UNIVERSITAS CAROLINA PRAGENSIS

Univerzita Karlova v Praze - 1. Lékařská fakulta

Respiratory System

Institute of Anatomy

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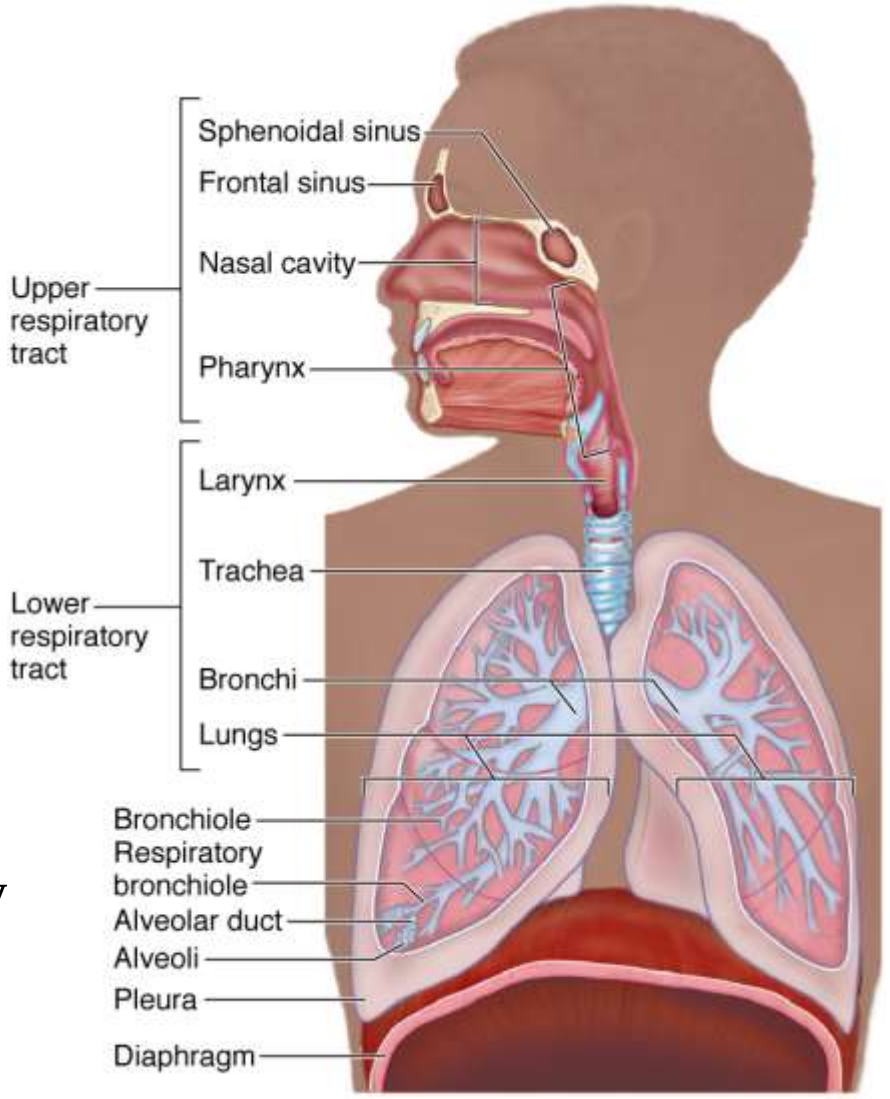
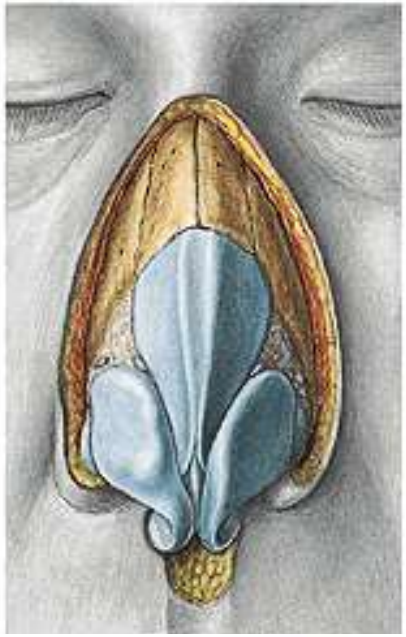
Subject: Anatomy 1

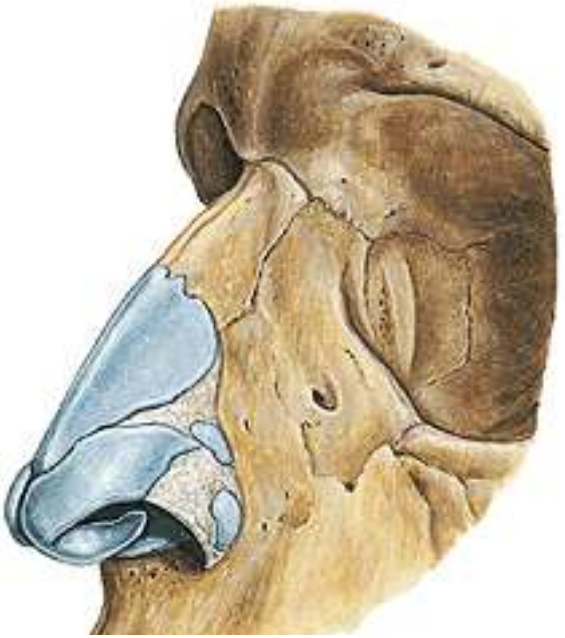
Date: January 2015

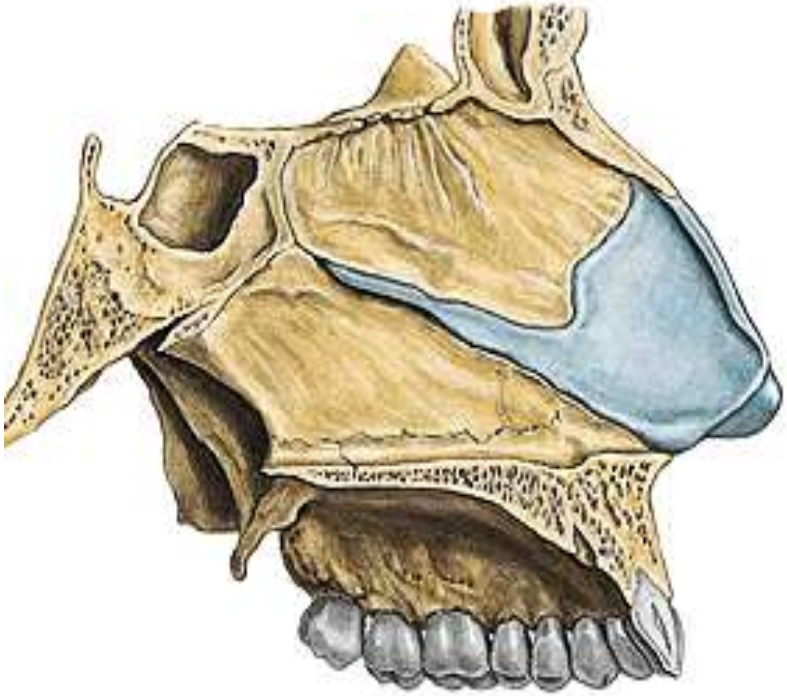
Division of respiratory system

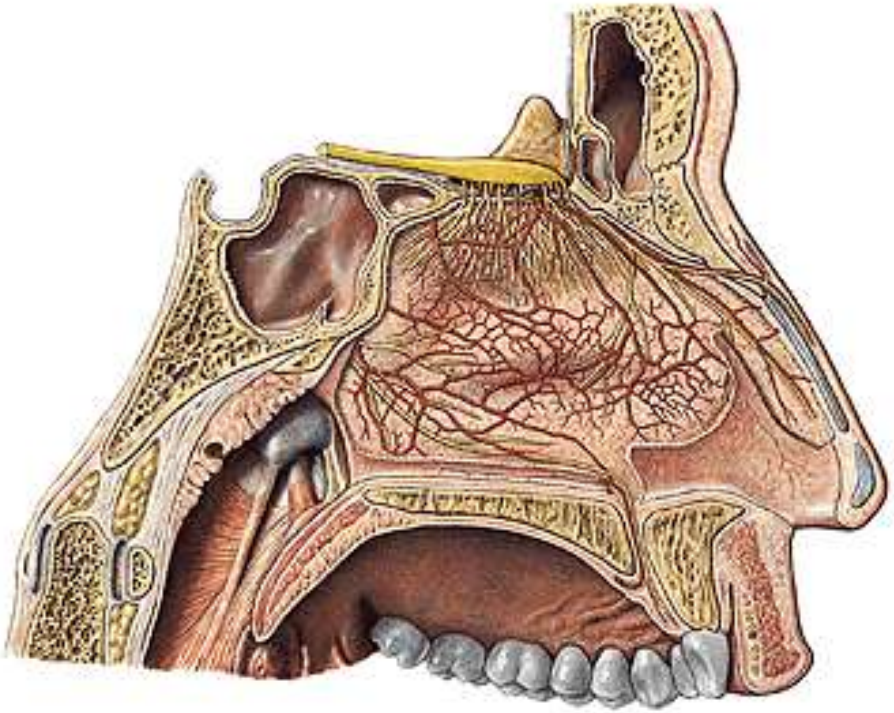
- Upper respiratory tract:
  - external nose
  - nasal cavity & paranasal sinuses
  - pharynx
- Lower respiratory tract:
  - larynx
  - trachea (windpipe)
  - bronchi (down to respiratory bronchioli)
  - lungs
- Significance: ENT vs. pneumology
  URTI vs. pneumonia

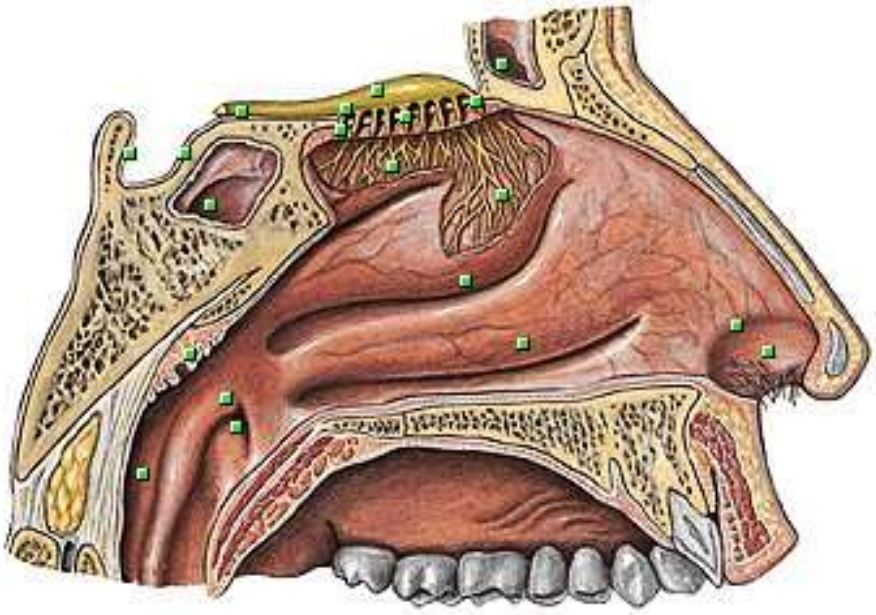


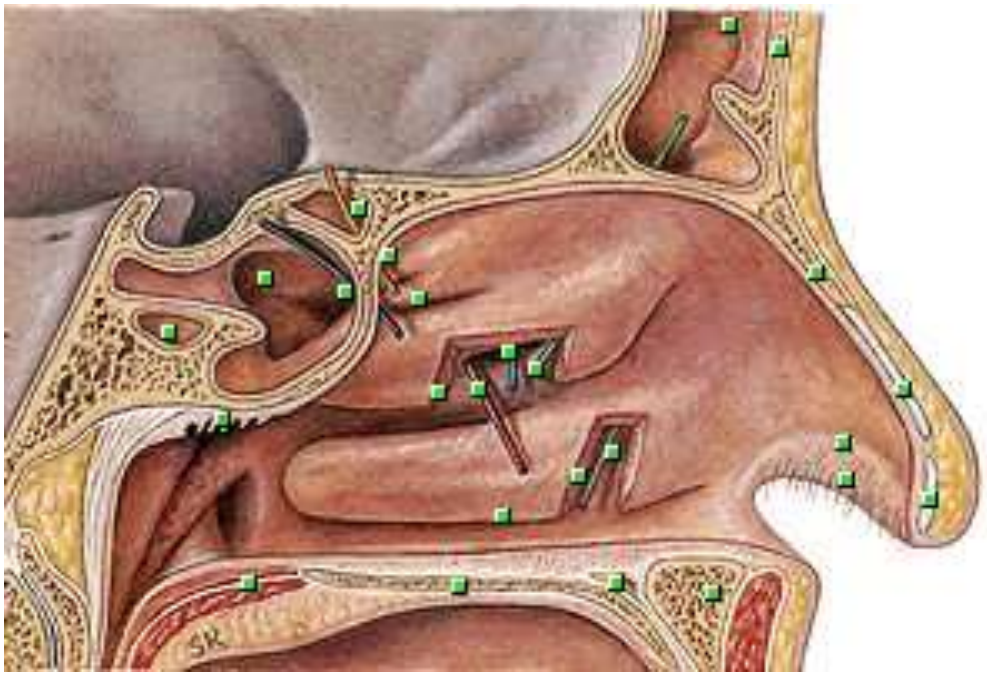












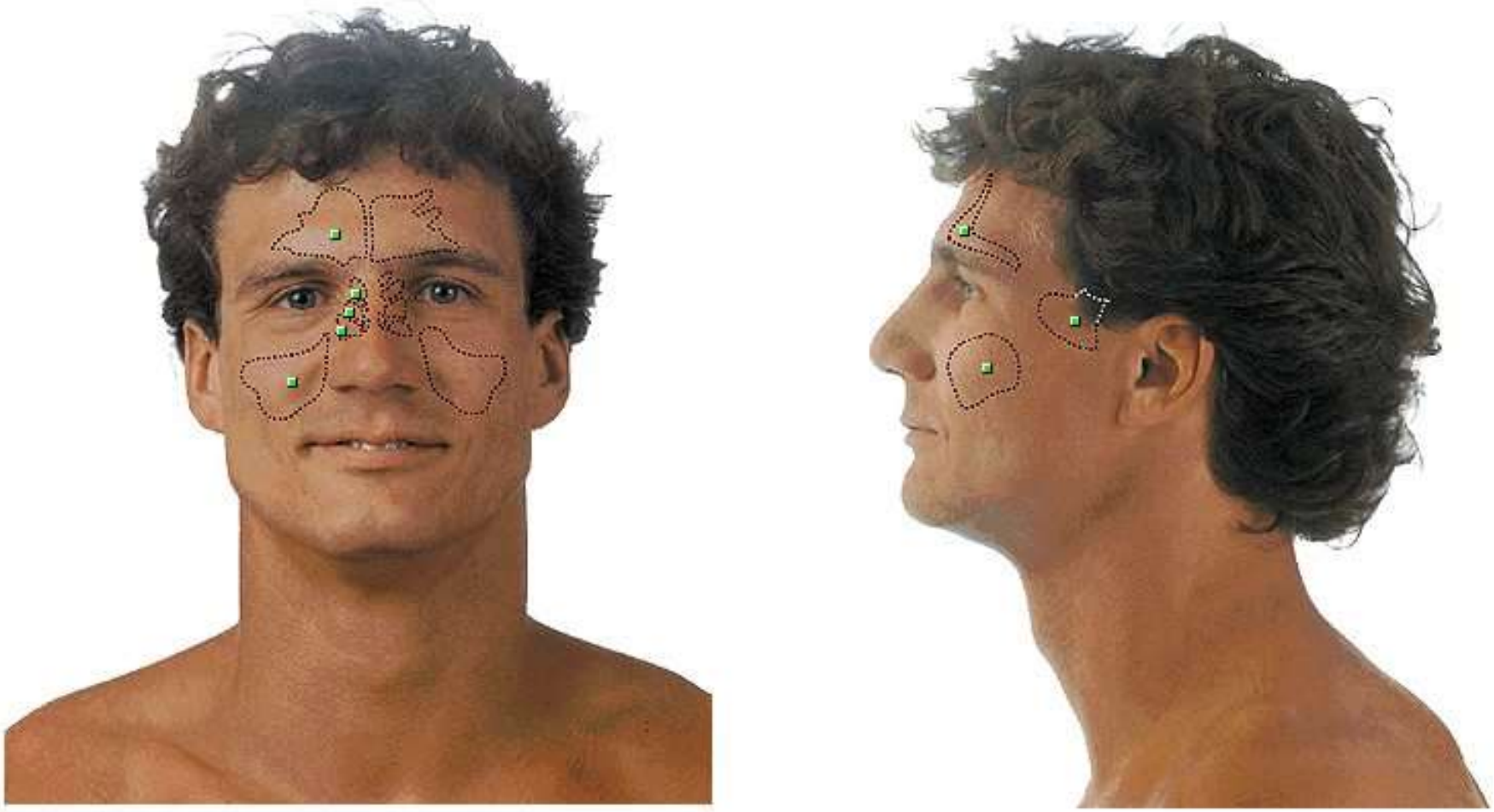
Nasal passages and paranasal sinuses

Nasal cavity and paranasal sinuses

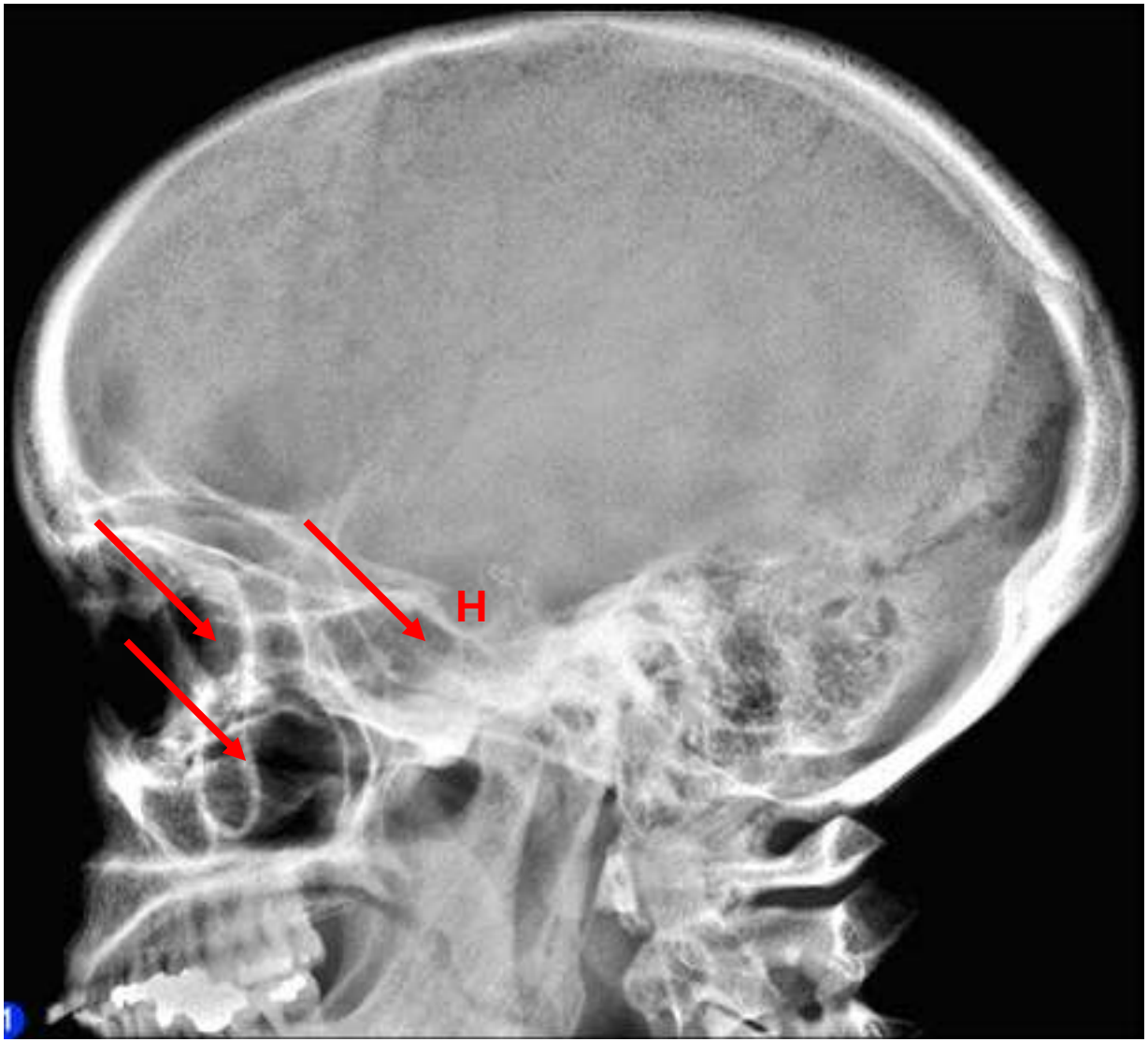
- Common colds are common
- Spatial relationships (syntopies) are important for spread of infection
- Complications: meningitis, teeth, orbit, mediootitis, mastoiditis, sinusitis…

Nasal cavity and paranasal sinuses

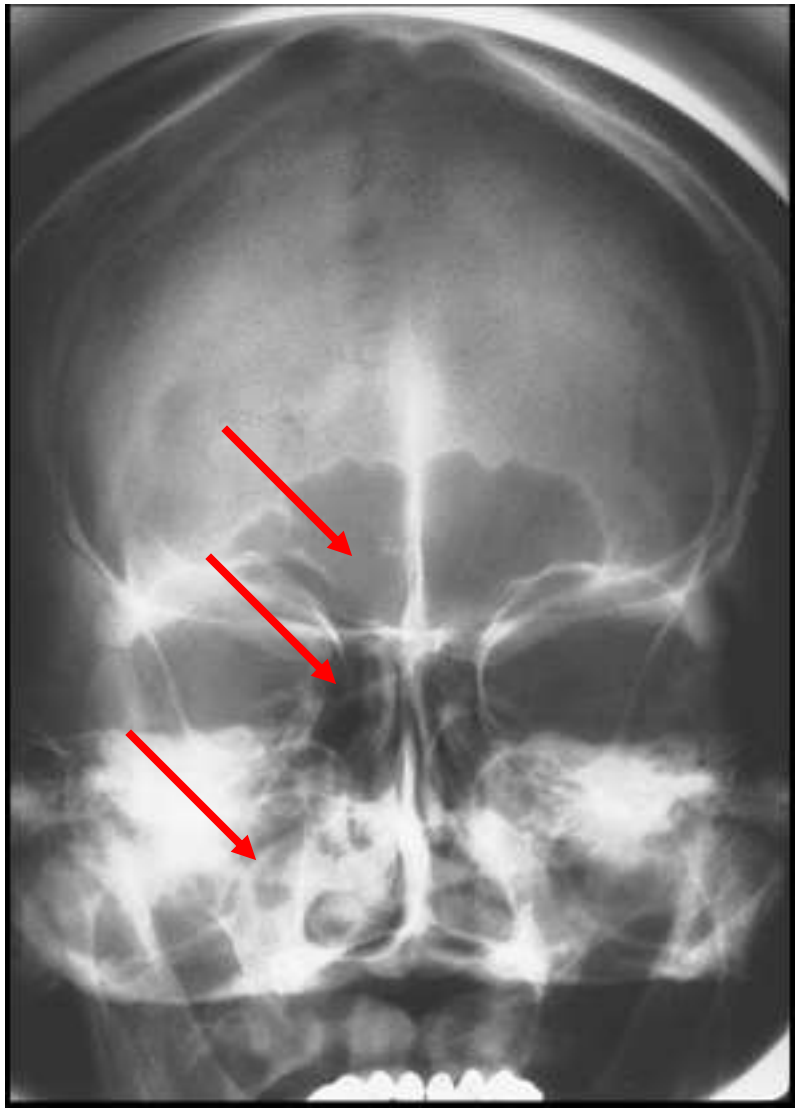
- Why do we have them (other than to keep ENT doctors in business)
- Maxillary, frontal, sphenoidal, ethmoidal
- Surface projections, visible and X-ray examination - sinusitis



