SEM IV ZOOA

CC8 UNIT 6:
NERVOUS SYSTEM AND SENSE ORGANS
(Part - 3)

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Receptor Organs in Vertebrates

Organisms are subjected to many influences from their surroundings constituting the environment. All changes in the environment, both external and internal, are known as stimuli. Organs of the body that detect these changes or stimuli are called receptors or sense organ. They receive information from the environment in the form of energy (mechanical, chemical, electrical, thermal or radiant) and change it into nerve impulses which are transmitted to the brain or spinal cord via afferent or sensory nerve fibers to which they are connected. Thus, sense organs have dual functions:

(1) they detect environmental changes or stimuli and then
(2) transmit this information in the form of nerve impulses to the central nervous system.

In turn, the central nervous system (CNS) integrates the incoming information and sends out messages via efferent or motor nerve fibers to effector organs which respond in appropriate manner.

The path of sensory information. Sensory stimuli must be transduced into electrochemical nerve impulses that are conducted to the brain for interpretation.

Classification of Receptors or Sense Organs

Sense organs are classified in many ways.

☐ **General Receptors.** **Various minute sense organs are distributed widely upon or within the body especially the skin. These cutaneous sense organs are collectively termed general receptors, for their exact functions are not clear and any one of them cannot be related to a single sensation alone.**

☐ **Special Receptors:** **On the other hand, the tongue, nose, eyes and cars are termed special receptors. They are concentrated in small areas particularly on the cephalic end of the body. They respond to particular types of stimuli or special senses and their functions are better understood.**

Receptors according to stimuli:

In a broad sense, we can recognize the following types on the basis of the stimulus to which they are sensitive.

(a) **Mechanoreceptors:** These are stimulated by touch and pressure (skin), vibrations or sound and balance (ears).

(b) **Chemoreceptors:** These are sensitive to smell, that is chemical substances or odors in air (nose), and o taste, that is substances in solution (tongue).

(c) **Photoreceptors:** These are sensitive to light waves or sight (eyes).

(d) **Thermoreceptors:** Sensitive to heat and cold (skin).

(e) **Nerve endings:** Sensitive to pain (skin).

Receptors according to location:

Receptors may also be classified according to the location of stimulus.

(a) Exteroceptors. These receive environmental stimuli from outside the organism and supply information about the surface of the body (touch, pressure, taste, heat, etc.). These include eyes, ears, nose, taste buds and cutaneous sense organs. The exteroceptors inform the organism about food mate or enemy.

(b) Proprioceptors: These are stretch receptors present in the muscles, joints, tendons, connective and skeletal tissues. They supply information about the so-called kinesthetic sense of equilibrium and orientation. They act like pressure gauges and are responsible for the maintenance of body posture.

(c) Interoceptors: These lie in various internal organs. They provide information about the internal body environment, such as CO2 concentration, blood composition, pain, fullness, etc. They are responsible for maintaining an appropriate internal body environment necessary for the continued survival of the organism.

5. Somatic and visceral receptors. Exteroceptors and proprioceptors are also called somatic receptors. Similarly, ineroceptors are called visceral receptors.

Some sense organs have a dual role. For example, sensory epithelium of nose and taste buds serves both as exteroceptor (somatic) as well as visceral receptor.

	Sense Organs or receptors	According to type of stimulus	According to location of stimulus	Stimuli	Functions
1.	Skin (cutaneous)	*Mechanoreceptors* *Thermoreceptors*	*Exteroceptors*	Contact Temperature	Detecting touch, hot and cold, etc.
2.	Muscles (kinesthetic)	*Mechanoreceptors*	*Proprioceptor*	Mechanical stretch	Feeling and gauging pressures.
3.	Tongue (gustatory)	*Chemoreceptor*	*Exteroceptors*	Dissolved chemicals	Tasting
4.	Nose (Olfactory)	*Chemoreceptor*	*Exteroceptor*	Volatile chemicals and gases in air.	Smelling
5.	Eyes (visual)	*Photoreceptors*	*Exteroceptors*	Light	Seeing
6.	Ears (auditory)	*Statoacoustic*	*Exteroceptors*	Sound and gravity	Hearing and balancing
7.	—	—	*Interoceptors*	Pain, fullness, CO_2 level, blood composition ,etc.	Maintaining internal body environment.

Important differences among similar receptors in different classes of vertebrates Olfactory Organs in Vertebrates

Olfactory organs are special visceral chemoreceptors concerned with the sense of smell.

These consist of a pair of cavities, the olfactory or nasal sacs, on the anterior end of head.

Their external openings are called nares or nostrils.

Cyclostomes have a single blind olfactory sac with a single extremal naris, but there are two olfactory nerves.

In fishes, olfactory sacs are blind sacs except in all lobe-finned fishes and Dipnoi having internal nares.

In all air breathing animals or tetrapods, each olfactory sac has an external as well as an internal nostril.

Unlike other receptors, processes of olfactory cells lead directly to brain so that they are termed neuro-sensory cells.

Humans detect smells by means of olfactory neurons located in the lining of the nasal passages.

The axons of these neurons transmit impulses directly to the brain via the olfactory nerve.

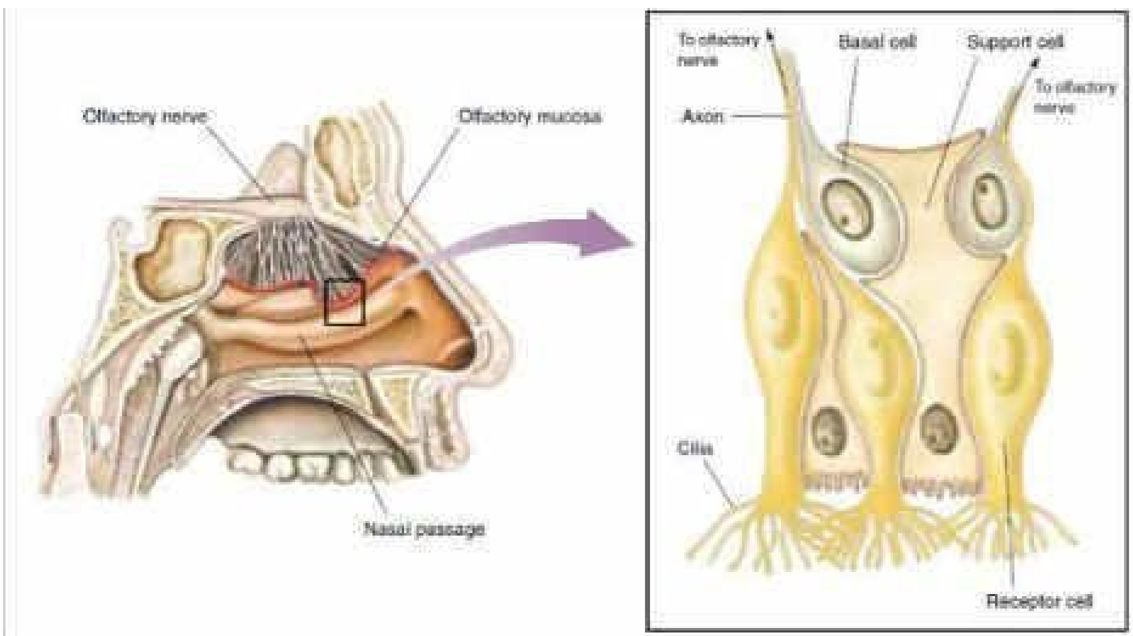
Basal cells regenerate new olfactory neurons to replace dead or damaged cells. Olfactory neurons typically live about one month.

