

A short story of Victor Hensen and a cell of the internal ear

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Abstract

Cells of Hensen of the internal ear are known from more than 100 years and investigations on their function(s) are still waiting for an answer. They were first described by the German scientist from Kiel, Christian Andreas Victor Hensen. This short historical review gives some details about the life, scientific activity and perspectives opened by the work of Victor Hensen.

Keywords: Victor Hensen, cell, internal ear.

☞ Introduction

One of the most fascinating structures of the human body is the internal ear, in terms of both development and organization. Along the years, this delicate and extremely efficient organ drew attention to many researchers in anatomy and physiology. Microscopic description and experimental studies done in the last century significantly improved our knowledge on the structure and function of the internal ear. As expected, the organ of Corti is thought to be a histological 'marker' of the internal ear, and for many decades the name of famous scientists was linked to some specific cells. In respect to this, we mention here Deiters' cells, also known as phalangeal cells, associated to the hair cells in the cochlea.

Besides hair cells and Deiters cells, the organ of Corti also contains three other types of epithelial cells called cells of Claudius, Boettcher and Hensen, after the name of scientists who first described them in the XIXth century. These cells are assumed to maintain the composition of the endolymph, but actually, their function(s) have not been completely established. Hensen cells, how they were discovered, which is their function(s), maybe who really Hensen was, and perhaps other questions will be answered in this brief historical review.

☞ A brief biography

Christian Andreas Victor Hensen was born by February 10, 1835, in the German city of Schleswig. His father, Hans Hensen, was director of the school of deaf and dumb at Schleswig and his mother, Henriette, was the daughter of the court physician Carl Saudicani. From the two marriages of his father, Victor Hensen had eight sisters and six brothers [1].

In 1845, Victor Hensen graduated the school of the cathedral of Schleswig and then the grammar school at Glückstadt in Holstein in 1854.

He studied medicine at the Universities of Würzburg, Berlin and Kiel and passed the final examination in 1858. He sustained the Doctorate Thesis in 1859, with a paper on epilepsy and urinary secretions [2]. After the doctorate, he worked at the university of Kiel, initially as prosector (until 1864) and then as professor of physiology at the University of Kiel between 1871 and 1911. During these four decades, he was the head of five marine biological expeditions. He married Andrea Katarina Friederika Seestern-Pauly, and they had two sons and two daughters. From 1878, he was the director of the Institute of physiology of Kiel. He was dean of the Faculty of Medicine for several years and Rector of the University of Kiel many times (Figure 1). Victor Hensen was an active member of the Leopoldine Academy and corresponding member of the Prussian and Bavarian academies of Science [1]. Until the end of his life, Hensen was the chairman of the Prussian Marine Commission. He retired at the age of seventy-six and died in Kiel in 1935.



Figure 1 – Christian Andreas Victor Hensen (1835–1924).

☞ Cells of Hensen

Cells of Hensen are found in the organ of Corti and are considered to be supporting cells for hair cells. The cells described by Hensen are located in the organ of Corti in an area delimited by the phalangeal processes

of the third row of supporting cells and by cells of Claudius. They form a layer of tall cells, arranged in several rows and rest on the basilar membrane of the cochlea [3, 4]. The shape of Hensen cell is different in different area of the cochlea. They are arranged in a single cell layer and are cuboidal in shape with elongated apical pole in the basal coil of the cochlea. In this area, the cytoplasm contains few organelles and no other specific structures. In the apical coil of the cochlea, Hensen cells are globular in shape and show an elongated apical surface; their cytoplasm contains more organelles and lipid droplets [4]. The presence of lipid droplets in the cytoplasm is well known from more than 80 years [5, 6], but their functional significance is still unknown. Recently, it was found that annexin A1 is stored in the lipid droplets and can mediate the anti-inflammatory effects of glucocorticoids in the cochlea [7]. The tectorial membrane is attached to Hensen's cells by its lateral end [8]. This anchorage may influence the connection of this membrane with hair cells.