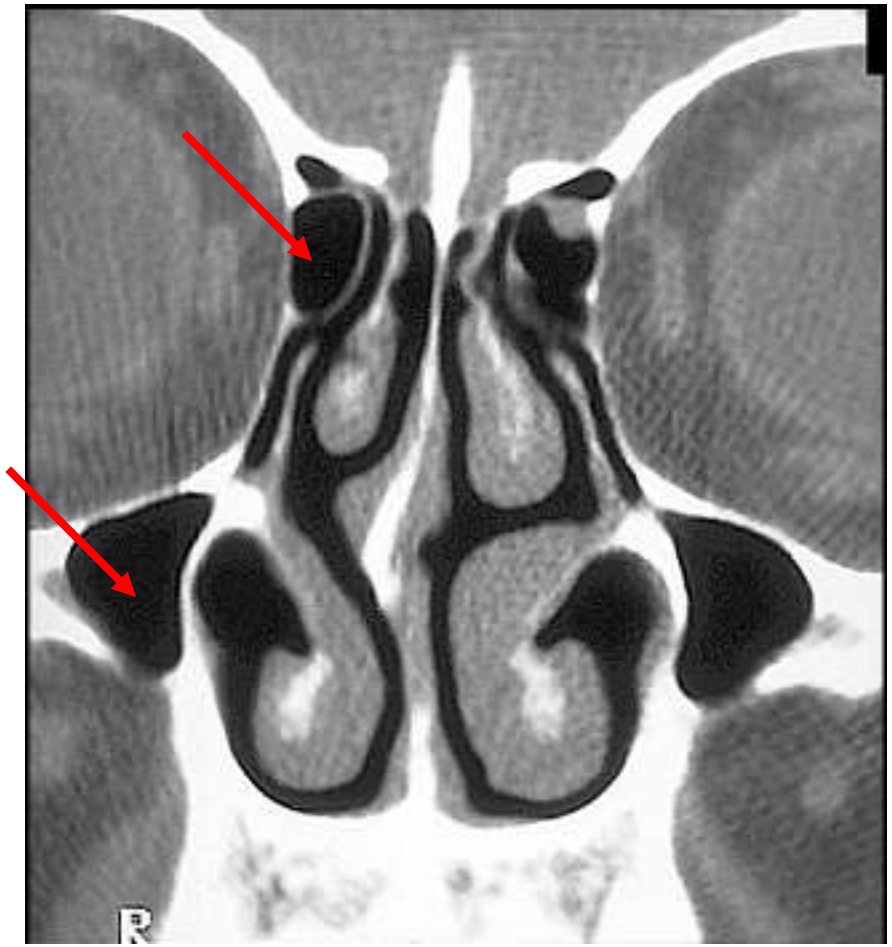
Surface projection of pasanasal sinuses



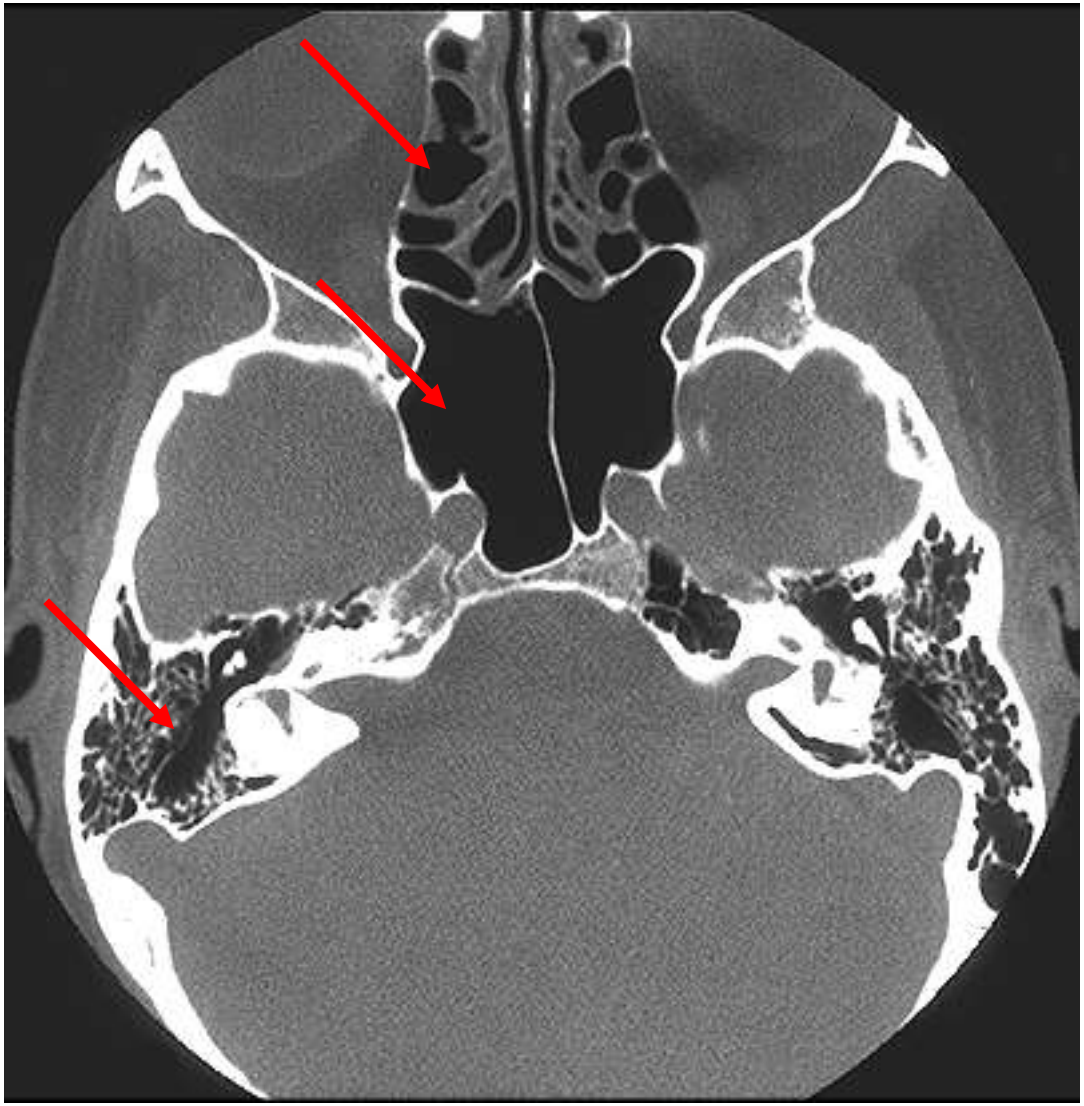
Lateral X-ray



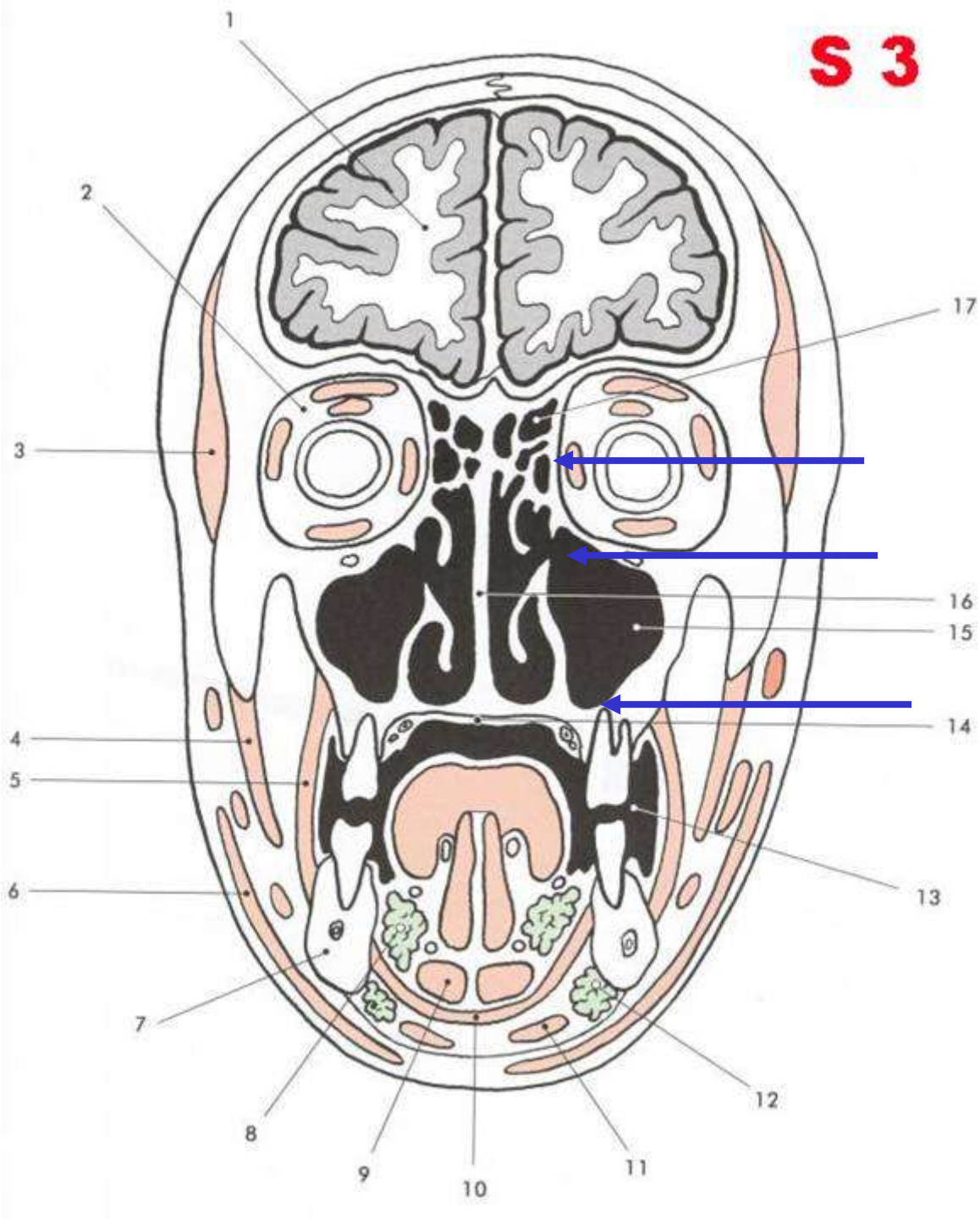
Frontal X-ray



Frontal CT



Horizontal CT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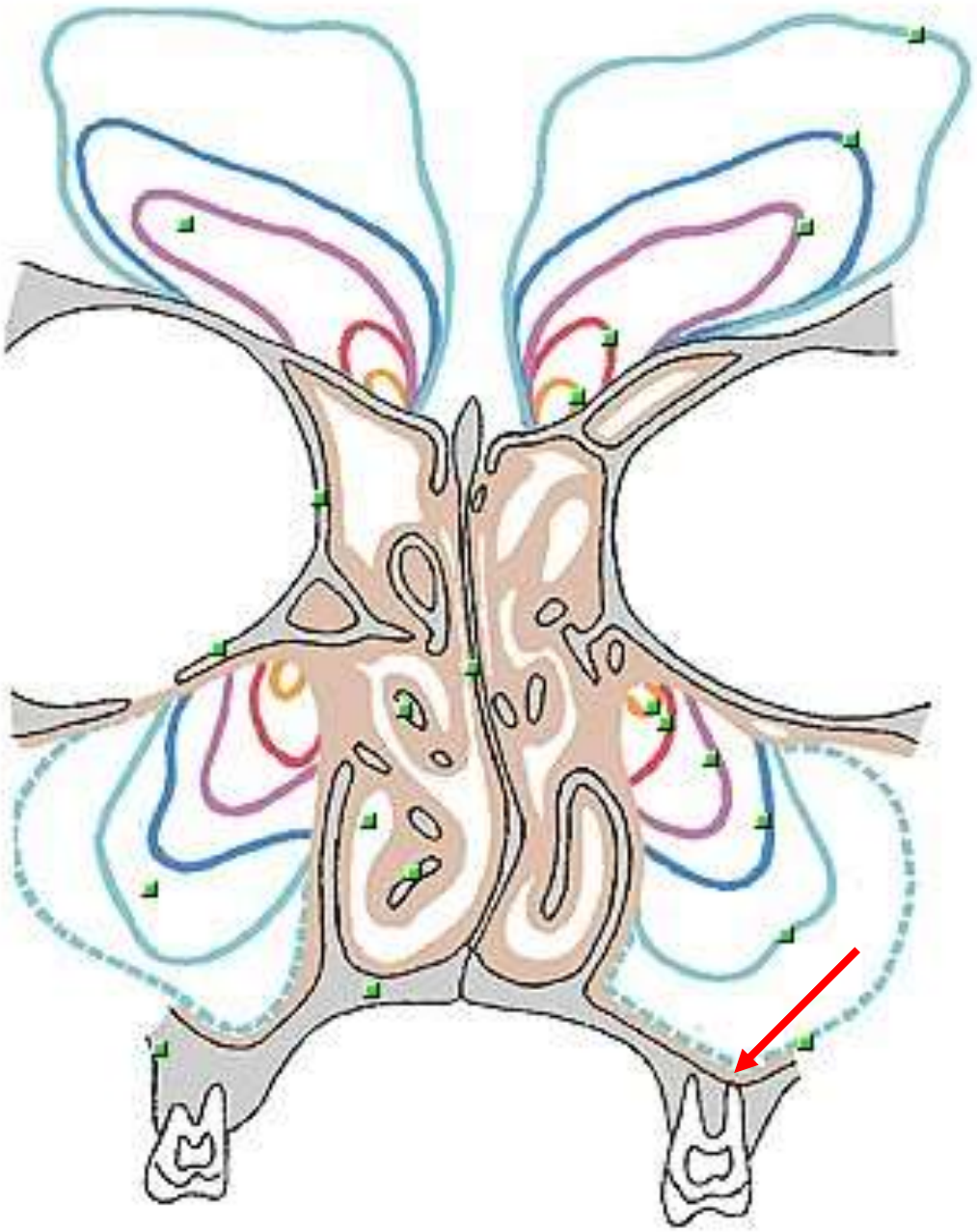
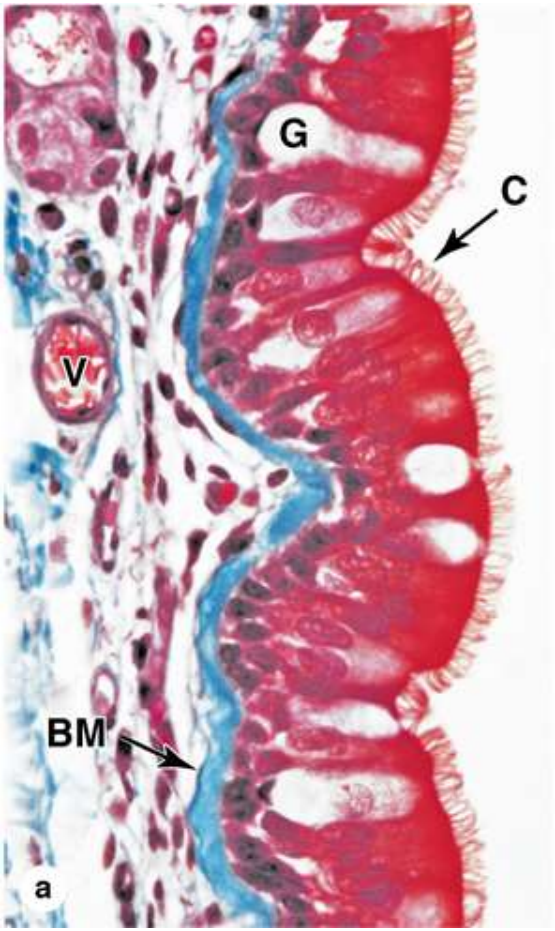
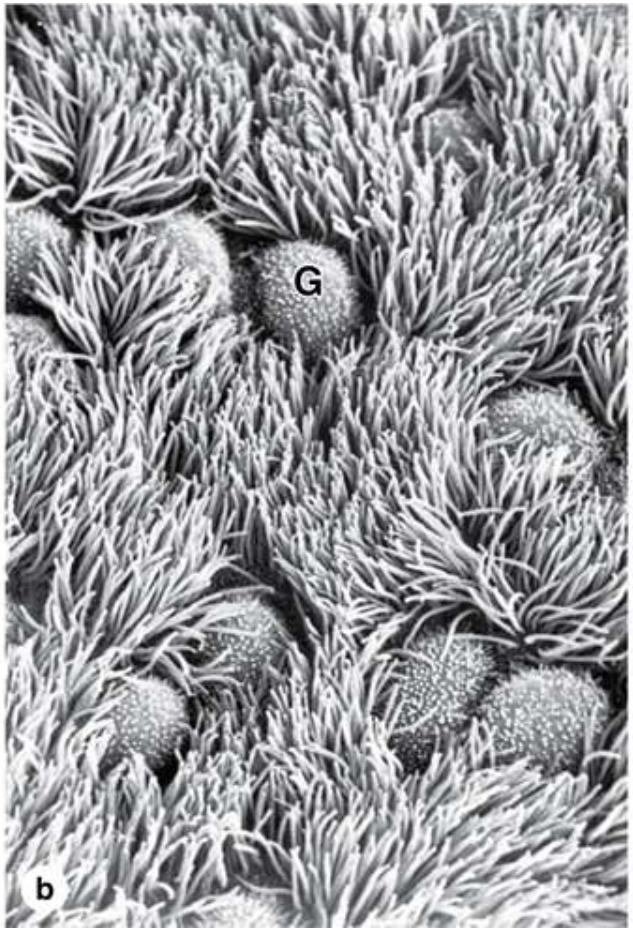
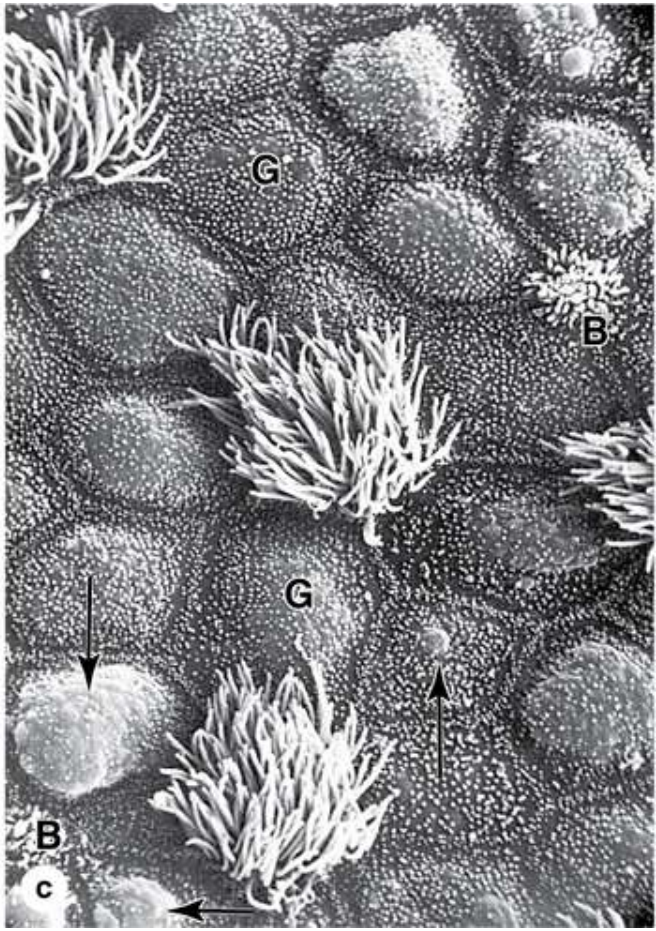
Postnatal growth of paranasal sinuses (pneumatization)



Histology of airways

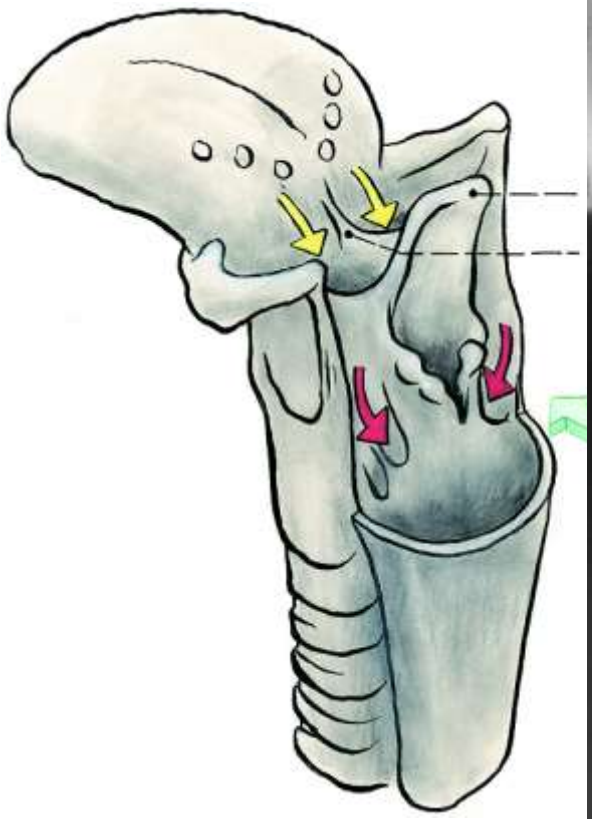


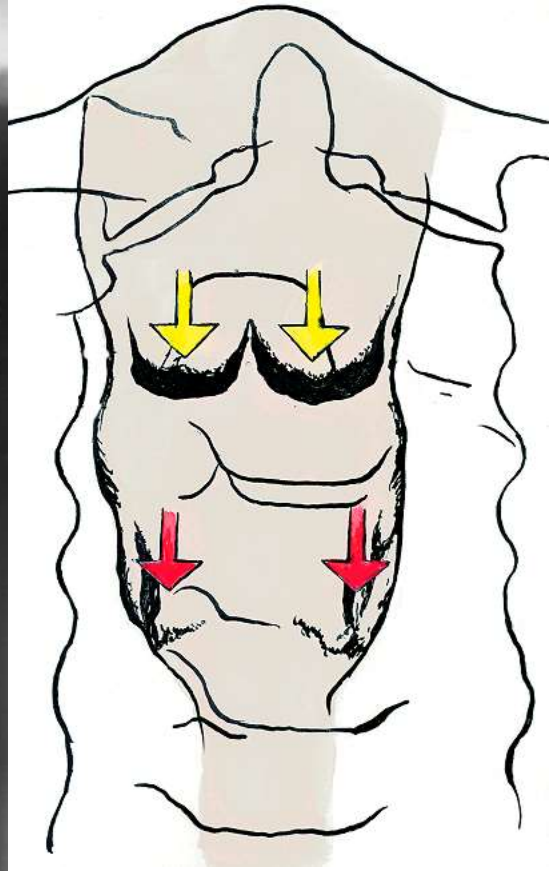


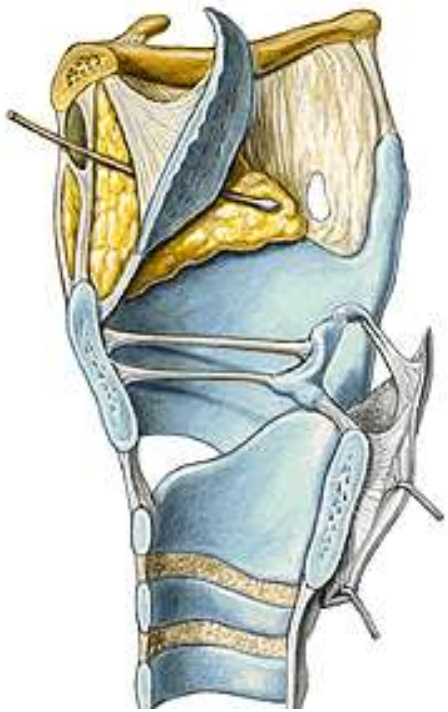


Taken from and see more in: Junquiera's Histology!

The Pharynx - crossing of breathing and swallowing pathways







Laryngeal cartilages

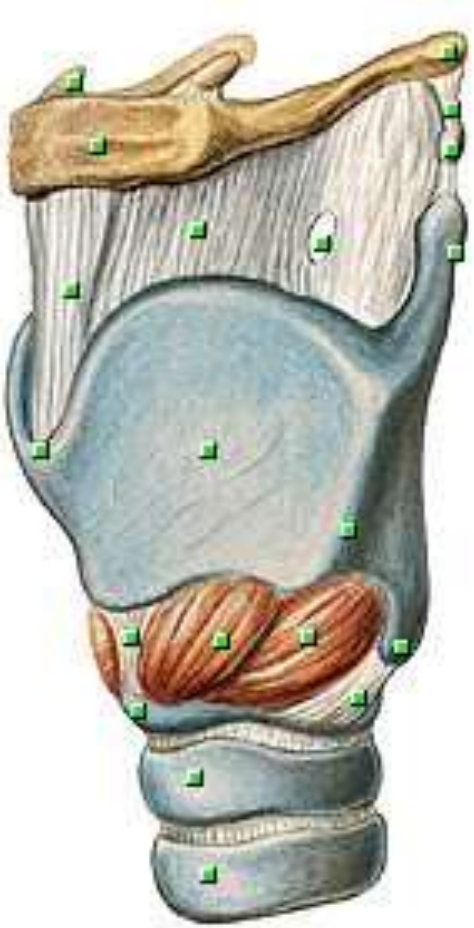
Thyroid cartilage – left + right lamina, superior + inferior notch, superior + inferior horn, oblique line, cricoid articular surface

Cricoid cartilage - arch, lamina, arytenoid + cricoid articular surface

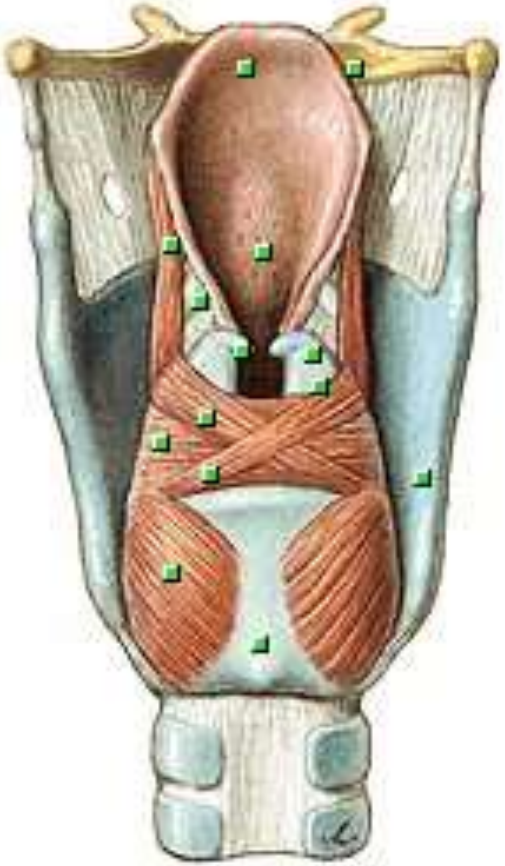
Arytenoid cartilage - base, apex, muscular + vocal process, cricoid articular surface,

