Some helpful videos on YouTube FOR Respiratory Block:

Oxygen Transport from Lungs to Cells :

http://youtu.be/5LjLFrmKTSA

Respiratory System 3D :

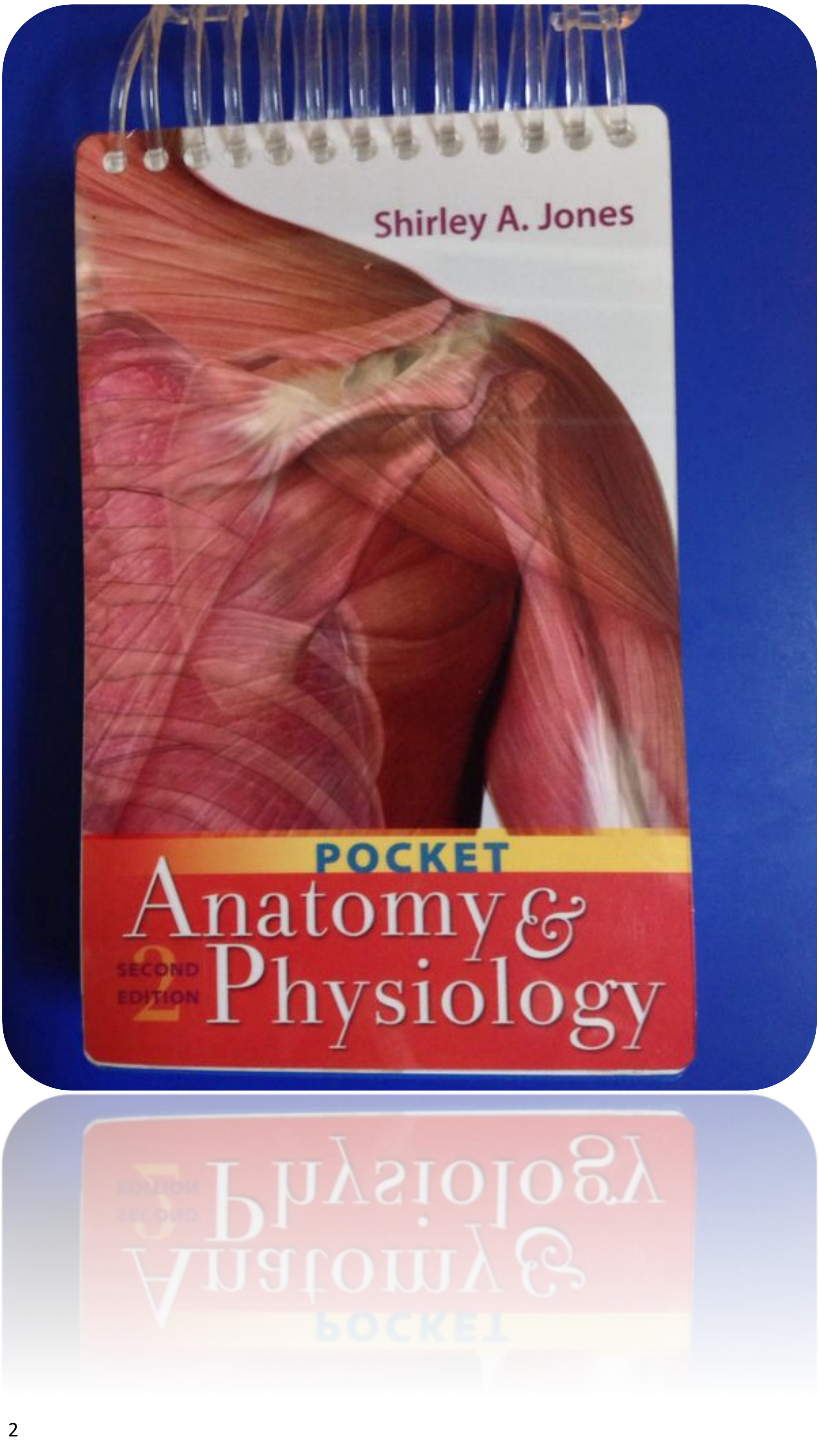
http://youtu.be/o2OcGgJbiUk

Parts of Respiratory system:

http://youtu.be/B1w3s9m3hIg

Done By :

Alaa alzulfi


Shirley A. Jones
POCKET
Anatomy &
SECOND EDITION 2
Physiology

RESPIRATORY SYSTEM

The respiratory system consists of the upper respiratory tract and lower respiratory tract. The lungs are the site of exchange of oxygen and CO_2. The remainder of the system gets air into and out of the lungs, an estimated 10,000 liters of air per day.

Upper Respiratory Tract

The **upper respiratory tract** comprises the parts of the respiratory system outside the thoracic cavity, from the nose to the upper trachea.

Nose and Nasal Cavities: The nose is the usual entryway for air. The two nasal cavities are lined with ciliated epithelium that has many goblet cells. Dust and pathogens become trapped on the mucus, and the cilia sweep it all toward the nasopharynx. The nasal mucosa also warms and humidifies inspired air so that the air reaches body temperature (37° C) and approximately 95% relative humidity by the time it reaches the alveoli.

Pharynx: The **pharynx** is a passageway from the nasal cavities to the larynx. The **nasopharynx** is an air passage only; it is above the level of the soft palate, which blocks it during swallowing. On its posterior wall is the **pharyngeal tonsil** (adenoids). On the sides, the **eustachian tubes**, when open, allow air into and out of the middle ear cavities, which allows the eardrums to vibrate properly. The **oropharynx** is directly behind the oral cavity; the **palatine tonsils** are on its lateral walls, and the **lingual tonsils** are on the base of the tongue. The **laryngopharynx**, like the oropharynx a passageway for both air and food, is below the oropharynx and opens into the larynx anteriorly and the esophagus posteriorly.

Larynx: The **larynx** is the airway between the laryngopharynx and the trachea; it is made of nine pieces of cartilage connected by ligaments. Cartilage is a firm tissue; it keeps the airway open. The **epiglottis** is the uppermost cartilage; it covers the opening of the larynx (glottis) during swallowing. The larynx contains the **vocal cords** that turn exhaled air into sound, which we turn into speech. The cricoid cartilage is the most inferior cartilage, and it connects the larynx to the trachea.

Lower Respiratory Tract

The **lower respiratory tract** comprises the parts of the system within the thoracic cavity, from the lower trachea to the lungs, and including the respiratory muscles and pleural membranes.