Olfactory sense is well developed in fishes and mammals.

But birds are practically devoid of it except in the kiwi.

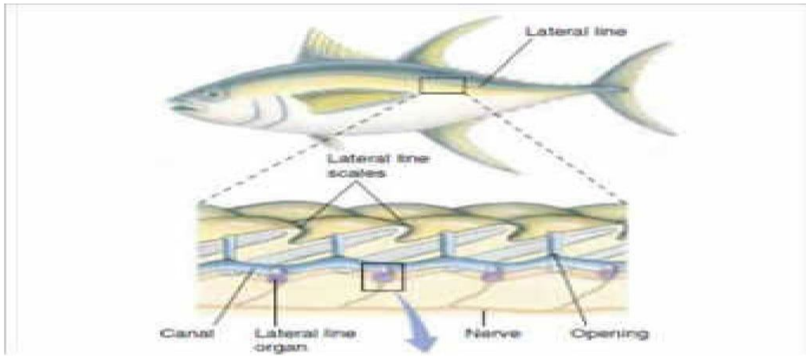
It has been experimentally demonstrated that salmon fishes with plugged nasal sacs are unable to find their home river tributaries in which to spawn.

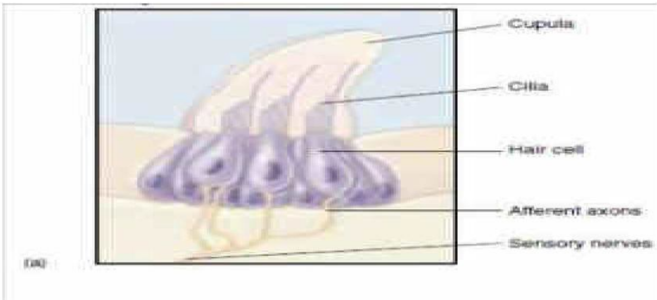
In most vertebrate groups, olfaction provides vital information to search food, predators, mates, and even the way home.

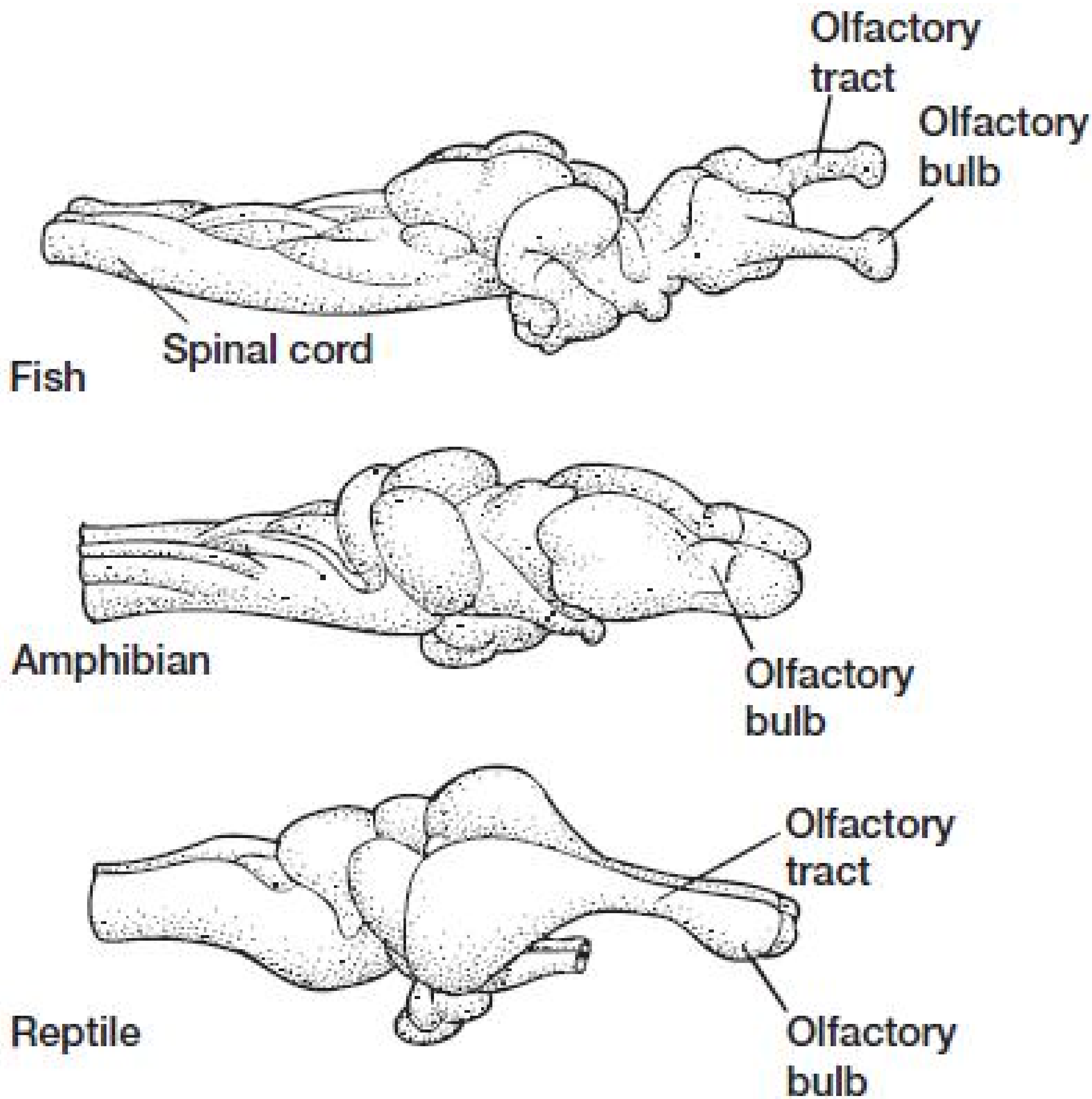


Organs of Jacobson or vomeronasal organs *are independent chambers below nasal cavities, found in most tetrapods, although they are sometimes vestigial. They are absent in fishes but occur as embryonic rudiments in most vertebrates. In reptiles they are best developed in lizards, snakes and sphenodon, but are absent in other crocodiles.*

