

NATURAL SCIENCES TRIPOS Part IA

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Tuesday 3 June 2008      9 to 12

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**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.

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. All answers must then be tied together in a single bundle with a **yellow** coversheet.

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

**STATIONERY REQUIREMENTS**

*Script paper*

*Rough work pad*

*Blue coversheets*

*Yellow coversheets*

*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. All parts of Question 1 carry equal marks.)**

**Question 1.**

- (a) What adaptations do spermatozoa have to reduce their size and what are the likely advantages of these adaptations?
- (b) Why are starch and glycogen curved while cellulose is linear, and how does this reflect their functions?
- (c) Tabulate the differences between active and passive transport of solutes across membranes.
- (d) Draw a labelled diagram illustrating the main types of association between proteins and membranes.
- (e) What is functional Magnetic Resonance Imaging (fMRI) and how is it used to monitor metabolism in the brain?
- (f) Sketch the events in a photosystem, from the absorption of a photon to the loss of an electron, indicating their timescales.
- (g) List three different mechanisms by which bacteria exchange genes. Considering the relative exposure of transferred DNA to chemical and physical hazards in each case, comment on the likely effectiveness in nature of these mechanisms of exchange.
- (h) How are the genomes of retroviruses replicated?
- (i) How do attenuators regulate transcription in bacteria?
- (j) What are RFLPs and how can they be used to track a disease in a pedigree?
- (k) Briefly outline how the gene responsible for a recessive X-linked human disease could be cloned if a cytologically visible deletion were available.
- (l) Briefly describe how proteins are imported into chloroplasts.
- (m) What are the key steps whereby phytochrome regulates photomorphogenesis in plants?

- (n) What determines the timing of the midblastula transition in the amphibian embryo?
- (o) Briefly explain the two main mechanisms that influence a cell's fate during development.

**SECTION B (All questions carry equal marks)**

2. Compare and contrast the structure of proteins and DNA. Discuss how the structures of these macromolecules depend on the chemical properties of their monomer building blocks.
3. Discuss the trafficking of proteins to membranes.
4. Describe the metabolic changes, with reference to specific pathways, that accompany (i) missing breakfast, and (ii) subsequently having a large lunch. Briefly, contrast the changes occurring in (i) to those in an extended fast.
5. Describe, with examples, how electron transfer reactions are used by cells to carry out energy-requiring processes.
6. Bateson and Punnett's work on the inheritance of flower colour and pollen shape in the sweet pea was inconsistent with Mendel's assertion that pairs of characters were inherited independently. How did Morgan explain these uncomfortable observations, and how did this explanation provide a foundation for the subsequent development of genetic mapping?
7. How is the abundance of individual proteins regulated in eukaryotic cells?
8. Describe the structure and function of the elements that are necessary for the normal behaviour of a eukaryotic chromosome.
9. How is the eukaryotic cell division cycle regulated?
10. Compare and contrast the models for patterning the antero-posterior and the proximo-distal axes of the developing vertebrate limb.

**END OF PAPER**