NATURAL SCIENCES TRIPOS Part 1A

Tuesday 2 June 2015 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.

*You may write on **both** sides of the paper.*

***Put all answers from Section A into one or more answer booklets**, tied up in a **single bundle**.*

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

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

Write your examination number on each mark book cover.

STATIONERY REQUIREMENTS
Answer booklets
Plain paper
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. These carry equal marks. Suggested total time: not more than one hour. Lengthy answers are not required.)

Question 1.

(a) How have scanning and transmission electron microscopy aided the study of cell biology?

(b) Outline *three* techniques you might use to determine the structure of proteins. What are their relative advantages and disadvantages?

(c) One red blood cell is placed in a hypertonic solution of NaCl, another is placed in a solution of $CaCl_2$ equimolar with the NaCl solution. What would you expect to happen and why?

(d) In metabolism, outline how the role of NADPH differs from that of NAD^+.

(e) What is the oxidative pentose phosphate pathway and what are its roles?

(f) Why is the Gibbs Free energy for the hydrolysis of ATP inside the cell lower than the standard Gibbs Free Energy for this reaction?

(g) What are restriction endonucleases and why are they produced by bacteria? Explain briefly how they have been exploited in the biosciences.

(h) Cite *two* pieces of experimental evidence, obtained after the rediscovery of Mendel's work, contradicting Mendel's assertion that reciprocal crosses give the same result.

(i) With the aid of a diagram, briefly describe the key experiment performed to demonstrate that DNA replication is semi-conservative.

(j) What are microarrays, and how can they be used to improve our understanding of biology and disease?

(k) What are the main differences in the transmission of human dominant X-linked and recessive X-linked mutations?

(l) Outline the Notch signalling pathway.

(m) Describe three types of genetic alterations that can create oncogenes. Give an example for each alteration.

(TURN OVER for continuation of Question 1)

(n) How would you generate a fate map of a developing amphibian embryo? What can fate maps tell you about embryo development?

(o) What is the Zone of Polarising Activity (ZPA)? Outline how the ZPA contributes to limb development.

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. How do eukaryotic cells use their cytoskeleton to maintain and change their shape?

3. Proteins are held together by several different forces. Describe these forces and discuss how they contribute to the higher-order structure of proteins.

4. Labelling techniques are used extensively in membrane biology. Describe the key techniques and discuss how they have contributed to our knowledge of membranes.

5. Describe the regulation of glycolysis with particular reference to metabolism in skeletal muscle and the liver.

6. Compare and contrast the methods used to construct genetic maps of *Drosophila melanogaster* chromosomes with those employed to construct a genetic map of the *rII* region of bacteriophage T4. Explain why it was possible to achieve much higher map resolution with T4 than with *Drosophila melanogaster*.

7. Using specific examples discuss how bacteria (prokaryotes) and eukaryotes regulate the transcription of their genes.

8. Describe the molecular basis of photomorphogenesis in *Arabidopsis thaliana*.

9. Outside the cell viruses are inert. What strategies do eukaryotic viruses use to replicate?

10. How has the study of homeotic mutations informed our understanding of animal and plant development? Give examples to illustrate your argument.

END OF PAPER