Neuromast or lateral line organs *are the sense organs concerned with life under water besides fishes they are found in cyclostomes and aquatic stages of amphibians. These are little groups of receptors supporting ectodermal cells found in lateral line canals these are supplied with nerve fibers and are called rheo receptors or current receptors. They can perceive vibrations of very low frequency and detect disturbances in water.*






Olfactory tract
Olfactory bulb
Spinal cord
Fish
Amphibian
Olfactory bulb
Reptile
Olfactory tract
Olfactory bulb

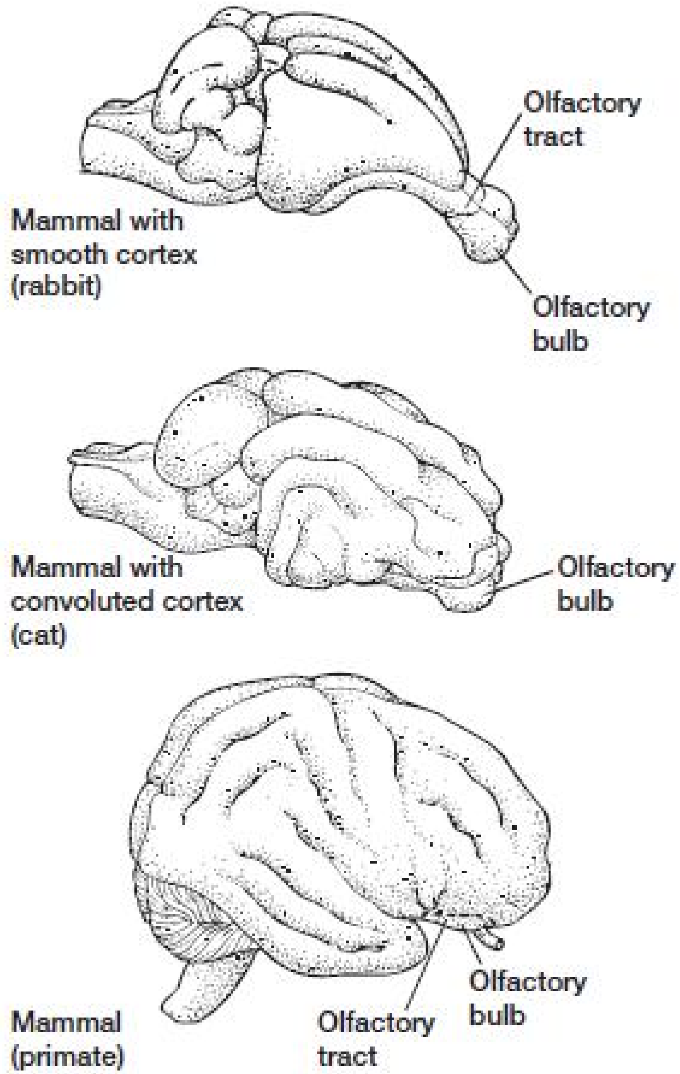
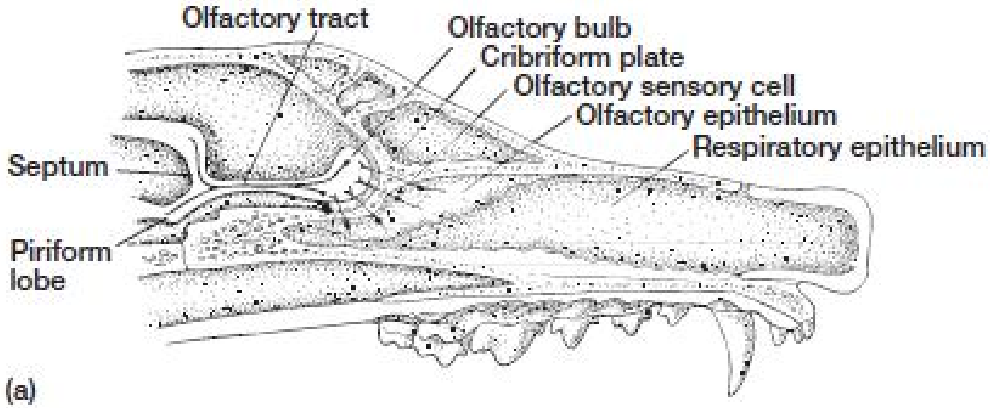
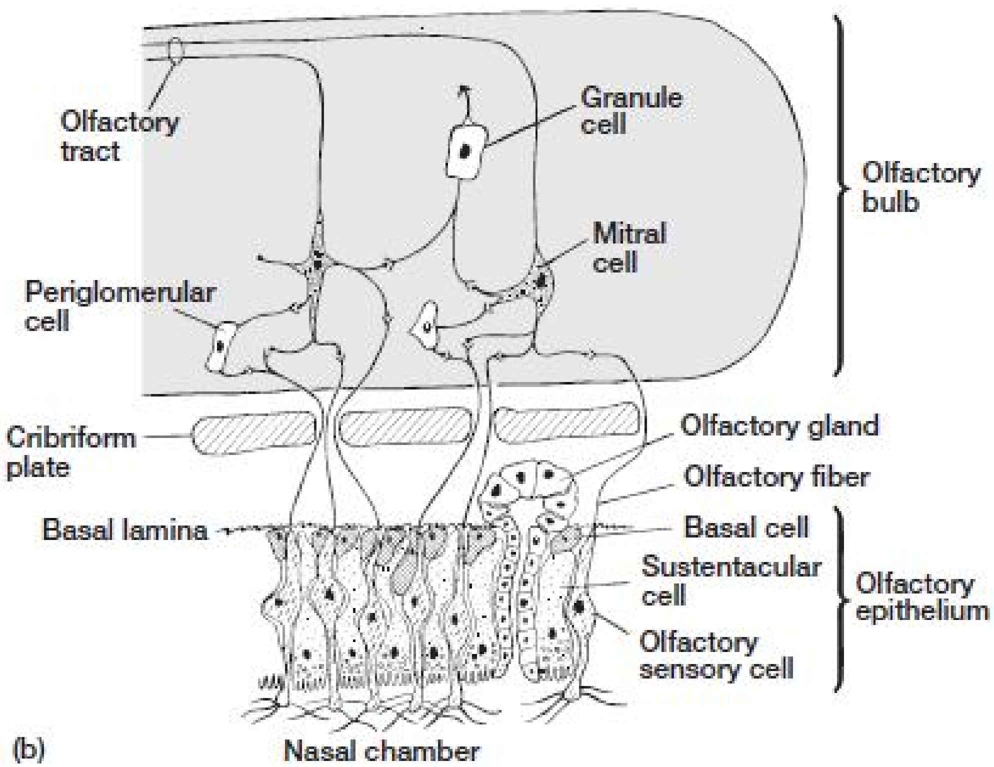


FIGURE 17.6 Olfactory bulb and tract. The olfactory tract is an extension of the brain rather than a nerve. The tip of this tract is usually expanded into the olfactory bulb, which receives the short olfactory nerve (not shown) arriving from the olfactory epithelium.

