Contents

44 Animal Sensory Systems

44.1 How Do Sensory Organs Convey Information to the Brain?

- **Transduction**: conversion of an external stimulus to an internal signal in the form of action potentials along sensory neurons.
  - Requires a sensory receptor:
    1. *Mechanoreceptors*: respond to changes in pressure.
    2. *Photoreceptors*: respond to particular wavelengths of light.
    3. *Chemoreceptors*: detect specific molecules.
    4. *Thermoreceptors*: respond to changes in temperature.
    5. *Nociceptors*: sense harmful stimuli such as tissue injury.
    6. *Electroreceptors*: detect electric fields.
    7. *Magnetoreceptors*: detect magnetic fields.
  - Frequency of action potential firing rate can indicate the intensity of the stimulus.
- **Transmission**: the process of sending the signal to the central nervous system.

44.2 Mechanoreception: Sensing Pressure Changes

- **Statocyst**: an fluid filled organ that grabs use to help sense pressure created by gravity.
- Direct physical pressure causes ion channels to open and close, creating voltage gated action potentials.
- **The Mammalian Ear**:
  - *Outer ear*: collects incoming pressure waves and funnels them into tube known as the ear canal, which leads to the **tympanic membrane**, or eardrum.

- *Middle ear*: contains three tiny bones that the eardrum passes vibrations to in order to amplify sound. One of the bones, called **stapes**, vibrates against a membrane called the **oval window**, which separates the middle ear from the inner ear.
- *Inner ear*: the oval window oscillates in response to vibrations which generates waves in a chamber known as the **cochlea**. These waves are pressure inputs the hair cells respond to.

▷ Hair cells, forming rows that sit in the middle chamber, are embedded in a tissue that sits atop the **basilar membrane**. In addition, the hair cells' stereocilia touch another smaller surface called the **tectorial membrane.**

▷ This sandwiching of hair cells produce very specific responses to various frequencies, allowing us to distinguish between them.

▷ **Lateral line system**: a mechanoreceptor organ that most fish and larval amphibians use. Consists of embedded gel-like domed structures called cupulae that lay inside canals along the length of the body.

44.3 Photoreception: Sensing Light

▷ **The Insect Eye**:

- **Compound eyes**: eyes composed of hundreds of thousands of light-sensing columns called **ommatidia**.
- Each ommatidium has lens that focuses light into a smaller number of receptor cells–usually four.

▷ **The Vertebrate Eye**:

- **Simple eye**: a structure with a single lens that focuses incoming light onto a layer of many receptor cells.
- **Structure of the Vertebrate Eye**:
  - *white of the eye*: outermost layer of the eye that consists of tough rind of white tissue called the *sclera*.
  - *Cornea*: a transparent sheet of connective tissue on the front of the

sclera.

- *Iris*: pigmented, round muscle just inside the cornea that can contract or expand to control the amount of light entering the eye.
- *Pupil*: hole in the center of the iris.
- *Lens*: works with the cornea to focus incoming light.
- *Retina*: a layer of photoreceptors and several layers of neurons.

- The photoreceptors are held in place by the pigmented epithelium.
- photoreceptors synapse with an intermediate layer of connecting neurons called **bipolar cells**.
- Bipolar cells synapse with neurons called **ganglion cells**, which form the innermost layer of the retina.
- The axons of the ganglion cells project to the brian via optic nerve.
- Photoreceptors come in two distinct types:
  - **Rods**: sensitive to dim light but not to color.
  - **Cones**: sensitive to different wavelengths of light, but not dim light.
- **Opsin**: a transparent membrane protein that associates with a molecule of pigment in the **retinal**.
- **Rhodopsin**: a two molecule complex similar ot opsin in rod cells.

44.4 Chemoreception: Sensing Chemicals

- Chemoreception occurs when chemicals bind to chemoreceptors, initiating action potentials in sensory neurons.
- **Gustation**: the sense of taste.
- **Olfaction**: sense of smell.
- **Taste buds**: clustered structures containing about 100 spindle shaped taste cells that make synapses with sensory neurons.
- *Salty*: due to sodium ions dissolved in food.

- *Sourness*: due to presence of protons.
- *Umami*: due to monosodium glutamate.
- **Odorants**: airborne molecules.
- **Olfactory bulb**: part of the brain where olfactory signals are processed and interpreted.
- **Pheromone**: a chemical that is secreted into the environment that affects the behavior or physiology of animals.

44.5 Other Sensory Systems

- Thermoreceptors are located in the central nervous system and also commonly found skin and other outer surfaces of animals.
- *nociceptor*: senses extreme temperatures as well as other painful stimuli produced by chemicals, excessive pressure, and tissue damage.
- **Ampullae of Lorenzini**: tiny pores scattered across a shark's head contain structures that are responsible for their electroreception. Sharks can detect electrical potentials as small as a nanovolt.
- *Electrogenic fishes* have specialized organs near their tails that generate electric fields stronger than those of regular nerves or muscles.
- *Magnetoreception*: seen in many organisms, including fungi, invertebrates, and all other vertebrate classes.

45 Animal Movement

45.1 How Do Muscles Contract?

- **Muscle fiber**: a muscle fiber is a long, thin muscle cell.
- Within each muscle cell are many threadlike, contractile structures called **myofibrils**.
- Myofibrils often look striped or striated due to alternating light and dark units called **sarcomeres**, which repeat along the length of a myofibril.
- The question of how muscles contract simplifies to how sarcomeres shorten.
- **Thin filaments** are composed of actin.
- **Thick filaments** are composed of myosin.
- **Sliding-filament model**: filaments slide past one another during contraction, with the sarcomere shorting with no change between the lengths of thick and thin filaments themselves.
- ATP is required for myosin to release from actin once the two molecules have bound to each other.
- **Tropomyosin** and **Tropnin** work together to block the myosin binding sites on actin. When the sites are blocked, the myosin-actin interaction cannot occur, relaxing the muscle.

45.2 Muscle Tissues

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