Questions
1. Damage to which branch(es) of CN X will cause changes in voice quality?
2. Which laryngeal muscles are the principal abductors that open the rima glottidis during breathing?
3. Which sensory nerve(s) innervate the mucosa of the larynx?
4. Which area of the larynx is not lined by respiratory ciliated pseudostratified columnar epithelium?
5. How are the mucous and serous glands in the mucosa of the larynx innervated?
6. Severe earache and infection in the external auditory meatus may cause patients to vomit.
   (a) Which nerve provides sensory innervation to the mucous membrane in the external auditory meatus?
   (b) Does this nerve have any sensory relationship with the gag reflex or gastrointestinal tract?
7. Why would eruption of the molar teeth in children or adolescents sometimes “refer” a pain in the ear?
8. Which cranial nerve provides sensory and secretomotor innervation to the mucosa lining the middle ear?
9. Why would a clinician restrict the opening of the tympanic membrane to the lower one-half and particularly the posteroinferior quadrant?
10. Why would a CN VII lesion in the internal acoustic meatus make the patient sensitive to loud noises?
11. Where in the temporal bone would one expect a lesion that gave signs of right-sided facial paralysis, dryness of the right eye, decreased auditory reception in the right ear, and a tendency to fall to the right side when standing with one’s eyes closed?
12. A 35-year-old woman had a partial thyroidectomy for the treatment of thyrotoxicosis. During the operation a ligature slipped off the right superior thyroid artery. In order to stop the hemorrhage, the surgeon blindly grabbed for the artery with artery forceps. The operation was completed without further incident. The next morning the surgeon noticed that the patient spoke with a husky voice. Using your knowledge of anatomy, state what likely happened to the patient. What is the condition of the right vocal fold? Where does the superior thyroid artery originate? Into what vessel does the superior thyroid vein drain?
13. Following a partial thyroidectomy in which difficulty was experienced in tying the left inferior thyroid artery, the patient was found to have unilateral partial section of the left recurrent laryngeal nerve. Describe the position assumed by the left vocal fold.
14. An 11-year-old girl is suffering from an acute infection of the right middle ear (acute otitis media). Trace the path taken by the pathogenic organisms from the nasal part of the pharynx to the middle ear. What anatomical structures are likely to be involved if the infection spreads beyond the confines of the middle ear?
15. A 23-year-old woman complained that recently, when she had a cold, she took an airplane flight, during which she became deaf and both ears started to ache. She told the flight attendant of her discomfort and was advised to suck on a candy. After a few
moments the woman experienced a popping sensation in both ears and her hearing returned. Her earache immediately disappeared. Using your knowledge of anatomy, can you explain this common complaint of air travelers?

16. After completing your last anatomy examination, your father decided to celebrate and take you out for a steak dinner. Obviously he had had a few drinks before meeting you. You noticed that his speech was slurred and that he was eating his steak very rapidly. Later you noticed your father's face change suddenly. He had a terrified look and then collapsed on the floor. At first you suspected that he had passed out from too much drinking, but as you examined him more closely you thought that perhaps he was having a stroke, a heart attack, or some other seizure. His pulse was strong and then his face began to turn blue (cyanosis). You then realized that your father was suffering from asphyxia. You opened his mouth widely and observed that a large piece of steak was caught in the posterior part of his throat. First you reached into his mouth with your second digit and tried to pull it out. On being unsuccessful, you rolled him into the prone position and, with your hands interlocked against his epigastrium, you gave him a forceful bear hug, exerting pressure on his abdomen inferior to his thorax. This increased his intraabdominal pressure and moved his diaphragm superiorly, forcing the air out of his lungs and expelling the piece of steak. **Problems.** Where was the piece of steak most likely lodged? If the “Heimlich maneuver” had not been successful and a physician at another table had come to help you, what lifesaving measures do you think he might have taken?

