

# Introduction to Neurobiophysics



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## Mechano-electrical Transduction: New Insights into Old Ideas

A.J. Ricci<sup>1</sup>, B. Kachar<sup>2</sup>, J. Gale<sup>3</sup>, and S.M. Van Netten<sup>4</sup>

<sup>1</sup>Neuroscience Center, Louisiana State University, New Orleans LA 70112, USA

<sup>2</sup>Section on Structural Cell Biology, National Institutes of Deafness and other Communicative Disorders, Bethesda MD 20892, USA

<sup>3</sup>Center for Auditory Research, UCL Ear Institute, University College London, 332 Gray's Inn Road, WC1X 8EE London, UK

<sup>4</sup>Department of Neurobiophysics, University of Groningen, 9747 AG Groningen, Netherlands

### Abstract

The gating-spring theory of hair cell mechanotransduction channel activation was first postulated over twenty years ago. The basic tenets of this hypothesis have been reaffirmed in hair cells from both auditory and vestibular systems and across species. In fact, the basic findings have been reproduced in every hair cell type tested. A great deal of information regarding the structural, mechanical, molecular and biophysical properties of the sensory hair bundle and the mechanotransducer channel has accumulated over the past twenty years. The goal of this review is to investigate new data, using the gating spring hypothesis as the framework for discussion. Mechanisms of channel gating are presented in reference to the need for a molecular gating spring or for tethering to the intra- or extracellular compartments. Dynamics of the sensory hair bundle and the presence of motor proteins are discussed in reference to passive contributions of the hair bundle to gating compliance. And finally, the molecular identity of the channel is discussed in reference to known intrinsic properties of the native transducer channel.

### Keywords

Mechanotransduction; Hair cells; Auditory; Mechanically-gated

### Introduction

Hair cells are specialized epithelial cells that serve as the mechanosensory cells of the inner ear. The apical surface consists of an array of large microvilli, called stereocilia, that together form the mechanosensory hair bundle. Mechanically-gated channels (MET) are located near the tops of these stereocilia. Channel gating and therefore the open probability is regulated by deflection of the hair bundle. It is widely assumed that the overall organization and function of the MET cellular mechanism is common to all hair cells. The basis for this general view comes from the characteristic staircase pattern of hair bundles (Fig. 1), the polarized directional sensitivity observed in all sensory hair bundles and the in vitro experiments showing that hair bundle deflection results in extremely rapid channel activation followed by bimodal adaptation, which reduces current amplitude. In addition, measurements of hair bundle stiffness during MET channel activation suggest a common spring-based mechanism for gating. Deciphering

Correspondence to: A.J. Ricci; email: aricci2@earthlink.net.

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