Epiglottis, Cuneiform + Corniculate + Triticeal cartilages

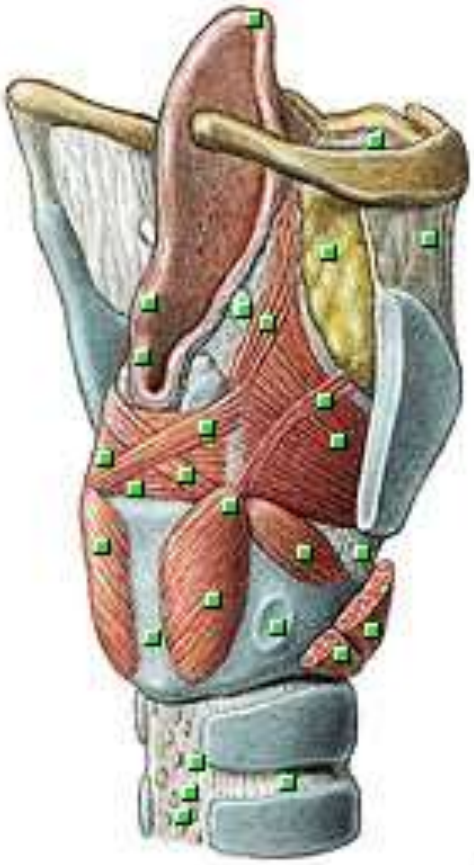
The Larynx - muscles



Anterior

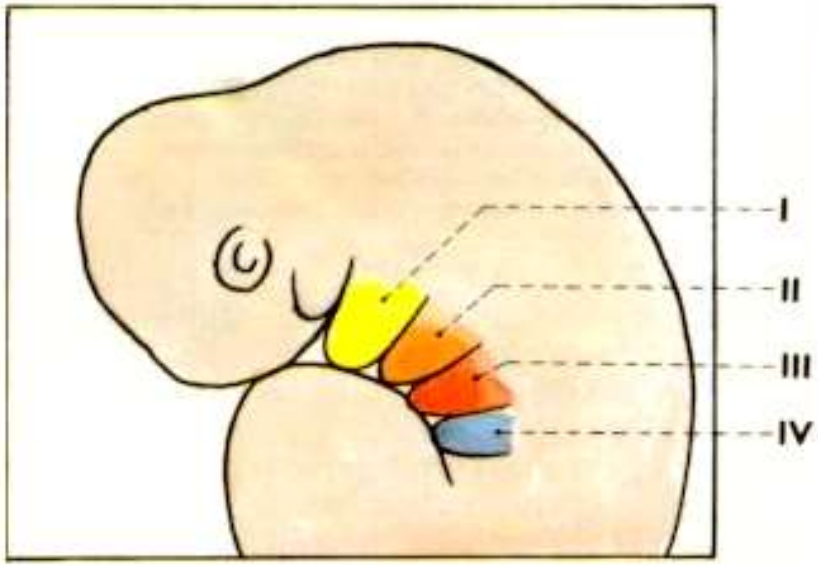


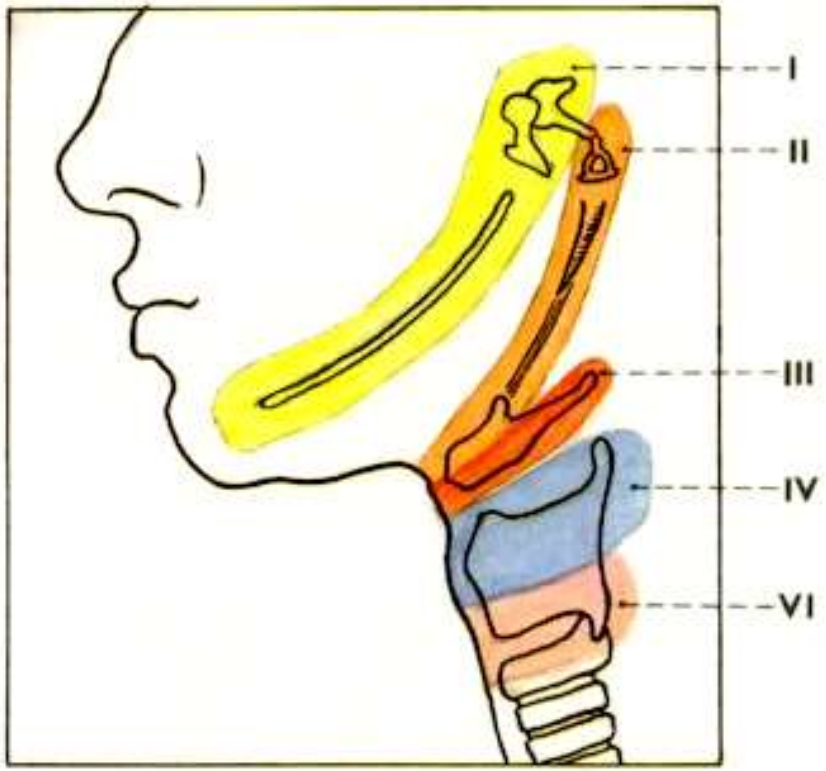
posterior



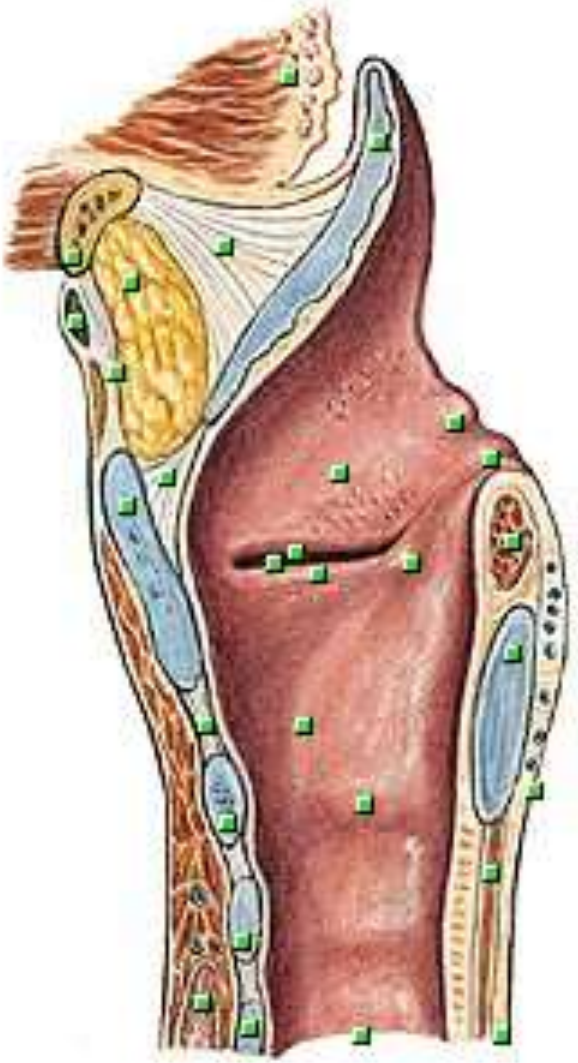
lateral

The Larynx - development



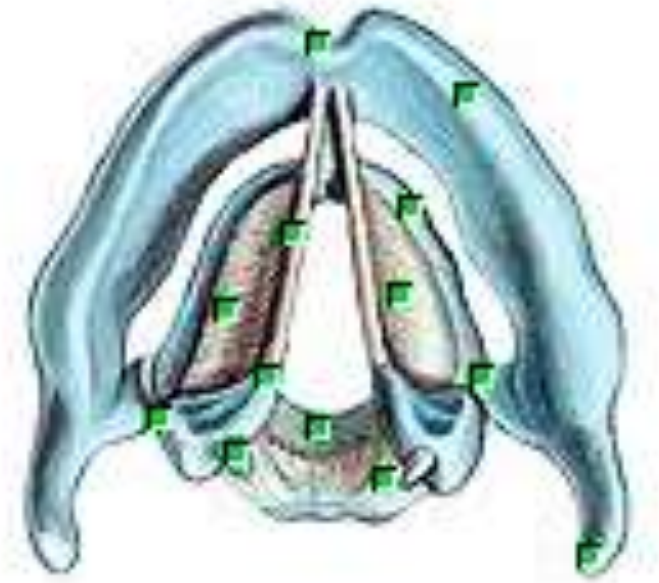


The Larynx - sagittal view

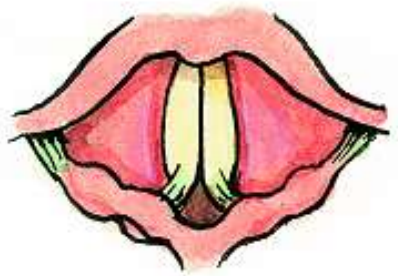


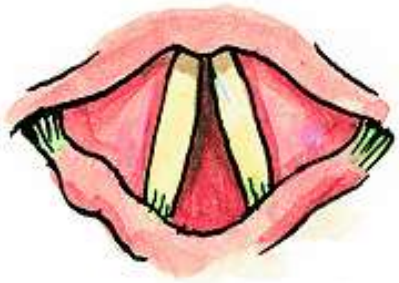
The Larynx - vocal cord movements

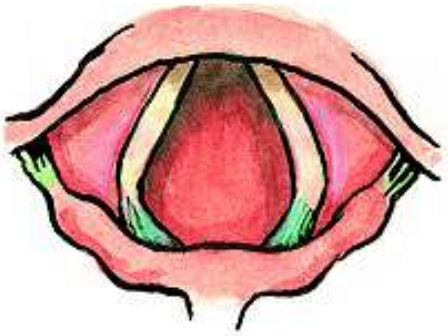
anterior



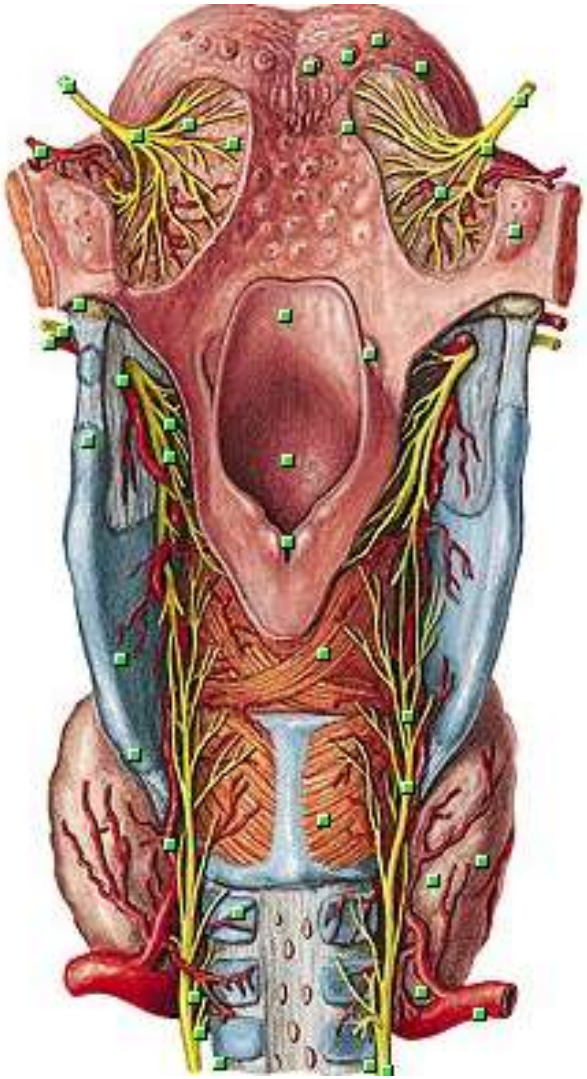
posterior

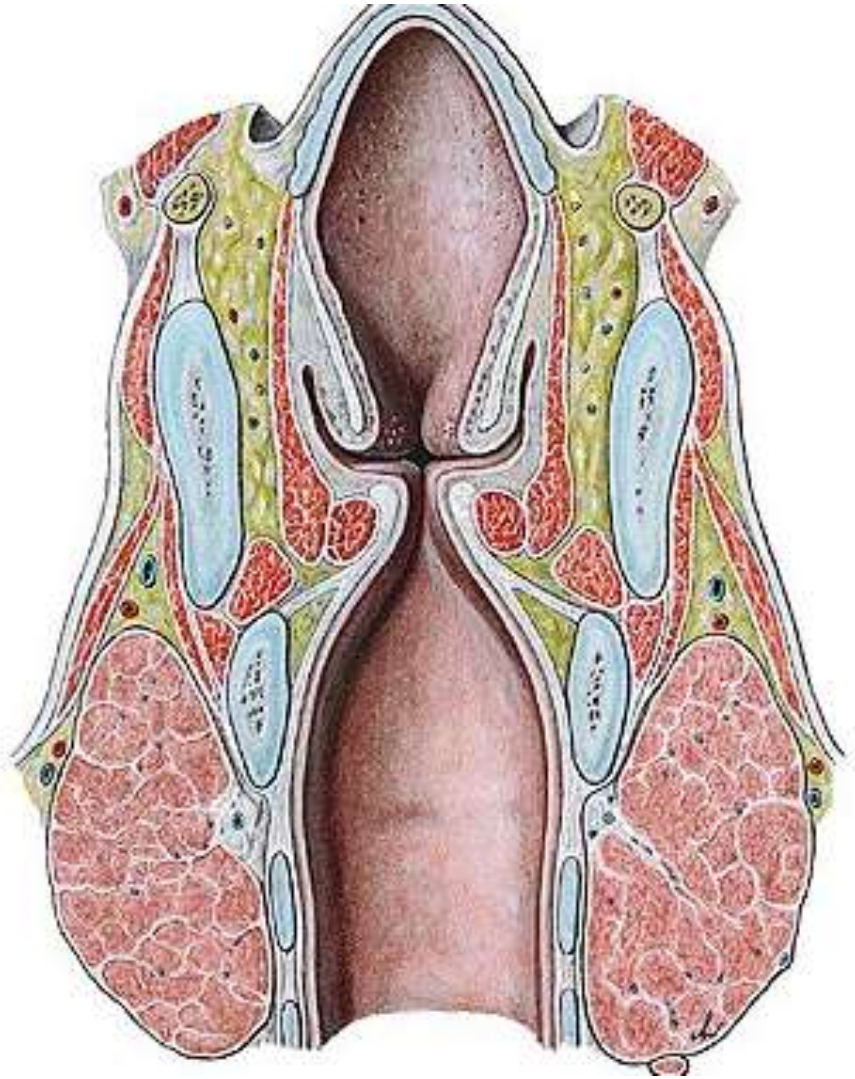




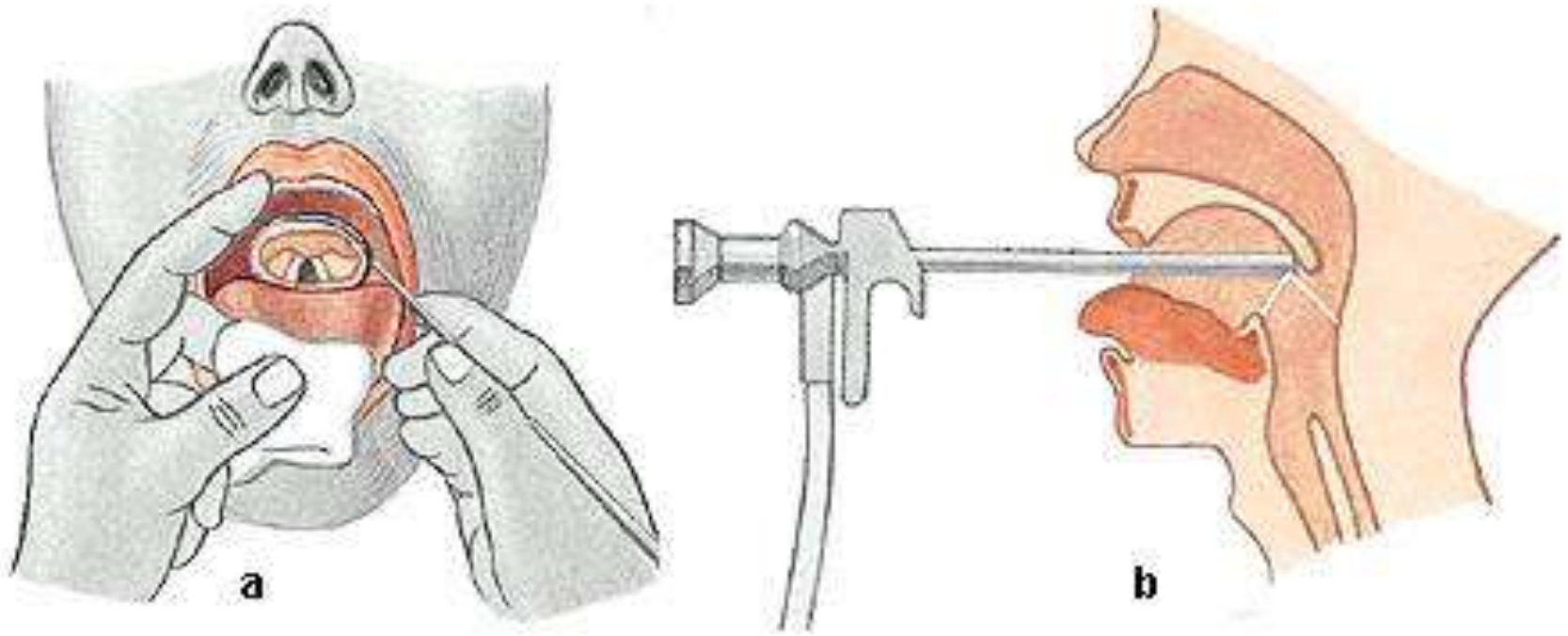


The Larynx - frontal view



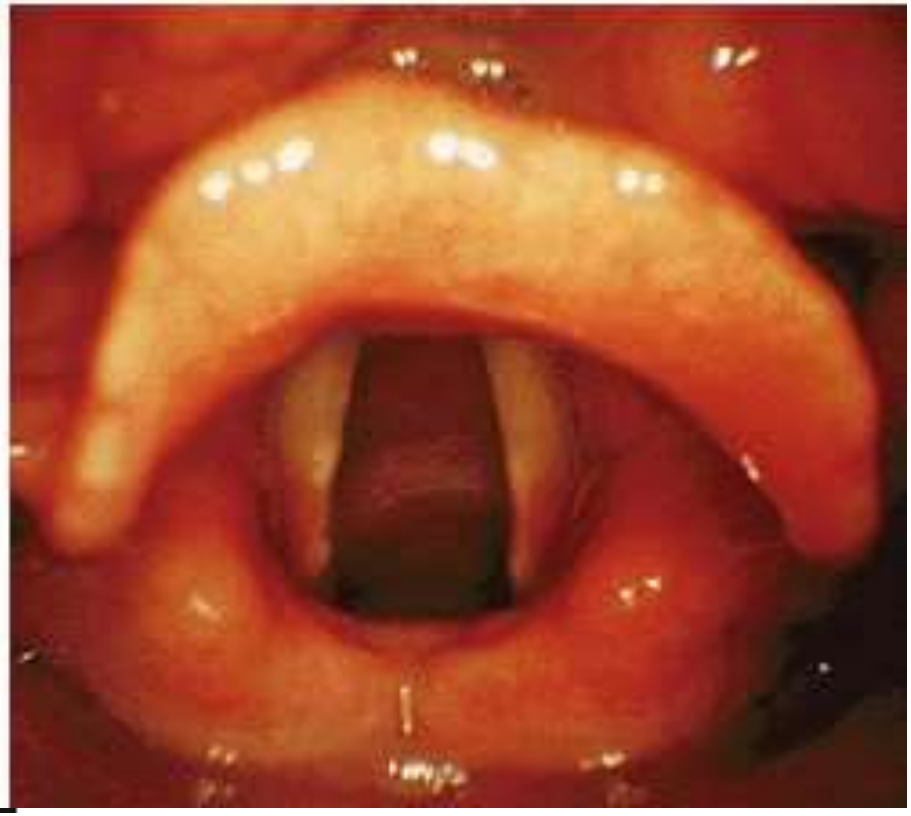


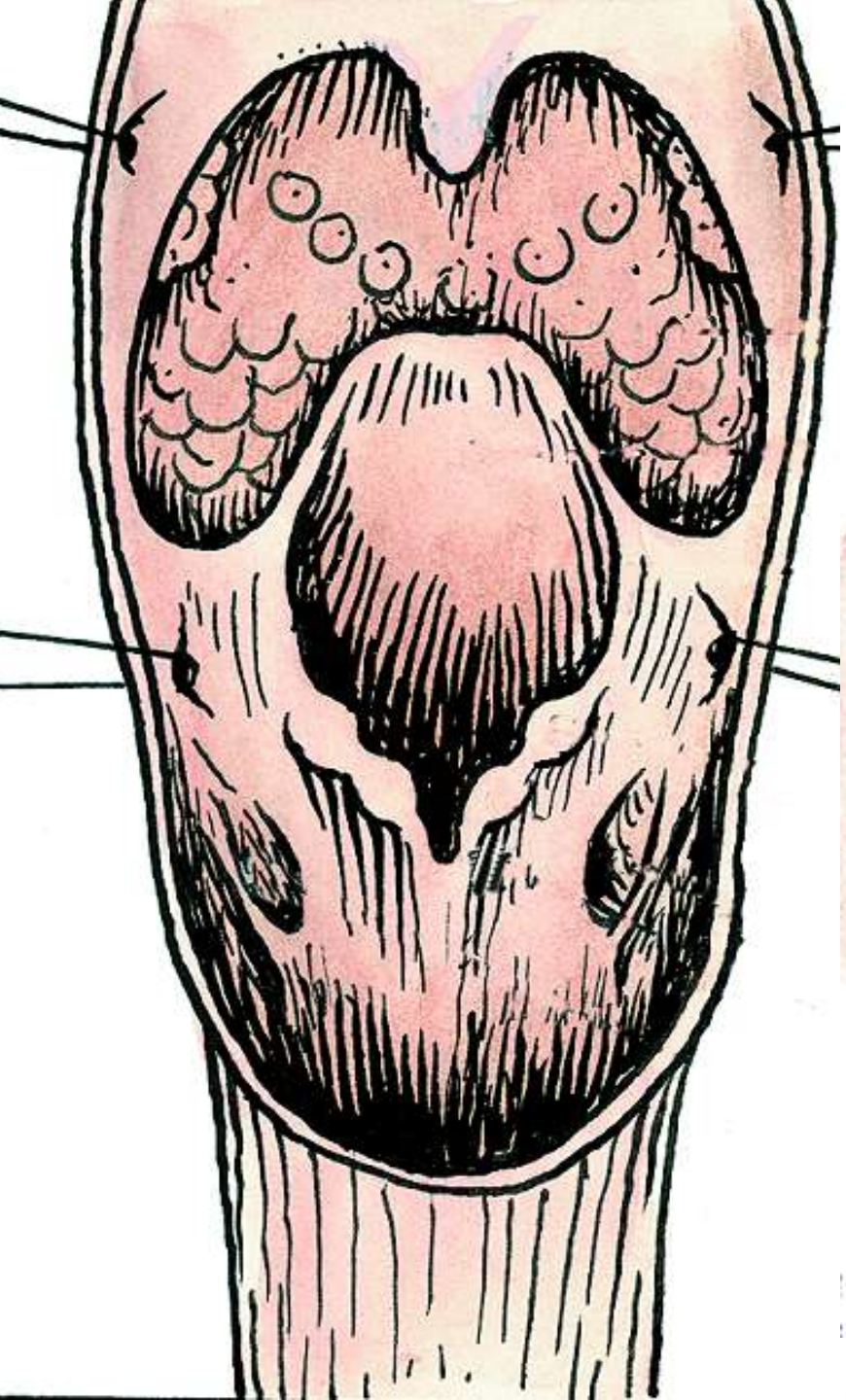
The Larynx - examination (laryngoscopy)

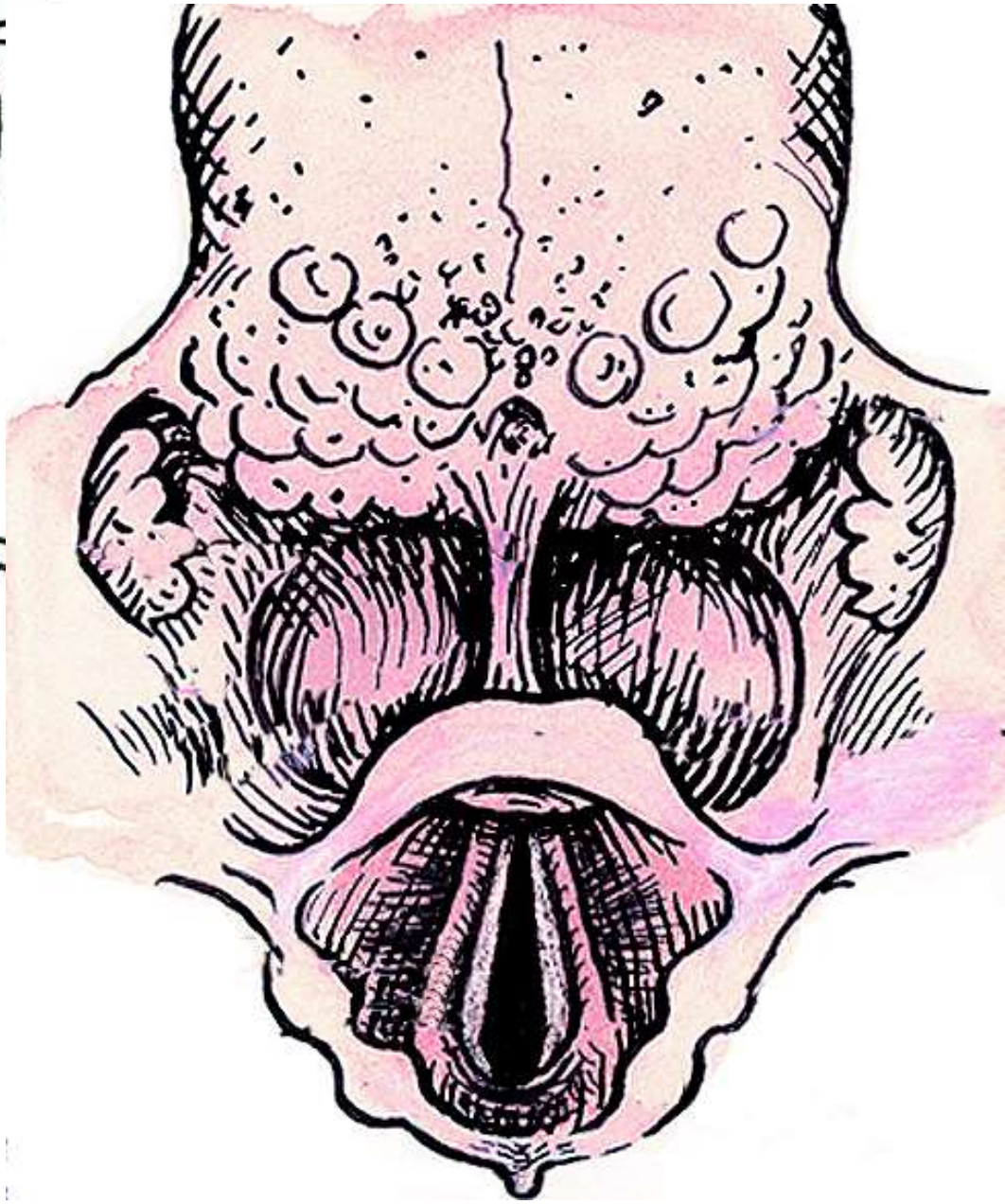


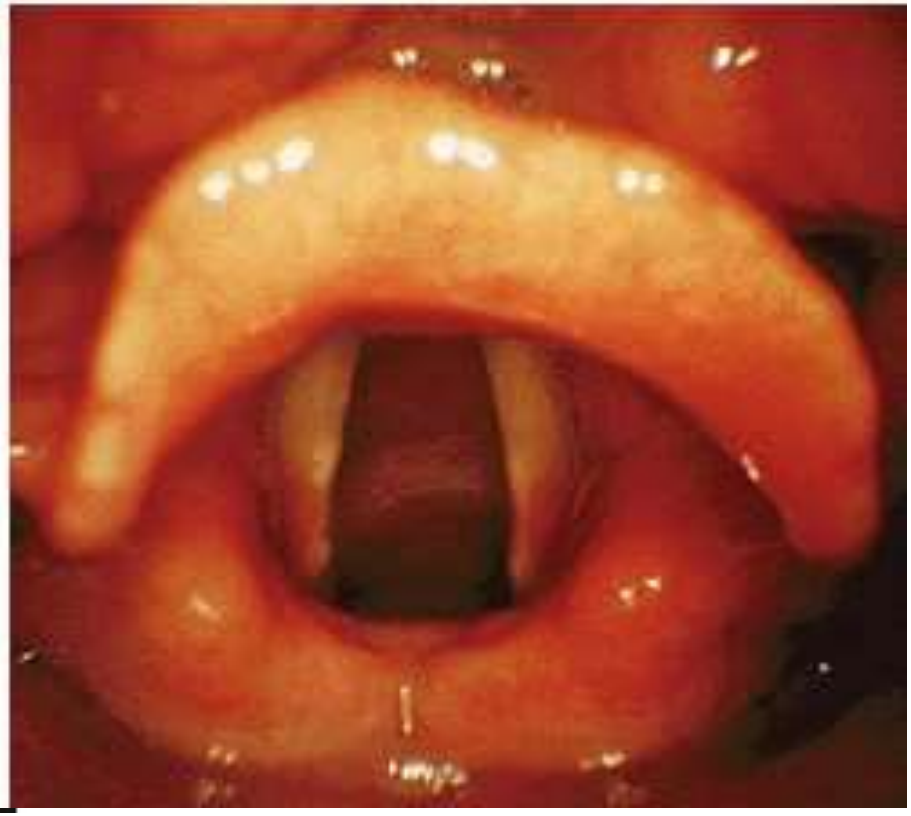
indirect

direct





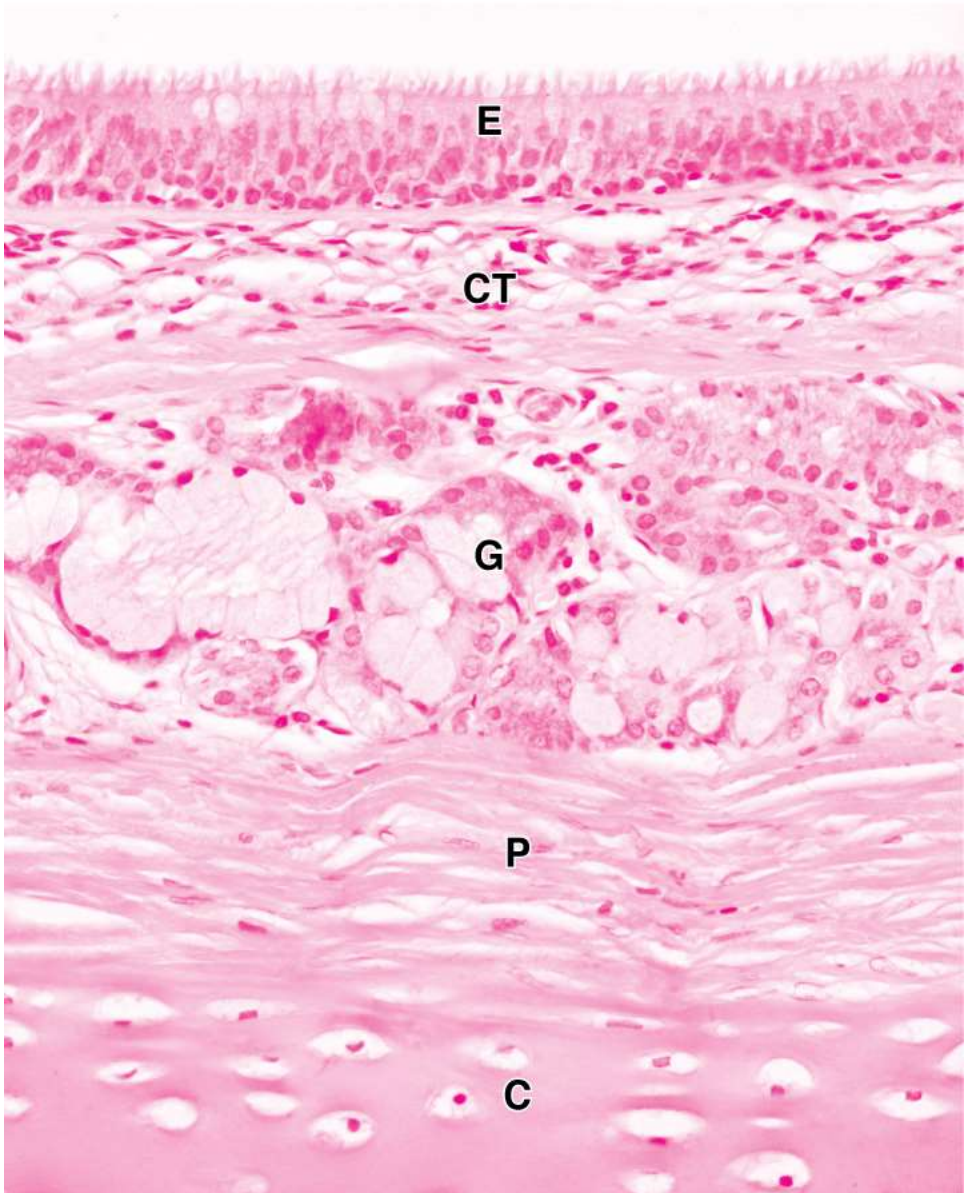




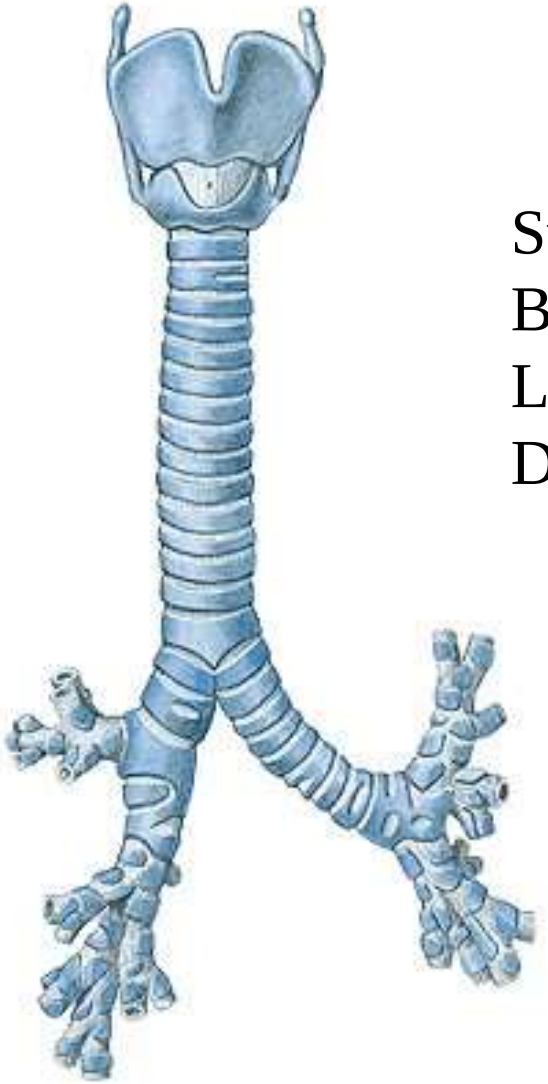
The Trachea - cross section

Histology of the Trachea

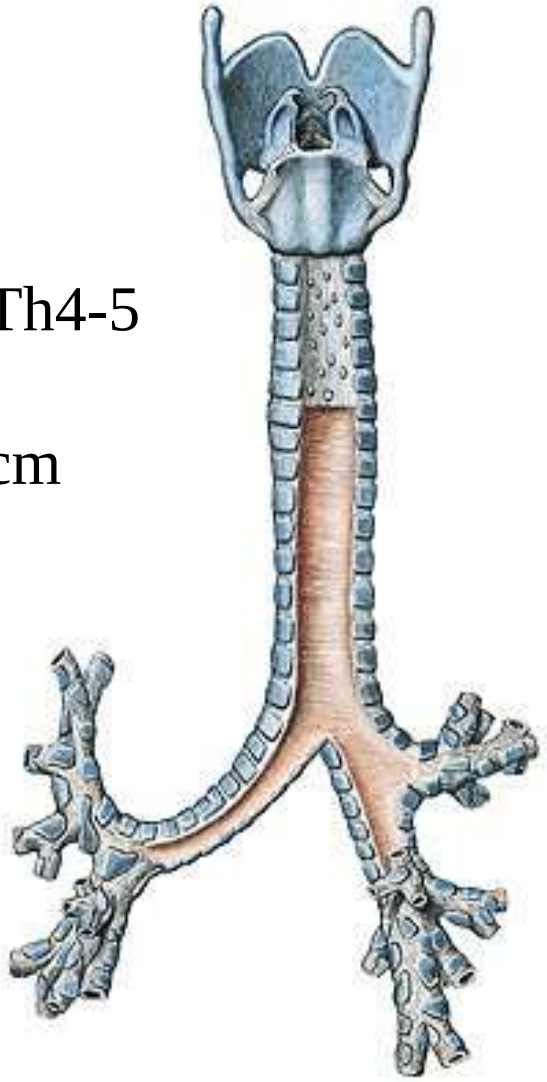
- Epithelium (cylindrical with cilia and goblet cells)
- Connective tissue
- Glands in lamina propria
- Hyaline cartilage covered by perichondrium
- Smooth (trachealis) muscle