Thoracic Cavity and Respiratory Muscles: The thoracic cavity is enclosed by the rib cage. Twelve pairs of **ribs** are attached posteriorly to the spine; all but the lower two pairs (floating ribs) are attached anteriorly to the sternum. Between adjacent ribs are the external and internal intercostal muscles. The **external intercostals** pull the ribs up and out for inhalation; the **internal intercostals** pull the ribs down and in for a forced exhalation. The **diaphragm** is a dome-shaped muscle that forms the floor of the thoracic cavity. During contraction, it shortens and the dome flattens. This downward motion of the diaphragm expands the thoracic cavity from top to bottom. Although breathing is a reflex, the diaphragm is skeletal muscle that can be voluntarily contracted. Motor nerves to the diaphragm are the right and left phrenic nerves.

Pleura: The pleural membranes are the serous membranes of the thoracic cavity. The **parietal pleura** lines the chest wall and the **visceral pleura** covers the lungs. Serous fluid is present in the potential pleural space; this fluid prevents friction as the two membranes slide past one another during breathing.

Trachea: The **trachea** is about 10 to 13 cm long, 1.5 to 2.5 cm in diameter, and extends from the larynx to the bifurcation into the left and right primary bronchi. Its lumen is kept open by the C-shaped cartilaginous rings in its wall. The open section of the C faces posteriorly, adjacent to the esophagus. The lining is ciliated epithelium, with many goblet cells. The cilia beat approximately 20 times per second. Foreign material caught in the mucus is swept up the trachea to the pharynx (where all is swallowed) at a rate of 2 to 3 mm per minute.

Bronchi: The trachea bifurcates at the carina into the **primary bronchi,** which conduct air right and left into the lungs. Each primary bronchus divides into **secondary (lobar) bronchi**: three to the right and two to the left. The secondary bronchi branch several more times, forming the bronchial tree.

Bronchioles: The **bronchioles** are the small airways. Their walls have smooth muscle cells, but do not have cartilage to keep them open. The terminal bronchioles are smaller still, and the respiratory bronchioles open into clusters of alveoli.

Lungs: The right and left lungs consist mainly of **alveoli**; each lung has approximately 300 million of these air sacs, arranged in clusters like bunches of grapes. Alveoli are surrounded by **elastin fibers** (contribute to exhalation) and by capillary networks of the pulmonary circulation. The alveolar walls are made of **simple squamous epithelium**, as are the pulmonary capillaries. The alveolar walls must be wet inside to allow the diffusion of gases, but wet walls may stick together and make inflation difficult. A lipoprotein called **surfactant** decreases the surface tension of the wet interior walls and makes inflation (inhalation) easier. In the alveoli, oxygen diffuses from the air to the blood, to be circulated throughout the body, and CO_2 from the tissues diffuses from the blood to the air, and will be exhaled. Pulmonary circulation begins at the right ventricle and pulmonary artery and ends with the pulmonary veins to the left atrium.

Mechanism of Breathing

Ventilation is the movement of air into and out of the lungs. Air moves because of changes in pressure within the bronchial tree and the alveoli; these changes are created by the respiratory muscles.

Inhalation: The external intercostals pull the ribs up and out, and the dome of the diaphragm flattens: the thoracic cavity is enlarged in all directions. As the chest cavity is enlarged, the lungs are expanded as well, and the **intrapulmonic pressure** (in the bronchial tree and alveoli) decreases, that is, drops below atmospheric pressure. Air rushes in until the intrapulmonic pressure is again equal to atmospheric pressure; this is a normal inhalation. Further inhalation is possible, with greater contraction of the respiratory muscles. Any inhalation is an active process; it requires muscle contraction, an expenditure of energy.

Exhalation: When the respiratory muscles relax, the thoracic cavity becomes smaller and compresses the lungs. Intrapulmonic pressure rises above atmospheric pressure, and air is forced out until the pressures are again equal. The elastic connective tissue that surrounds the alveoli recoils after being stretched with inhalation and helps to make normal exhalation a passive (rather than active) process. Further exhalation, however, is active, because energy is required for the contraction of the internal intercostals and abdominal muscles.

Pulmonary Volumes and Capacities

Tidal Volume: Volume of air inspired or expired with each breath (at rest, approximately 500 mL).

Inspiratory Reserve Volume: Amount of air that can be inspired forcefully after inspiration of tidal volume (at rest, approximately 3000 mL).

Expiratory Reserve Volume: Amount of air that can be forcefully expired after expiration of tidal volume (at rest, approximately 1100 mL).

Residual Volume: Volume of air remaining in the respiratory passages and lungs after the most forceful expiration (approximately 1200 mL).

Inspiratory Capacity: Tidal volume plus inspiratory reserve volume (approximately 3500 mL).

Functional Residual Capacity: Expiratory reserve volume plus residual volume (approximately 2300 mL).

Vital Capacity: Sum of the inspiratory reserve volume, tidal volume, and expiratory reserve volume (approximately 4600 mL).

Total Lung Capacity: Sum of the inspiratory and expiratory reserve volumes plus the tidal and residual volumes (approximately 5800 mL).

All of these volumes and capacities vary; the most important determining factors are a person's size (height) and age.

Movement and Transport of Gases

Oxygen and CO_2 diffuse along gradients of their **partial pressure** (P), from high to low. The air in the alveoli has a high Po_2 and a low Pco_2; the blood in the pulmonary capillaries has a low Po_2 and a high Pco_2. Therefore, oxygen diffuses from the air to the blood, and CO_2 diffuses from the blood to the air (this exchange is called **external respiration**).

In the blood, most **oxygen** is carried by red blood cells; oxygen bonds to the **iron** of their **hemoglobin** molecules (some O_2 is dissolved in the plasma). Most **carbon dioxide** is carried in the form of **bicarbonate ions** (HCO_3^-) in the plasma (some is dissolved in plasma and some is carried by hemoglobin).

In the tissues, pressure gradients again determine the movement of gases. The blood in the systemic capillaries has a high Po_2 and a low Pco_2; the tissue fluid around cells has a low Po_2 and a high Pco_2. Therefore, oxygen diffuses from the blood to the tissues, and CO_2 diffuses from the tissues to the blood (this exchange is called **internal respiration**).

Regulation of Respiration

Nervous Regulation: The primary respiratory centers are in the **medulla** of the brain: the inspiration center and expiration center. The **inspiration center** generates impulses in spurts; these impulses to the respiratory muscles bring about inhalation. The **expiration center** is activated when there is a need for forceful exhalations, beyond the normal. In the **pons** are two more centers: the **apneustic center** prolongs inhalation (to normal), and the **pneumotaxic center** interrupts the apneustic center, thus contributing to a normal exhalation. During quiet breathing, an inhalation lasts 1 to 2 seconds, and an exhalation lasts 2 to 3 seconds. A normal respiratory rate is 12 to 20 breaths per minute.

