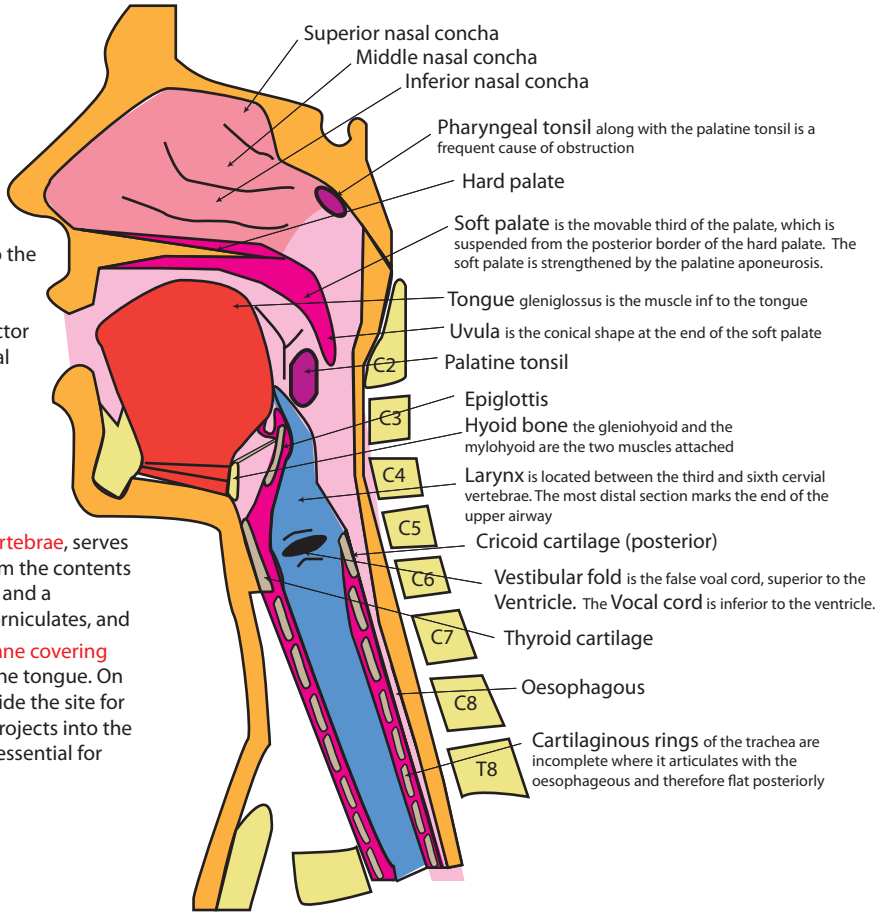
ANATOMY OF THE RESPIRATORY SYSTEM

UPPER AIRWAY The upper airway is the portion of the airway from the nares and the lips to the distal end of the larynx.

Nose breathing is typically through the nose. This confers two advantages, there is improved filtration by vibrissae hairs and humidification of inspired gas because the nasal septum and the turbinates greatly increase the surface area of muscosa available for evaporation and the turbulent flow improves contact. The consequence is increased resistance to flow such that at higher flows (>35 l/min) oral breathing is required.

Palate and Tongue During breathing at rest the tongue is pressed against the hard palate and air flows through the nose, the pharynx in to the larynx. When oral breathing is used (or when swallowing) the soft palate becomes rigid and arches up and back under control of the palatine aponeurosis (tensor and levator palati) to lie against the superior constrictor the the pharynx known as Passavant's ridge to form the palatopharyngeal sphincter. The pressure of the air in the mouth reinforces the soft palate's movement.



The larynx, which lies at the level of the third through sixth cervical vertebrae, serves as the organ of phonation and as a valve to protect the lower airways from the contents of the gastrointestinal tract. The structure consists of muscles, ligaments, and a framework of cartilages. These include the thyroid, cricoid, arytenoids, corniculates, and the epiglottis. The epiglottis, a fibrous cartilage, has a mucous membrane covering that reflects as the glossoepiglottic fold onto the pharyngeal surface of the tongue. On either side of this fold are depressions called valleculae. These areas provide the site for placement of the curved MacIntosh laryngoscope blade. The epiglottis projects into the pharynx and overhangs the laryngeal inlet. However, it is not absolutely essential for sealing off the airway during swallowing.