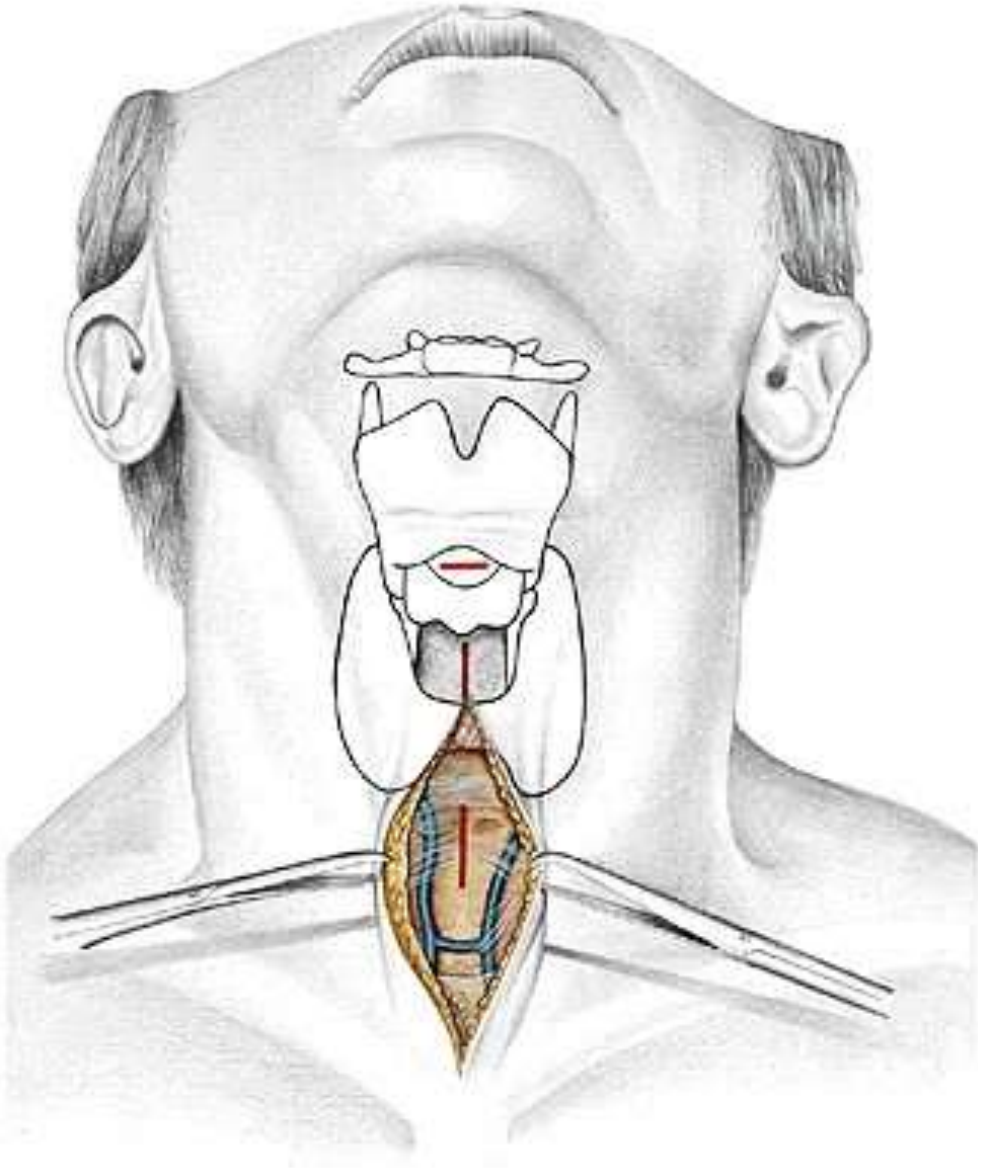
The trachea and segmental bronchi

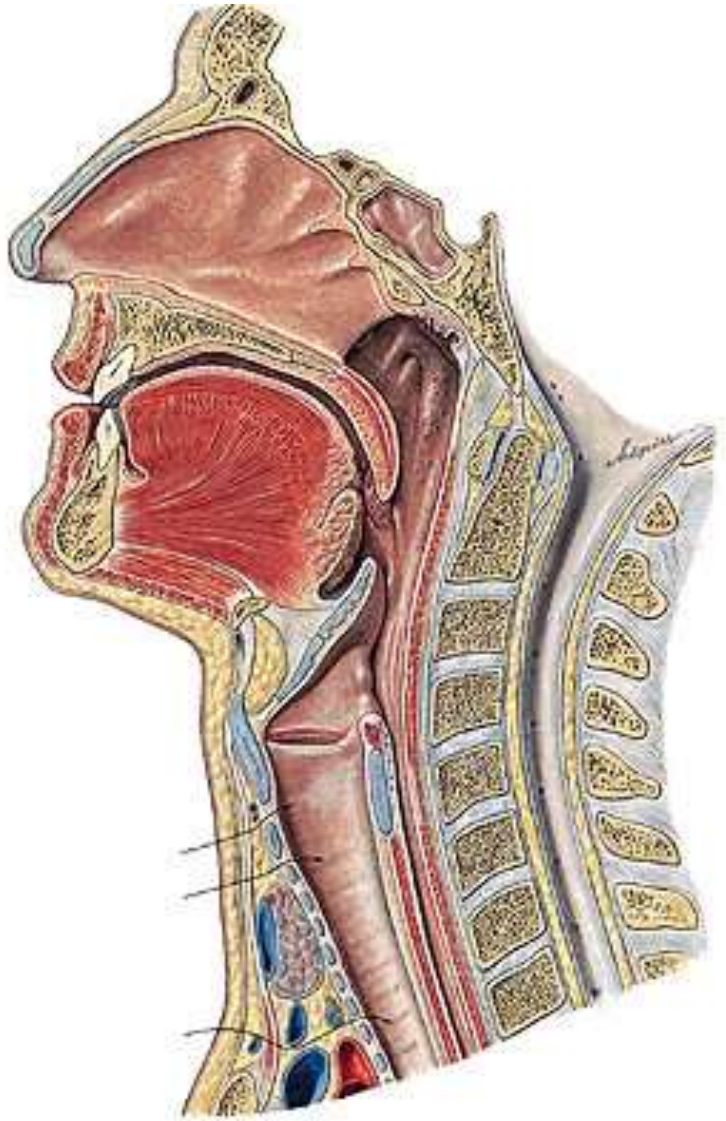


Starts at C6
Bifurcation at Th4-5
Length: 13 cm
Diameter: 2.5 cm



Coniotomy and tracheotomy



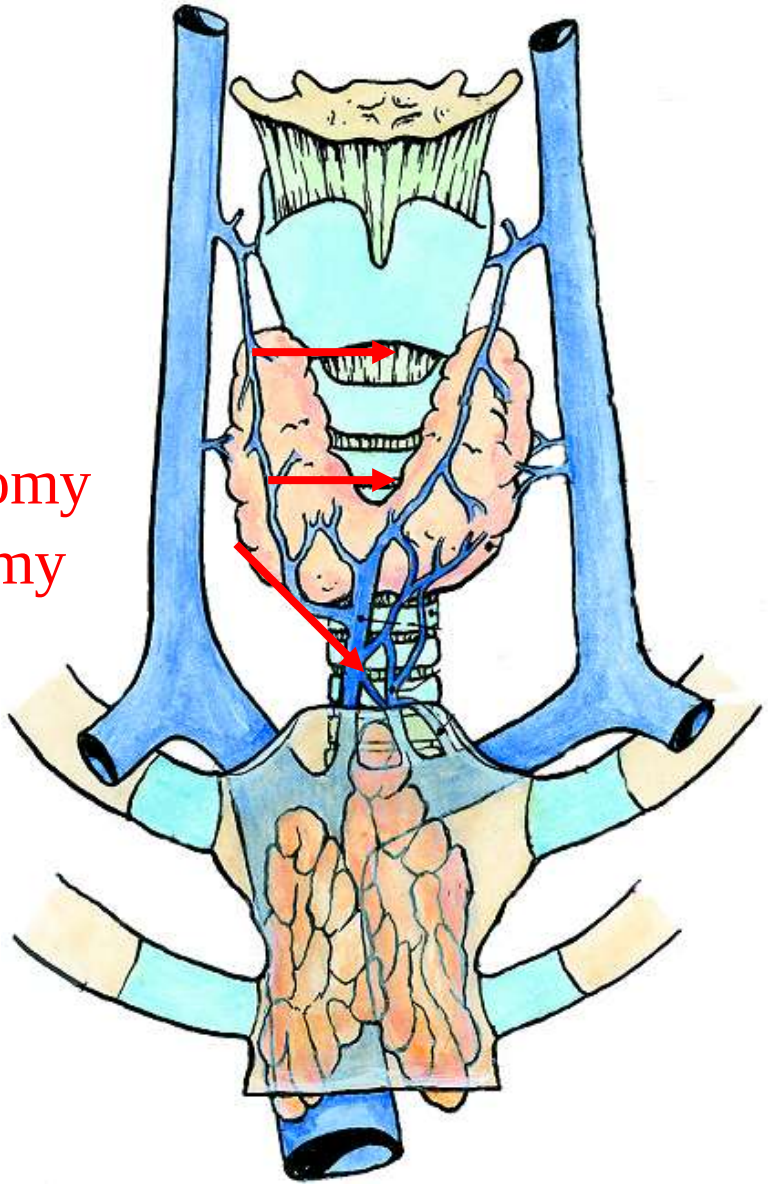


Coniotomy and tracheotomy

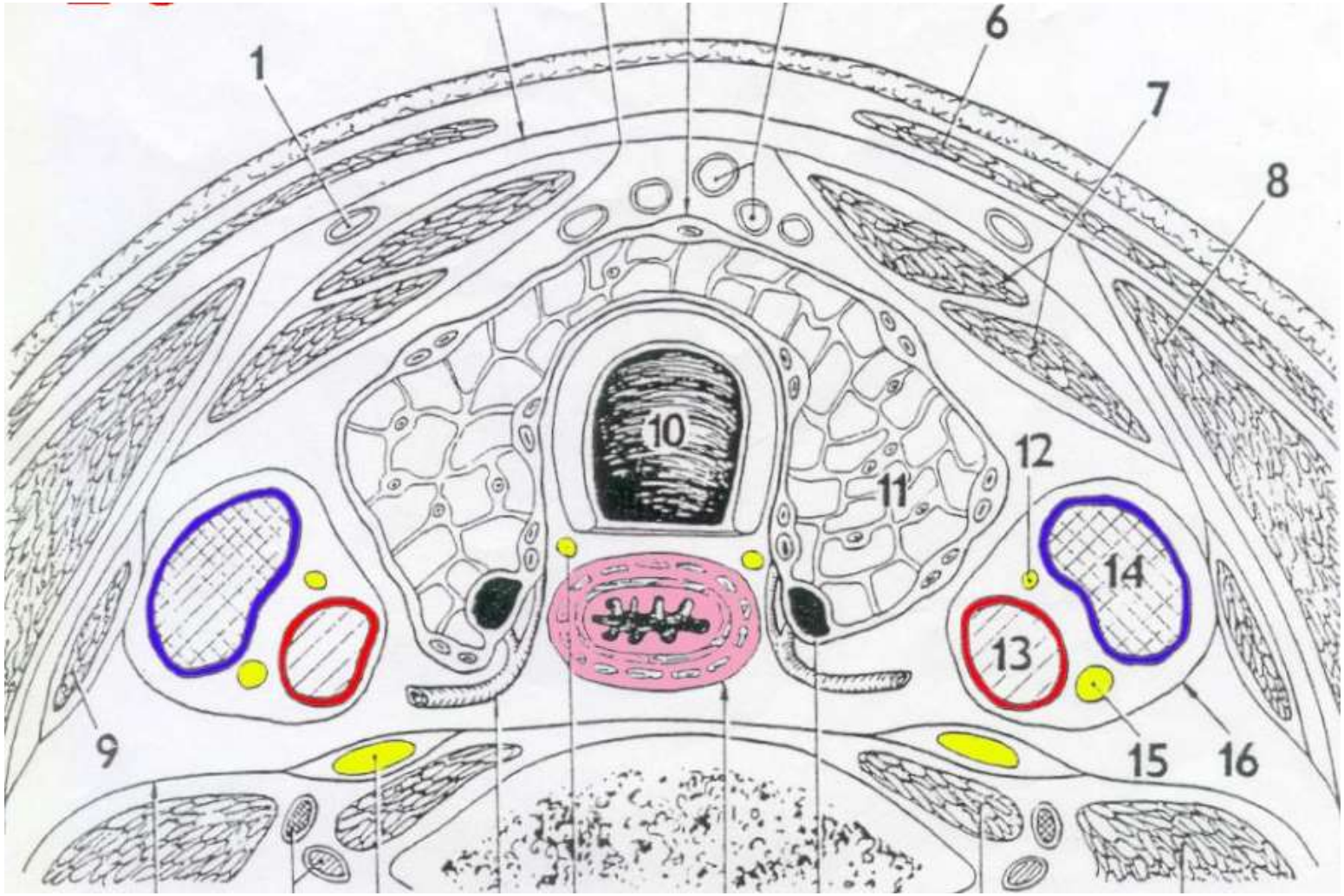
coniotomy

Superior tracheotomy

Inferior tracheotomy



Syntopy of the cervical part of trachea



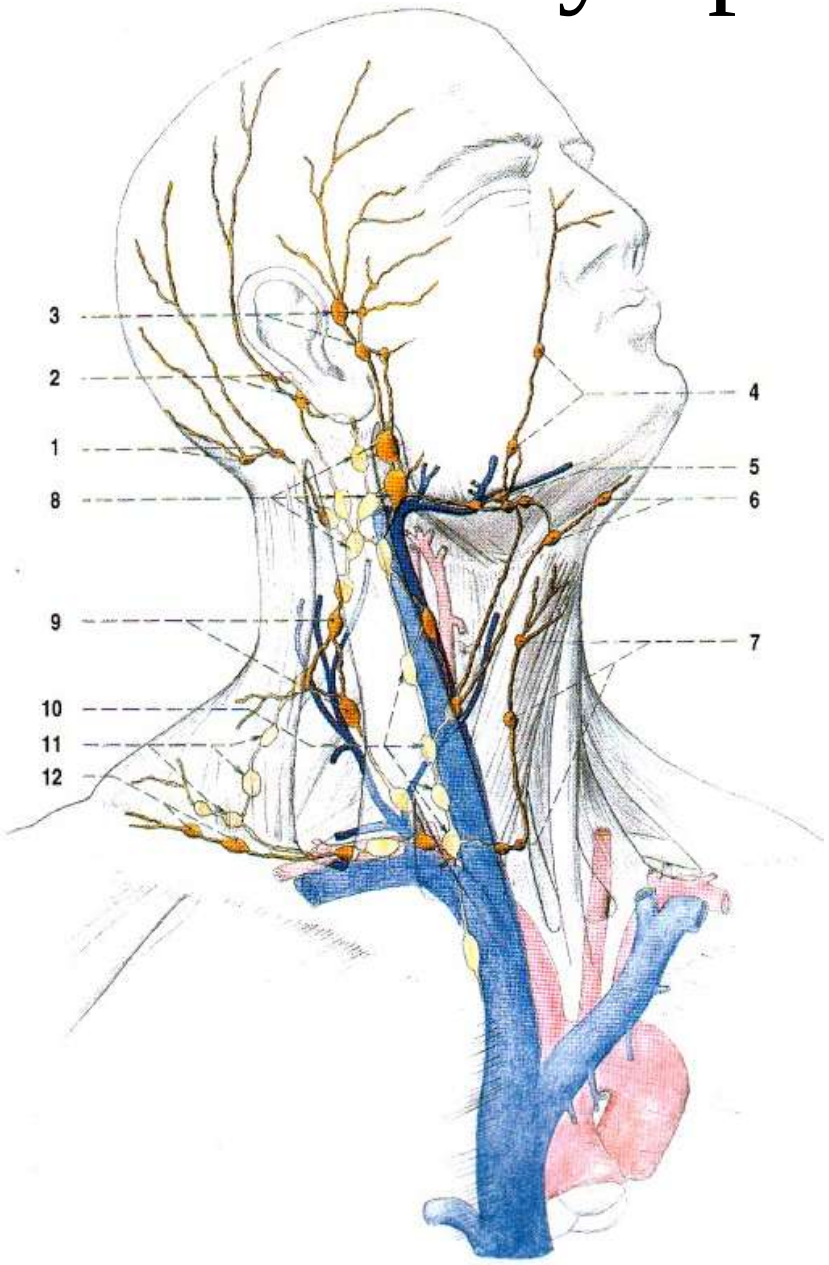
Blood supply

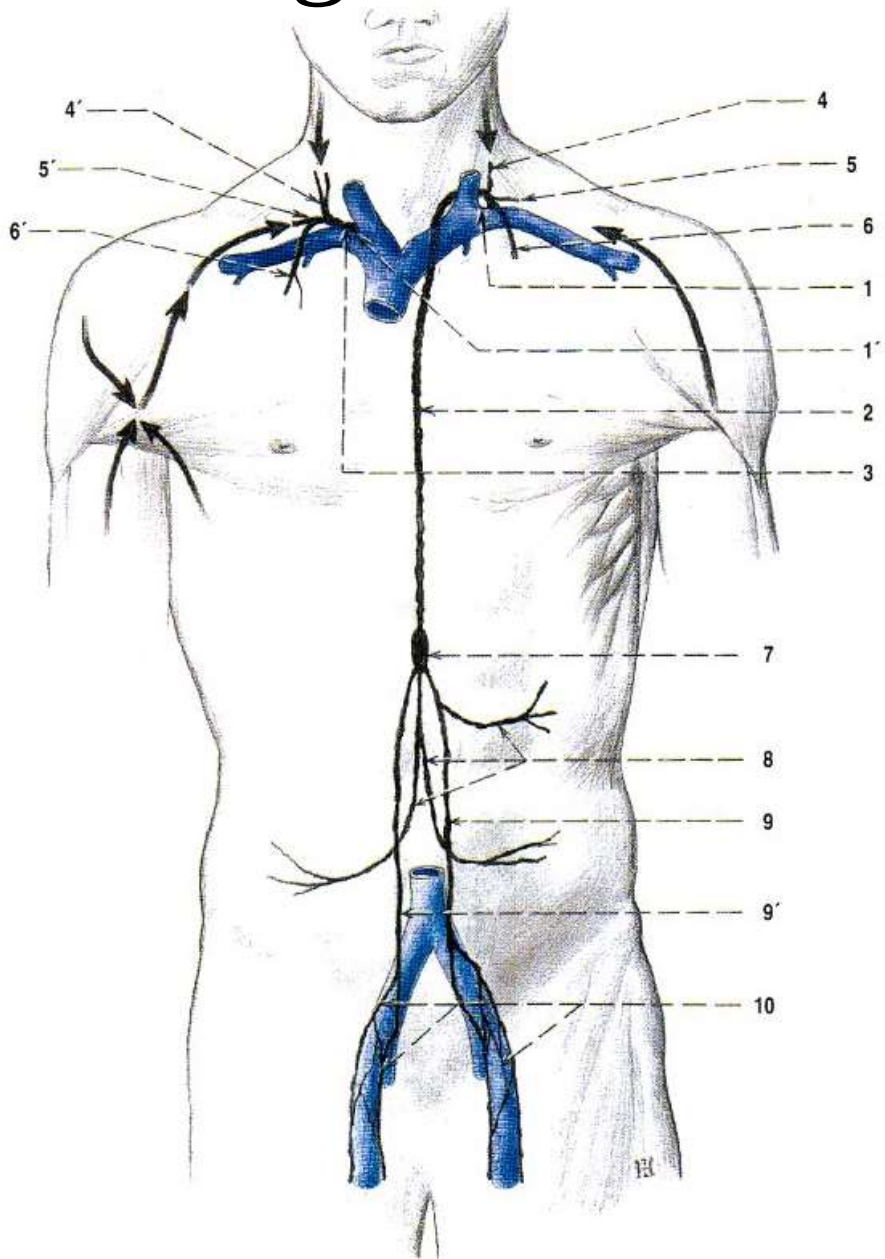
- Nasal cavity - ethmoidal and sphenopalatine artery
- Larynx -superior and inferior laryngeal artery
- Trachea - branches from thyroid arteries or thoracic aorta

Innervation

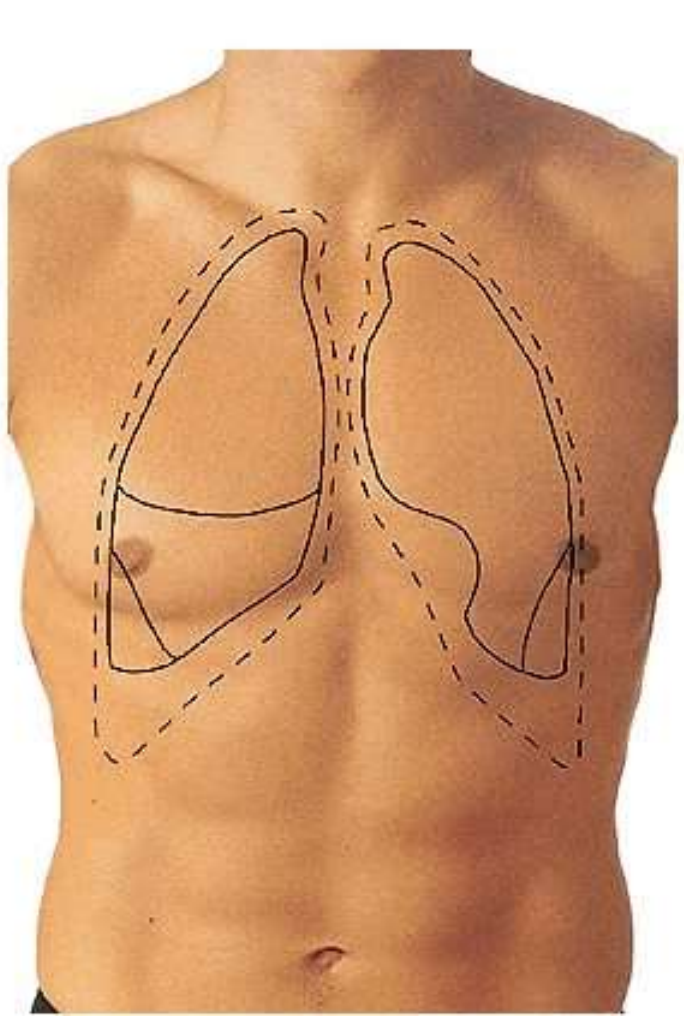
- Nasal cavity - I, V1, V2; parasympathetic fibers from VII
- Larynx -superior and recurrent laryngeal nerve (from X)
- Trachea - X, cervical sympathetics

Lymphatic drainage

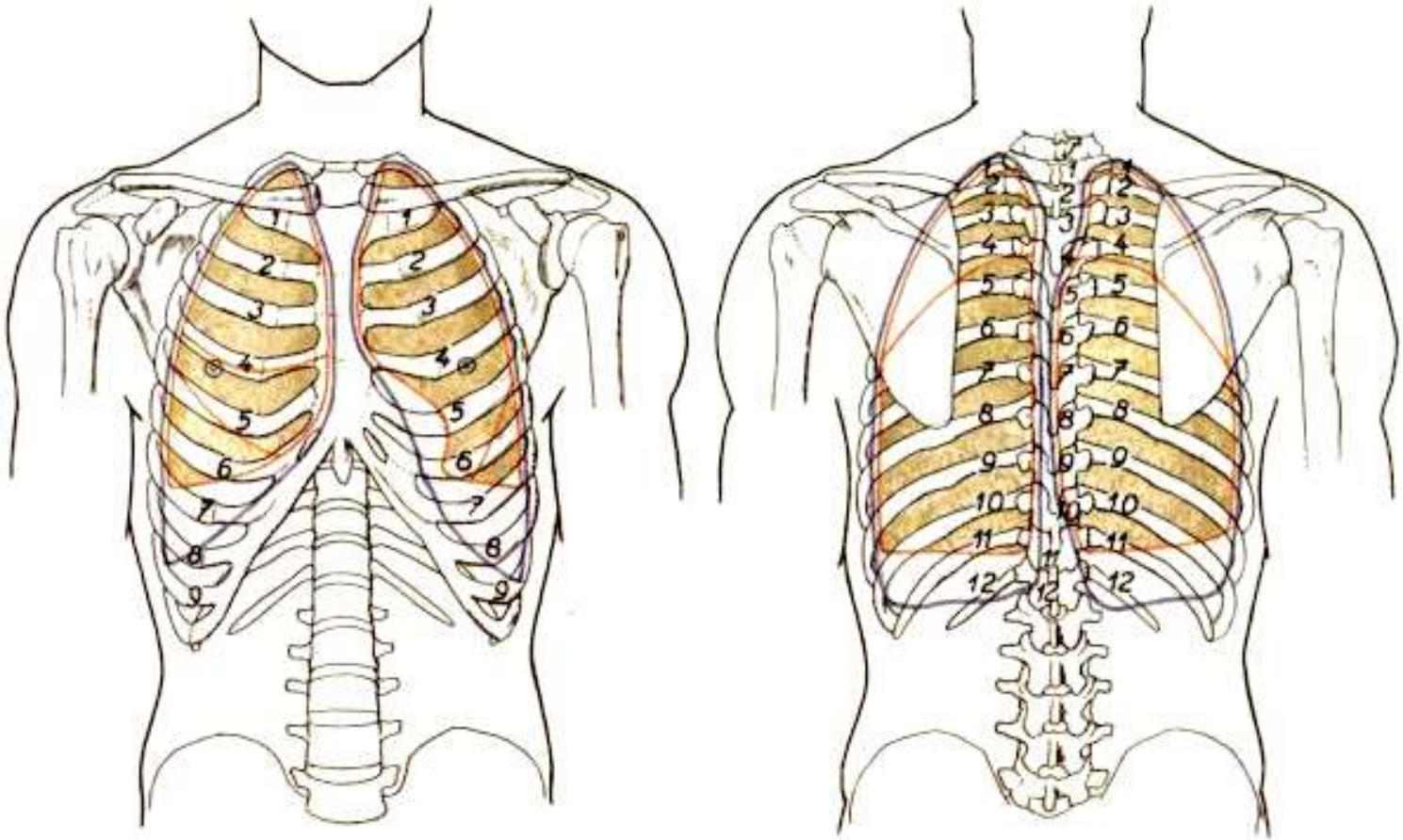




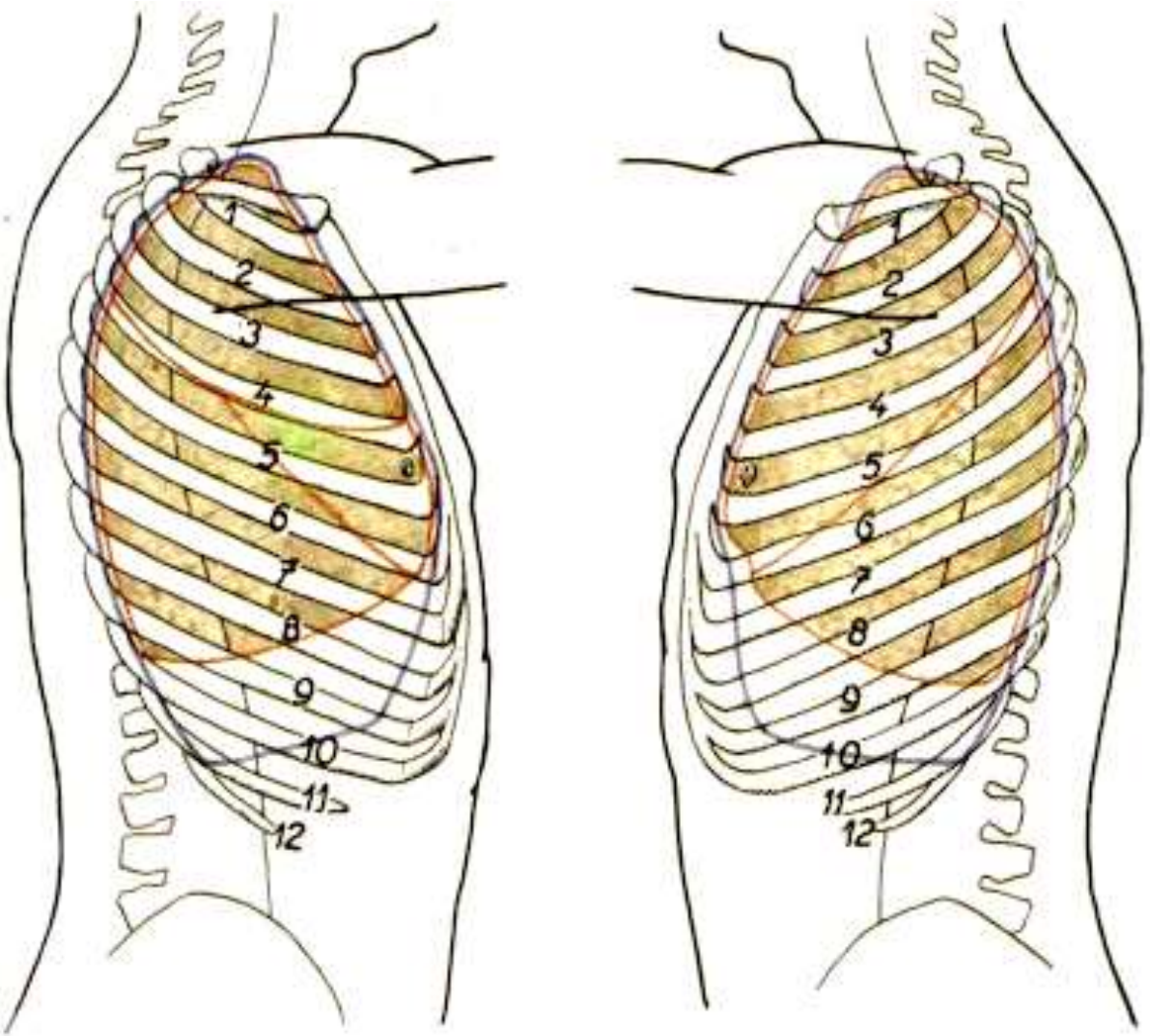
The Lungs & Pleura - projections



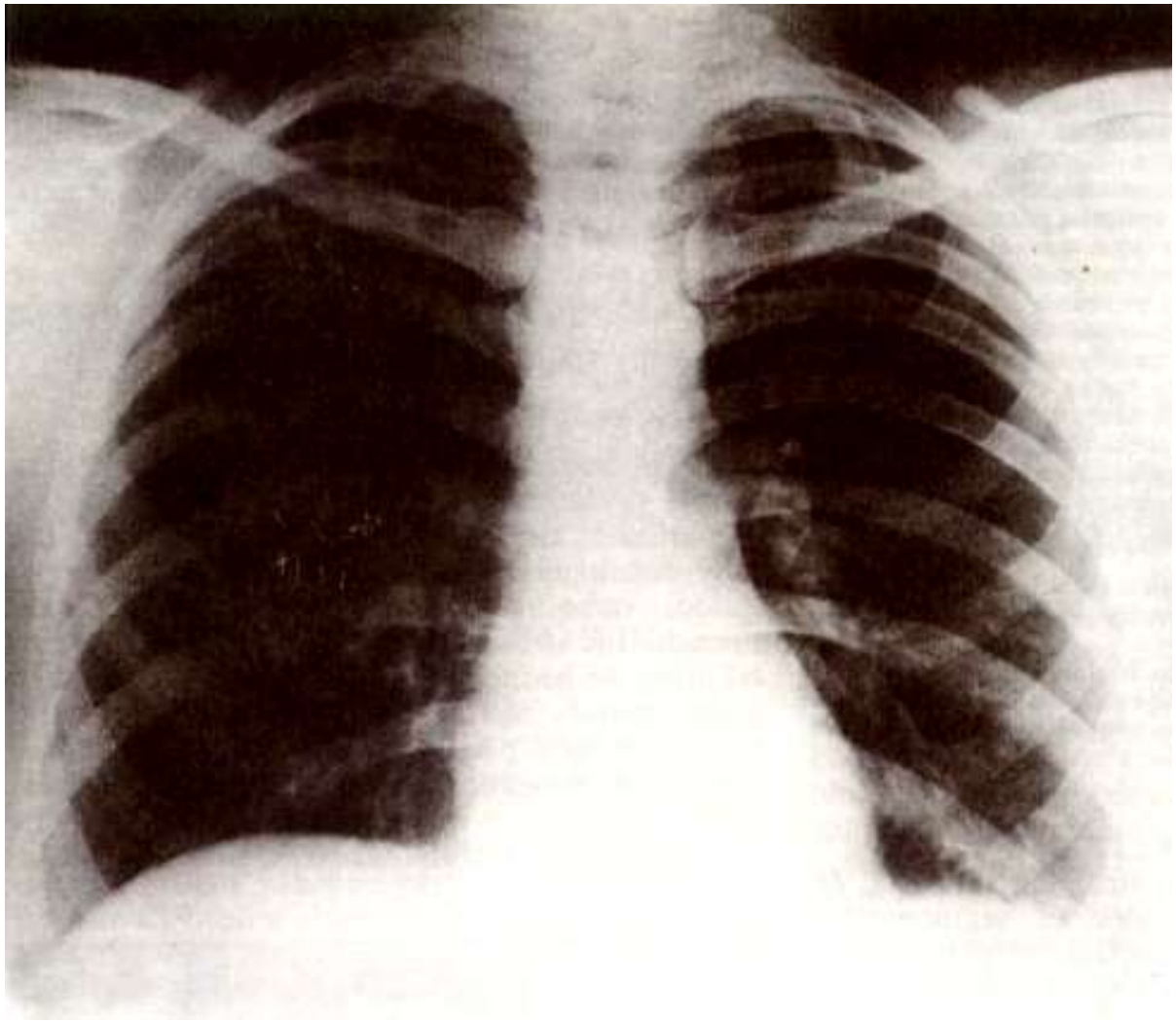
Borders of Lungs & Pleura



Borders of Lungs & Pleura

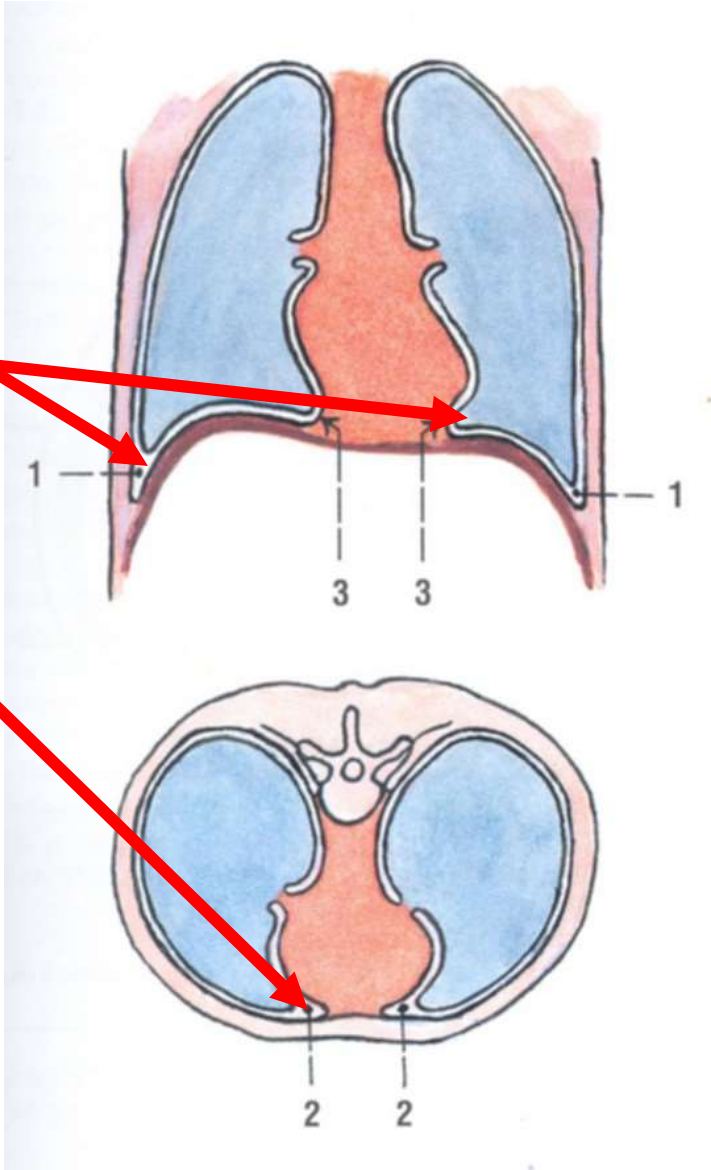


The Lungs & Pleura - projections

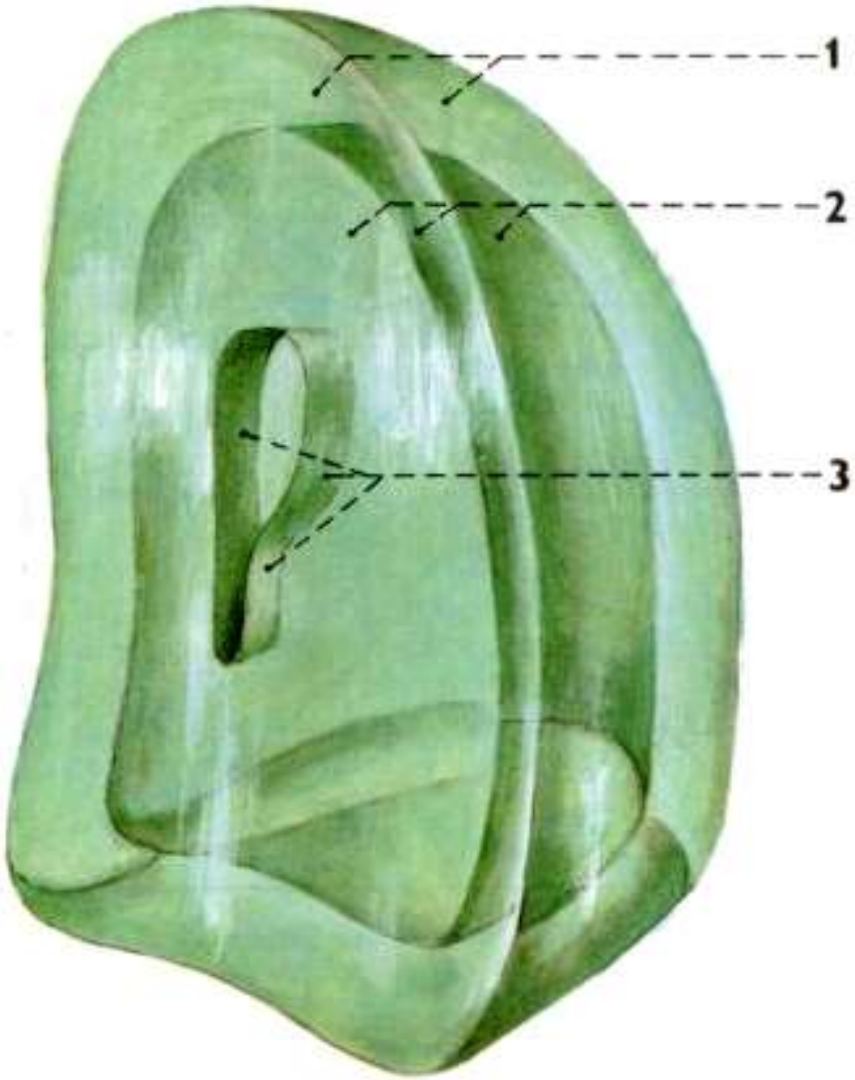


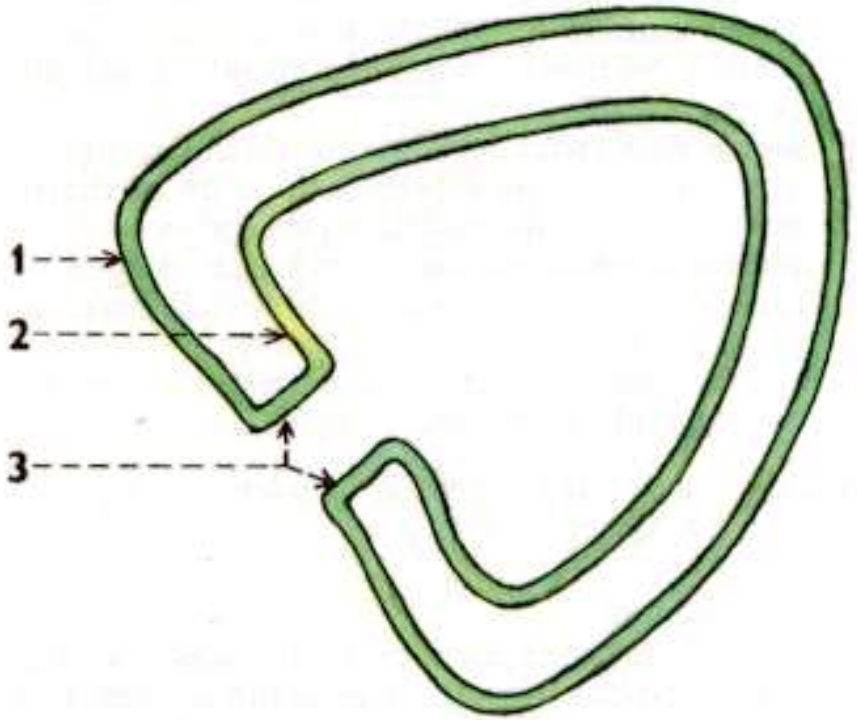
Pleural recesses

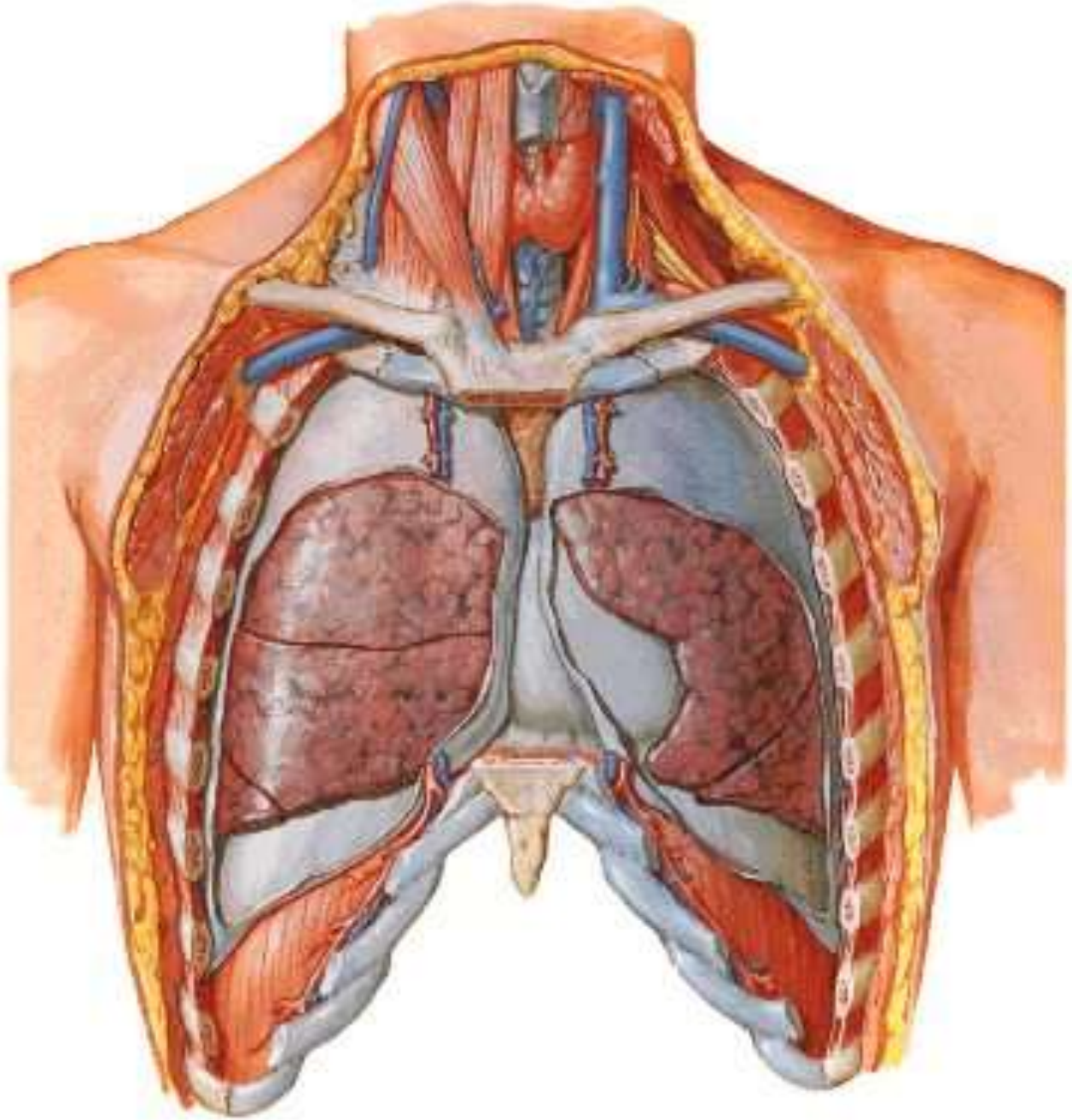
- Costodiphragmatic recess - accumulation of fluids
- recessus phrenicomediastinalis
- recessus costomediastinalis