Chemical Regulation: Changes in blood gases also affect respiration. The strongest stimulus to increase breathing is an increase in the CO_2 level. More CO_2 means that more hydrogen ions will be formed ($CO_2 + H_2O \rightarrow H_2CO_3 \rightarrow H^+ + HCO_3^-$); the hydrogen ions lower the pH of blood and tissue fluid. This change is detected by **central chemoreceptors** in the **medulla**. The medulla will increase the rate and depth of respiration to increase the amount of CO_2 exhaled, to decrease the formation of H^+ ions, to raise the pH to normal. Changes in oxygen level in the blood are detected by **chemoreceptors** in the **carotid arteries** and **aortic arch**, with the glossopharyngeal and vagus nerves sensory, transmitting impulses to the respiratory centers in the medulla. Oxygen levels must be quite low before this becomes the major stimulus to increase the rate and depth of breathing.

Respiration and Acid-Base Balance

Respiration affects the pH of body fluids because breathing controls the amount of CO_2 present in these fluids. Respiration may be the cause of a pH imbalance, or it may be compensation, a corrective mechanism, for a metabolic pH imbalance.

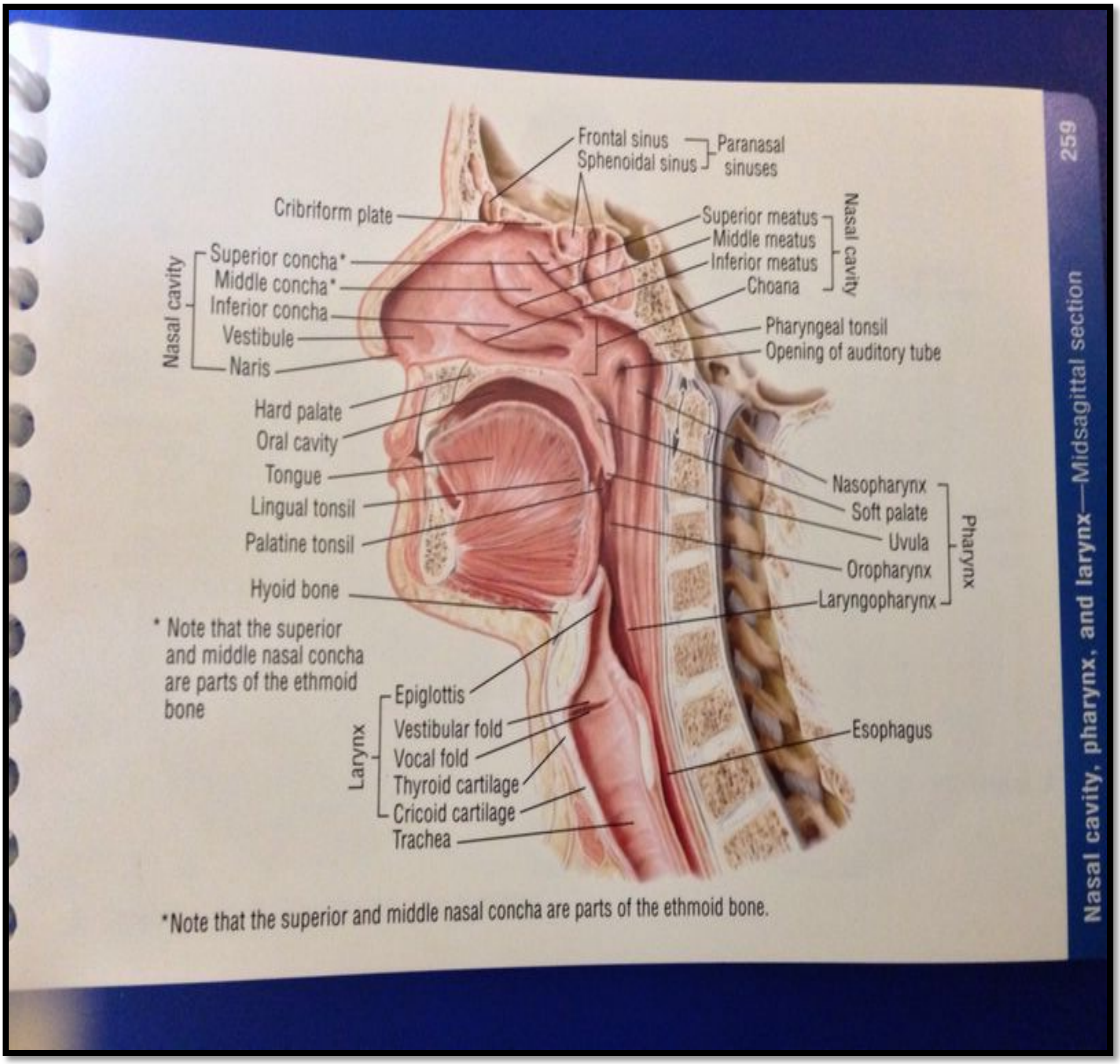
Respiratory acidosis is caused by anything that decreases the rate or effectiveness of breathing (any pulmonary disease, for example). Exhalation of CO_2 is impaired, and the accumulating CO_2 lowers the pH.

Respiratory alkalosis is the result of a faster than normal breathing rate. As CO_2 is exhaled more quickly, pH rises.

Respiratory compensation for metabolic acidosis (perhaps from kidney disease) involves more rapid respirations to get rid of CO_2 and decrease the formation of H^+ ions.

Respiratory compensation for metabolic alkalosis involves slowing the breathing rate to conserve CO_2 and increase the formation of hydrogen ions.