After Tuchmann–Duplessis et al.



(a)



(b)

FIGURE 17.7 Olfactory epithelium. (a) Nasal passages in mammals are lined with respiratory epithelium. The olfactory epithelium is a small region of this lining that contains specialized neuronal fibers that make contact with neurons of the olfactory tract. These processes relay impulses to the piriform lobe and septal area of the brain. (b) Histology of olfactory epithelium. The olfactory epithelium includes supportive sustentacular cells, basal cells, and olfactory sensory cells. The apical surface of each olfactory cell develops cilia that project into the air passage. Its basal end consists of a nerve fiber that travels through the cribriform plate into the olfactory bulb, where it synapses with periglomerular, mitral, and granule cells. Fibers of the mitral cells constitute the olfactory tract, which goes to the brain.

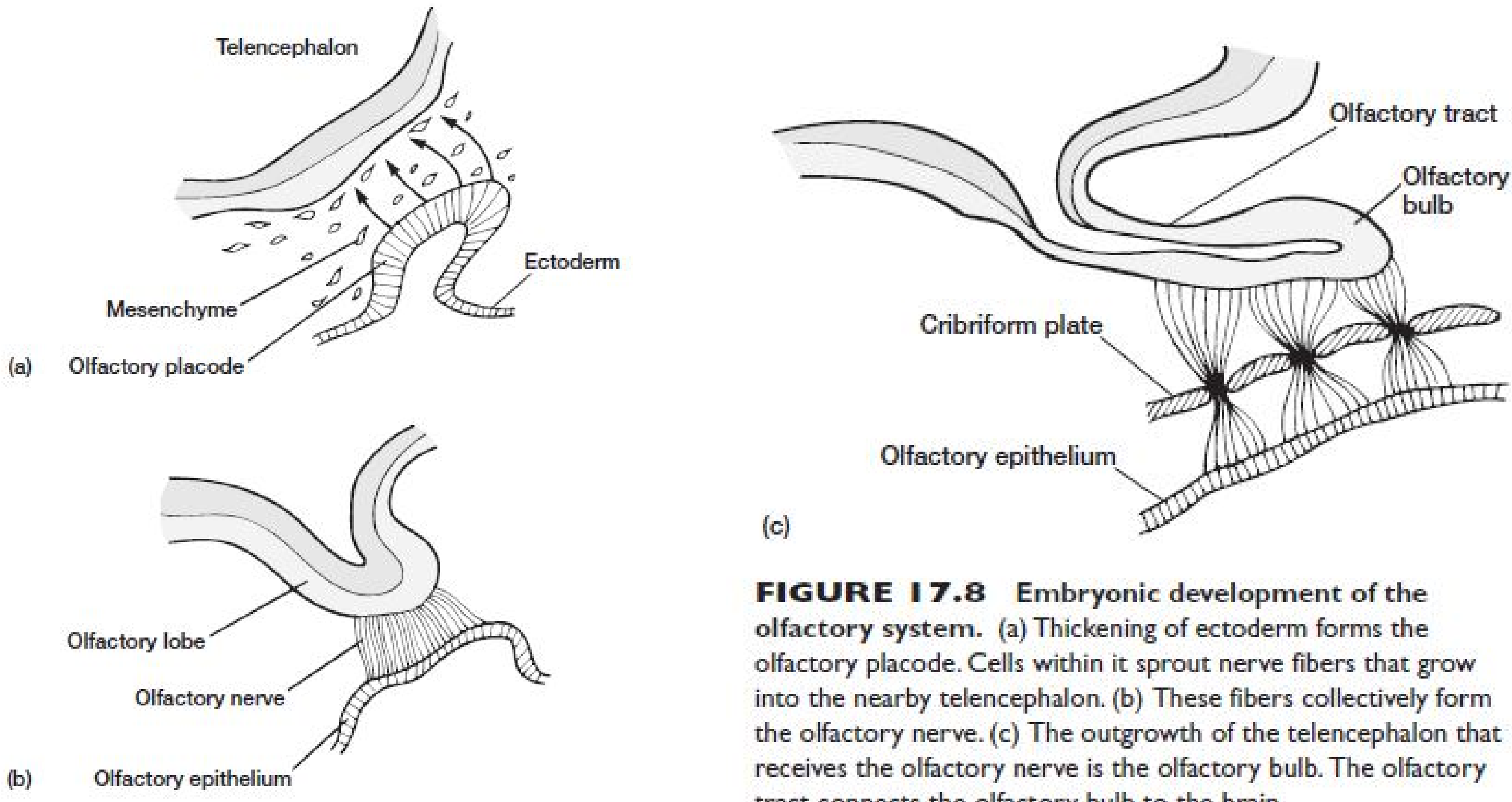


FIGURE 17.8 Embryonic development of the olfactory system. (a) Thickening of ectoderm forms the olfactory placode. Cells within it sprout nerve fibers that grow into the nearby telencephalon. (b) These fibers collectively form the olfactory nerve. (c) The outgrowth of the telencephalon that receives the olfactory nerve is the olfactory bulb. The olfactory tract connects the olfactory bulb to the brain.