The Pleural Cavity

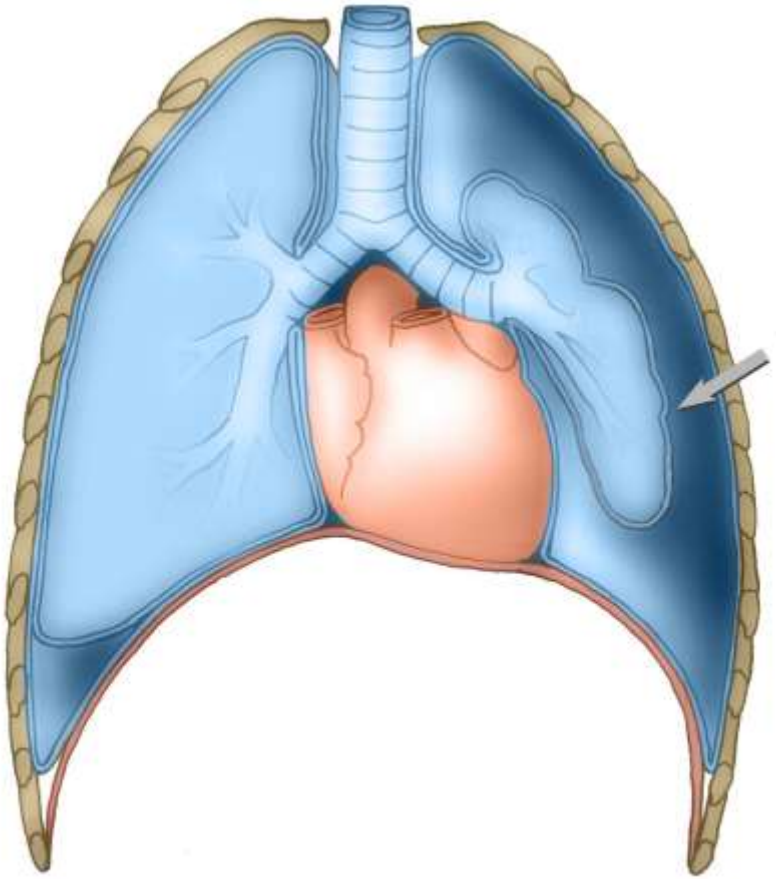




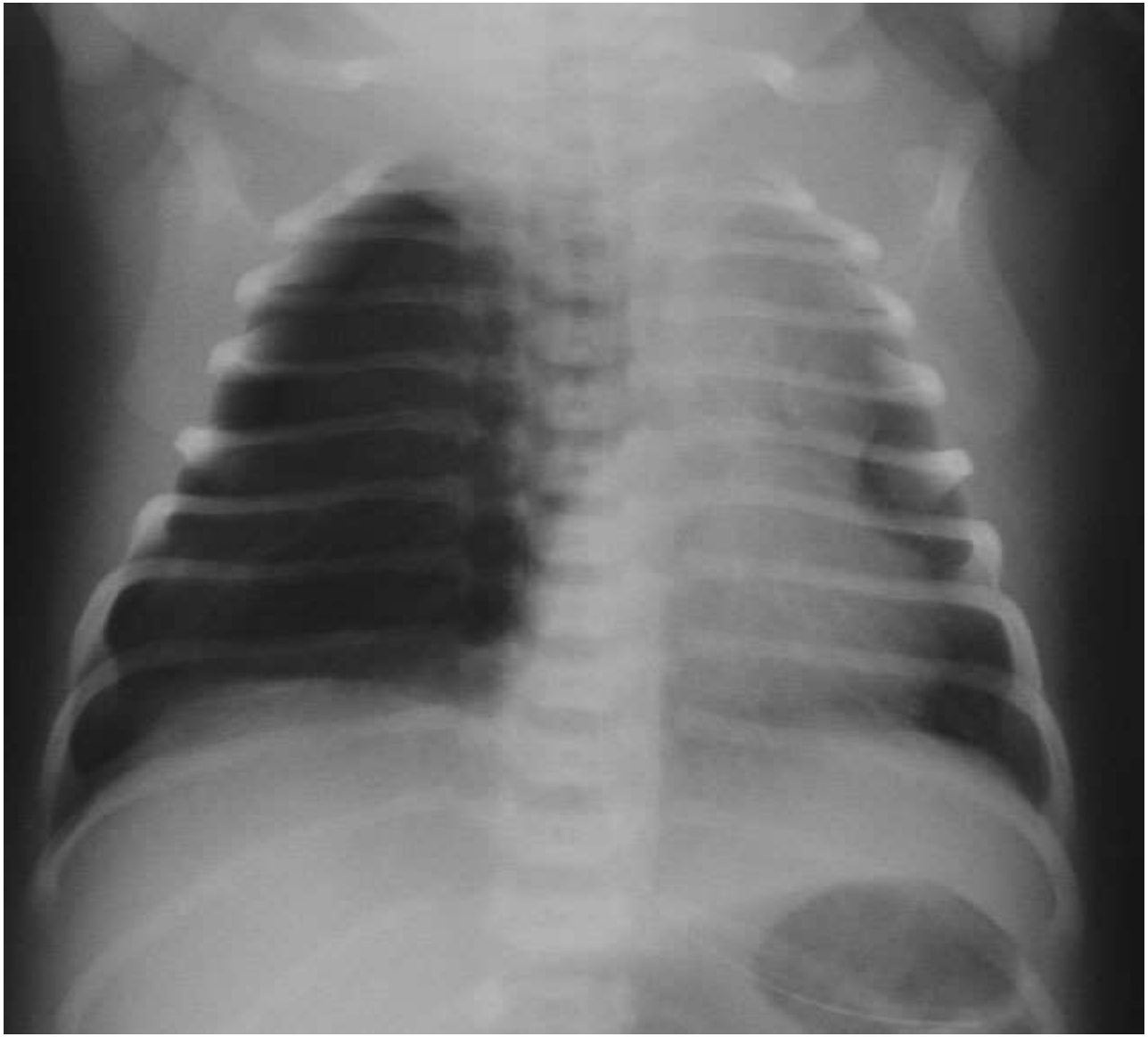


Pneumothorax

- Penetration of the pleural cavity equalizes pressure
- This results in the collapse of the affected lung
- Could be classified as open, closed, or tension
- Treatment is by drainage that facilitates air resorption

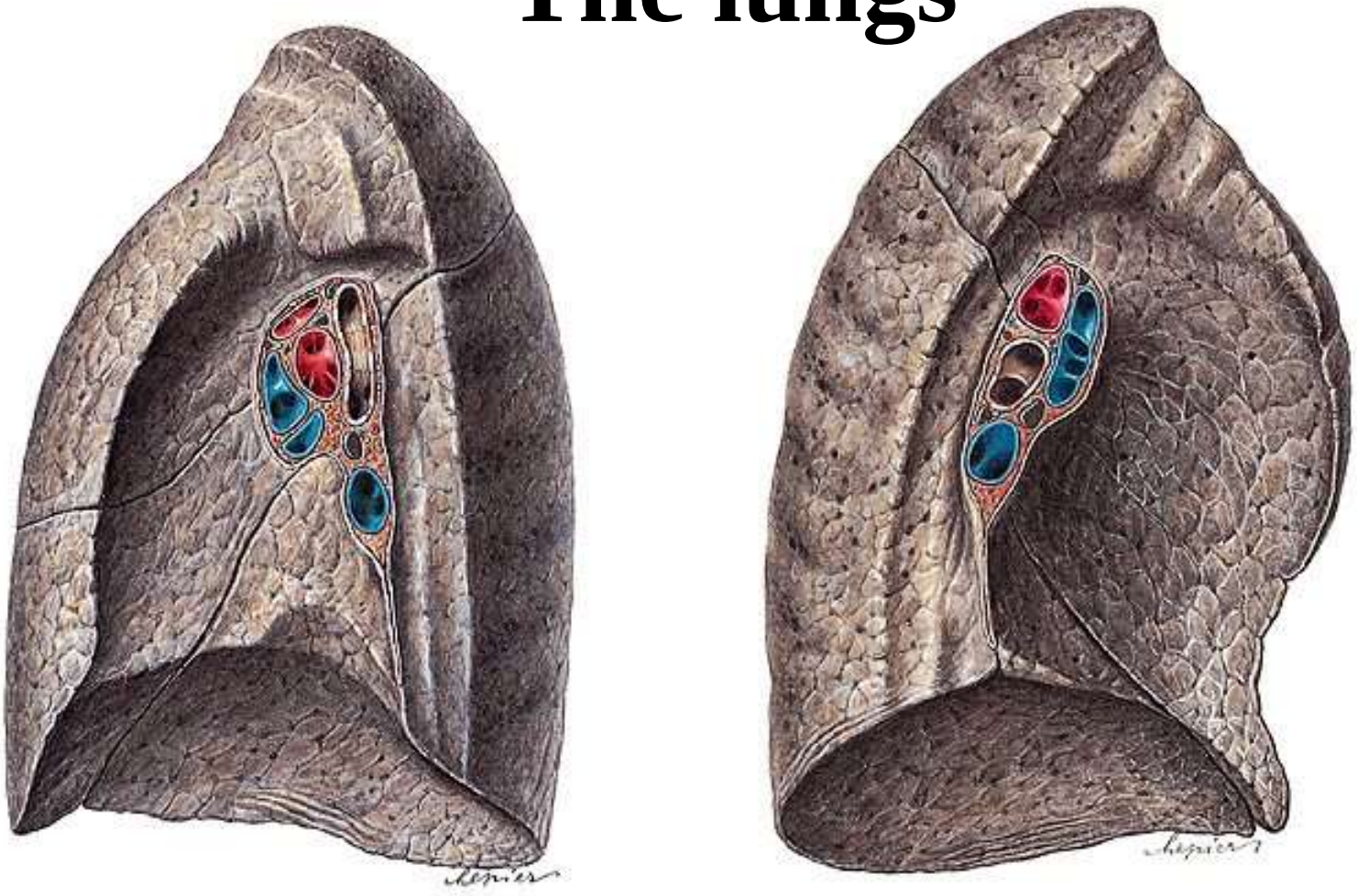


Pneumothorax - X-ray

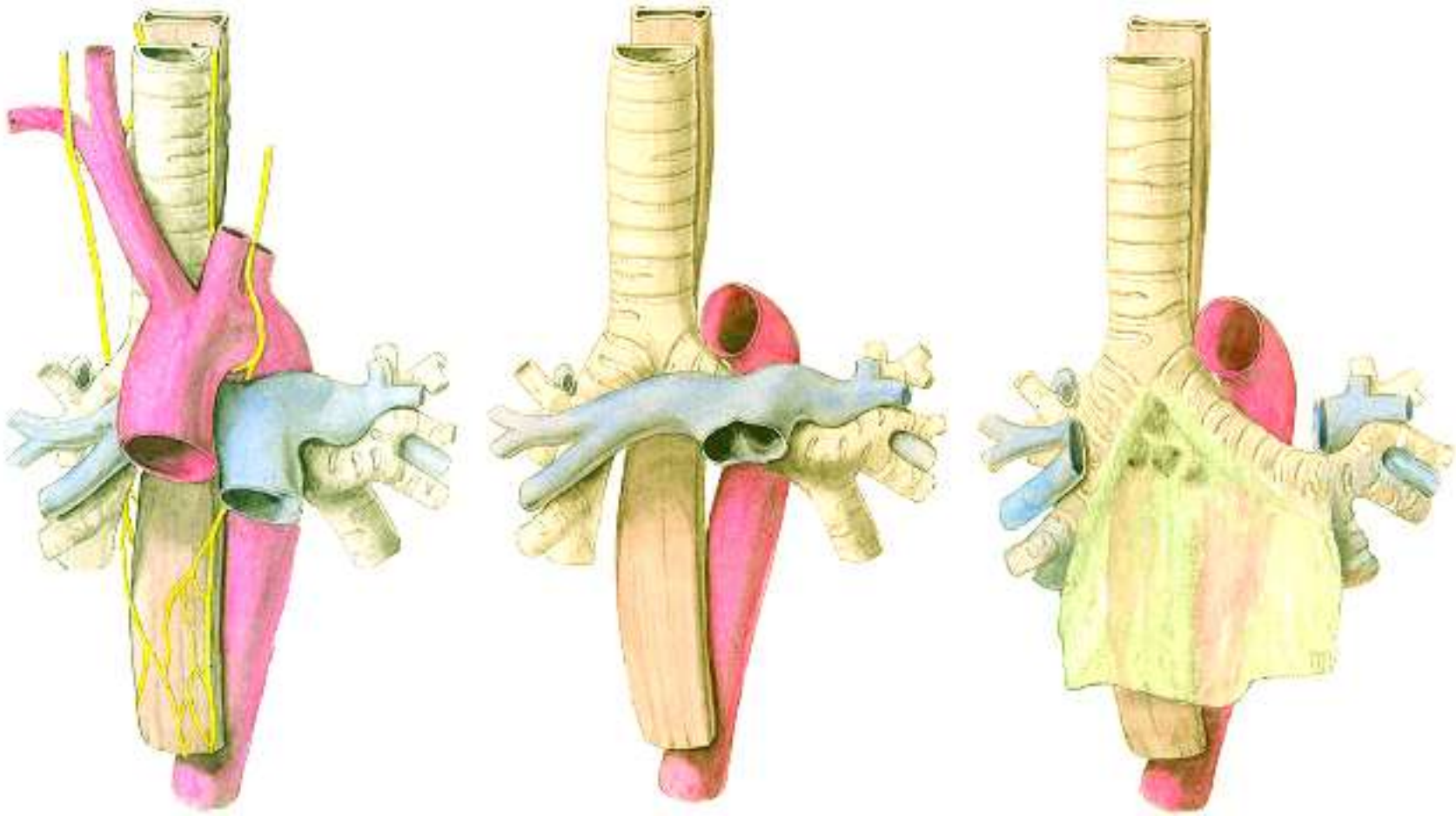


The lungs

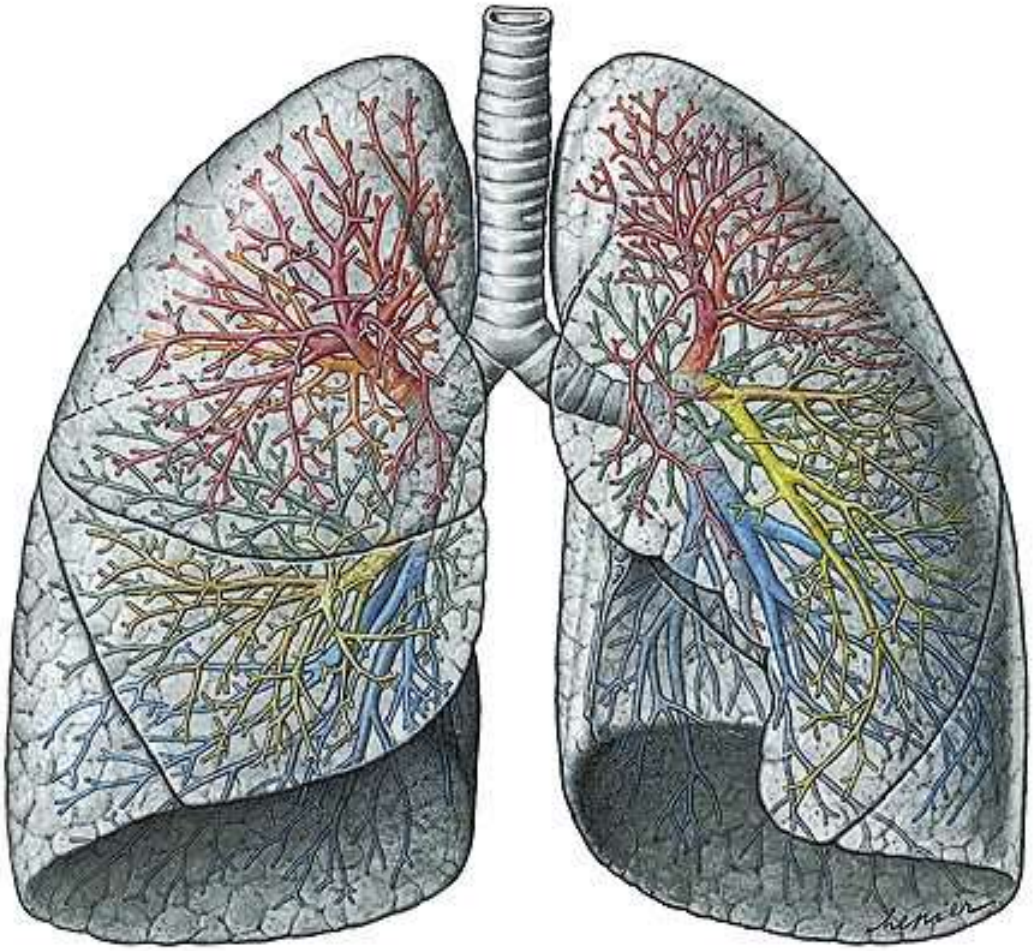
The lungs

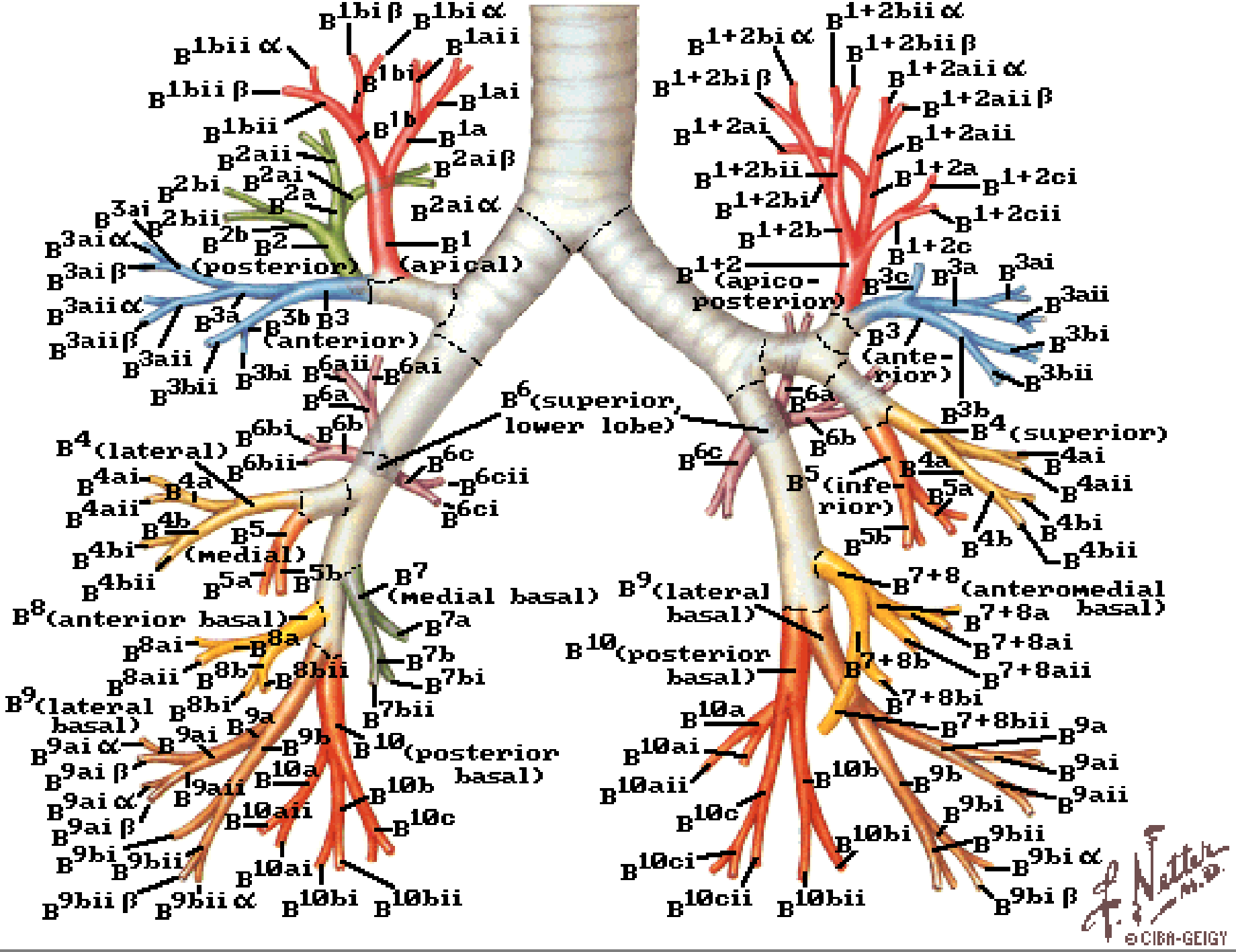


Syntopies of the trachea and main bronchi



The bronchopulnonary segments




B1bi β
B1bi α
B1bii α
B1laii
B1bi
B1bii β
B1lai
B1bii
B1b
B1a
B2aii
B2ai β
B2bi
B2ai
B2a
B2aii α
B3ai
B2bii
B3ai α
B2b
B2
B1
(apical)
B3ai β
(posterior)
B3aii α
B3a
B3b
B3
B3aii β
(anterior)
B3aii
B3bii
B3bi
B6aii
B6ai
B6a
B6 (superior, lower lobe)
B6bi
B6b
B4 (lateral)
B6bii
B6c
B6cii
B4ai
B4a
B6ci
B4aii
B4b
B5
B4bi
(medial)
B4bii
B5a
B5b
B7
(medial basal)
B8 (anterior basal)
B7a
B8ai
B8a
B7b
B8aii
B8b
B8bii
B7bi
B9 (lateral basal)
B8bi
B7bii
B9a
B9ai
B10 (posterior basal)
B9ai α
B9b
B9ai β
B10a
B9aii
B10b
B9ai α
B10aii
B10c
B9ai β
B9bi
B9bii
B10ai
B9bii β
B9bii α
B10bi
B10bii
B1+2bii α
B1+2bi α
B1+2bii β
B1+2bi β
B1+2aii α
B1+2aii β
B1+2ai
B1+2aii
B1+2bii
B1+2a
B1+2ci
B1+2bi
B1+2cii
B1+2b
B1+2c
B1+2 (apico-posterior)
B3c
B3a
B3ai
B3aii
B3
(ante-rior)
B3bi
B3bii
B6a
B3b
B6b
B4 (superior)
B6c
B4ai
B5 (infe-rior)
B4a
B4aii
B5a
B4bi
B5b
B4b
B4bii
B7+8 (anteromedial basal)
B9 (lateral basal)
B7+8a
B7+8ai
B10 (posterior basal)
B7+8b
B7+8aii
B7+8bi
B10a
B7+8bii
B9a
B10ai
B9ai
B10aii
B10b
B9b
B9aii
B10c
B9bi
B10bi
B9bii
B10ci
B9bi α
B10cii
B10bii
B9bi β
F. Netter M.D.
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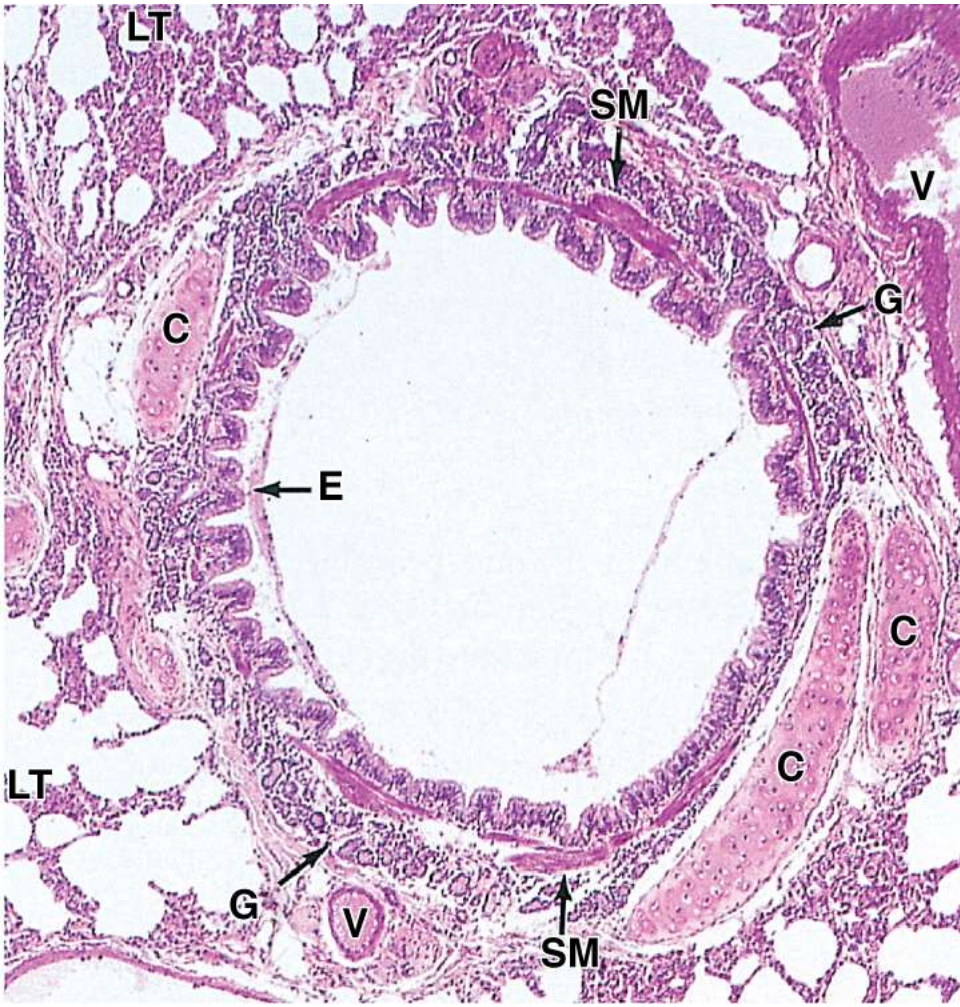
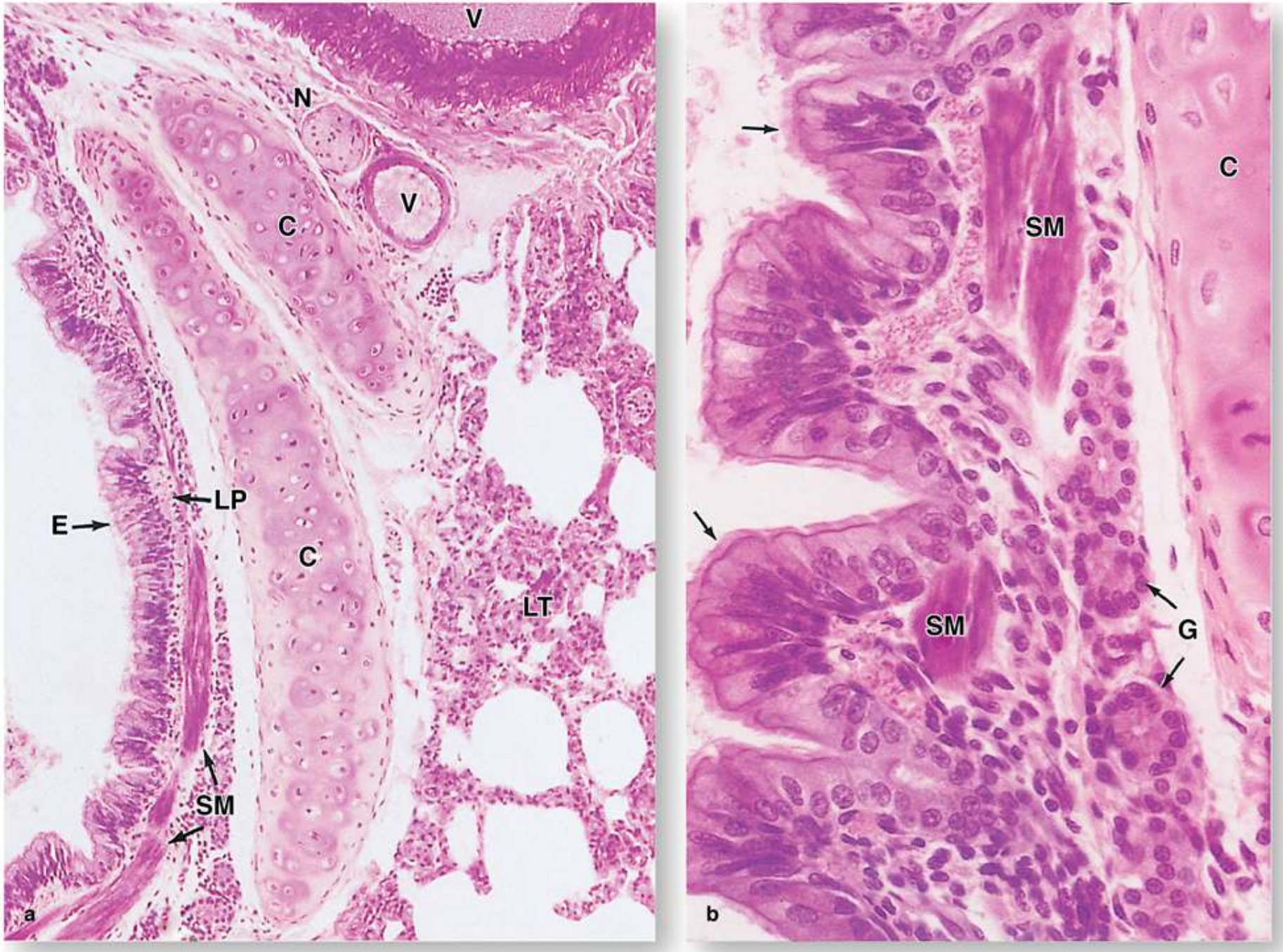
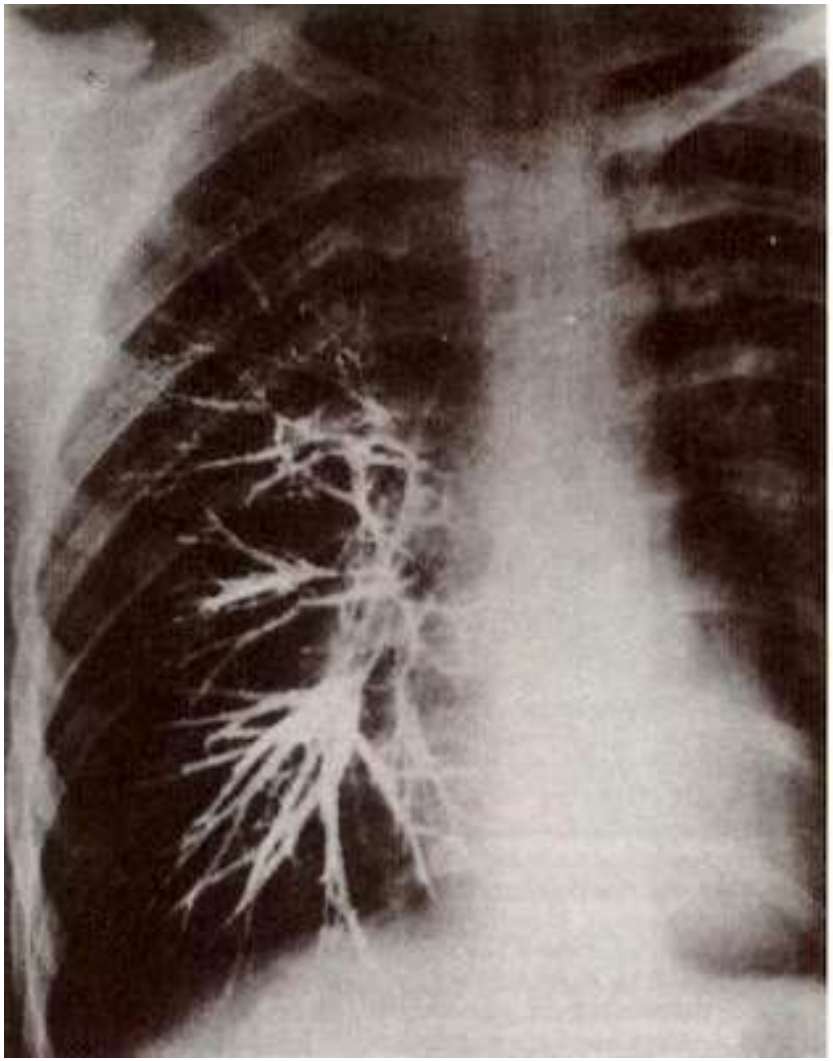
Histology of the Bronchi