The respiratory system responds within seconds to minutes to a pH imbalance but has limited capacity to correct an ongoing imbalance. There is a limit to how fast or slow the breathing rate can become and how long that new rate can be maintained. Therefore, the maximum respiratory compensation is about 75%.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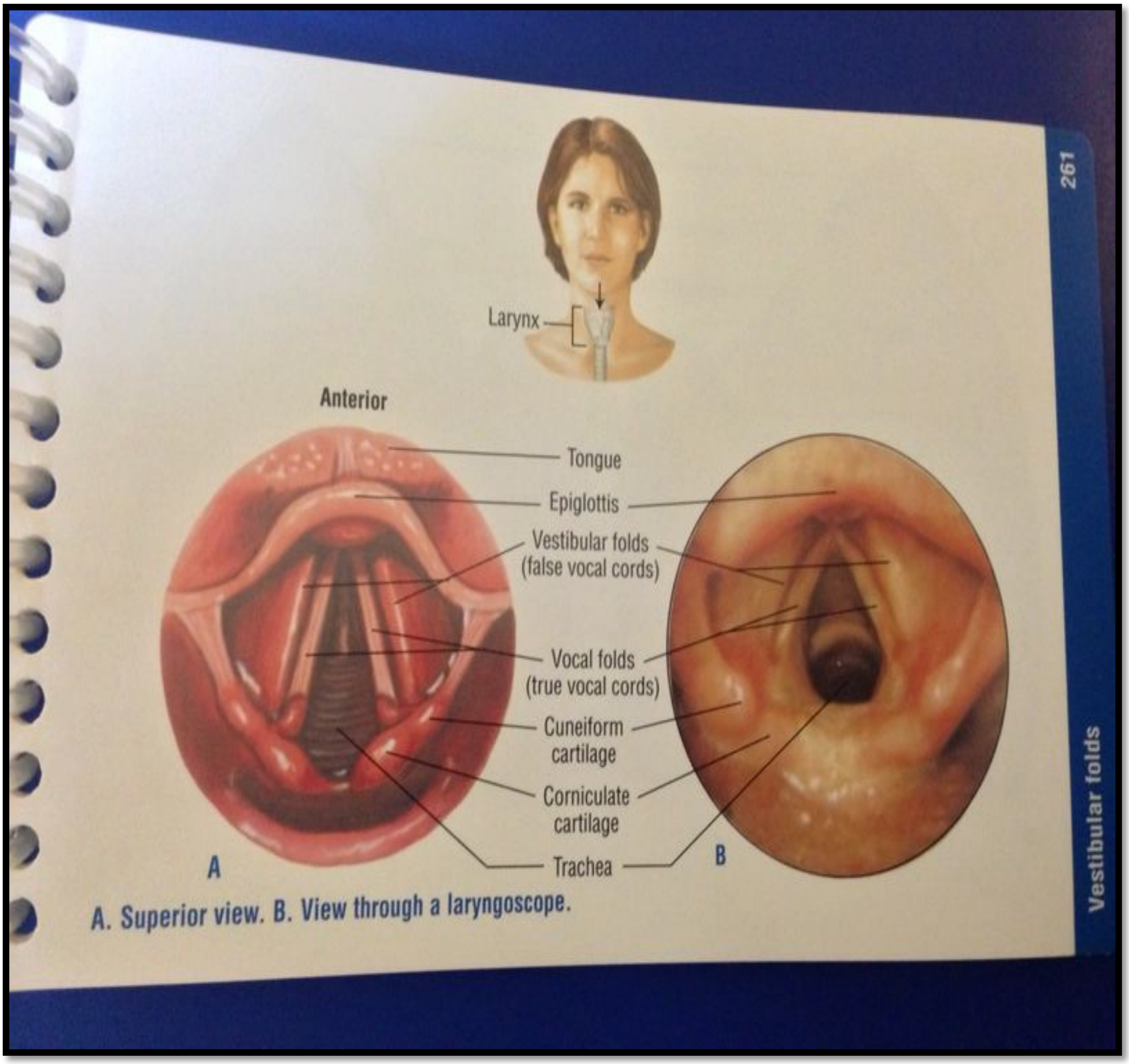
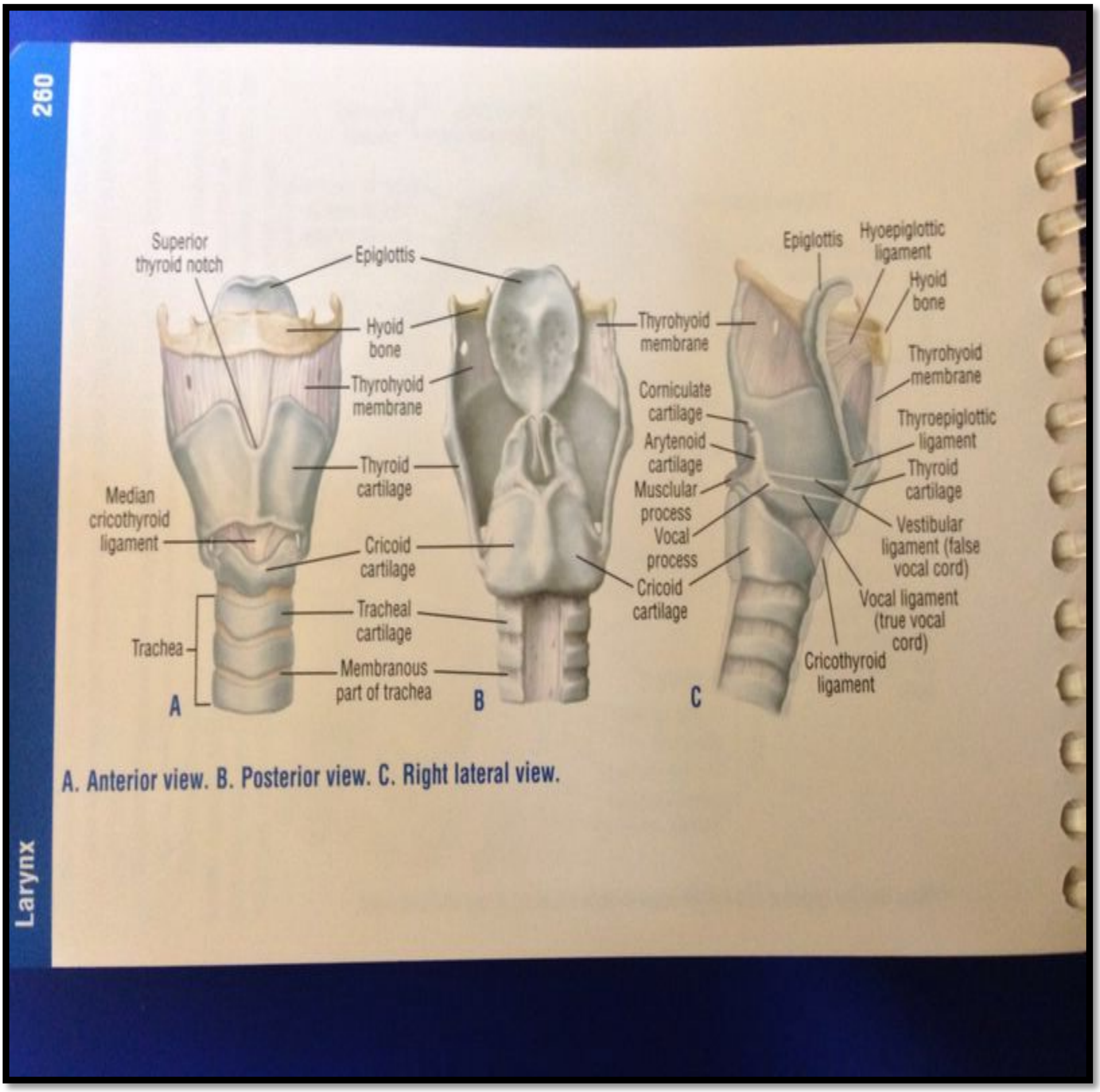
Nasal cavity, pharynx, and larynx—Midsagittal section
Frontal sinus
Sphenoidal sinus
Paranasal sinuses
Cribriform plate
Nasal cavity
Superior concha*
Middle concha*
Inferior concha
Vestibule
Naris
Superior meatus
Middle meatus
Inferior meatus
Choana
Nasal cavity
Pharyngeal tonsil
Opening of auditory tube
Hard palate
Oral cavity
Tongue
Lingual tonsil
Palatine tonsil
Hyoid bone
Nasopharynx
Soft palate
Uvula
Oropharynx
Laryngopharynx
Pharynx
* Note that the superior and middle nasal concha are parts of the ethmoid bone
Larynx
Epiglottis
Vestibular fold
Vocal fold
Thyroid cartilage
Cricoid cartilage
Trachea
Esophagus
*Note that the superior and middle nasal concha are parts of the ethmoid bone.