**Answers**
1. Recurrent laryngeal nerve and external laryngeal nerve
2. Posterior cricoarytenoids
3. Internal laryngeal nerves to mucosa above vocal cords and recurrent laryngeal to the mucosa below the vocal cords
4. Mucosa of vocal cords that rim the rima glottidis (vocal folds lined with stratified squamous nonkeratinizing epithelium).
5. Parasympathetic fibers in CN X (mainly recurrent laryngeal branches)
6. (a) CN X; (b) Yes
7. The common embryological origins of mandible and ear ossicles (malleus and incus) and a common CN V₃ nerve innervation (although via different terminal branches of CN V₃), gives these areas a common basis for pain perception.
8. CN IX (glossopharyngeal n.).
9. To avoid the attachment to the malleus and injury to the chorda tympani
10. Paralysis of the stapedius muscle and hence a decreased ability to attenuate sound at the oval window
11. In the right internal acoustic meatus
12. A good surgeon never, never, blindly grabs at a bleeding artery. Pack the wound and then later, when the bleeding has stopped, remove the pack and clamp the artery under direct vision. In this case the superior laryngeal artery was successfully clamped, but the external laryngeal nerve was also included and severely damaged. As a consequence of
this, the cricothyroid muscle on the right side was paralyzed. This muscle normally tenses
the vocal fold of the same side. In this patient the right vocal fold was slack, causing
hoarseness of the voice. The superior thyroid artery arises from the external carotid
artery at a level just below the tip of the greater cornu of the hyoid bone. The superior
thyroid vein drains into the internal jugular vein.

13. The left vocal fold assumes the adducted midline position.
14. The pathogenic organisms ascend from the nasal part of the pharynx through the
auditory tube into the tympanic cavity. They may then spread posteriorly into the
mastoid antrum and the mastoid air cells (acute mastoiditis). They may extend medially
from the antrum to the sigmoid sinus, causing venous sinus thrombosis and possibly
septicemia. The organisms may spread superiorly through the tegmen tympani, causing
meningitis and possibly later an abscess in the temporal lobe of the brain or in the
cerebellum. They may spread medially to involve the facial nerve or the labyrinth of the
internal ear (labyrinthitis).

15. A severe cold involving the mucous membrane of the nasopharynx can spread to the
auditory tube. Inflammatory edema can cause the mucous membrane of the tube to swell
and block the lumen of the tube. As a result, the air in the tympanic cavity is no longer in
communication with the nasopharynx. The trapped air is now slowly absorbed into the
bloodstream, producing a partial vacuum in the tympanic cavity. The tympanic
membrane is sucked medially and its mobility is impaired. The failure of the tympanic
membrane to vibrate is responsible for the deafness. The vacuum and the pull on the
tympanic membrane cause the ear to ache. Repeated swallowing while sucking on a
candy causes the salpingopharyngeus muscle to pull the auditory tube open, and in many
cases allows air to pass the obstruction. The sudden popping sounds in the ear result
from air rushing into the tympanic cavity. Once the pressure is equalized on both sides
of the tympanic membrane, normal hearing returns and the earache ceases.