Cayé-Thomasen P *et al.* [9] have shown that these cells express erythropoietin receptors and cyclooxygenase 2. The expression of these molecules is significantly altered by sound exposure [10]. Based on these data, it was suggested a cytoprotective function of products generated by cyclooxygenase 2 in hearing and in cellular stress conditions, like intense noise exposure. It was suggested that Hensen cells may play a regulatory role in ion and water balance of cochlear fluids through the expression of purinergic receptors and calcium activated chloride canals [11]. The involvement of Hensen cells in the transport of ion and water is strongly supported by their ultrastructure [12].

Ten years ago, Hensen cells were shown to express heregulin and thus, they can be involved in cell proliferation in the vestibular and cochlear system, particularly for erbB-receptors expressing cells [13]. Hensen cells retain the capacity to differentiate into tectal cells that can give rise to hair cells, and into subtectal cells that differentiate into supporting cells (also called Deiters cells) [14]. The ability of Hensen cells to give rise to new hair cells seems to be induced by the overexpression of Math1 [15].

☞ Victor Hensen as scientist

Hensen was strongly involved in many fields of research, like medicine, chemistry, zoology and marine biology. Based on his findings, we may say today that he was biologist, oceanographer, ecologist and inventor, but does not matter the job, he brought a significant contribution in many fields of science.

The doctor

After graduation of medical studies, Victor Hensen worked as doctor in the lunatic asylum at Schleswig, and so was born the idea of the possible diagnostic relationship between epilepsy and urinary secretion that was the topic of his Doctoral Thesis. Victor Hensen worked for many years in anatomy and embryology at Kiel, and his main area of research was related to sense organs. He discovered the Hensen duct in the ear,

Hensen cells and Hensen stripe [3]. He was a pioneer of histophysiological studies and using these methods, he made some essential discoveries related to the hearing and sight. Starting from 1863, Hensen investigated the decapod hearing organ and the structure of human cochlea. These studies led to the description of Hensen's cells, Hensen duct, and discovered that fibers of the basal membrane increase in length from the base to the tip of the cochlea. He also contributed to better understanding of the structure of the eye and described the "Hensenian zone" in the "Q" section of the skeletal muscle fibers.

The chemist

In chemistry, he worked on the metabolism of carbohydrates. As an active chemist, he invented a method for the extraction of pure glycogen from animal tissues. For years, it was a priority dispute on the discovery of glycogen between Claude Bernard and Victor Hensen [16]. Actually, Hensen verified Claude Bernard's data on the content of glycogen in the liver tissue in the laboratory of Scherer at Würzburg.

The zoologist

He is better known by the scientific community as zoologist, because he coined the term "plankton" and is thought to be the founder of biological oceanography. In birds and mammals, Hensen found a particular transient structure, called later Hensen's node, in the anterior-most site of the primitive streak, which is essential for the development. Hensen's node gives rise to the notochord [17]. Later studies showed that transplantation of the Hensen's node to an ectopic site in the embryo induces a new axis in the organism. Victor Hensen also investigated fertilization and development of the rabbit and guinea pig, and discovered other structures that retain his name. He studied the earthworms in the garden of the Kiel Institute, and discovered that worms bore down into the ground over one meter deep. The tunnels left are used as guide paths by plant roots.

The marine biologist

Victor Hensen is even better known for his work in oceanography and he is one of the first well-known marine ecologists [18]. In 1867, Hensen became a member of the Prussian House of Representatives and he stimulated studies on the ocean. From this perspective, he founded the Royal Prussian Commission for the Exploitation of the Oceans. Victor Hensen is the first that introduced the term "plankton" and he was a passionate marine biologist [19]. During expeditions in the North Sea, Baltic, and Atlantic Ocean, he learned how to collect the plankton and invented some specific devices for this purpose [20]. Interestingly, he developed quantitative methods to determine the amount of commercially available fish and on this basis, it was calculated the profitability of fisheries [1]. A research vessel, *RV VICTOR HENSEN*, was named in his honor [21]. Based on his studies, it was developed the discipline of "Biological Oceanography".

Even nowadays, after more than 100 years from his main discoveries, we are still looking for an explanation and possible application of some contributions of Victor Hensen to the biological sciences.

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