Morphological Characterization of Cell Receptors

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1 Introduction

The understanding of what receptors are and how they work began with the “receptor concept” proposed by EHRLICH and LANGLEY (1878). The coordination by receptors of thousands of interactions between living cells was later realized to be a fundamental mechanism of intercellular communication and
a prerequisite for the functional integrity of multicellular organisms. Receptor proteins are essential (a) to transmit information from one cell to another, (b) to transduce signals from the cellular environment to intracellular targets and to nuclear DNA for regulating cell function, (c) to take up special substances in a highly controlled manner to maintain cell metabolism, and (d) to handle toxins and artificial drugs. These functions are accomplished by a specific set of proteins which can be localized in the cell membrane, the intracellular organelles, or the cytosol and/or the nucleus. A wide variety of biochemically very different signal molecules can bind to these receptor proteins, transporting specific information which in turn induces specific cellular reactions.

1.1 Function of Cell Receptors in Intercellular Communication

To fulfill the complex task of regulating diverse cellular activities, eukaryotic cells are thought to communicate in three different ways:

1. The **neural system** performs rapid long-distance cell-to-cell communication, innervating the voluntary and smooth muscle systems, blood and lymph vessels, most endocrine organs, the diffuse endocrine system, and many other target cells by specialized junctions (synapses). Nerve cells form extremely long cell protrusions (axons) to contact the selected target cells directly. At synapses the nerve cells secrete very short-range chemical mediators (catecholamines), called neurotransmitters, which bridge the small distance between the nerve end and the receptor of the target cell, e.g., muscle cell.

2. The **humoral or endocrine system** controls a great variety of processes and activities, such as embryological development, growth, maturation, cellular differentiation, and metabolic homeostasis. The vehicle of signal transportation is the blood and the extracellular fluid. The system is characterized by wide distribution of signals throughout the body. One has to imagine that nearly every cell of the body is surrounded by the same "mixture of signals" released from a great number of endocrine or endocrine-related cells into the circulation. The precision of this system is guaranteed by the specificity of cell receptors, which recognize only that one signal which fits to the related receptor. Signal transmission in the humoral system is slower (minutes) than in the neural system (seconds). Thus, the former is more likely to regulate and balance processes which have a longer turnover rate.

3. In addition there exist specialized cells that secrete chemical signals into the intercellular fluid, where they are rapidly detected and taken up by receptors of adjacent cells (paracrine) or by themselves (autocrine), providing a signaling system. The majority of these signals are peptide hormones or hormone-like substances that function as local chemical mediators and act only on cells in the immediate environment.