ENGINEERING TRIPOS PART IIA

Monday 2 May 2011 9.00 to 10.30

Module 3G3

INTRODUCTION TO NEUROSCIENCE

*Answer not more than **three** questions.*

All questions carry the same number of marks.

*The **approximate** percentage of marks allocated to each part of a question is indicated in the right margin.*

There are no attachments.

STATIONERY REQUIREMENTS
Single-sided script paper

SPECIAL REQUIREMENTS
Engineering Data Book
CUED approved calculator 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

1 (a) The following questions are about hearing.

(i) Describe the processes that allow sound to be decomposed into different frequencies in the inner ear.

(ii) Describe the mechanisms that allow sound to be localised. Include in your description details of how these mechanisms apply to sounds of different frequencies.

(iii) Describe how neurons in the auditory pathway may become tuned to particular changes in sound frequency over time such as an increase or decrease in frequency. [50%]

(b) The following questions are about vision.

(i) Write brief notes on

A. Complex cells

B. Retinotopic maps

C. Optical imaging of the brain

D. The contrast-sensitivity function

E. Physiological depth cues

(ii) The brain is said to code efficiently for colour. Explain what this means and the evidence that supports the statement. [50%]

2 (a) Write brief notes on:

(i) Label-line codes

(ii) Coarse coding

(iii) Tapped delay lines

(iv) The role of gamma efferents in spindles

(v) Reflex reversal [50%]

(b) The following questions are about the action potential.

(i) What is a reversal potential and what determines its value?

(ii) What are the roles of voltage-sensitive ion channels in the action potential?

(iii) Describe the factors that can increase action potential propagation velocity. [50%]

3 (a) State for each of the following substances whether they are neurotransmitters produced by the brain, neurotransmitter agonists, neurotransmitter antagonists, secondary messengers, or retrograde messengers:

(i) NMDA

(ii) glutamate

(iii) serotonin

(iv) NO

(v) AP5

(vi) Ca^{2+}

(vii) dopamine

(viii) AMPA

(ix) cAMP

(x) GABA

[20%]

(b) Describe the main neural pathway involved in the gill withdrawal reflex of Aplysia and the sequence of events in this pathway during a reflex response. [30%]

(c) Explain what changes at the cellular level underlie the following three aspects of LTP as measured in extracellular recordings:

(i) increased amplitude of the population EPSP, [10%]

(ii) increased amplitude of the population spike, [20%]

(iii) decreased latency of the population spike. [20%]

4 (a) Explain how the NMDA receptor acts as a coincidence detector. Include in your explanation which cellular-molecular events need to coincide for detection, and how detection of coincidence is signalled by the NMDA receptor? [30%]

(b) Describe the differences between associative and non-associative forms of learning in Aplysia at the level of behaviour. [20%]

(c) Describe three different experimental conditions in which it can be shown that the activity of dopaminergic cells is consistent with a temporal difference error signal. [30%]

(d) Describe what is the standard consolidation theory, and how experiments with hippocampal lesions support it? [20%]

END OF PAPER