A. Superior view. B. View through a laryngoscope.



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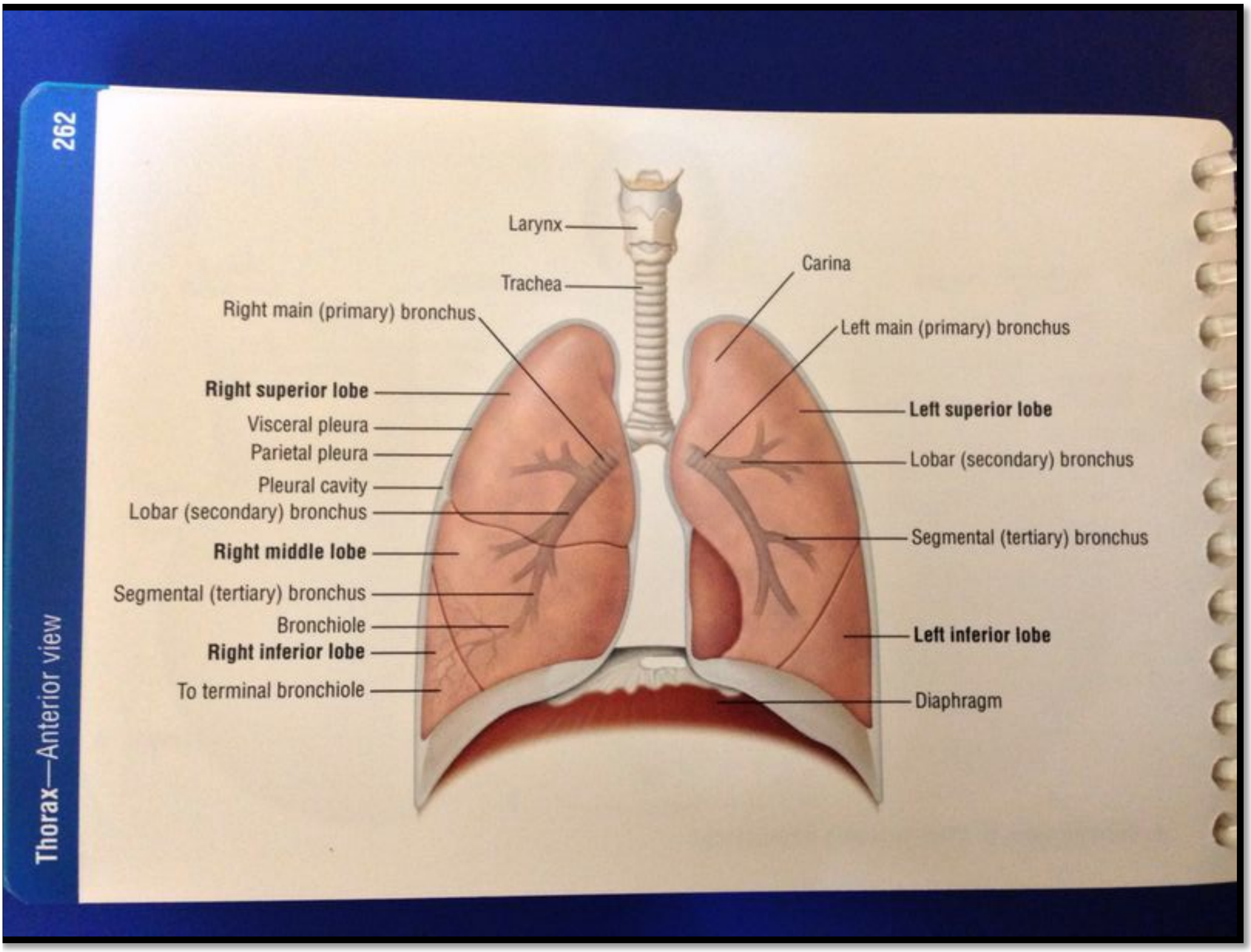
Larynx
Superior thyroid notch
Epiglottis
Hyoid bone
Thyrohyoid membrane
Thyroid cartilage
Median cricothyroid ligament
Cricoid cartilage
Trachea
Tracheal cartilage
Membranous part of trachea
A
B
Thyrohyoid membrane
Corniculate cartilage
Arytenoid cartilage
Muscular process
Vocal process
Cricoid cartilage
C
Epiglottis
Hyoepiglottic ligament
Hyoid bone
Thyrohyoid membrane
Thyroepiglottic ligament
Thyroid cartilage
Vestibular ligament (false vocal cord)
Vocal ligament (true vocal cord)
Cricothyroid ligament