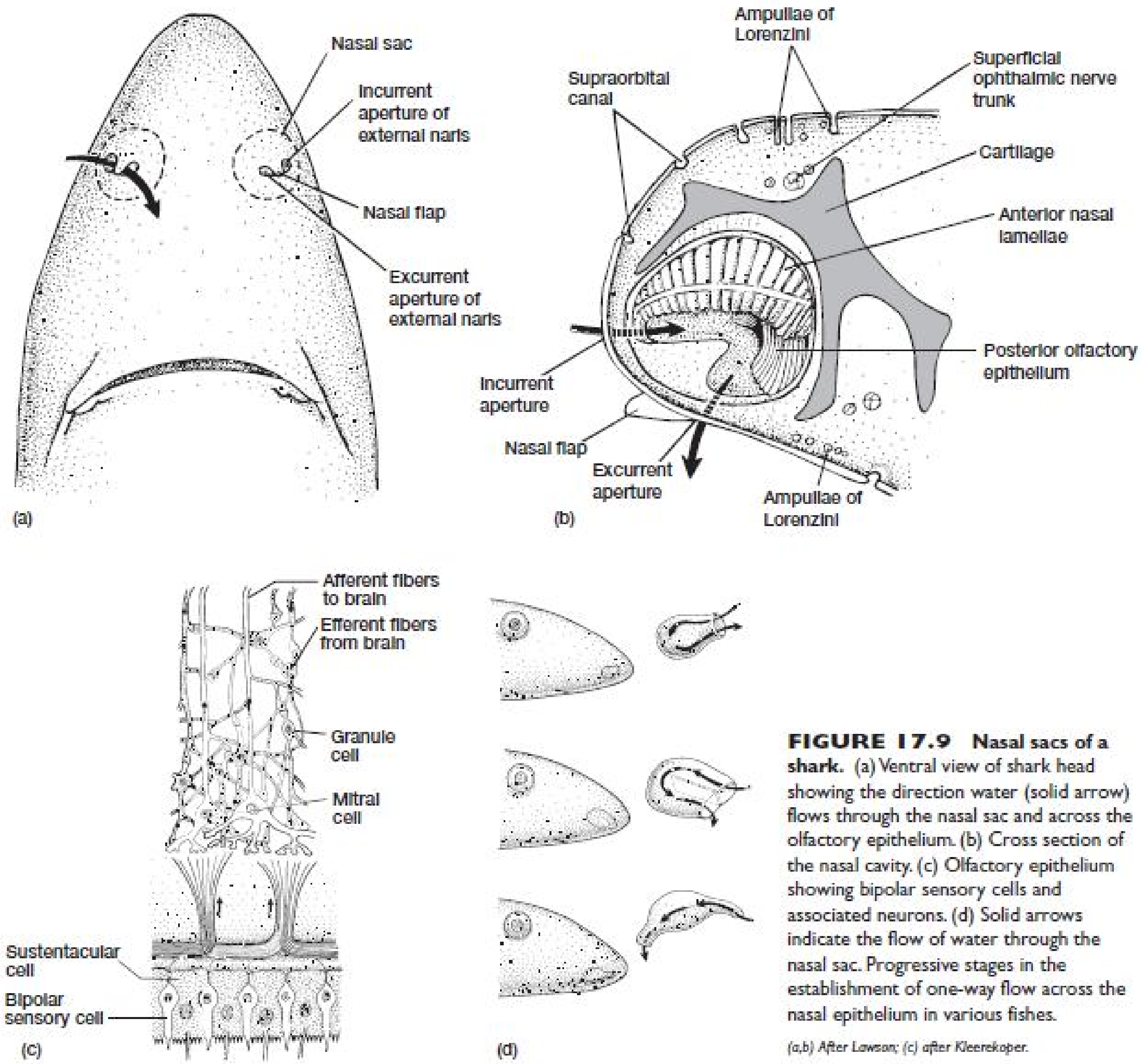
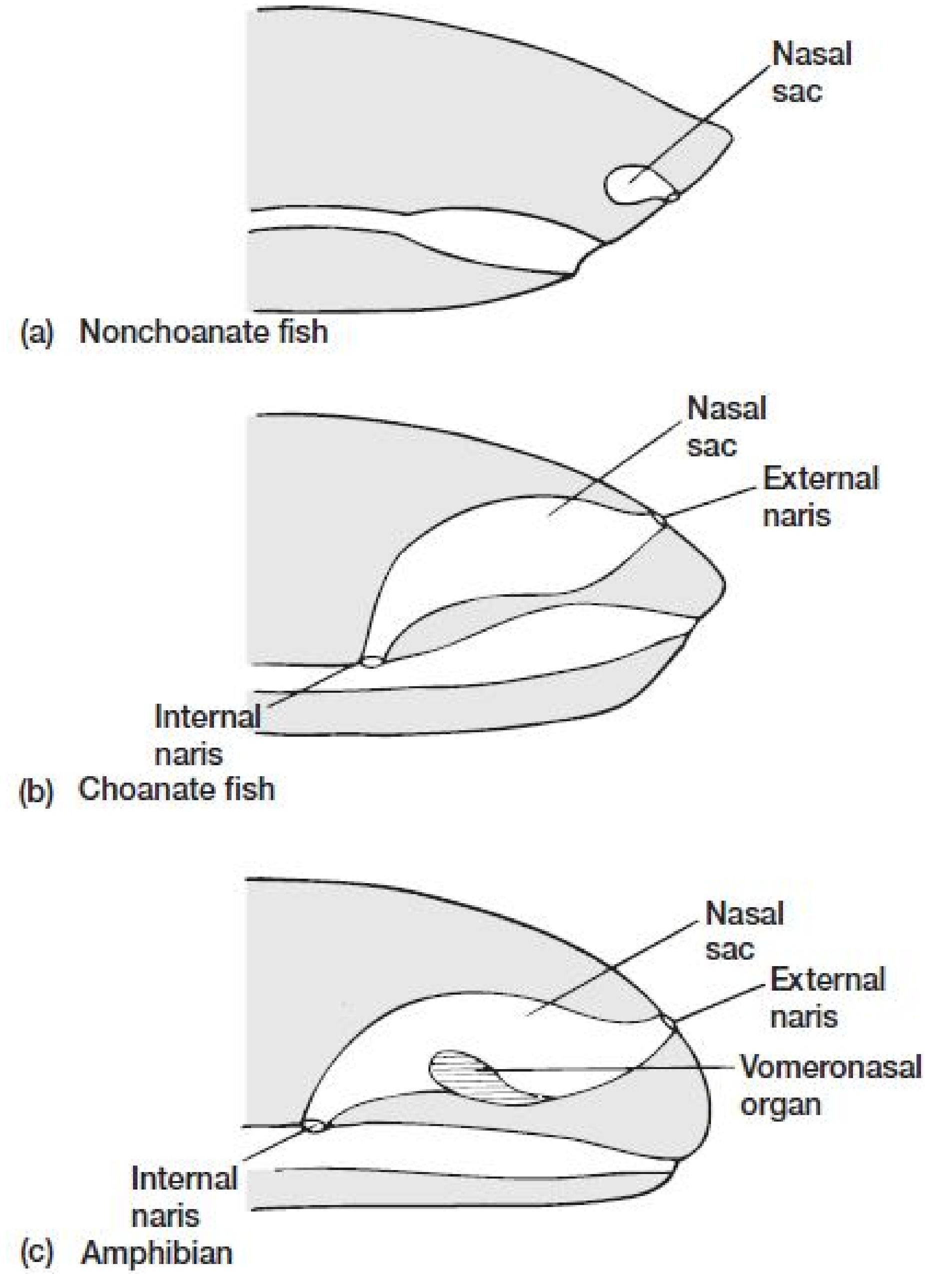


FIGURE 17.9 Nasal sacs of a shark. (a) Ventral view of shark head showing the direction water (solid arrow) flows through the nasal sac and across the olfactory epithelium. (b) Cross section of the nasal cavity. (c) Olfactory epithelium showing bipolar sensory cells and associated neurons. (d) Solid arrows indicate the flow of water through the nasal sac. Progressive stages in the establishment of one-way flow across the nasal epithelium in various fishes.

