Resting Membrane Potential of the Stria Cells of the Guinea-Pig

The object of this paper is to examine the effect of potassium ions on the resting membrane potential of the stria cells. A higher concentration of potassium ions in the external environment of muscle cells or nerve cells has been known to depolarize the resting membrane potential. The present study was undertaken because the stria cells face the endolymph, and the endolymph contains a high concentration of potassium ions (150 mEq/l) and the resting membrane potentials have not been previously measured, although Bekesy\textsuperscript{a} et al. did report that inside the stria cells the potential was negative, but gave no measurements.

**Method. Electrode.** Fine microglass electrode with tip diameter between 0.5 μm to 0.8 μm were used to record the endocochlear DC potential from the scala media and the resting membrane potential of the stria cells. The electrodes were filled with 3 M KCl. The resistances were checked before using, only those in the range between 15 MΩ to 30 MΩ and with low tip potential (between 5-8 mV) were selected for measurements. A high input impedance differential electrometer amplifier Keithley 604 or Nikon Koden microglass electrode amplifier was used for recording.

**Measurements of resting membrane potentials in vivo.** Coloured and white guinea-pigs were used throughout this study. The animal was deeply anaesthetized under Nembutal, and the head was firmly fixed on a headholder. The bulla was opened as previously described\textsuperscript{b}. A small hole (diameter about 50-80 μm) just above the middle region of the stria-ligamentum was made on the bony cochlear wall by means of a fine steel-needle which bare 3 sharpened edges. Care was taken to avoid bleeding. The Ag-AgCl-microglass electrode was adjusted to a 90° direction so that it could pass into the hole and through the cells of ligamentum spirale and the 3 layered cells of stria vascularis. The insertion of the electrode with the aid of a Leitz manipulator was advanced gently in order to show the clear potential drop negative potential just inside the stria cells and the 3 layered cells of stria vascularis. The attachment of the electrode to the stria regiosus was demonstrated with 90° direction so that it could pass into the hole and through the cells of ligamentum spirale and the 3 layered cells of stria vascularis. Therefore, regarding adrenergic receptors and adenyl cyclase system, it is speculated that a similar relationship exists between the aorta of SHR and the cutaneous resistance vessels of rabbit ear, and such characteristics may be associated with an increase in the vasoconstrictor response to NA in the artery of SHR\textsuperscript{b}.

**Zusammenfassung.** Die Wirkung von Noradrenalin auf den peripheren vasculären Widerstand wurde am isolierten Kaninchenohr untersucht und festgestellt, dass die Wirkung einer α-adrenergen Stimulation durch β-adrenergen Stimulation verstärkt wird.

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Measurements of resting membrane potentials of the stria cells in vitro. After recording the endocochlear DC potential, the cochlea was cut in half, and the part without the modiolus but with the intact stria vascularis was used for measurements of the resting membrane potentials. The opened cochlea was washed thoroughly either in Ringer’s solution or in artificial endolymph. Substrates were added sometimes in both solutions and phosphate buffer at pH 7.2 to 7.6. Simple media as 150 mM KCl or 150 mM NaCl were also used. All these media were saturated with oxygen before using.

The surface of the stria vascularis was placed facing upwards in a small glass chamber and fixed with Histo-acryl blue. In this manner the electrode was brought into contact with the surface of a stria cell. Each surface cell had an area about 100 μm² (Figure 1). The medium was replaced continuously, except when the recording was in progress.

Two methods were used for inserting the electrode in order to obtain the resting membrane potential: 1. with a Leitz manipulator and 2. combination with a Leitz manipulator and a ‘Jolter’ (manufactured by Nihon-Koden Electronic Co. Tokyo, Japan). This instrument the ‘Jolter’ can vibrate through its driver and is triggered with a stimulator, in an upwards direction with an accuracy of e.g. 1 μ, 2 μ, or 3 μ. After first observing on the oscilloscope that the tip of the electrode was very close or in contact with the surface of the stria cell, current was then applied from the stimulator; a sudden and definite vibration was produced by ‘Jolter’, then the tip of the electrode was inserted into the cell. All the experiments were measured at room temperature and some were measured at 22°C; a few at 36°C.

Results. Resting membrane potential of stria cells in vivo. Figure 2 shows the endocochlear DC potential recording from the scala media. As the fine electrode passed through the ligamentum spirale and the 3 layers of the stria cells, the voltage dropped to negative. The value was between negative 12 mV to negative 20 mV in 30 different insertions. The negative potential immediately before the registration of positive endocochlear potential must be from the resting membrane potential of stria cells, since the stria cells are the only cells in direct contact with the endolymph in this region. Nevertheless, as the electrode passed through the cell, either totally or partially damaged it, the exact value of the resting membrane potentials could not be assessed by this method. Many attempts were made to record the resting membrane potentials of the stria cells from an opening made at the apex of the cochlea, the electrode being arranged in a way that it could pass through the Reissner’s membrane into the scala media and onto the stria cells. No stable recordings were obtained. It was necessary to record the resting potential in vitro.

Resting membrane potential in vitro. When the electrode was inserted into a surface cell of the stria vascularis with the aid of the Leitz manipulator, there was a sharp negative potential often followed by rapid depolarization until the potential reached a somewhat stable level. This rapid depolarization was probably due to an injury of the