NATURAL SCIENCES TRIPOS Part 1A

Tuesday 31 May 2016 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 your examination number on each answer booklet cover.

***Section A: put all short question answers from Question 1 into one or more 20 page answer booklets**, tied up in a **single bundle**.*

***Section B: start a new 8 page answer booklet for each question and write the question number clearly on its cover**. When using more than one answer booklet for a question, tie together the answer booklets containing parts of the same answer.*

***Yellow coversheet: enter the numbers of the 3 essay questions you answered** from Section B and leave this loose on top of your pile of answer booklets.*

STATIONERY REQUIREMENTS

Answer booklets (1 x 20 page and 3 x 8 page)
Rough work pad
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

(Answer all parts of Question 1. Each part carries equal marks. Suggested total time: not more than one hour. Lengthy answers are not required.)

Question 1

(a) How does DNA exemplify the properties required of any molecule used to store genetic information in a biological system?

(b) What is the anomeric carbon atom in polymers of D-glucose? Why is it important?

(c) What are the properties of the transition-state complex of an enzyme-catalysed reaction?

(d) Draw and annotate a diagram to explain the important features of an ion channel protein.

(e) Briefly describe why fatty acids provide more energy per mole than glucose under oxidative conditions.

(f) Describe three pieces of evidence for chemiosmosis.

(g) Explain how experiments performed by Gregor Mendel refute each of the following assertions:
   (i) in reproduction the male parent provides the information and the female the raw materials (Aristotle),
   (ii) reproduction involves the irreversible mixing of characters from the two parents (Hippocrates).

(h) Briefly describe the key elements of nucleotide excision repair.

(i) What has changed in genome sequencing technologies since the human genome sequence was published? How is this impacting on the understanding of human biology?

(j) What are Single Nucleotide Polymorphisms and how are they used to help characterize human disease?

(k) How do viruses suppress the translation of host cell mRNAs and enable viral mRNAs to be translated instead?

(l) How can a mutation in one of the two alleles of p53 contribute to an increased risk of cancer?

(m) Describe the intracellular signalling pathway that occurs in the signal relay between *Dictyostelium* cells during aggregation.

(n) Describe three changes that occur at the mid-blastula transition in a *Xenopus* embryo.

(o) How are auxins transported in a developing plant embryo?

SECTION B

(Answer three questions, each in a separate answer booklet. All questions carry equal marks. Suggested total time for this section: two hours.)

2. Identify three distinct classes of RNA present in both eukaryotic and prokaryotic cells. Describe the role of each in protein synthesis.

3. It is estimated that half of a cell's ATP supply is used by the plasma membrane Na^+-K^+-ATPase or by the H^+-ATPase. Discuss these proteins and their importance to cells.

4. Explain, with examples, the key mechanisms that allow photosynthetic organisms to convert light energy into ATP and NADPH.

5. How does organic nitrogen in a dead animal in the soil get converted to protein amino acids in living plants?

6. Discuss horizontal gene transfer in bacteria. Describe each of the three main mechanisms involved and how these processes have been important in recent bacterial evolution.

7. Discuss how DNA replication was shown to be both semi-conservative and semi-discontinuous.

8. How is genome-wide analysis of gene expression performed and how can it be used to improve our understanding of biology and disease?

9. Describe the intracellular signalling network that regulates the control of glycogen breakdown in mammalian muscle cells in response to adrenaline.

10. Using *Drosophila* as an example, discuss how experiments in model organisms have led to our current understanding of developmental biology?

END OF PAPER