(a,b) After Lawson; (c) after Kleerekoper.


Nasal
sac
(a) Nonchoanate fish
Nasal
sac
External
naris
Internal
naris
(b) Choanate fish
Nasal
sac
External
naris
Vomeronasal
organ
Internal
naris
(c) Amphibian

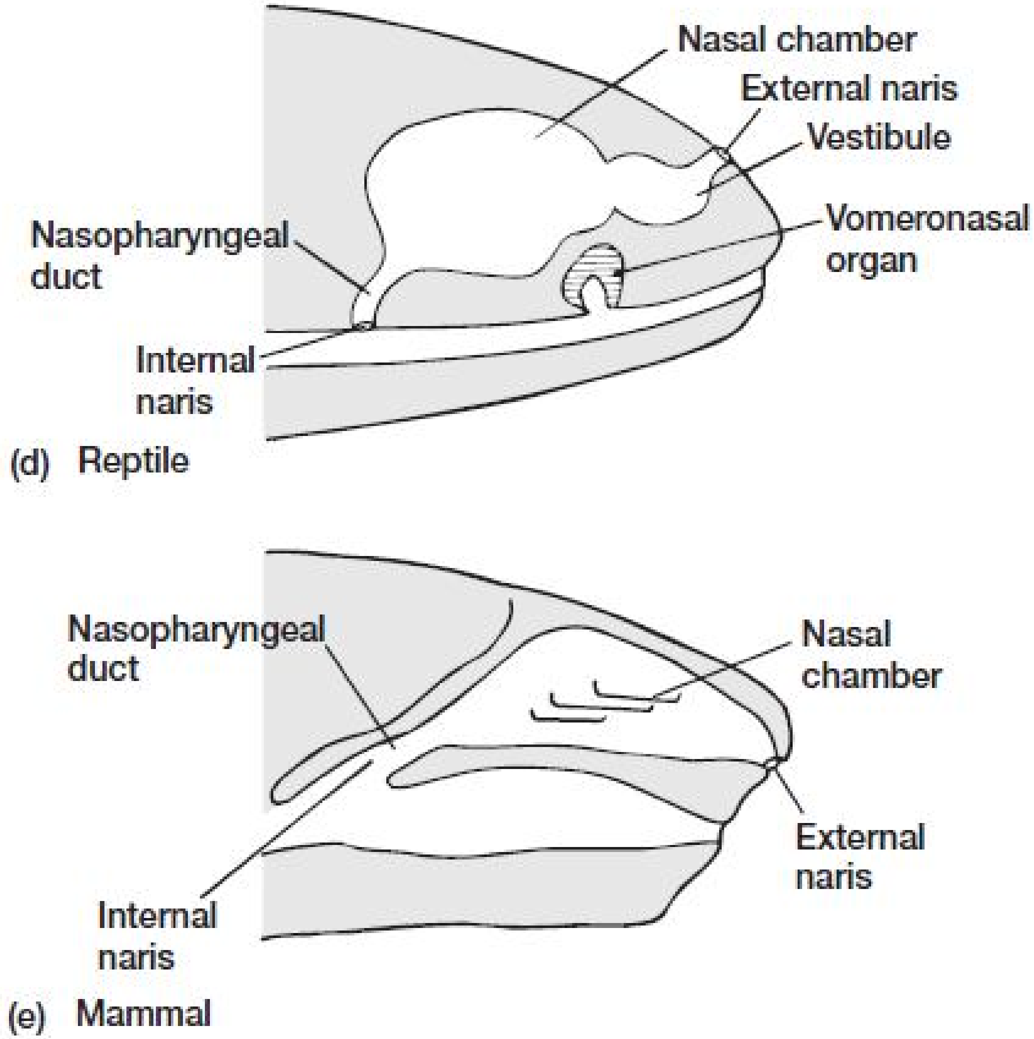


FIGURE 17.10 Phylogeny of olfactory organs. Note that the vomeronasal organ is absent in fishes but present in most tetrapods. (a) Nonchoanate fish. (b) Choanate fish. (c) Amphibian. (d) Reptile. (e) Mammal.