A. Anterior view. B. Posterior view. C. Right lateral view.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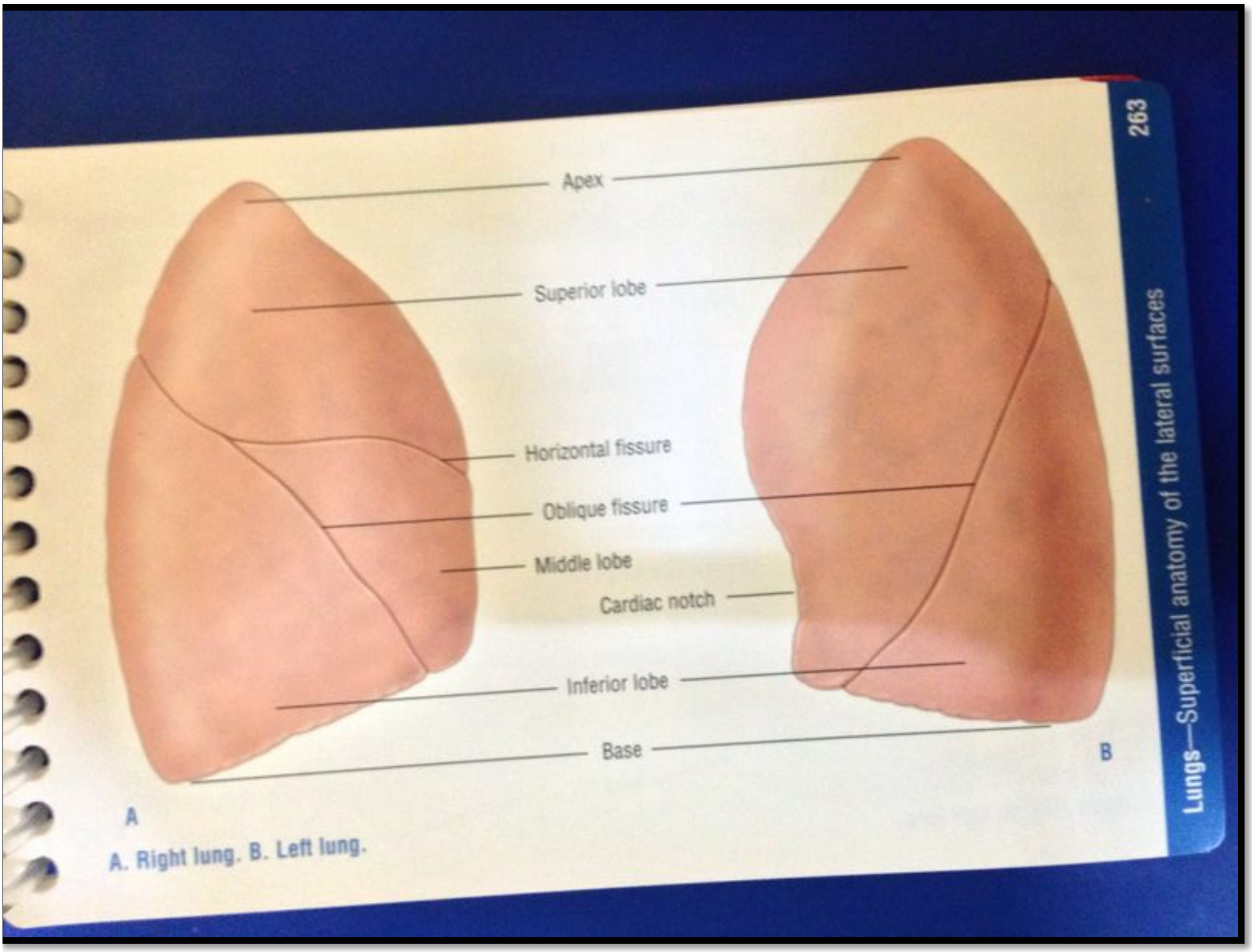
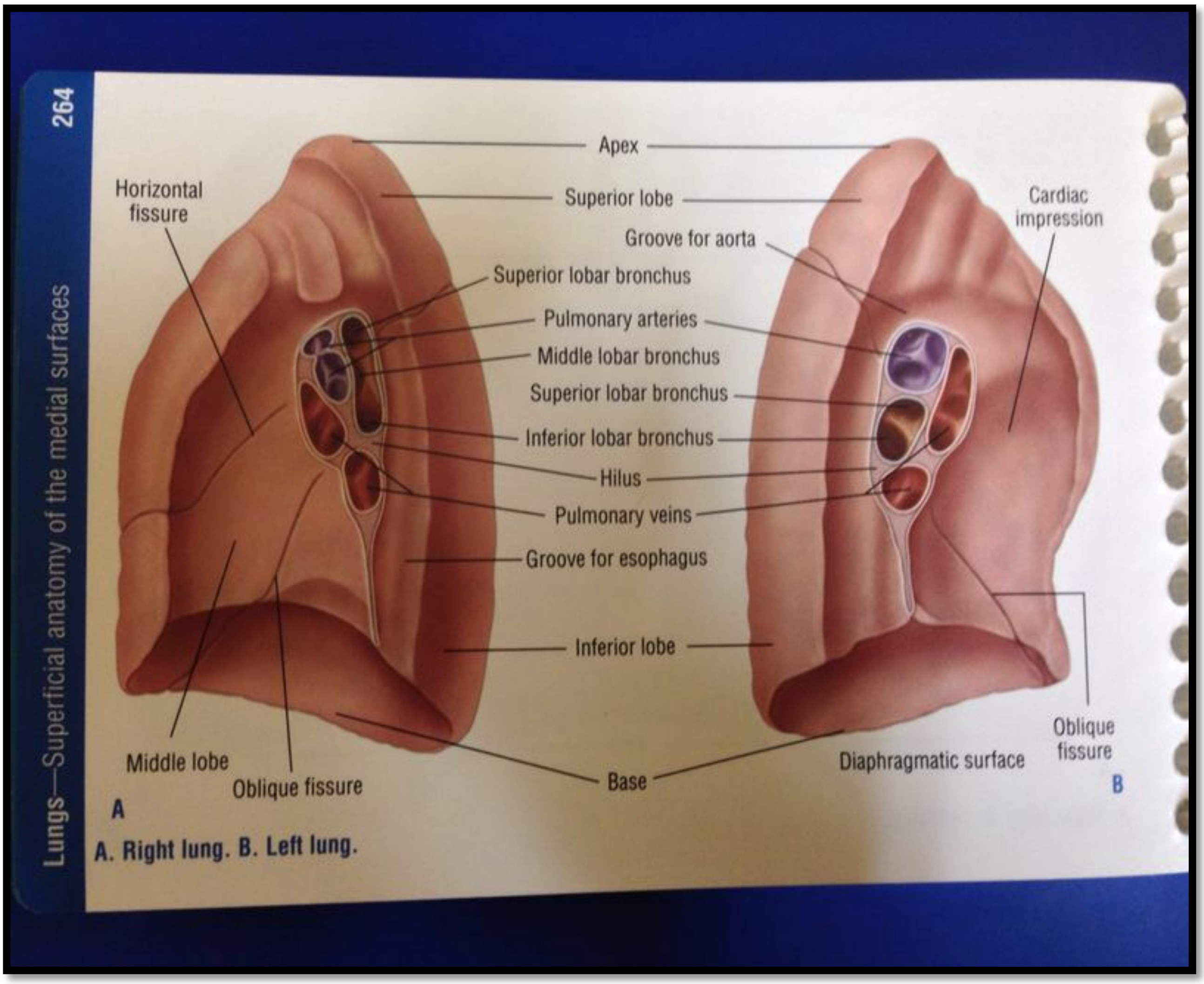
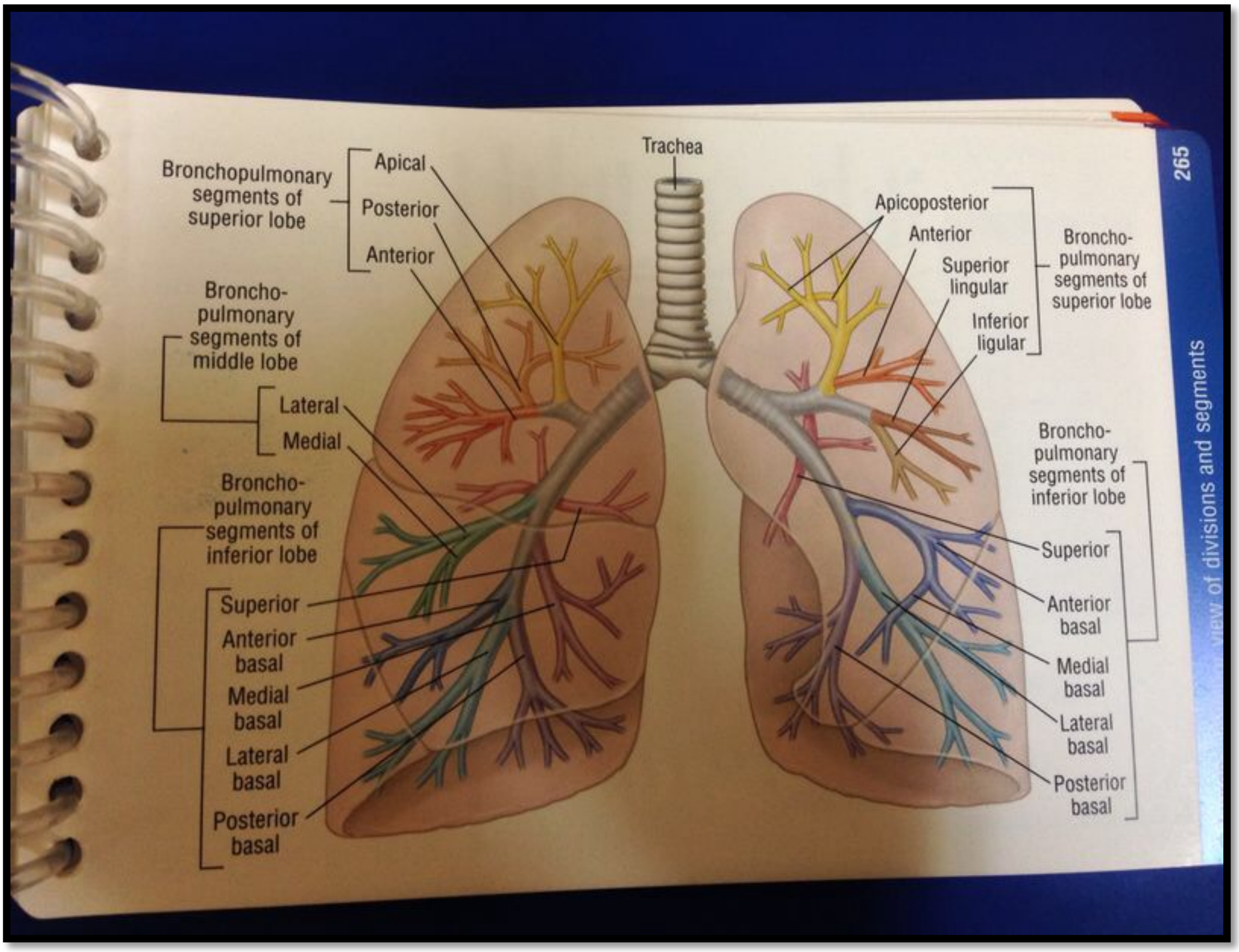
Thorax—Anterior view
Larynx
Trachea
Carina
Right main (primary) bronchus
Left main (primary) bronchus
Right superior lobe
Visceral pleura
Parietal pleura
Pleural cavity
Lobar (secondary) bronchus
Right middle lobe
Segmental (tertiary) bronchus
Bronchiole
Right inferior lobe
To terminal bronchiole
Left superior lobe
Lobar (secondary) bronchus
Segmental (tertiary) bronchus
Left inferior lobe
Diaphragm


