

NATURAL SCIENCES TRIPOS Part IA

Tuesday 7 June 2011

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) Using diagrams, illustrate the structures that bring about cytokinesis in (i) an animal and (ii) a plant cell.
- (b) Sketch the energy diagram for an exergonic reaction. Include in your sketch the reaction path for the same reaction catalysed by an enzyme. Briefly explain how enzymes help to drive endergonic reactions.
- (c) Use an annotated diagram to explain how transport of glucose from the intestinal lumen across an epithelial cell is achieved.
- (d) How does the intermembrane space of the mitochondrion differ from the mitochondrial matrix?
- (e) Briefly discuss why the conversion of glucose to glucose 6-phosphate is an important regulatory step in glycolysis.
- (f) Describe the interconversion of photons, quanta and energised electrons during photosynthesis.
- (g) Pre-Mendelian theories suggested that inheritance involved either irreversible mixing of the characteristics of the two parents (Hippocrates), or that information came from the male and raw materials from the female (Aristotle). Describe experiments performed by Mendel which demonstrated that both theories were wrong.
- (h) Describe, with the help of diagrams, how errors in (i) meiosis I and (ii) meiosis II could give rise to aneuploidy.
- (i) Briefly outline the post-transcriptional processing events that take place during the generation of eukaryotic mRNA.
- (j) How can DNA microarrays contribute to the study of human diseases?
- (k) Outline the role of protein kinases in mitotic control.
- (l) Describe connections between viruses and cancer.

- (m) What is the significance of the Bicoid and Oskar proteins for *Drosophila* development? How are they localised to opposite poles of the egg cell?
- (n) How are cells assigned to form mesoderm in (i) *Drosophila* and (ii) *Xenopus*?
- (o) Describe an abscisic acid receptor of plants.

SECTION B

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

2. Eukaryotic cells are subdivided into intracellular compartments. Discuss the advantages and challenges of this organisation.
3. Summarise the forces that hold the tertiary structures of proteins together. Discuss, with examples, the roles of these forces in supersecondary structures.
4. Discuss the mechanism and importance of F-ATPases.
5. In mammals, two carbons enter the citric acid cycle as acetyl-CoA but two carbons leave as CO₂. Discuss the metabolic implications for fat and glucose metabolism.
6. Describe how the study of bacteria and their viruses (bacteriophages) laid the foundation for the development of recombinant DNA technology in the 1970s.
7. Compare and contrast DNA replication in eukaryotes and prokaryotes.
8. Compare and contrast linkage and association studies for identifying human disease genes.
9. How do growth factors, stem cells and programmed cell death contribute to the control of cell proliferation in multi-cellular organisms?
10. Describe the roles of G-proteins in signalling.

END OF PAPER