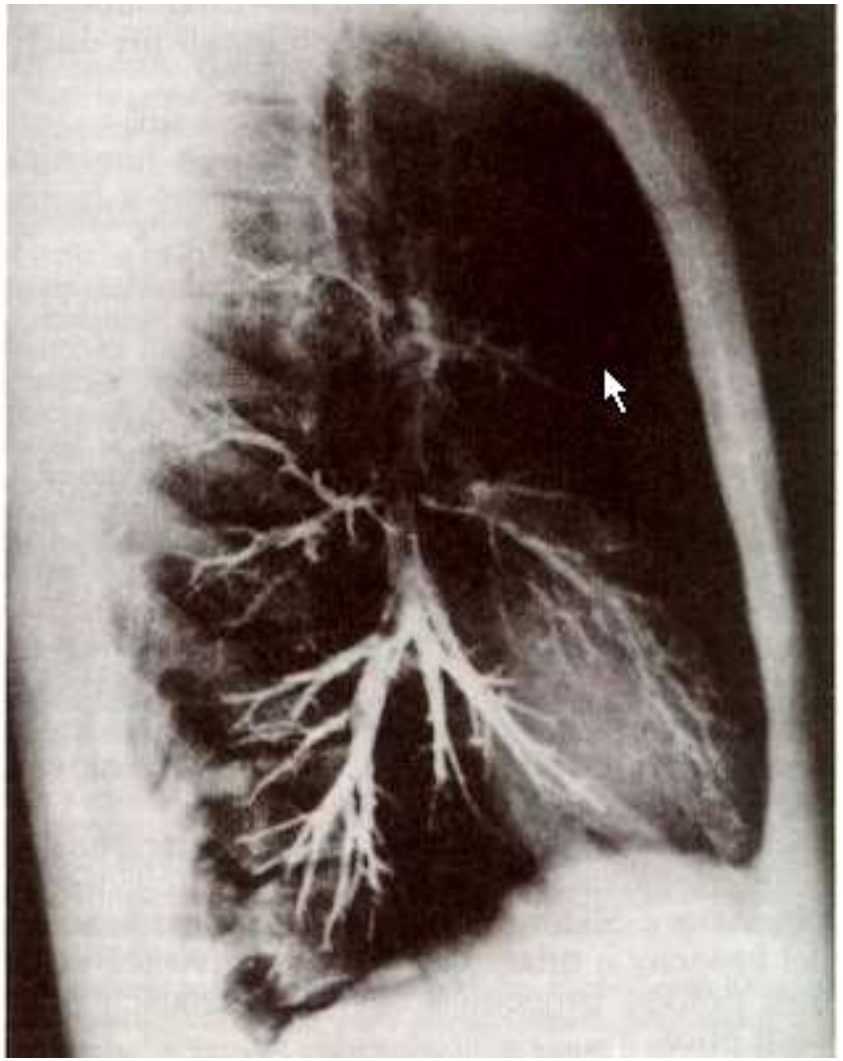
- Epithelium (cylindrical with cilia and goblet cells)
- Connective tissue
- Glands in lamina propria
- Hyaline cartilage (discontinuous)
- Smooth muscle




V
N
V
C
E
LP
C
LT
SM
a
SM
C
SM
G
b

Bronchography

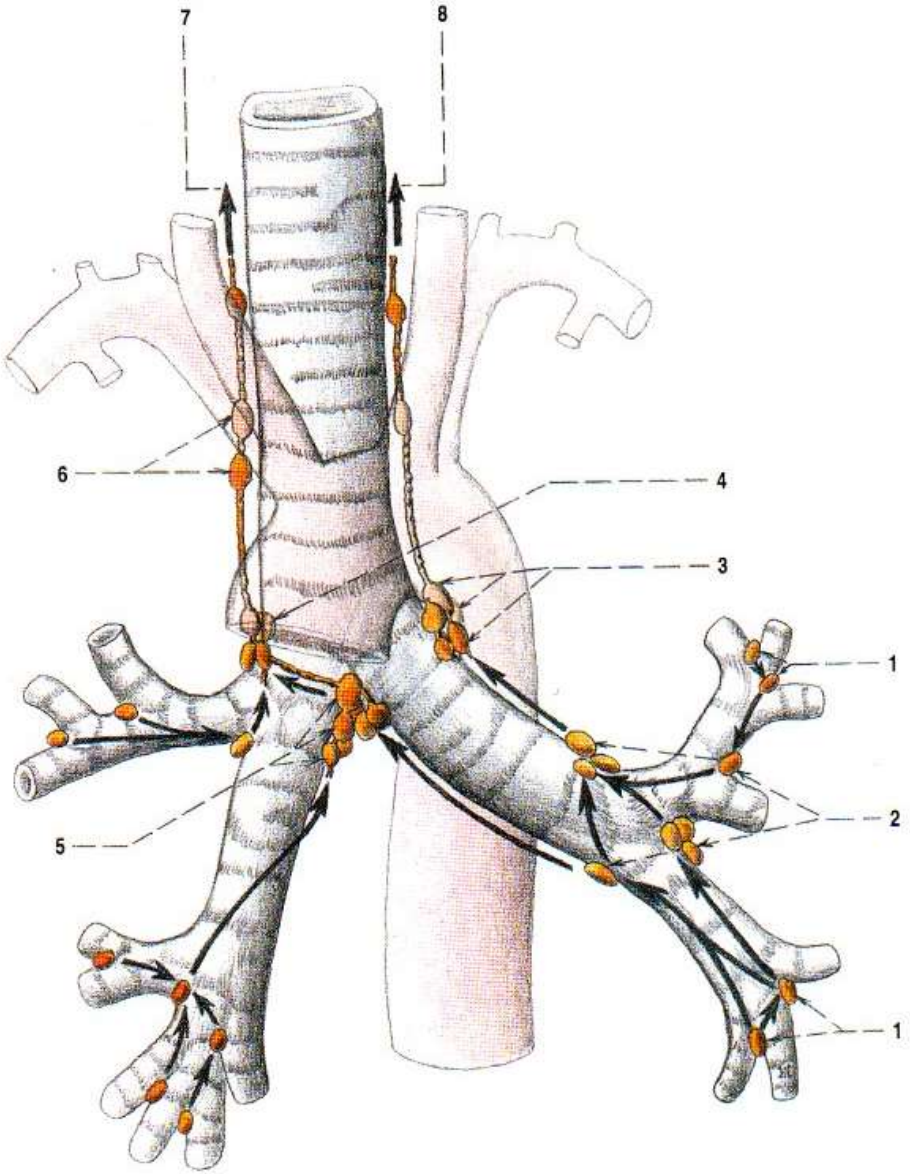




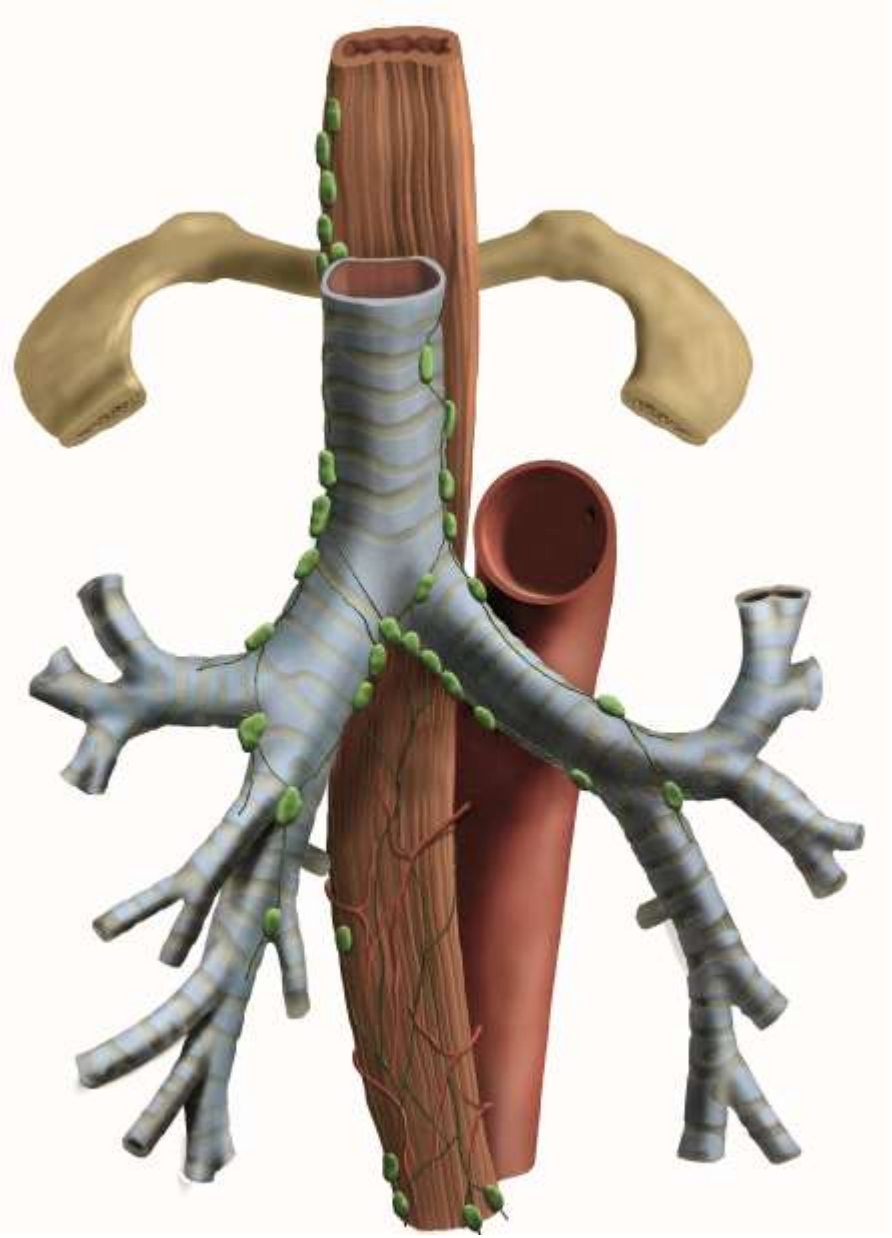
Blood supply & innervation

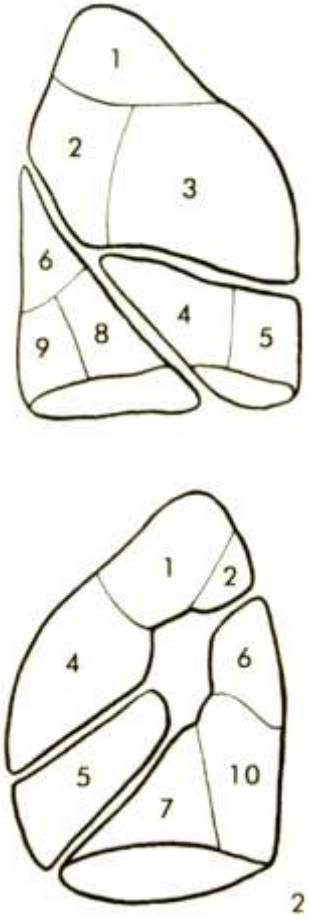
- Pulmonary artery and branches - functional
- Rr. bronchiales from thoracic aorta or intercostal arteries - nutritive
- Pulmonary vein, anastomoses
- Parasympathetic: left and right vagus
- Sympathetic: inferior and middle cervical ganglia, rami from the first four thoracic ganglia; almost no pain (only parietal pleura via intercostal nerves)

Lymphatic drainage



Lymphatic drainage



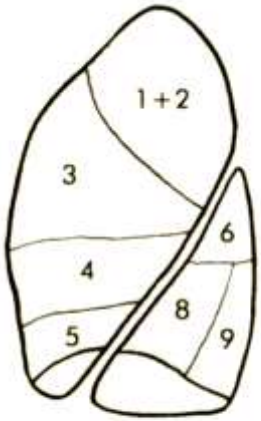


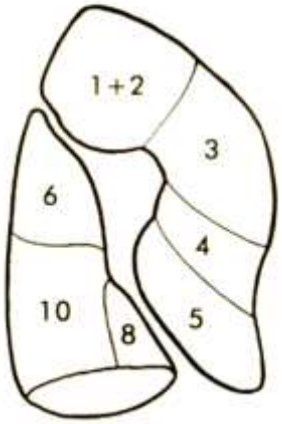
Right Lung

Superior lobe: (1) apical, (2) posterior, (3) anterior

Middle lobe: (4) lateral, (5) medial

Inferior lobe: (6) superior (apical), (7) medial basal, (8) anterior basal, (9) lateral basal,(10) posterior basal





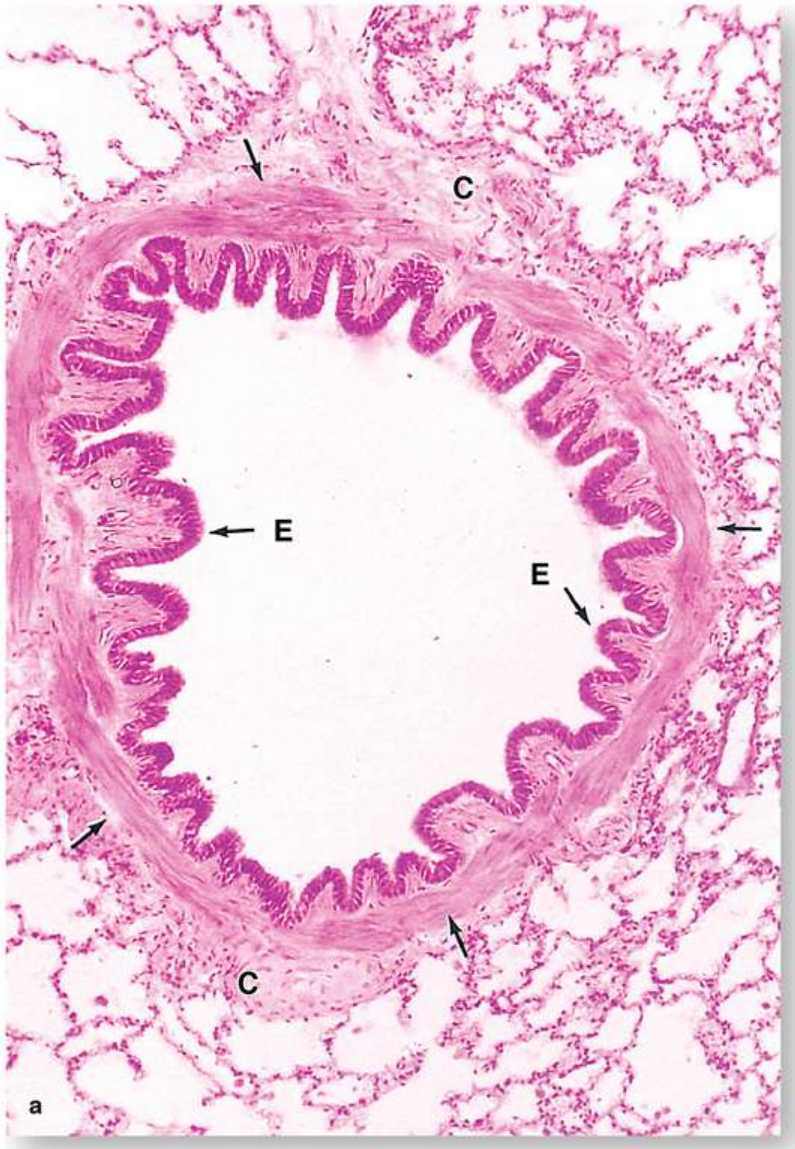
Left Lung

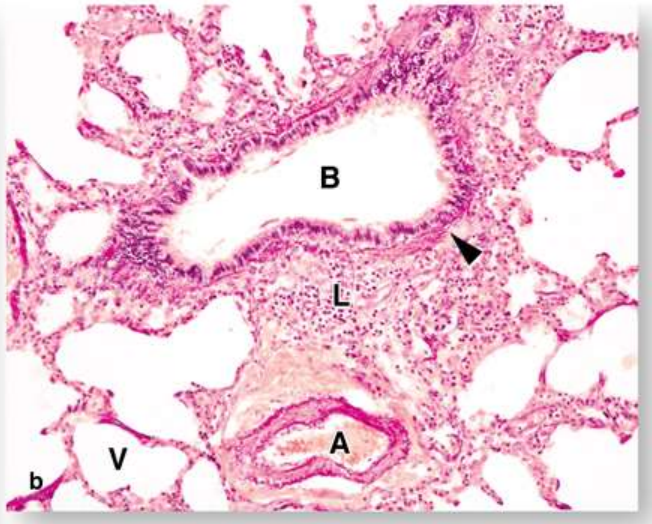
Superior lobe: (1) apical, (2) posterior, (3) anterior, (4) superior lingular, (5) inferior lingular

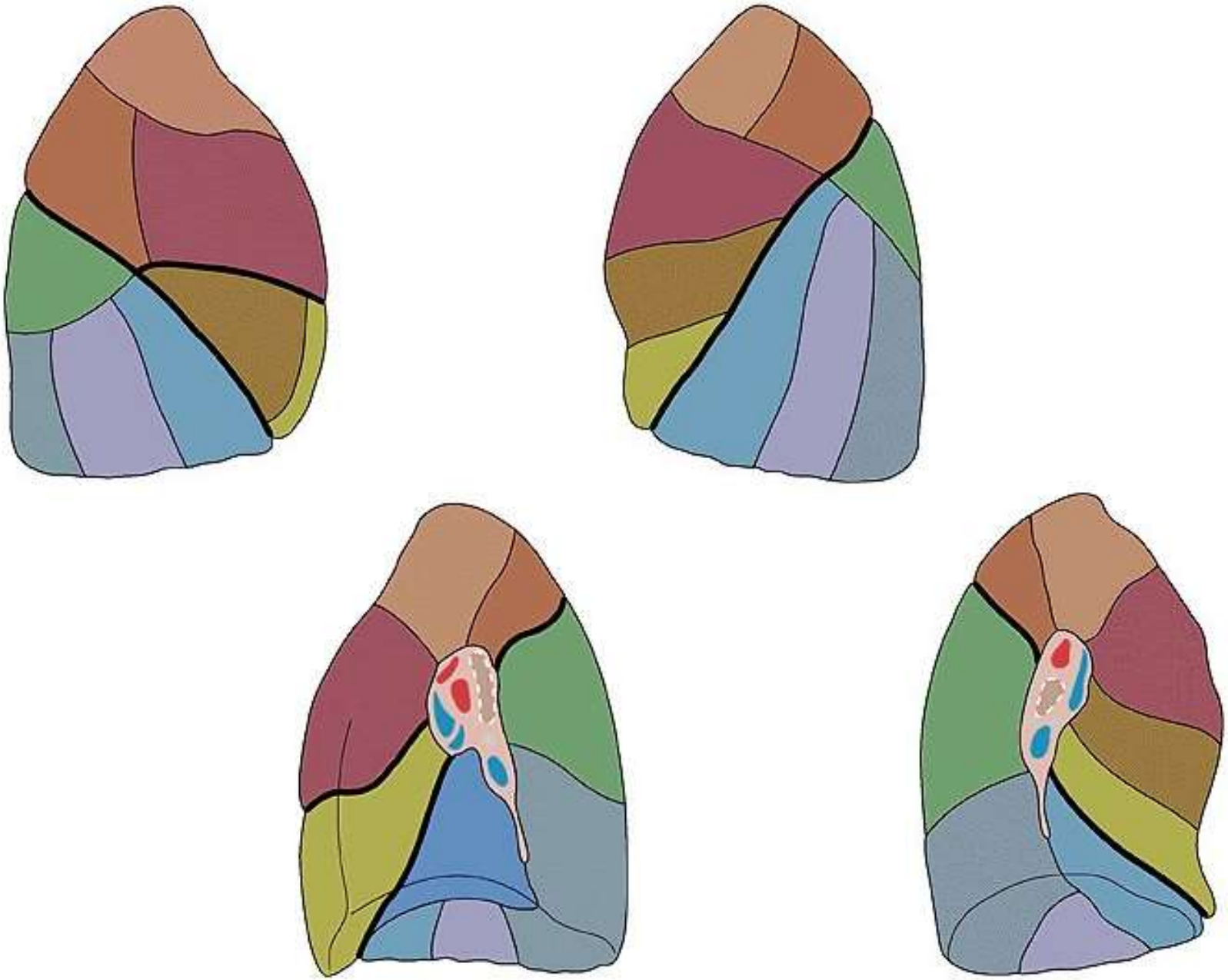
Inferior lobe: (6) superior (apical), (7) medial basal, (8) anterior basal, (9) lateral basal, (10) posterior basal

The Bronchioli

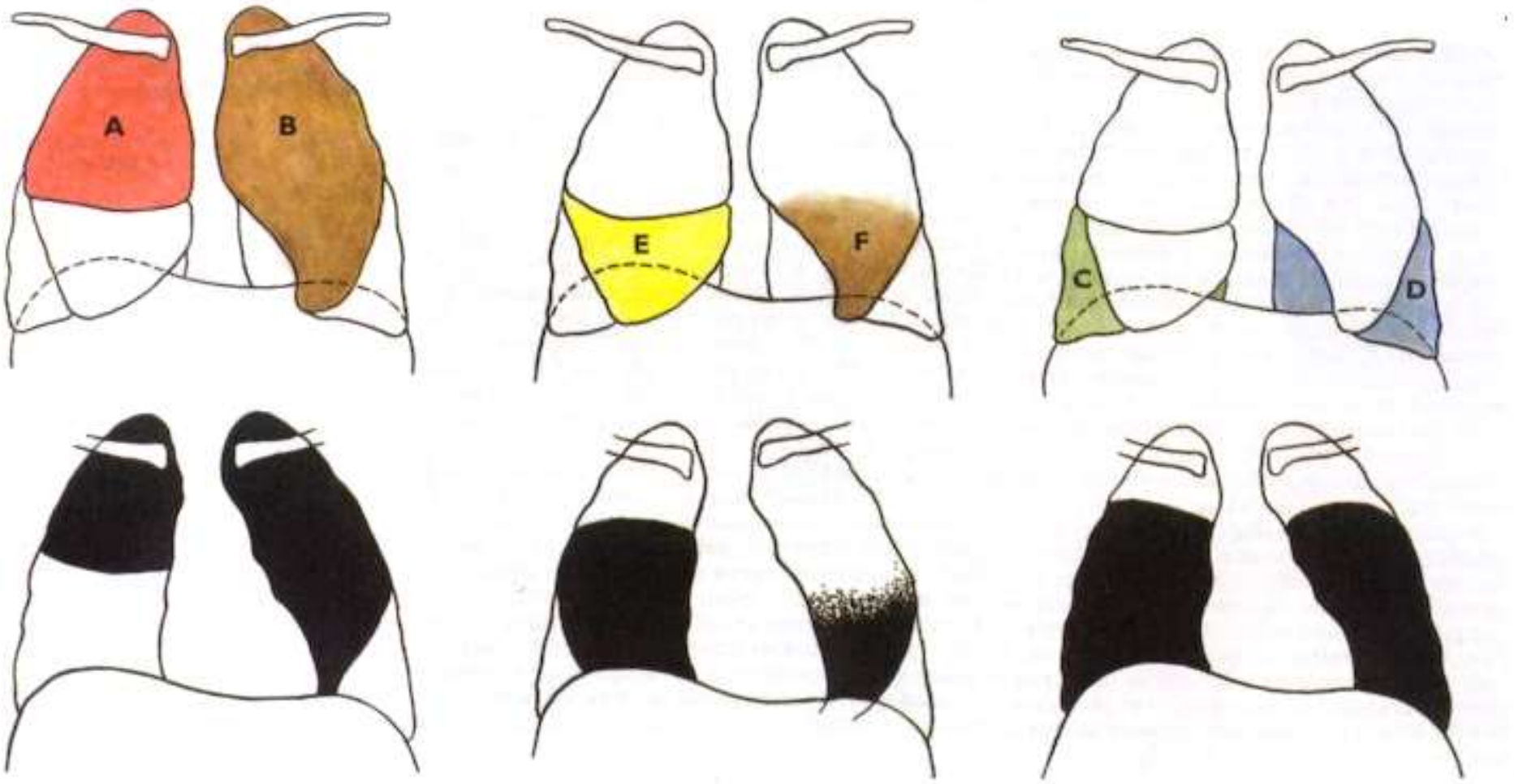
- No cartilage, just smooth muscle => bronchocostriction in asthma!



