

42 Disorders of Smell and Taste

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All environmental chemicals necessary for life enter the body by the nose and mouth. The senses of smell (olfaction) and taste (gustation) monitor such chemicals, determine the flavor and palatability of foods and beverages, and warn of dangerous environmental conditions, including fire, air pollution, leaking natural gas, and bacteria-laden foodstuffs. These senses contribute significantly to quality of life and, when dysfunctional, can have untoward physical and psychological consequences. A basic understanding of these senses in health and disease is critical for the physician, because thousands of patients present to doctors' offices each year with complaints of chemosensory dysfunction. Among the more important recent developments in neurology is the discovery that decreased smell function is among the first signs, if not the first sign, of such neurodegenerative diseases as Parkinson's disease (PD) and Alzheimer's disease (AD), signifying their "presymptomatic" phase.

ANATOMY AND PHYSIOLOGY

Olfactory System Odorous chemicals enter the front of nose during inhalation and active sniffing, as well as the back of the nose (nasopharynx) during deglutition. After reaching the highest recesses of the nasal cavity, they dissolve in the olfactory mucus and diffuse or are actively transported by specialized proteins to receptors located on the cilia of olfactory receptor cells. The cilia, dendrites, cell bodies, and proximal axonal segments of these bipolar cells are located within a unique neuroepithelium covering the cribriform plate, the superior nasal septum, superior turbinate, and sectors of the middle turbinate (Fig. 42-1). Each of the ~6 million bipolar receptor cells expresses only one of ~450 receptor protein types, most of which respond to more than a single chemical. When damaged, the receptor cells can be replaced by stem cells near the basement membrane. Unfortunately, such replacement is often incomplete.

After coalescing into bundles surrounded by glia-like ensheathing cells (termed fila), the receptor cell axons pass through the cribriform plate to the olfactory bulbs, where they synapse with dendrites of other cell types within the glomeruli (Fig. 42-2). These spherical structures, which make up a distinct layer of the olfactory bulb, are a site of convergence of information, because many more fibers enter than leave them. Receptor cells that express the same type of receptor project to the same glomeruli, effectively making each glomerulus a functional unit. The major projection neurons of the olfactory system—the mitral and tufted cells—send primary dendrites into the glomeruli, connecting not only with the incoming receptor cell axons, but with dendrites of periglomerular cells. The activity of the mitral/tufted cells is modulated by the periglomerular cells, secondary dendrites from other mitral/tufted cells, and granule cells, the most numerous cells of the bulb. The latter cells, which are largely GABAergic, receive inputs from central brain structures and modulate the output of the mitral/tufted cells. Interestingly, like the olfactory receptor cells, some cells within the bulb undergo replacement. Thus, neuroblasts formed within the anterior subventricular zone of the brain migrate along the rostral migratory stream, ultimately becoming granule and periglomerular cells.

The axons of the mitral and tufted cells synapse within the primary olfactory cortex (POC) (Fig. 42-3). The POC is defined as those cortical structures that receive direct projections from the olfactory bulb, most notably the piriform and entorhinal cortices. Although olfaction is unique in that its initial afferent projections bypass the thalamus, persons with damage to the thalamus can exhibit olfactory deficits, particularly ones of odor identification. Such deficits likely reflect the involvement of thalamic connections between the primary olfactory cortex and the orbitofrontal cortex (OFC), where odor identification occurs. The close anatomic ties between the olfactory system and the