UNIVERSITY OF CAMBRIDGE

NATURAL SCIENCES TRIPOS Part 1A

Tuesday 3 June 2014 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) Use a diagram to describe how you would distinguish an enzyme that is allosterically controlled from one that obeys Michaelis-Menten kinetics.

(b) Explain why uracil is one of the four bases in RNA, but DNA contains thymine instead.

(c) Explain the structural basis of phospholipid diversity using a labelled diagram.

(d) Briefly, describe an experiment that tests for rotational movement of F-ATPase sub-units.

(e) Outline the likely journey of a nitrogen atom from the atmosphere to a beef sandwich.

(f) In metabolism what are activated carriers and why are they so common in metabolic pathways?

(g) Petite mutants in yeast can be nuclear or cytoplasmic. What pattern of inheritance would you expect in the case of (i) nuclear and (ii) cytoplasmic mutations?

(h) How does a eukaryotic cell pack two metres of DNA into the nucleus?

(i) Describe the role of sigma factors in promoter recognition in prokaryotes.

(j) Explain how DNA fingerprinting works.

(k) How does p53 function as a tumour suppressor?

(l) Describe three methods that can be used to detect apoptotic cells.

(m) What are homeotic mutations? Give one example each for a homeotic mutation in an animal and in a plant. Outline basic similarities and differences between animal and plant homeotic genes in terms of genomic arrangement and protein structure.

(n) Describe how quorum sensing controls bioluminescence in *Vibrio fischeri*.

(o) Briefly describe two examples of signalling processes in eukaryotes that use cytosolic receptor proteins to detect the initial stimulus molecule.

SECTION B

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

2. Genes are almost all in the nucleus, but proteins are required at many different, specific places within and outside cells. How does the eukaryotic cell solve this transport and sorting problem?

3. The polysaccharides are constructed from a limited repertoire of simple sugars and their derivatives. Explain how the different organisation of bonds between sugar residues gives rise to diverse polysaccharide structures, and how this defines their utility.

4. Why is the direction of transport of electrons and hydrogen ions across membranes important in ATP synthesis?

5. Describe with examples how regulation is exerted in metabolic pathways in the short and longer term.

6. The pioneering experiments in gene cloning by Cohen and Boyer in the 1970s were possible because these scientists brought together three disparate areas of prokaryotic genetics. Describe each of these three areas in its own right and then explain how their combination enabled the development of DNA cloning technology.

7. "Bacteria and eukaryotes have similar strategies to replicate their DNA". Discuss.

8. Describe, with examples, how RFLPs and SNPs can be used for identifying human disease genes.

9. "Embryonic development begins with the mother". Discuss and give examples of experiments that support your argument.

10. "Secondary messengers are essential components of eukaryotic signal transduction pathways." Using examples, discuss the validity of this statement.

END OF PAPER