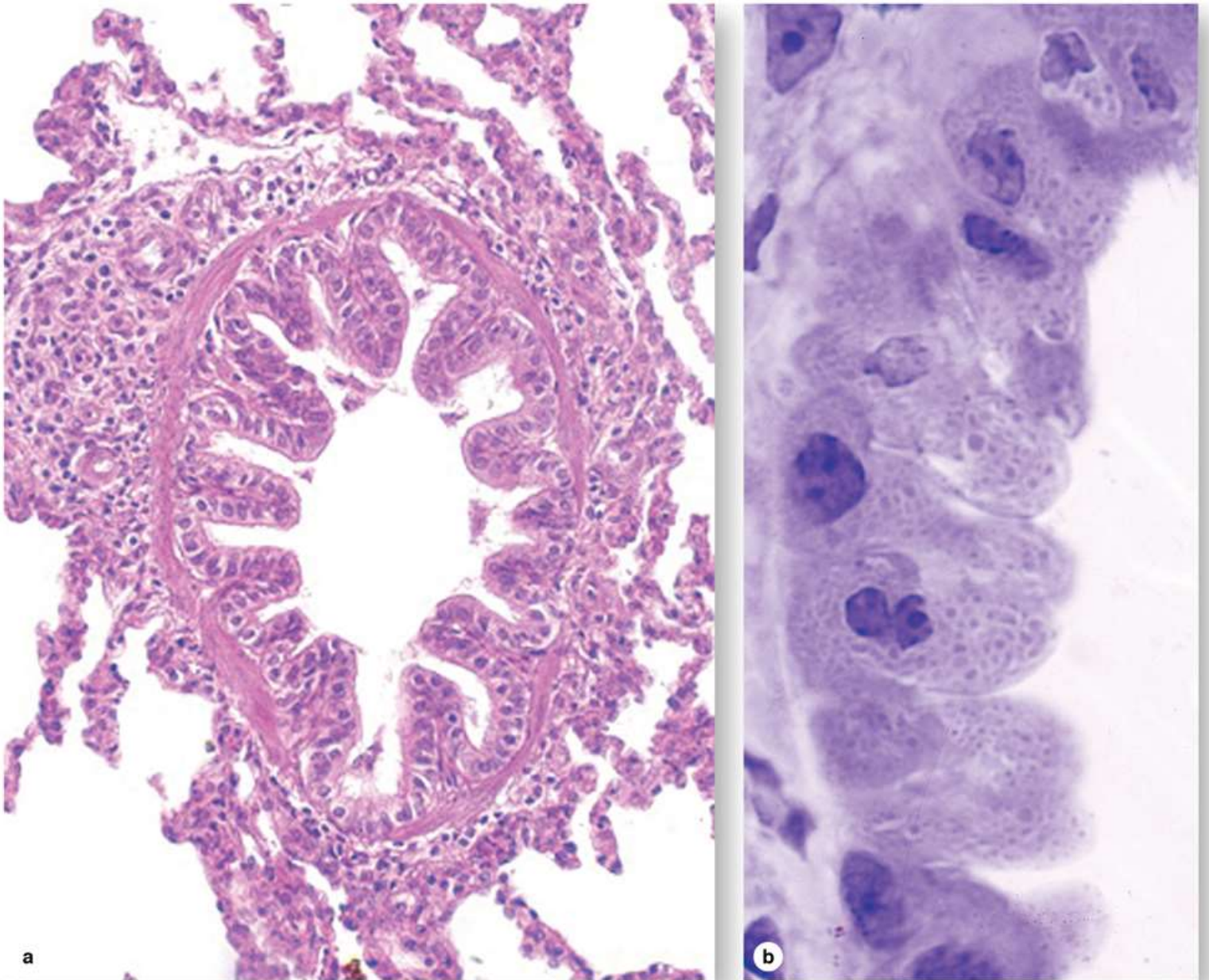




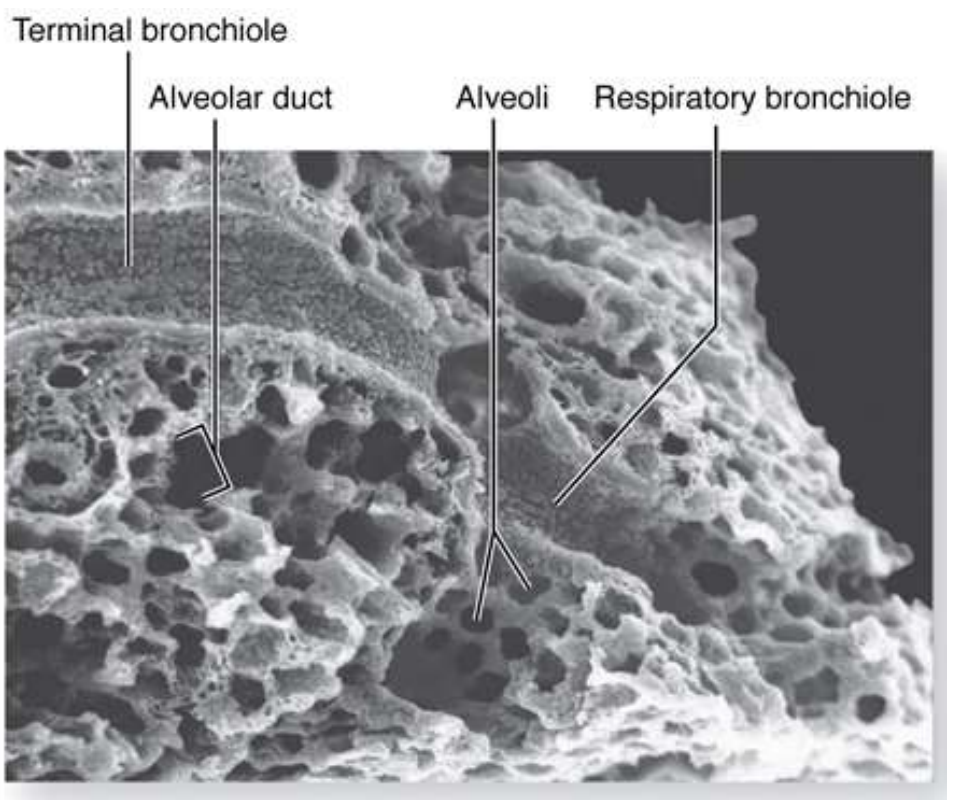
The Lung Lobes - projections

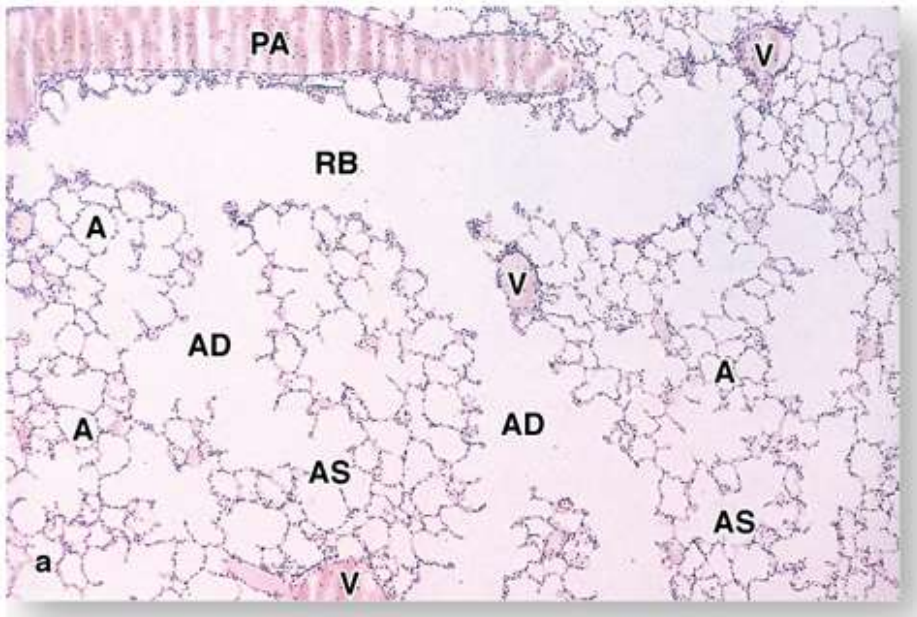


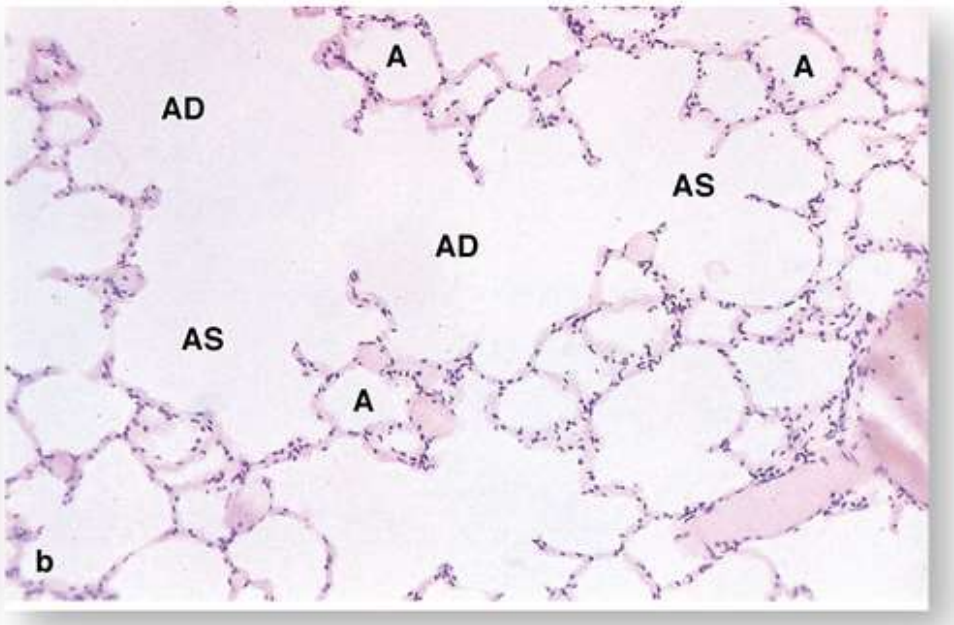
Terminal bronchioli and Clara cells

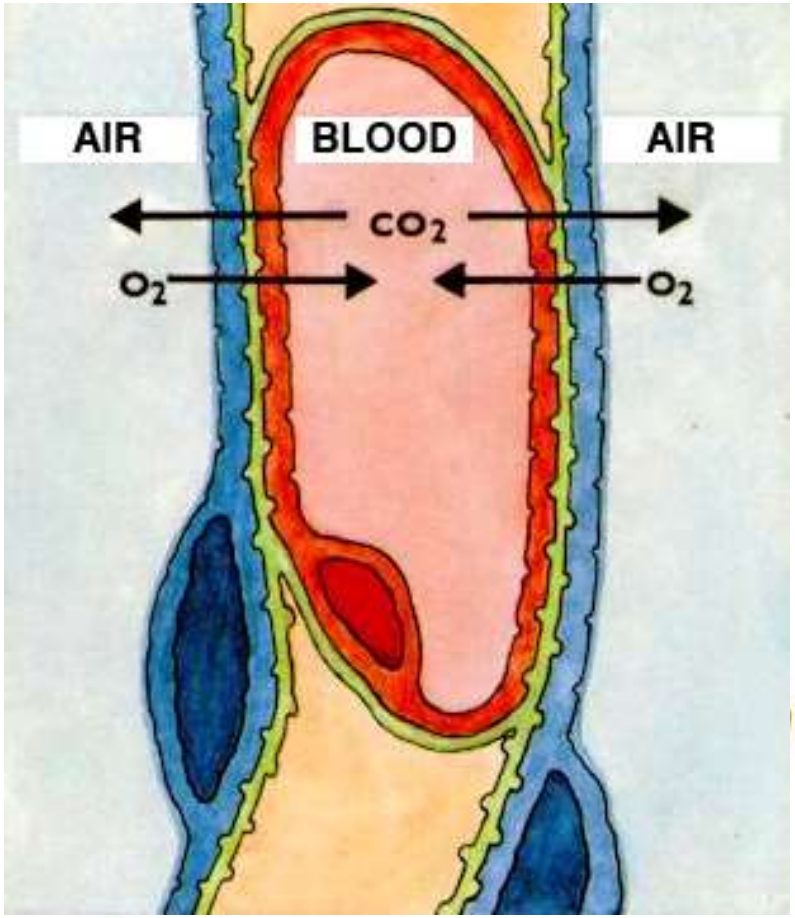


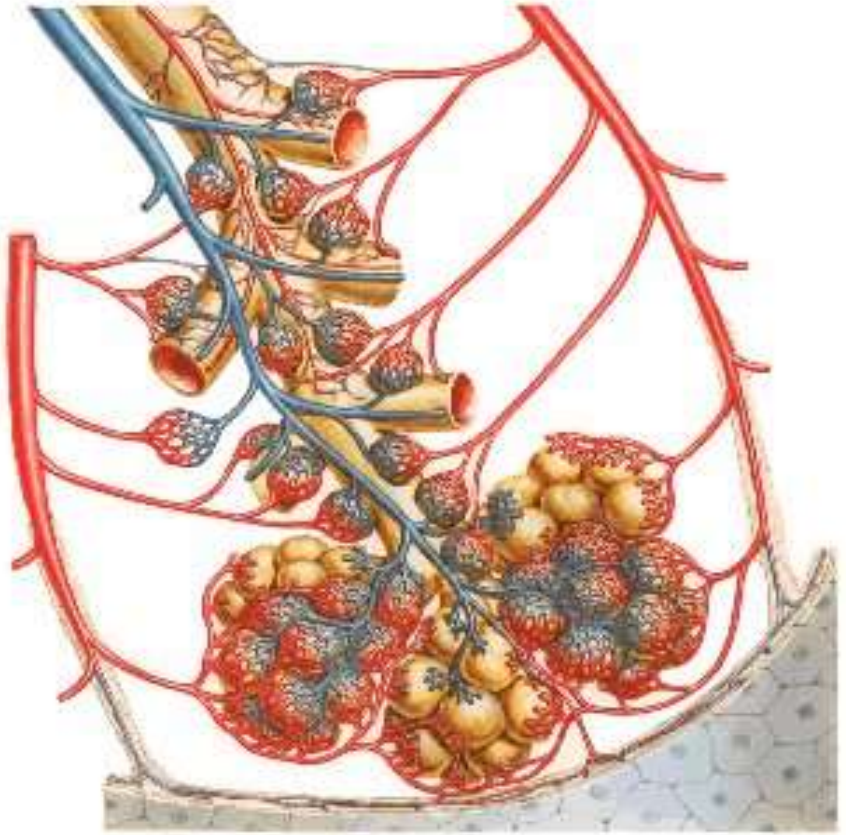
Histology of lung tissue - respiratory bronchioli, alveolar ducts, alveoli



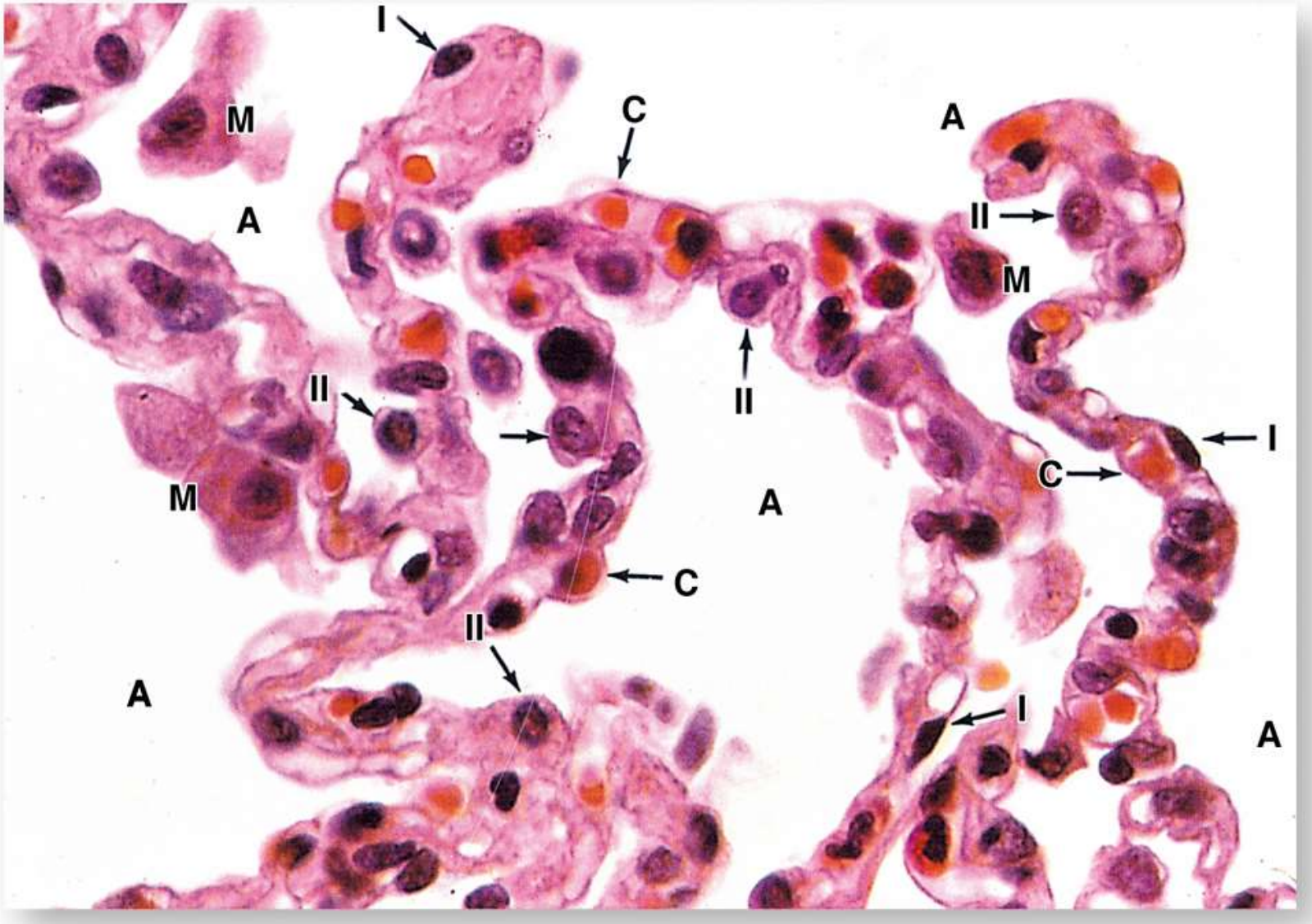






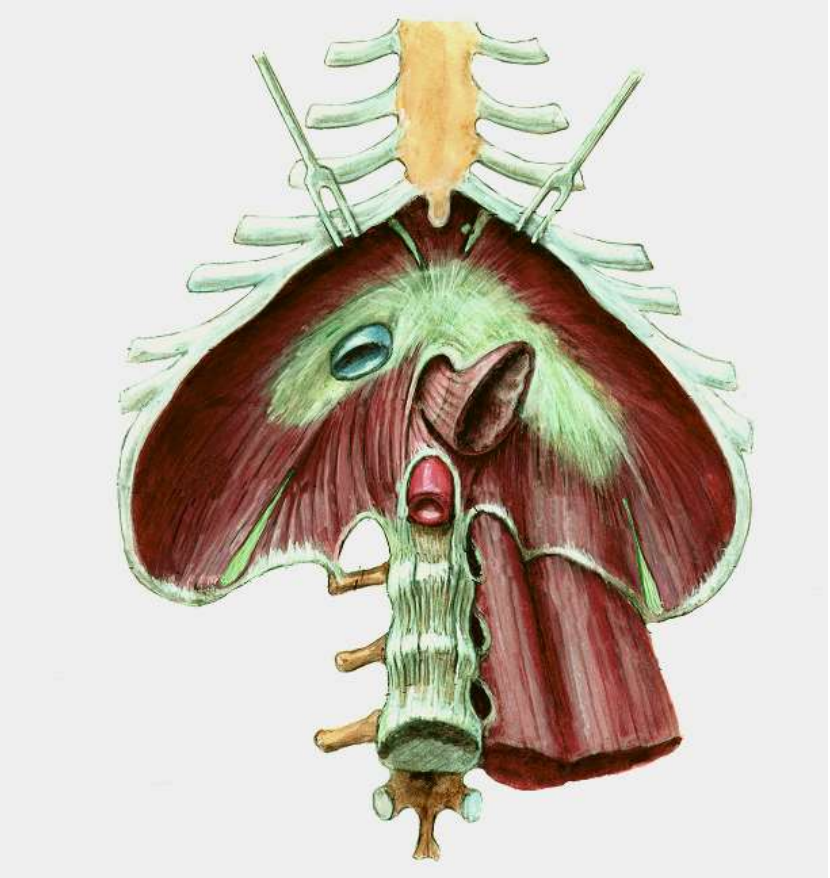


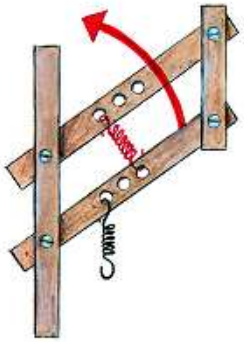
Branching ~23 bifurcations, 300-400 mil alveoli
surface area: 40-80 sq. m., air-blood barrier 0.2-0.5 μm

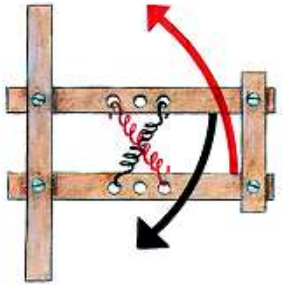


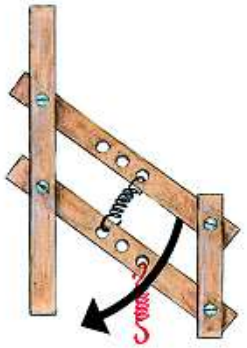
Alveolar wall: Capillaries, type I & II alveolar cells, macrophages

The muscles of respiration





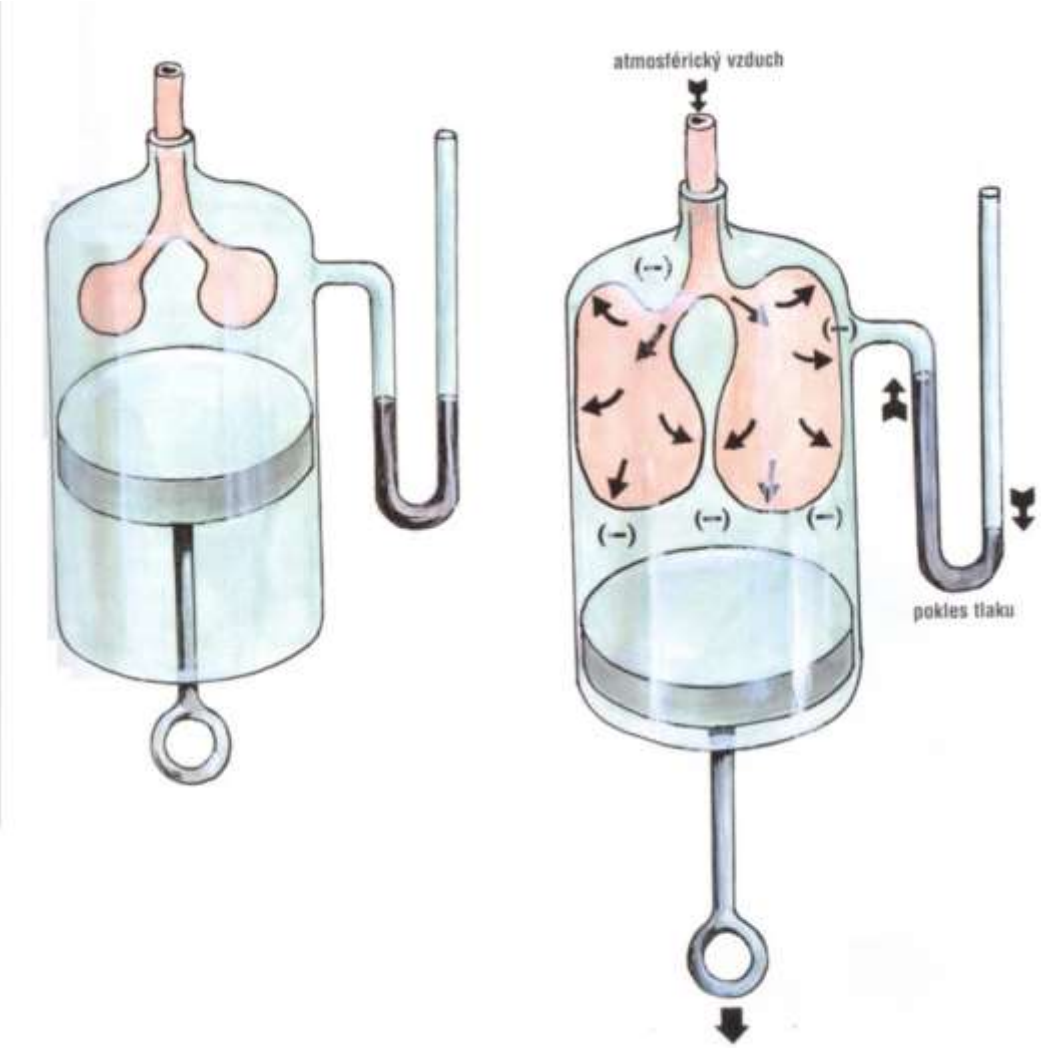


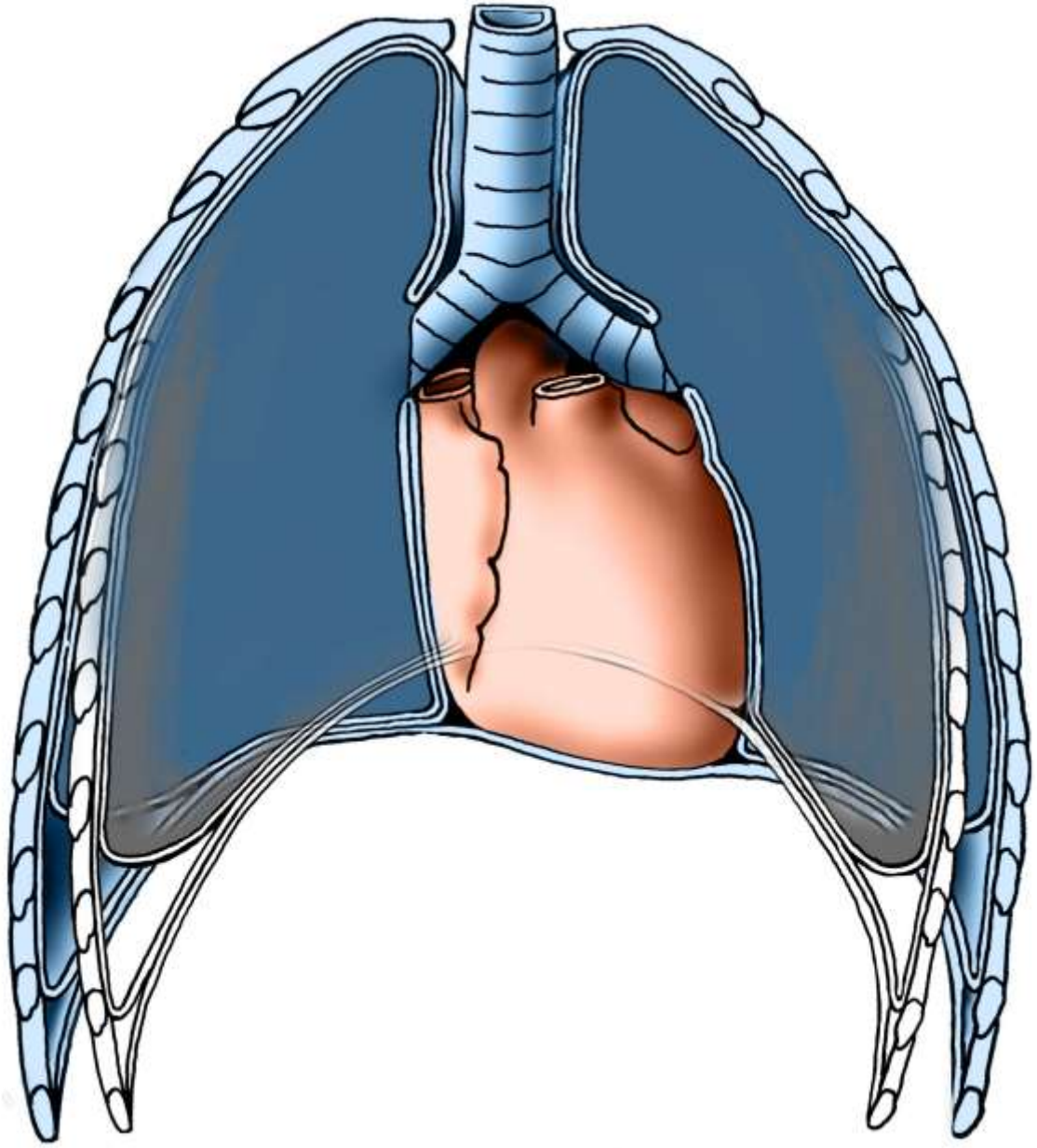


Diaphragma (C3-C5)
Intercostal mm. - bucket handle action
Accessory respiratory muscles

Mechanism of breathing

- Piston
  &
  syringe

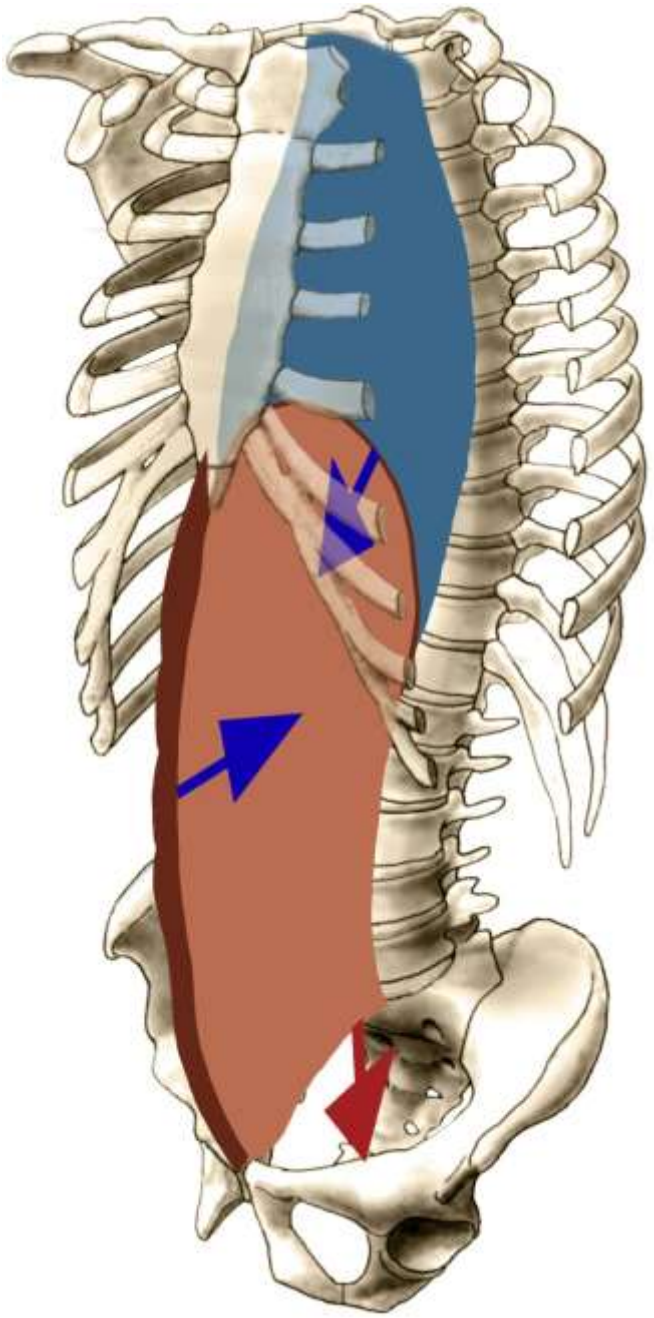




Respiratory movements of the diaphragm

Abdominal press

- Simultaneous contraction of diaphragm and abdominal muscles
- Increased abdominal pressure useful during miction, defecation, parturition
- If the pelvic diaphragm is contracted as well, supports the lumbar spine (muscular corset)



Pleural cavity

Parietal pleura

Costal part

Mediastinal part

Diaphragmatic part

Pleural cupula (dome)

Pleural recesses:

costodiaphragmatic

costomediastinal

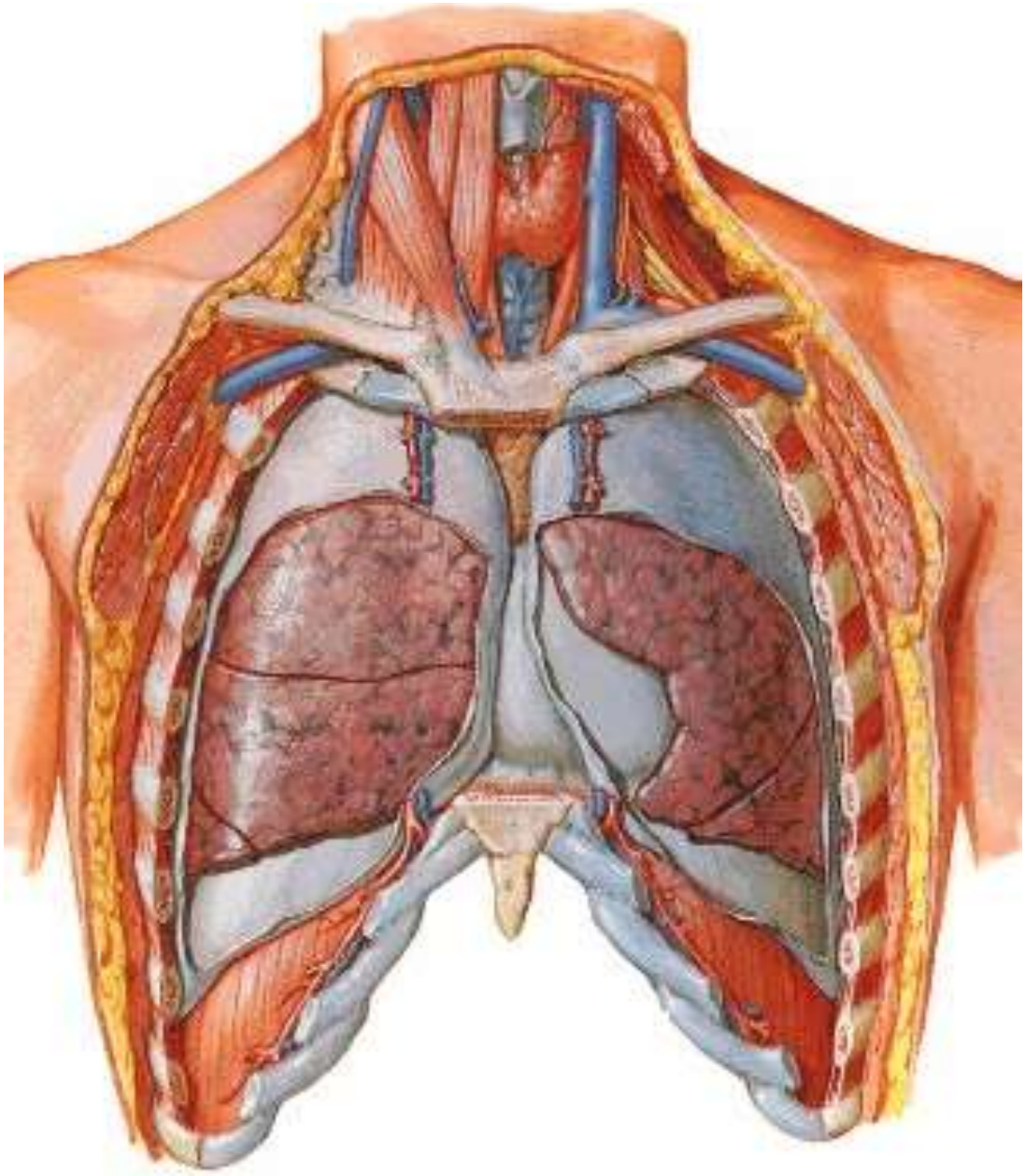
phrenicomediastinal

Pulmonary lig.