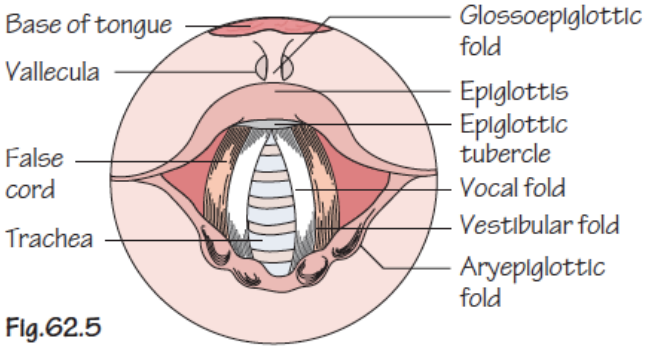
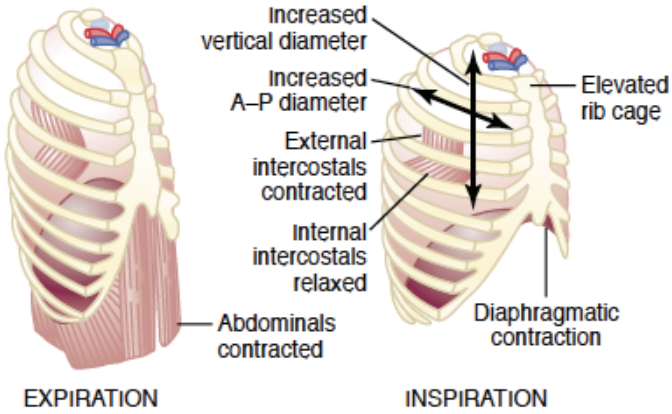


Fig.62.5
The larynx as seen through a laryngoscope

Airway differences due to age After about 8 years of age, airway differences between adults and children mainly reflect size differences. The newborn has the most dramatically different anatomy from the adult, and it persists during the first year of life and then slowly evolves to the adult form. Differences include a large head that tends to flex the short neck and obstruct the airway and a disproportionately large tongue that may cause airway obstruction and more difficult laryngoscopy. The larynx is more cephalad in infants because the cricoid cartilage is opposite the fourth cervical vertebra (rather than the sixth in adults). The epiglottis is longer and stiffer, and it lies more horizontally than in adults. The cricoid cartilage is the narrowest point of the airway until about age 8. The shorter trachea also leaves less margin for error in placement of the endotracheal tube. The angles of the main bronchi take-off points make left-sided endobronchial intubation as likely as right-sided procedures.

Muscles of respiration During inspiration negative pressure is created primarily by the retraction of the diaphram. With only a small change in the pressure, the pharynx would collapse without the relfex contraction of the pharyngeal dilator muscles, glenioglossus and tensor and levator palati. When in the supine position these muslces are also important in stopping the soft palate falling back against the posterior pharyngeal wall. Failure of these muscles which preserve airway patency may occur during sleep, hypoxia or anaesthesia.

In the larynx during inspiration the the posterior cricoaryenoid muscles acting by rotating the arytenoid cartilages, abducts the vocal cords to reduce resistance. During expiration the thyroartenoid muscles adduct the vocal cords, increasing resistance, possibly to prevent lower airway collapse.



The diaphram is a dome shaped membraneous muscle separating the the abdominal cavity and chest, and in adults has a surface area of approx 900cm2. It is the most important inspiratory muscle, with motor innervation solely from the phrenic nerves (C3-5). When it contracts the diaphram acts like a piston as well as flattens out in shape increasing the volume of the lungs and therefore creating negative pressure. The external intercostal muscles connect adjacent ribs and project downward and forward. When they contract the ribs are pulled upward and forward increasing the size of the lung volume and augmenting the action of the diaphram. The main accessory muscles of inspiration are the scalene muscles which elevate the first two ribs, and the sternomastoids which raise the sternum.

Expiration is passive during quiet breathing but during exercise it becomes active. The most important muscle is the abdominal wall which contracts, increasing intrabdominal pressure and resulting in the diaphram being pushed upward. The internal intercostal muscles perform the opposite action of the externals, pulling the ribs downward and inward thus decreasing intrathoracic pressure. They also stiffen which prevents bulging outward due to straining.