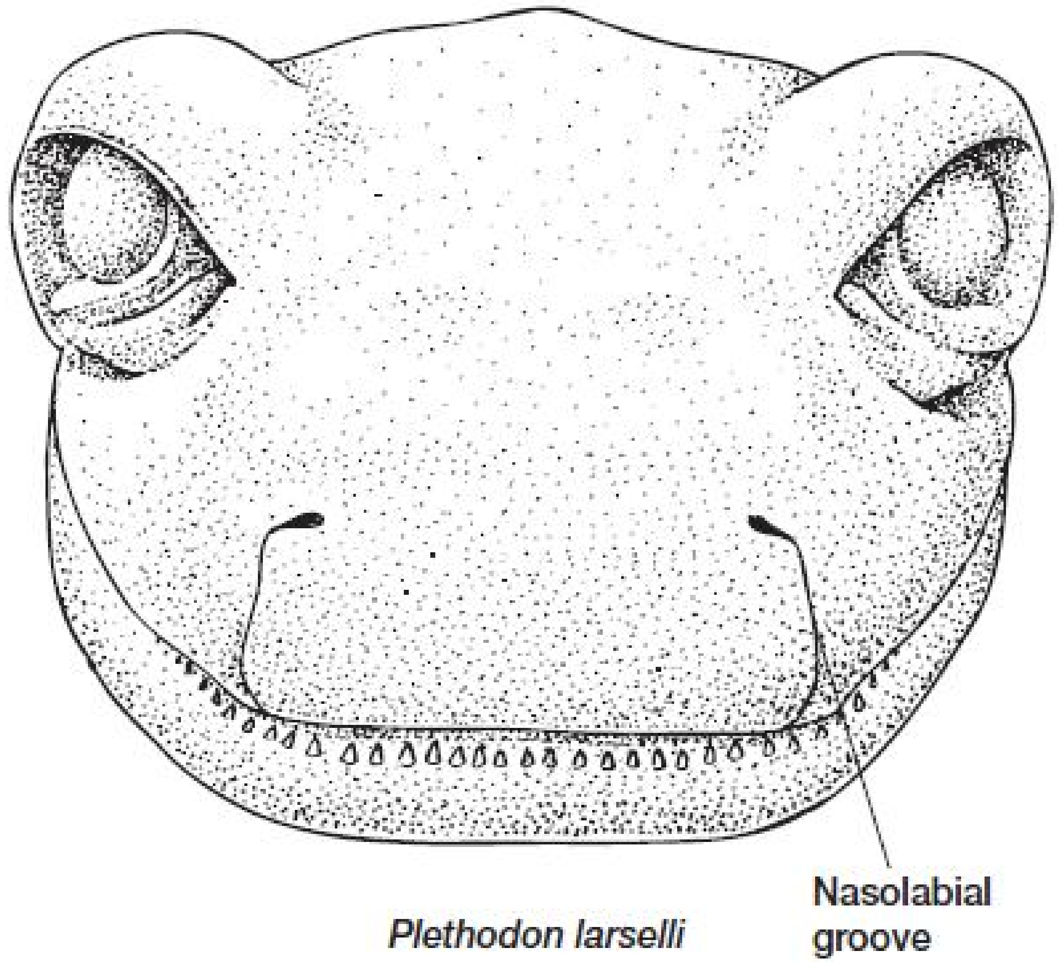


FIGURE 17.11 **Head of Larch Mountain salamander *Plethodon larselli*.** In plethodontid salamanders, a nasolabial groove runs between the mouth and nostrils. It is thought to convey chemicals from mouth to nose.

Based on photographs supplied by J. H. Larsen.

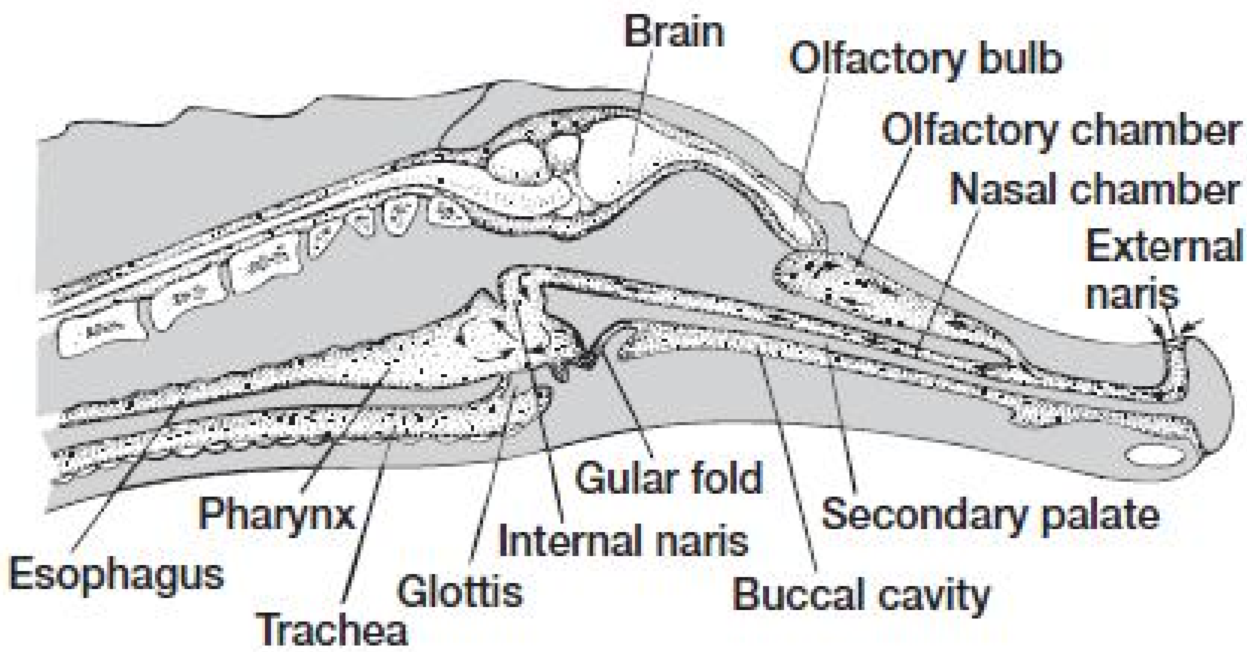
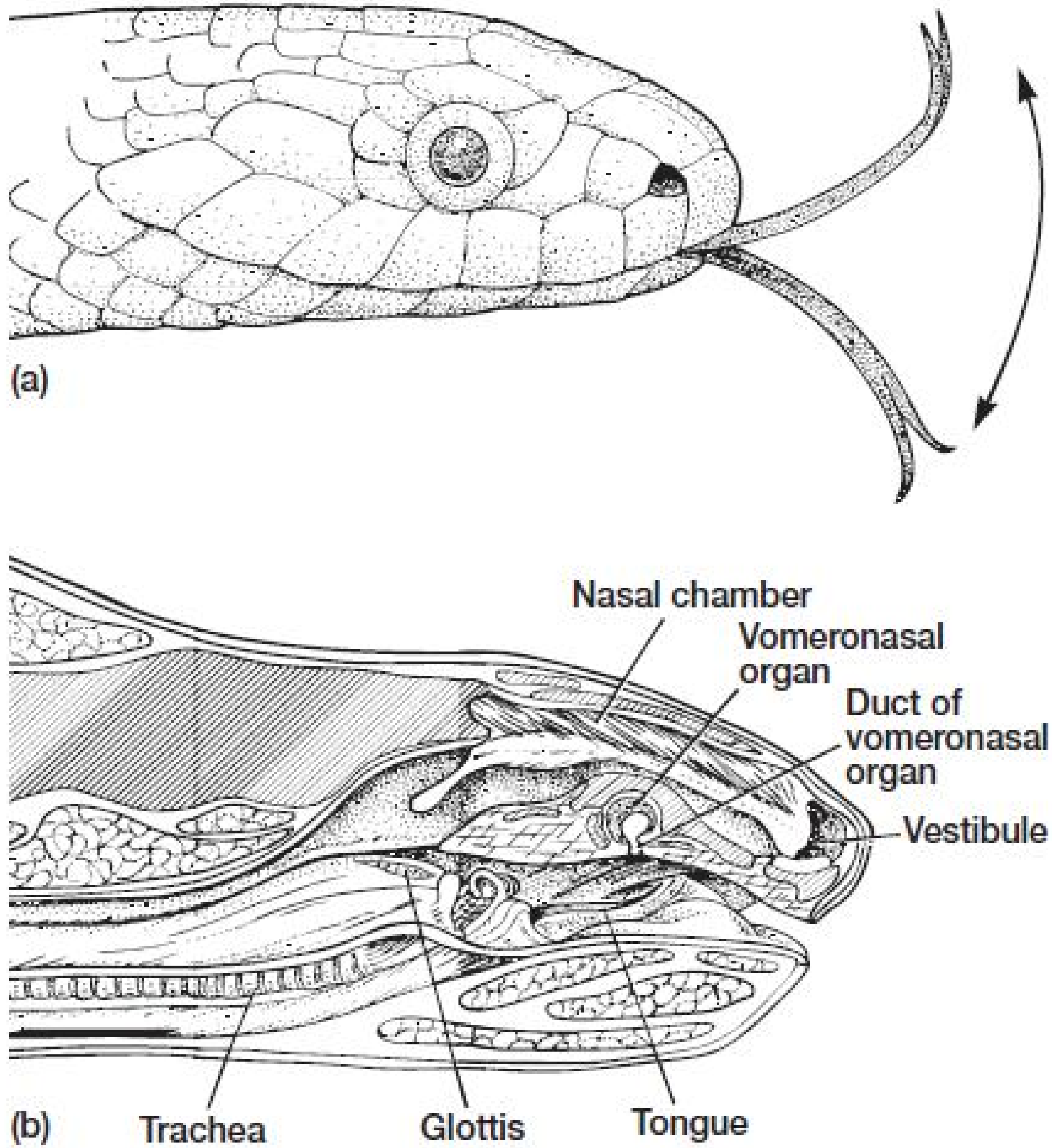


