



First Semester

June 2001

Student Number _____

Surname _____

Given name _____

Physiology of the Auditory System 510

INSTRUCTIONS

Time allowed: 3 hours

Reading time: 10 minutes

This paper contain 2 parts on 10 pages

Part A is worth 50 marks & contains short answers

ANSWER ALL QUESTIONS IN THE SPACES PROVIDED

Part B is worth 50 marks& contains 5 essays

ANSWER 4 of the 5 ESSAYS

Section A – Short answer questions.
Answer ALL questions in the spaces provided.

1. In the space indicated, give the correct name for the entities described in the list below. Only a single word or short phrase is required.

i) Connects scala tympani to the cerebrospinal fluid

.....

ii) Connects scala vestibuli to scala tympani

.....

iii) Connects scala media to the saccule

.....

iv) Connects the utricle to the endolymphatic sac

.....

v) Sense organs that detect angular acceleration of the head

.....

v) The membranous termination to scala tympani

.....

vi) The opening into the osseous labyrinth into which the stapes footplate inserts

.....

vii) The cellular boundary between scala media and scala vestibuli

.....

viii) The ion-pumping epithelium on the lateral wall of scala media

.....

ix) The “tight” apical boundary of the organ of Corti that faces scala media

.....

x) The fluid contained in scala tympani and scala vestibuli

.....

xi) The fluid contained in scala media

.....

x) Fine structures that are the site of transduction on the apical surface of the hair cells

.....

xi) An acellular accessory structure lying above the organ of Corti

.....

xii) An acellular accessory structure on which the organ of Corti sits

.....

xiii) The high frequency end of the cochlea

.....
xiv) The low frequency end of the cochlea

.....
xi) Contains the cell bodies of the primary auditory neurones

.....
xii) The central core of the cochlea

.....
xiii) Tunnel through which the central axons of the primary auditory neurones emerge

.....
xi) Branch of the basilar artery that supplies the inner ear

.....
xii) The complex arterial system that provides the blood supply to the brainstem

.....
xiii) The major artery supplying the cortical regions involved in hearing

.....
xiv) The lobe of the brain that contains the primary auditory cortex

.....
xv) The nuclei in the brain where binaural interactions first occur

.....
2. In the space indicated, describe the salt composition of

i) scala media.....

ii) scala tympani.....

iii) scala vestibuli.....

iv) hair cell cytoplasm.....

3. Briefly explain the force/s that determine ion flow through the hair cell transduction channels.

4. Which cells produce the cochlear microphonic and the summing potential, and what is the explanation for any differences between them?

5. Name the two ions which have the most profound influence on the resting potential and the action potential of nerve cells and describe and briefly explain the effect of changing the extracellular concentrations of these ions on these two electrical phenomena.

6. Name and describe with diagrams the process by which cells such as hair cells, or nerve cells, release neurotransmitters, and how these neurotransmitters act on other cells. Your answer should include the ions and membrane molecules involved at each stage.

7. Draw a diagram of a typical nerve action potential, with approximate time and voltage scales, and clearly explain what is meant by the term “threshold” with respect to action potential generation.

8. Briefly explain what is meant by an ion “pump” and explain what the normal role of ion pumps is in the nervous system.

9. Draw a carefully labelled block diagram showing the major nuclei and their interconnections in the ascending auditory pathway from one cochlea to the cortex. Your diagram should indicate clearly any decussations in the pathways.

10. In vestibular physiology, the vestibulo-ocular reflex (VOR) is used by ear nose and throat surgeons and neurologists to test the function of one part of the vestibular system.

(a) Describe the VOR, and explain which part of the vestibular system is checked by this test and why the method specifically tests this section rather than others?

Suppose a patient were lying horizontally on their back (head up 30 degrees), and warm water was flushed into their left ear to stimulate the semicircular canal on that side.

(b) What is this test called?

(c) In a normal subject, which way would the fluid move in the horizontal semicircular canal, which way would the subject perceive their head to move, and which way would the eyes move slowly (due to the VOR) and rapidly (saccadic movement)?

(d) What is meant by "fast adaptation" when referring to the firing of the auditory nerve to a tone-burst?

(e) List five possible causes of sudden onset deafness.

(f) There are two main mechanisms by which we mammals obtain directional cues from sounds in the environment. What are the two main mechanisms for directional hearing?

Section B – Essay questions.
Answer FOUR (4) of the five questions below.

Answer each in a SEPARATE answer book.
Each question is worth equal marks and should take about 20 minutes.

1. (a) Draw a detailed diagram of the middle ear cavity, labelling all of the important parts (at least twenty features are expected).

and

- (b) Draw a detailed cross-section of the organ of Corti, labelling important features (at least twenty features are expected).

2. One of the typical signs of outer hair cell damage is hyper-recruitment, or simply “recruitment”. Describe the phenomenon of recruitment as observed clinically, and explain its origins in terms of the growth of vibration of the organ of Corti with sound level in a normal and damaged cochlea, AND in terms of the frequency tuning curves of a population of auditory neurones within the cochlea. How does recruitment relate to the sensation of an abnormal pitch shift accompanying cochlear damage known as “diplacusis”?

3. Explain the origin of the frequency tuning curve of a single auditory neurone in terms of the vibration of the organ of Corti in the cochlea. Include a description of the travelling wave motion along the cochlea, and the role of mass, stiffness, damping and the active process of outer hair cells in assisting vibration. Explain clearly the difference between the tuning with and without outer hair cell assistance.

4. In your lectures, most forms of cochlear hearing loss were categorised in terms of the four B’s: Block, Bias, Battery and Bundle. What was meant by these terms, give examples of each, and briefly suggest the symptoms which might accompany such problems?

5. Explain the mechanisms of peripheral masking or two-tone suppression, and explain the meaning and the physiological origin of the phenomenon commonly referred to as “the upward spread of masking”.

