? What stereoisomer does it normally form and why?

(d) How do sterols aid membrane stability?

(e) Briefly discuss why, in mammals, the conversion of pyruvate to acetyl-CoA is an important regulatory step.

(f) Outline three different strategies used by living organisms to capture energy from their environment.

(g) Describe briefly two experimental observations made by geneticists during the first half of the 20^{th} century that appeared to contradict Mendel's view of inheritance. In each case state clearly which specific aspect of Mendel's hypothesis is being challenged.

(h) Which two pieces of experimental evidence were instrumental to the development of Watson and Crick's model of B-form DNA?

(i) Describe the "loop" (also known as the "trombone") model for DNA replication in *E. coli*.

(j) Briefly describe three strategies organisms use to balance the dosage of products from genes located on the X chromosome.

(k) Some cytoplasmic organelles contain DNA. Briefly outline the current thinking about the origin and function of this DNA.

(l) Give examples of how viruses alter the host cell cycle.

(m) What is the zone of polarising activity (ZPA)?

(n) What is a fate map? Illustrate with two annotated examples.

(o) How are pseudopodia localised appropriately in the *Dictyostelium* chemotaxis response?

SECTION B

(Suggested time: two hours. Answer three questions. All questions carry equal marks.)

2. The helix underpins biology. Discuss this statement in relation to the structure of both DNA and proteins.

3. Describe the journey of a glycosylated integral membrane protein from the ribosome to insertion into the cell membrane in a eukaryotic cell.

4. Discuss how the breakdown of glucose to pyruvate or lactate, and the reverse process, are both made energetically favourable. How are they regulated to prevent waste of energy?

5. Explain the main differences between mitochondria and chloroplasts.

6. Describe the principles underpinning the construction of a genetic map. In what ways would you expect a physical map of the same chromosome (constructed by analysis of DNA sequence data) to differ from the genetic map?

7. Describe the similarities and differences between transcriptional regulation at bacterial and eukaryotic promoters. In your answer explain why the process of attenuation (gene regulation by transcriptional termination) is generally limited to prokaryotic organisms?

8. Describe the structural features of eukaryotic chromosomes required for successful replication and transmission.

9. Discuss the central role of protein phosphorylation in the cell division cycle.

10. Describe in detail two signaling pathways leading to the regulation of eukaryotic gene expression. Use as your examples one pathway in which inactivation of a negative regulator is the primary signaling event and another pathway in which upregulation of an activator is central.

END OF PAPER