FIGURE 17.12 Sniffing by the crocodile. In tetrapods, olfaction often depends on the arrival of new chemicals with each respiratory exchange of air to the lungs. Sniffing allows more frequent sampling of air without increasing respiratory rate. The crocodile can close both the glottis and the gular fold, momentarily isolating the nostrils and the mouth. By depressing the floor of the pharynx, fresh air can be drawn just into the olfactory chamber and new chemicals sampled without respiratory ventilation.

After Pooley and Gans.



(a)
Nasal chamber
Vomeronasal organ
Duct of vomeronasal organ
Vestibule
(b)
Trachea
Glottis
Tongue

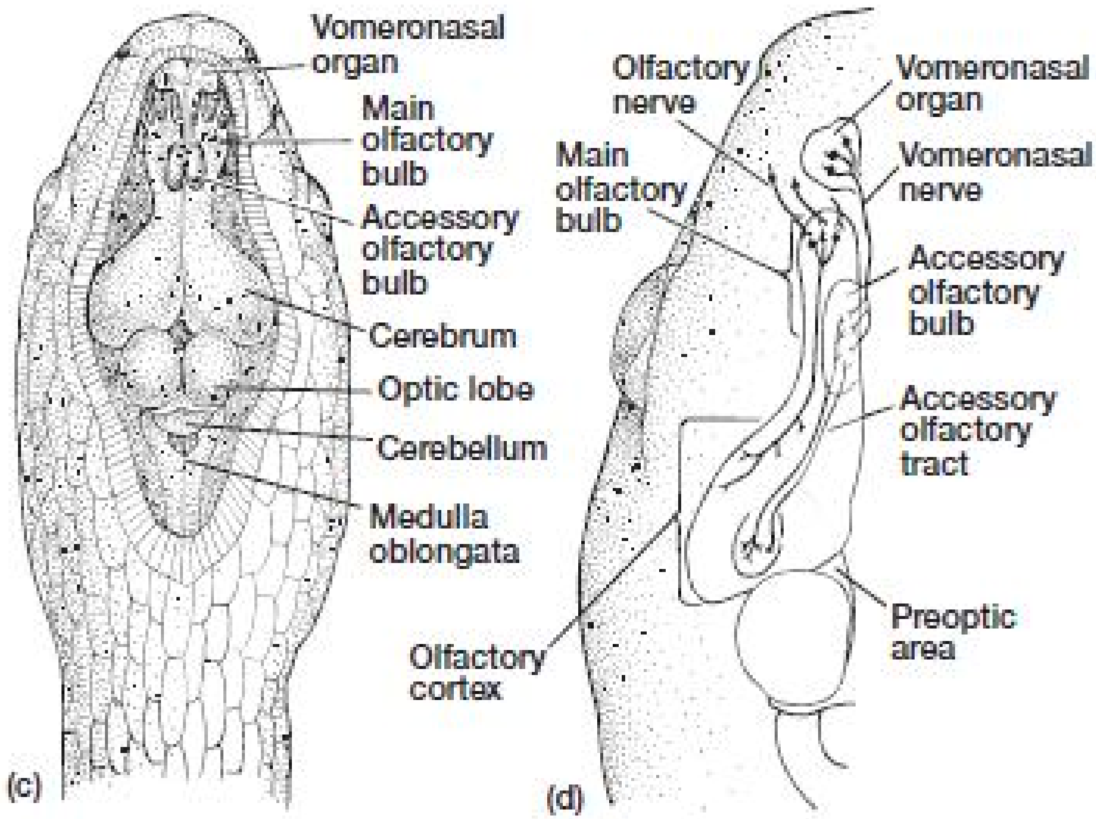


FIGURE 17.14 Tongue flicking in snakes. (a) Snakes, like lizards, extend their tongues to sweep air in front of them. The tongue collects and then transports airborne particles into the mouth. Probably along with other oral membranes, the tongue wipes these particles onto the vomeronasal organ on the roof of the mouth. (b) Sagittal section of the head of a boa constrictor. The vomeronasal organ is a blind pocket with a lumen that opens directly into the mouth via a duct. The tip of the retracted tongue projects from its sheath beneath the trachea. (c) Skull and overlying tissue have been cut away to reveal a dorsal view of the snake brain. (d) Neuroanatomy of a snake's olfactory organs. The main olfactory bulb receives input from the olfactory epithelium. The accessory olfactory bulb, via a separate tract, receives information from the vomeronasal organ. Vomeronasal and olfactory systems are separate chemoreceptive organs whose fibers travel separately within the olfactory tract. Thereafter, sensory information tends to be brought together in the olfactory cortex of the telencephalon.

REFERENCES:

Kardong, K. Vertebrates. Comparative Anatomy, Function and Evolution. *Sense Organs*.