

## CHAPTER NINETEEN

### Content Review

1. Chemoreceptors detect specific molecules in our environment; for example, taste buds on the tongue detect specific molecules in our food and drink. Thermoreceptors respond to changes in temperature, as when free nerve endings in our skin alert us that we are touching something hot. Mechanoreceptors respond to touch, pressure, vibration, and stretch; for example, hair cells in the ear detect changes in equilibrium. Baroreceptors detect changes in pressure within body structures, as when receptors alert us to an expanding bladder and the need to evacuate it. Nociceptors respond to pain as a result of tissue damage.
2. Somatic nociceptors detect molecules in our external environment, whereas visceral nociceptors detect molecules in our internal environment. Referred pain occurs when impulses from some viscera are not perceived as originating in the organ, but in dermatomes of the skin. This misinterpretation of the pain source is related to both the site of visceral pain origin and the superficial area to which the pain is referred. Often these sensations occur because neurons from the same spinal cord segment innervate both the visceral region where the damage occurs and the superficial region to which the pain is referred.
3. Sensory stimuli detected by gustatory cells within taste buds result in nerve impulses conducting this information through CN VII (facial) from the anterior two-thirds of the tongue and CN IX (glossopharyngeal) from the posterior one-third of the tongue. All gustatory information projects first to the nucleus solitarius in the medulla oblongata and then to the hypothalamus and amygdala for activation of autonomic reflexes, and to the thalamus for processing. From the thalamus, axons project gustatory information to the cerebral cortex for analysis of taste sensations.
4. Receptor molecules in olfactory hairs bind to odor molecules dissolved in the mucus lining the olfactory epithelium of the nasal cavity. The olfactory neurons (receptor cells) project axons through the cribriform plate into the paired olfactory bulbs lying inferior to the frontal lobes of the brain. These axons synapse on neurons in the olfactory bulbs, which then project axon bundles through the olfactory tracts directly to the olfactory cortex in the temporal lobe.
5. Pupil size or diameter is controlled by the two smooth muscle layers in the iris. One group of smooth muscle fibers (the sphincter pupillae muscle, or pupillary constrictors) is arranged in a pattern that resembles concentric circles around the pupil. This smooth muscle layer is controlled by the parasympathetic division of the ANS. When these muscle fibers contract, they constrict the pupil. The other group of muscle fibers (the dilator pupillae muscle, or pupillary dilators) is organized in a radial pattern extending peripherally through the iris from the outer edge of the pupil. This smooth muscle layer is controlled by the sympathetic division of the ANS. When these muscle fibers contract, they dilate the pupil. Only one set of these smooth muscles can contract at any one time.
6. The ciliary muscles in the ciliary body contract to change the tension in the suspensory ligaments. When the ciliary muscles relax, the ciliary body moves posteriorly, away from the lens, and so the tension on the suspensory ligaments

increases. Constant tension applied to the suspensory ligaments causes the lens to flatten so that we can focus on distant objects. The process of making the lens more spherical in order to view close-up objects is called accommodation. It is controlled by the parasympathetic division of the ANS. Stimulation of the ciliary muscle by parasympathetic axons causes the muscle to contract. When the ciliary muscle contracts, the entire ciliary body moves anteriorly and thus moves closer to the lens itself. This process allows for reduction in the tension of the suspensory ligaments and a release of some of their “pull” on the lens, so the lens can become more spherical.

7. The anterior cavity contains a fluid called aqueous humor, which is a filtrate of plasma that resembles CSF and is produced by the epithelium covering the ciliary body. The aqueous humor is secreted into the posterior chamber, an open area between the lens and the iris. From the posterior chamber, it flows through the pupil into the anterior chamber, which is the space between the iris and the internal surface of the cornea. The aqueous humor is continually reabsorbed across the covering epithelium into a vascular space, called the scleral venous sinus located in the limbus between the cornea and the sclera. The scleral venous sinus conducts the reabsorbed aqueous humor to the veins that drain the eye.
8. The tensor tympani and the stapedius are two tiny skeletal muscles within the middle ear. They restrict ossicle movement if exposure to loud noises occurs, thus protecting sensitive receptors in the inner ear.
9. In the inner ear are spaces called the bony labyrinth. Within the bony labyrinth are membrane-lined, fluid-filled tubes and spaces, called the membranous labyrinth. Receptors for equilibrium and hearing are housed, along with supporting cells, within a sensory epithelium lining part of the membranous labyrinth.
10. (1) Sound waves are collected by the auricle and funneled through the external auditory canal to make the tympanic membrane vibrate. (2) The vibration of the tympanic membrane causes movement in the auditory ossicles. The foot of the stapes moves like a piston in the oval window, causing pressure waves in the perilymph fluid of the inner ear. (3) Pressure waves travel through the perilymph in the scala vestibuli. (4) Pressure waves cause the vestibular membrane to vibrate, resulting in pressure wave formation in the endolymph of the cochlear duct. Pressure waves in the cochlear duct displace a specific region of the basilar membrane, causing distortion of stereocilia on hair cells of the spiral organ. This distortion causes a stimulus in the cochlear nerve. Remaining pressure waves are transferred to the perilymph of the scala tympani. (Excess pressure waves then leave the inner ear through the round window.)