263
Lungs—Superficial anatomy of the lateral surfaces
Apex
Superior lobe
Horizontal fissure
Oblique fissure
Middle lobe
Cardiac notch
Inferior lobe
Base
A
B
A. Right lung. B. Left lung.


264
Lungs—Superficial anatomy of the medial surfaces
Horizontal fissure
Apex
Superior lobe
Groove for aorta
Cardiac impression
Superior lobar bronchus
Pulmonary arteries
Middle lobar bronchus
Superior lobar bronchus
Inferior lobar bronchus
Hilus
Pulmonary veins
Groove for esophagus
Inferior lobe
Middle lobe
Oblique fissure
Base
Diaphragmatic surface
Oblique fissure
A
B
A. Right lung. B. Left lung.



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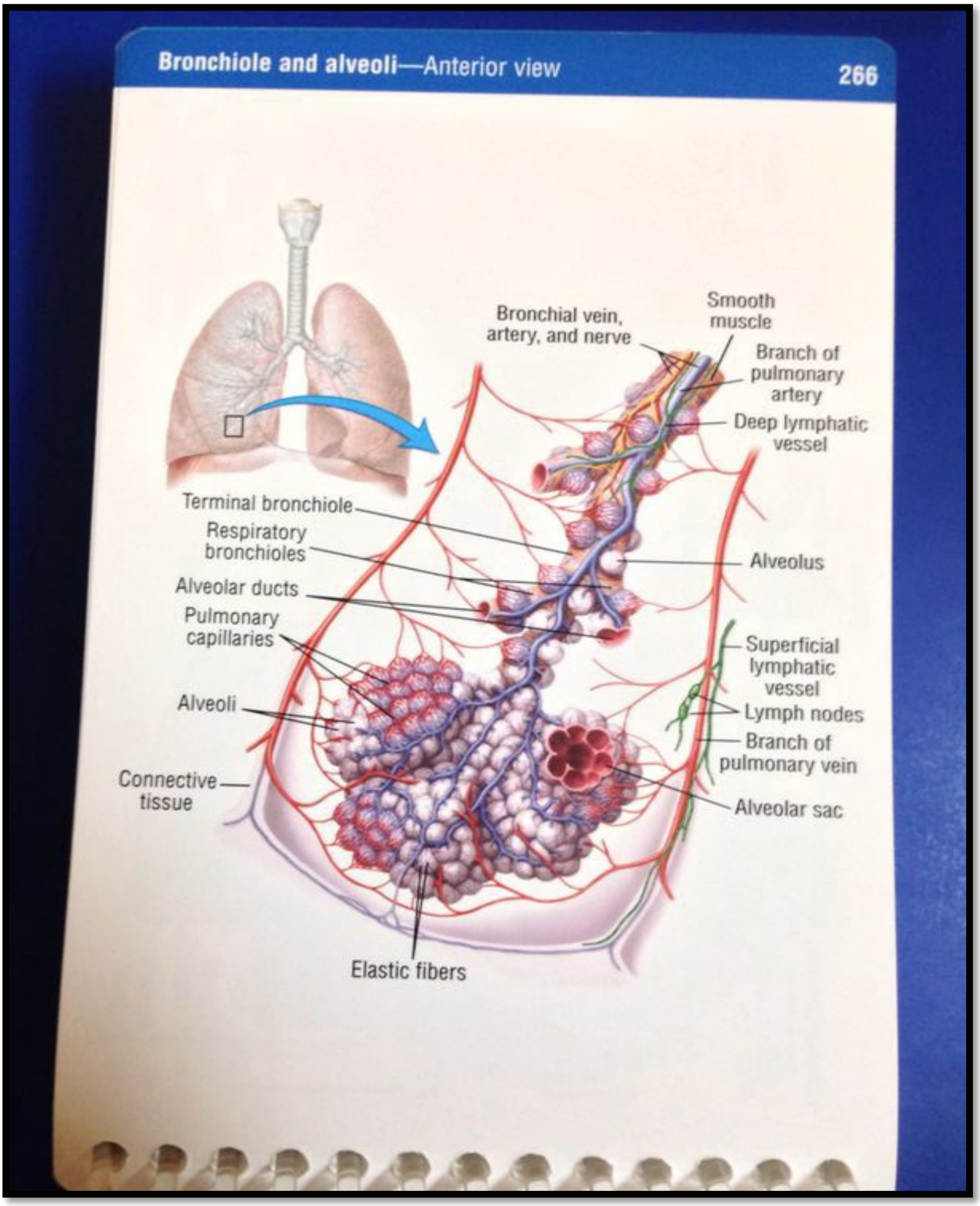
Trachea
Bronchopulmonary
segments of
superior lobe
Apical
Posterior
Anterior
Broncho-
pulmonary
segments of
middle lobe
Lateral
Medial
Broncho-
pulmonary
segments of
inferior lobe
Superior
Anterior
basal
Medial
basal
Lateral
basal
Posterior
basal
Apicoposterior
Anterior
Superior
lingular
Inferior
ligular
Broncho-
pulmonary
segments of
superior lobe
Broncho-
pulmonary
segments of
inferior lobe
Superior
Anterior
basal
Medial
basal
Lateral
basal
Posterior
basal
of divisions and segments