16. Probably the piece of steak was lodged in the inlet of the larynx. Choking on food is a
common cause of laryngeal obstruction, particularly in children, in persons who have
consumed too much alcohol, and in persons with neurological impairment. Many
“restaurant deaths,” thought to be caused by heart attacks, have been shown to result
from choking. Persons with dentures and/or who are drunk are less able to chew their
food properly and to detect a bite that is too large. The mucous membrane of the
superior part of the larynx is very sensitive, and contact by a foreign body (e.g., a piece of
steak) causes immediate explosive coughing to expel it. However, if there is neurological
impairment or the person is drunk, this response may be reduced or absent. Sometimes a
foreign body enters the piriform recess or passes through the larynx and becomes lodged
in the trachea or a main bronchus. Usually, as in the present case, the piece of steak is
only partly in the larynx, but entry of air into the trachea and lungs is largely prevented.
The patient would likely have died within minutes, almost certainly before there was time
to get him to a hospital, if the piece of steak had not been dislodged using the Heimlich
maneuver, enabling adequate respiration to be reestablished. Had the emergency
procedure not been successful, the physician would likely have first tried to get the piece
of steak out of the patient's larynx with a long spoon or a slender fork. If these
procedures had failed, he would likely have performed a lifesaving, emergency inferior
laryngotomy. If he happened to have a large bore needle with him, he would have inserted it through the median cricothyroid ligament. If not, he probably would have used a penknife or a steak knife to make an incision through the midline of the neck into the cricothyroid ligament (cricothyrotomy). Probably the physician would have inserted a large plastic straw or a tube of some sort (e.g., the empty barrel of a ball point pen), to enable the patient to breathe while he was being taken to a hospital for removal of the piece of steak from his larynx and repair of the cervical wound.

**Cases without printed interpretations**

- **Patient Norence T.** This 40-year-old woman had her recurrent laryngeal nerves injured bilaterally during a thyroidectomy for “goiter” a year ago. When the anesthesiologist removed the nasotracheal tube following the surgery, she showed considerable respiratory distress. The surgeon therefore performed a tracheostomy and placed an endotracheal tube with an external opening in the midline of the lower neck. She was sent home after three days to convalesce, with no strenuous work allowed. She was scheduled for weekly visits to assess the regeneration of the damaged recurrent laryngeal nerves, but after one year both vocal cords remain paralyzed, and the patient is unable to abduct the vocal cords to expand the rima glottidis. The otolaryngologist describes how he will create an “opened airway” through the trachea by suturing one of the paralyzed vocal cords to the lateral wall of the larynx. This should allow removal of the endotracheal tube and closure of the tracheostomy. The patient will have an adequate but diminished airway and a hoarse voice, which is expected to remain as a permanent condition.

- **Patient Nancy D.** This 35-year-old woman developed complete inner-ear deafness bilaterally following a severe febrile illness when she was 11 years old. She was trained in sign language and was able to maintain fairly good speech patterns. Recently, she returned from a major audiology center that specializes in research and treatment by surgically implanting “cochlear prostheses.” At ENT Rounds this morning, her case is presented. She demonstrates her substantial ability to understand and repeat sentences spoken behind her back. The ensuing lengthy discussion of hearing problems challenges your knowledge of the inner ear and related structures.

- **Patient Bobby F.** This 5-year-old preschooler has had a history of recurring upper respiratory infections with accompanying middle ear infections (otitis media). The episodes were treated by antibiotic therapy, but the child’s mother had to miss a number of days at work while caring for the child during the treatment. When you examined the nasopharynx you could see an abundant amount of lymphoid tissue (“adenoids”) that surrounded the opening of the auditory tube. You assume that your clinical supervisor (who is an otolaryngologist) will remove this tissue to facilitate the drainage capacity of the middle ear. However she elects to install a small tube in each eardrum to drain the middle ear into the external ear. The tubes are placed in the inferior posterior quadrant of each tympanic membrane. Follow-up: Subsequent upper respiratory infections during the next year are not accompanied by the severely painful earaches. The pediatrician intends
to remove the ear tubes when the child’s facial growth permits the natural drainage through the auditory tube—i.e., if they have not dropped out accidentally meanwhile.

• A woman suffered from recurring inflammation in the paranasal sinuses. Often this was accompanied by otitis media (middle ear infection). How are these two events linked? If untreated, the infection might also spread to the conjunctiva. Describe the infection pathway.

• A man complained of a toothache in the region of his right upper molars, yet his dentist could not find anything somatically wrong with these teeth. He referred his patient to an otolaryngologist who diagnosed the problem as maxillary sinusitis (inflammation of the mucosa in the maxillary sinus). Use your knowledge of anatomy to explain this diagnosis.