Bronchiole and alveoli—Anterior view
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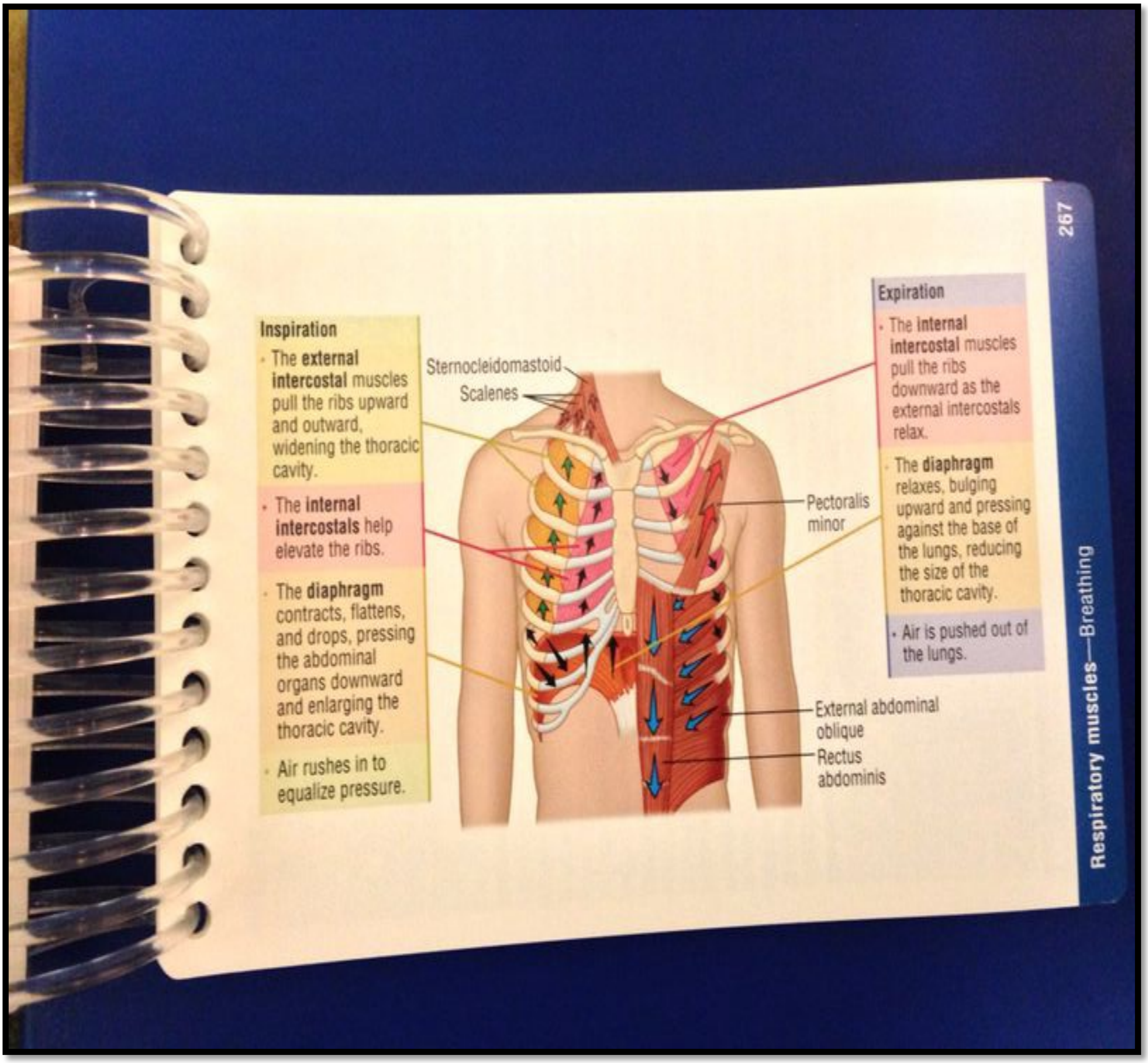
Bronchial vein, artery, and nerve
Smooth muscle
Branch of pulmonary artery
Deep lymphatic vessel
Terminal bronchiole
Respiratory bronchioles
Alveolus
Alveolar ducts
Pulmonary capillaries
Superficial lymphatic vessel
Lymph nodes
Alveoli
Branch of pulmonary vein
Connective tissue
Alveolar sac
Elastic fibers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Inspiration
The external intercostal muscles pull the ribs upward and outward, widening the thoracic cavity.
The internal intercostals help elevate the ribs.
The diaphragm contracts, flattens, and drops, pressing the abdominal organs downward and enlarging the thoracic cavity.
Air rushes in to equalize pressure.
Sternocleidomastoid
Scalenes
Pectoralis minor
External abdominal oblique
Rectus abdominis
Expiration
The internal intercostal muscles pull the ribs downward as the external intercostals relax.
The diaphragm relaxes, bulging upward and pressing against the base of the lungs, reducing the size of the thoracic cavity.
Air is pushed out of the lungs.
Respiratory muscles—Breathing