bronchopericardial membrane

Mediastinum

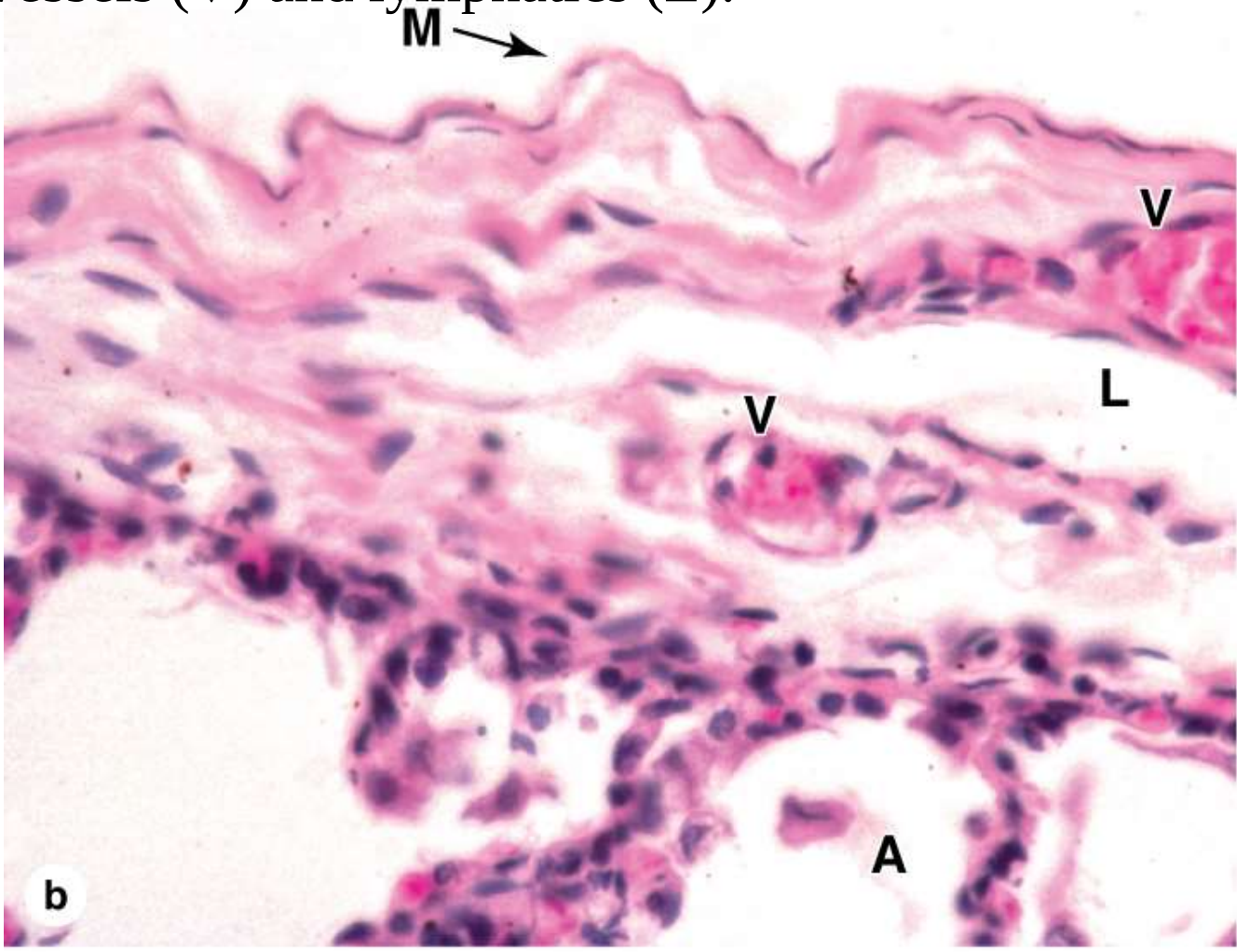
Superior, Inferior – anterior, middle, posterior

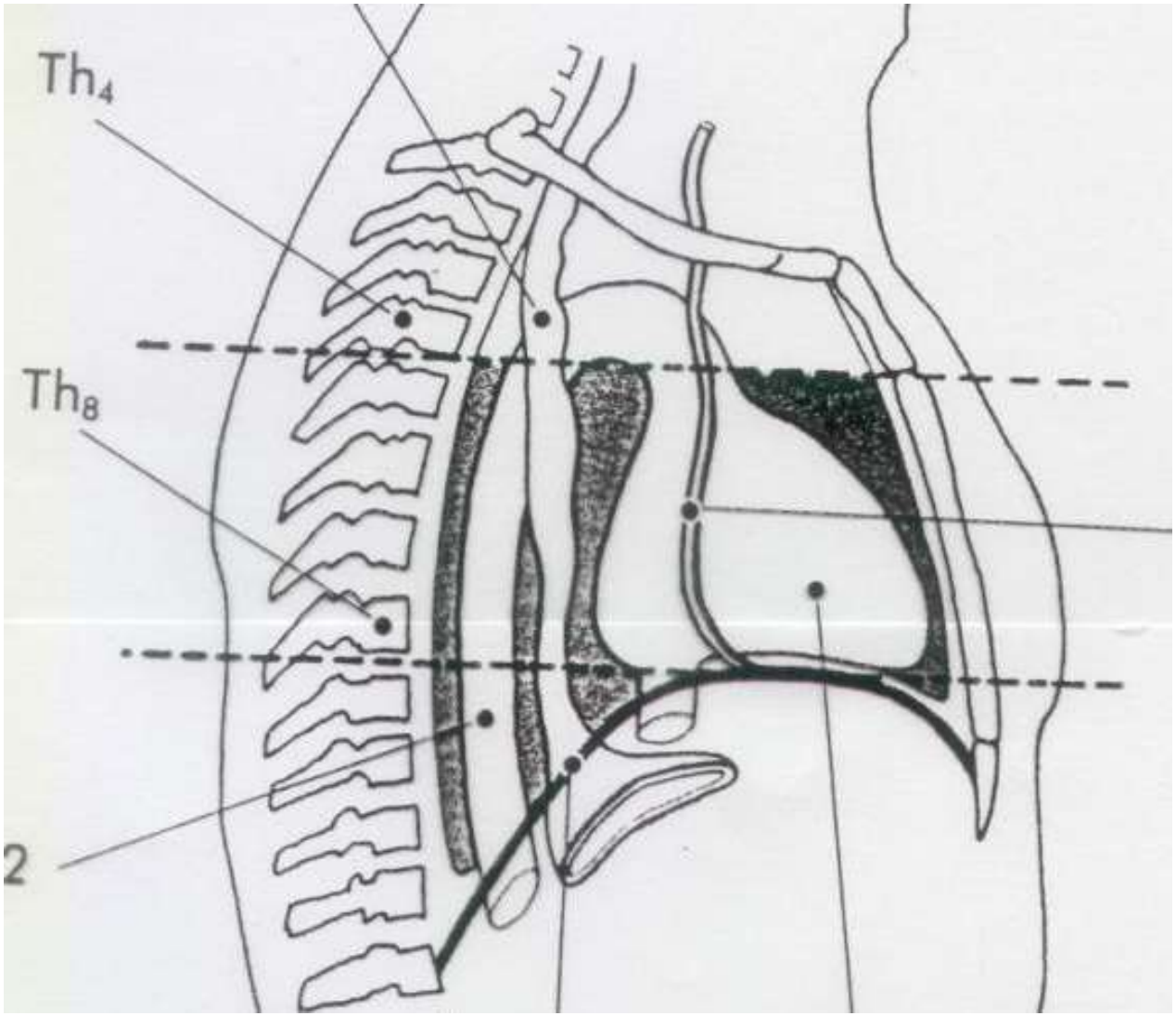


The Pleura

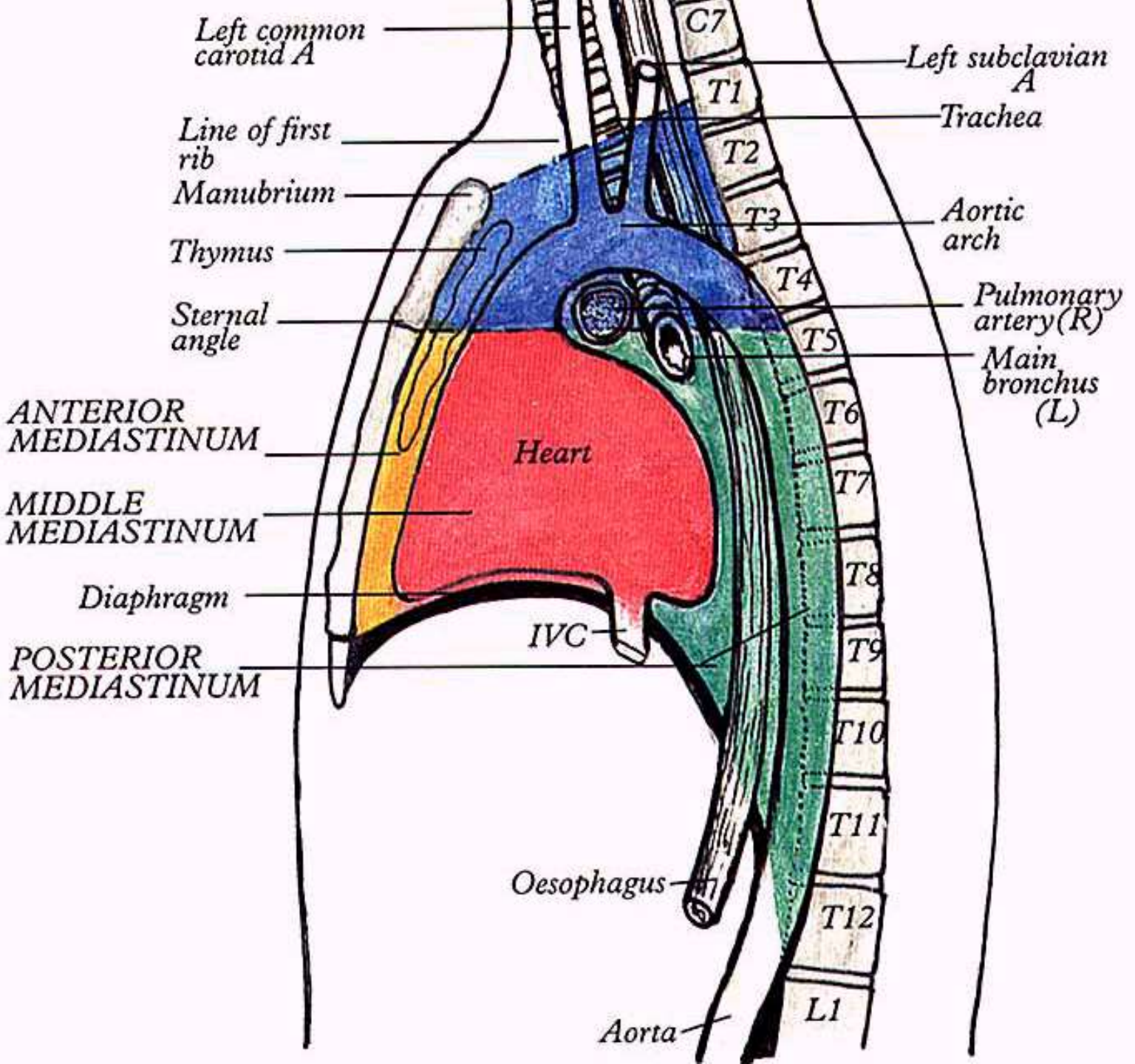
Lined by mesothelium (M) secreting pleural fluid
(WHY this is NOT an epithelium?)

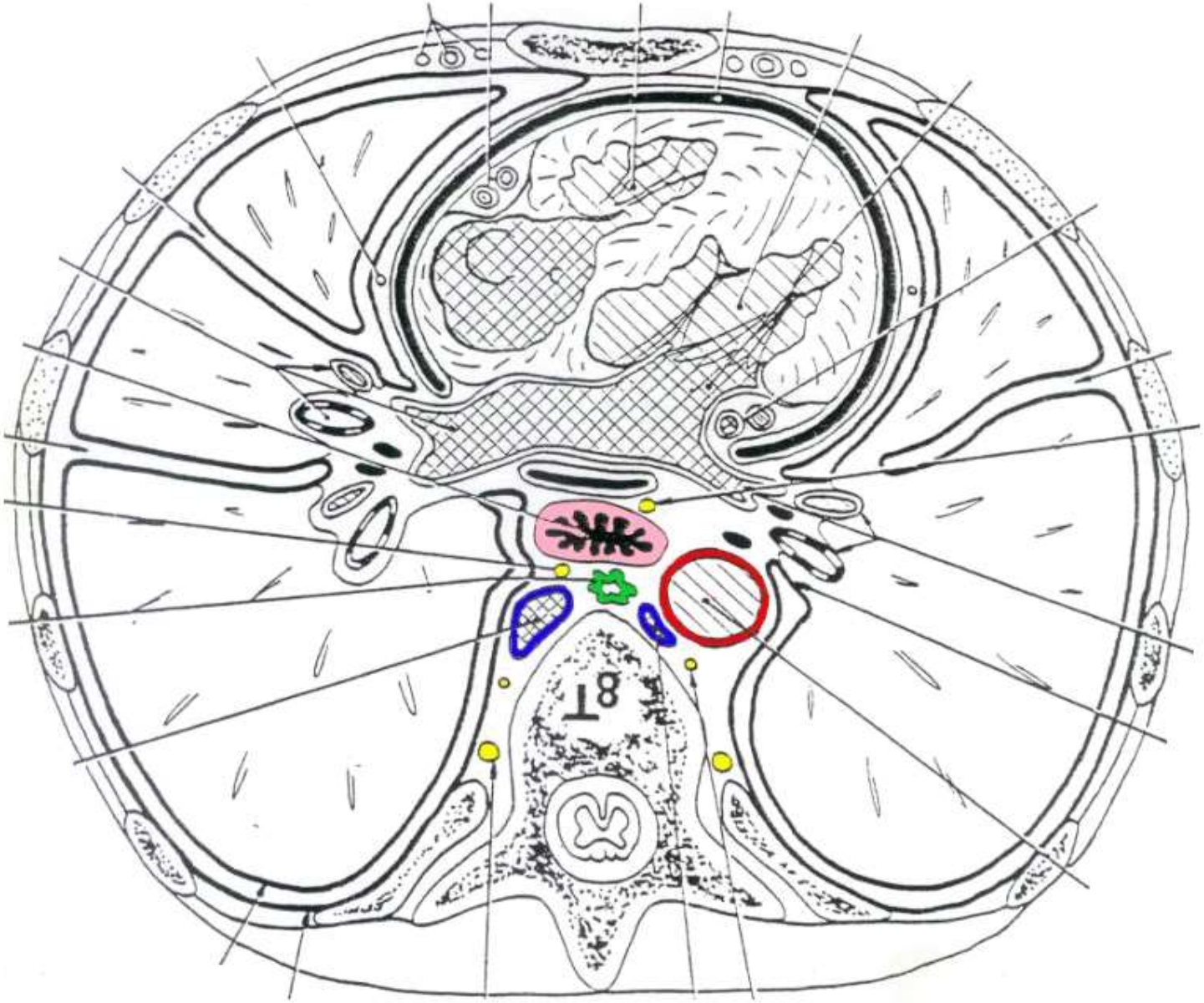
The connective tissue is rich in both collagen and elastic fibers and contains both blood vessels (V) and lymphatics (L).





Mediastinum interpleural space)
superius, inferius – anterius, medium, posterius


Left common carotid A
Left subclavian A
Trachea
Line of first rib
Manubrium
Thymus
Aortic arch
Sternal angle
Pulmonary artery (R)
Main bronchus (L)
ANTERIOR MEDIASTINUM
Heart
MIDDLE MEDIASTINUM
Diaphragm
IVC
POSTERIOR MEDIASTINUM
Oesophagus
Aorta
C7
T1
T2
T3
T4
T5
T6
T7
T8
T9
T10
T11
T12
L1

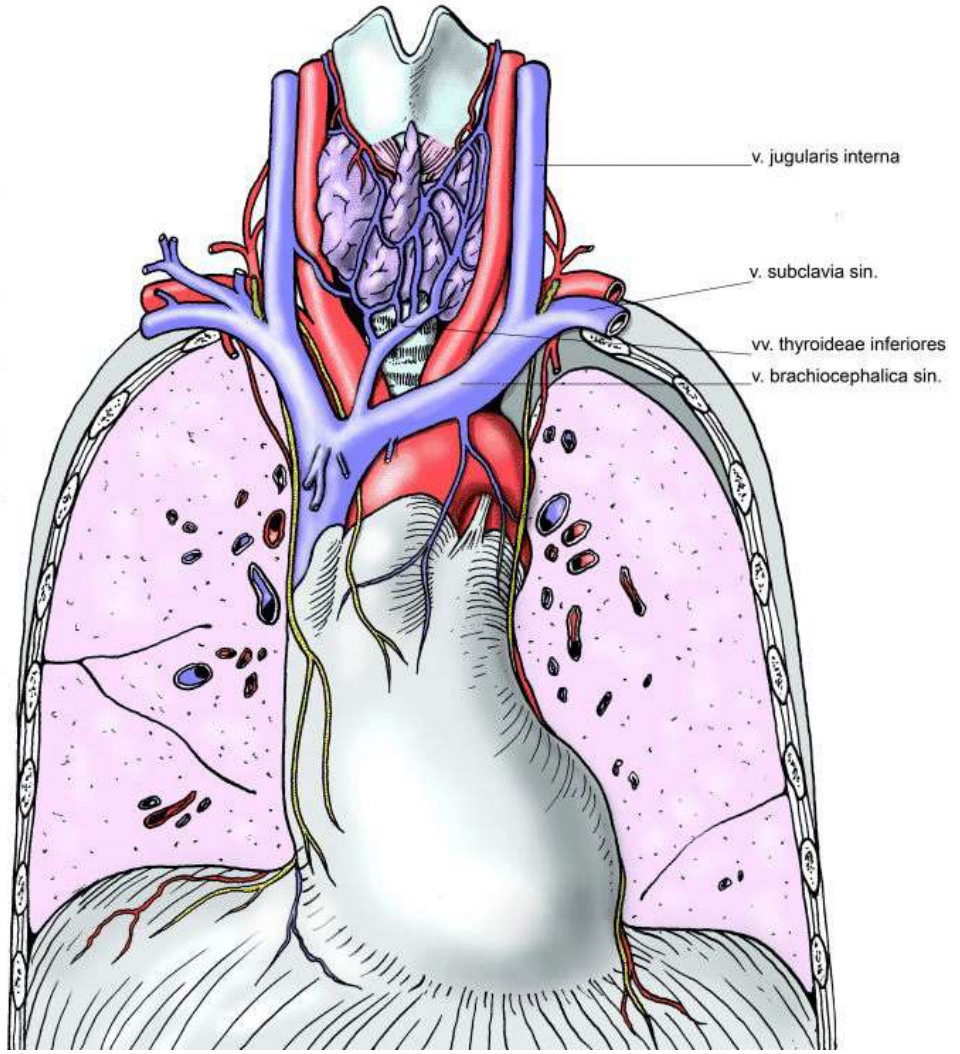

8T

Mediastinum

Space in thorax between the left and right pleural cavities, filled by vessels, organs, fatty tissue

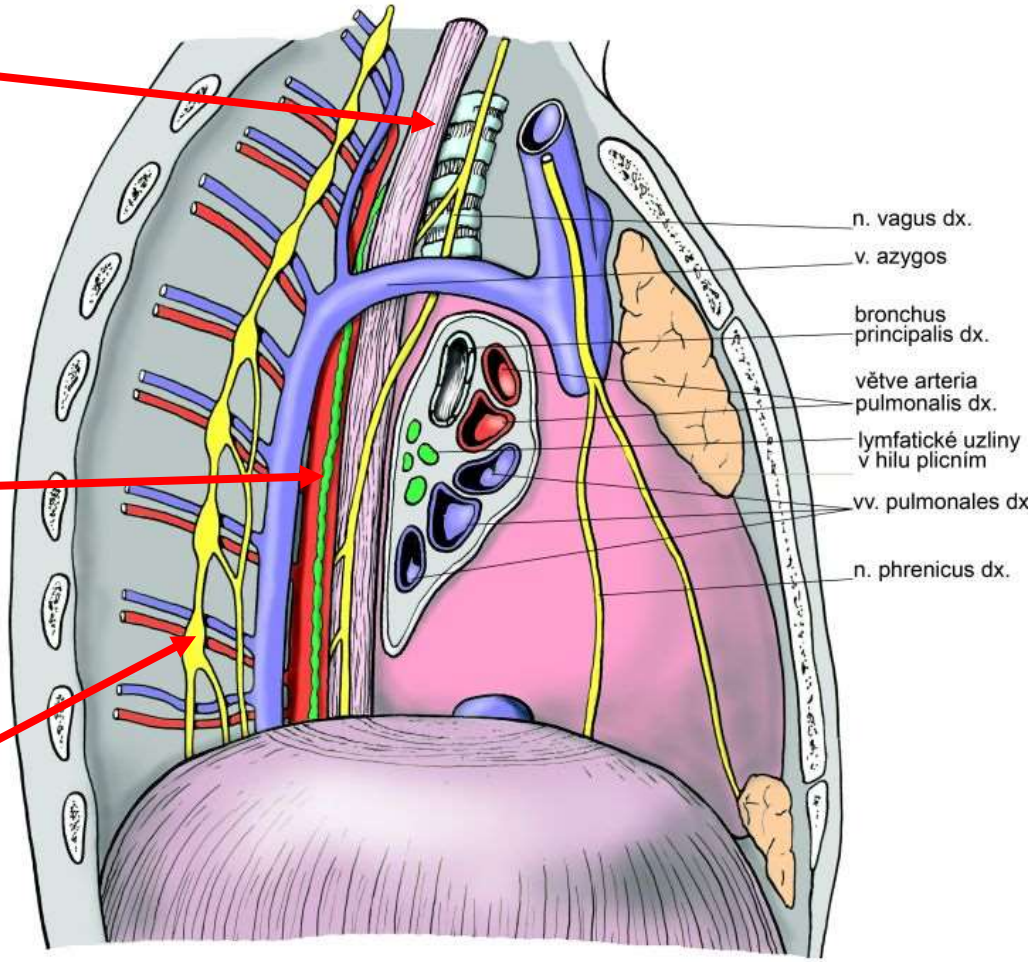
Borders:

- cranial – apertura thoracis superior
- caudal – diaphragm
- ventral – sternum and ribs
- dorsal – vertebral column



Posterior mediastinum

- esophagus
- n. vagus dexter et sinister (plexus oesophageus)
- Aortic arch (end)
- aorta thoracica
- ductus thoracicus
- v. azygos
- v hemiazygos et hemiazygos accessoria
- truncus sympaticus dexter et sinister
- Lymph nodes



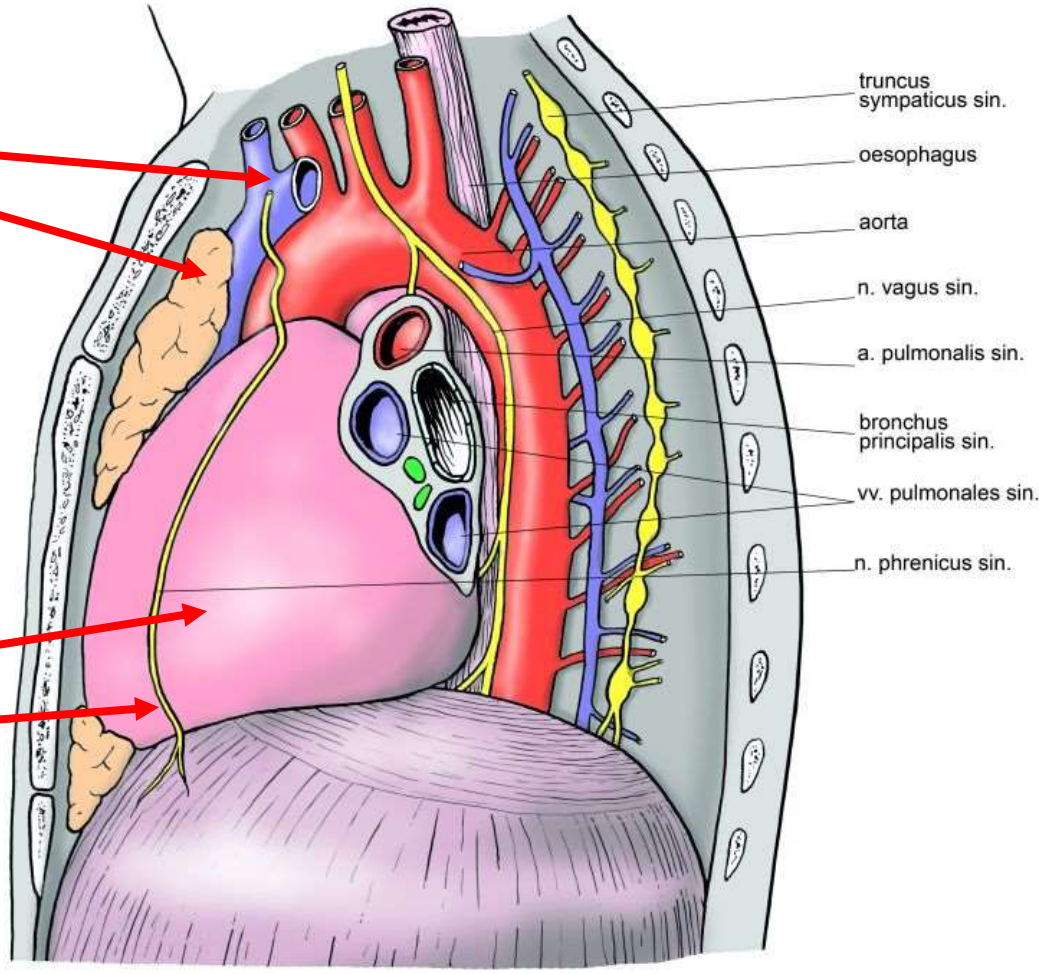
Anterior mediastinum

Anterior superior mediastinum

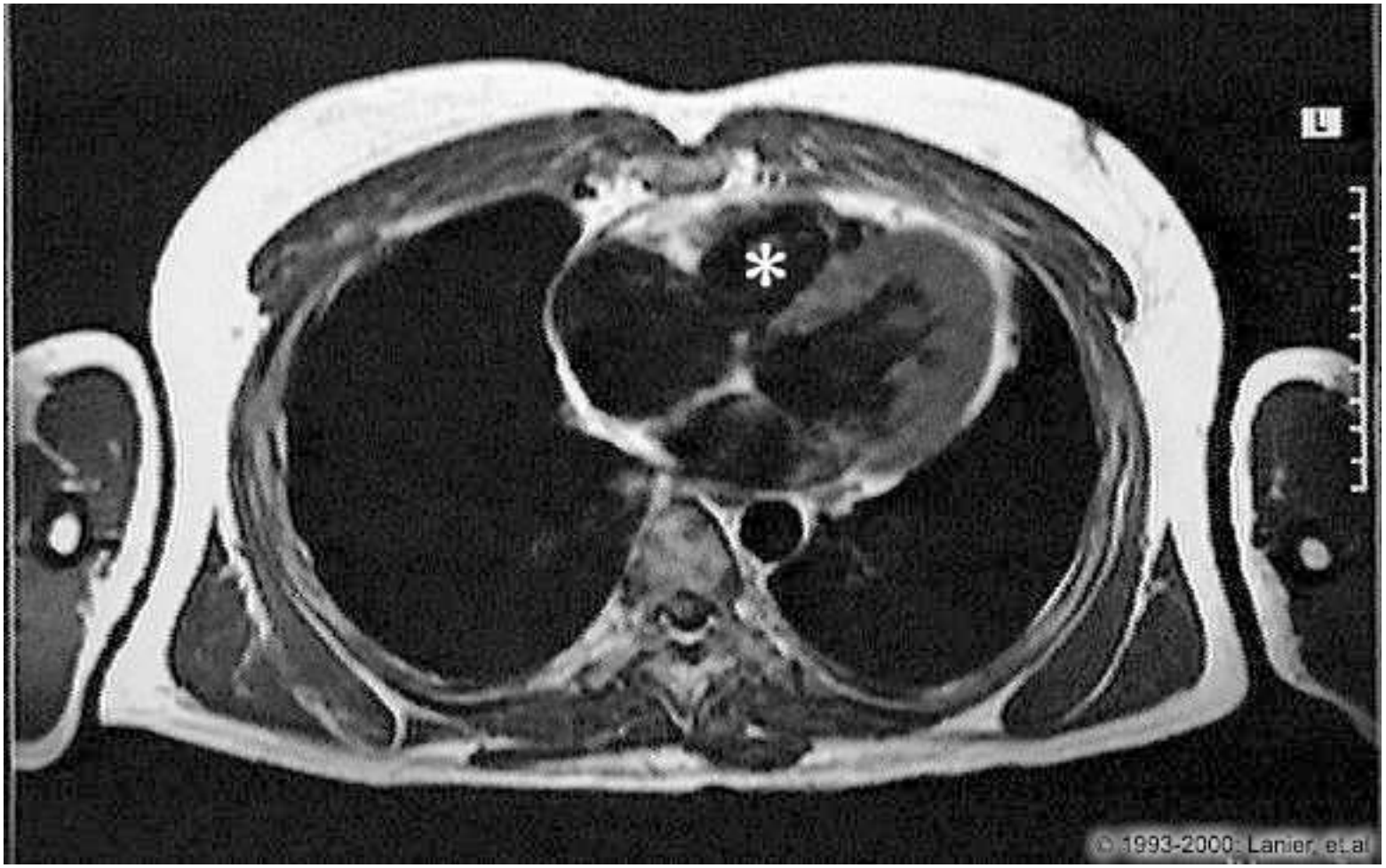
- thymus
- Venous layer – vv. brachiocephalicae, v. cava sup., plexus thyroideus impar
- Arterial layer – aortic arch and its branches
- Trachea, bronchi, recurrent laryngeal nerve

Anterior inferiror (middle) mediastinum

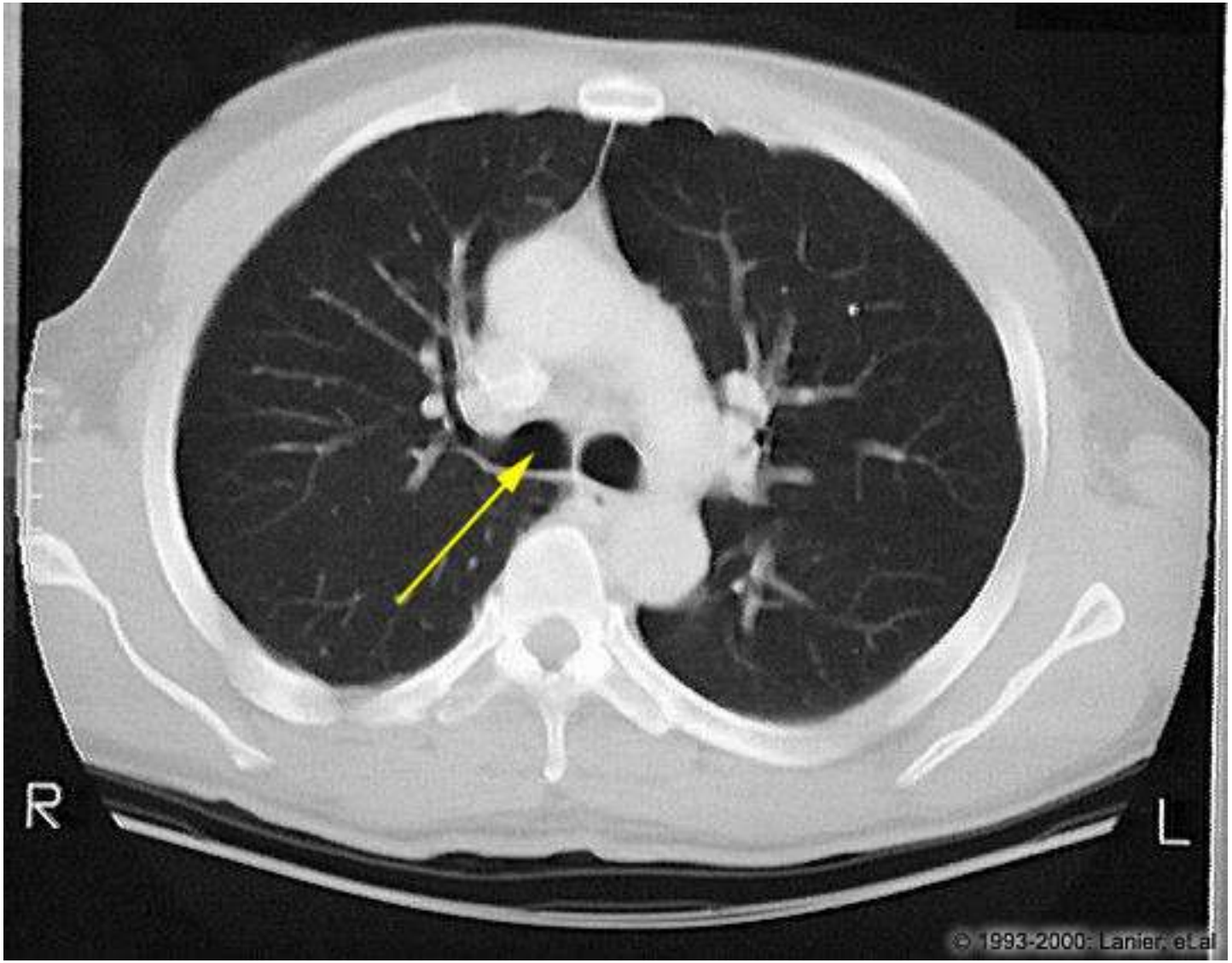
- Heart in pericardium
- n. phrenicus



What is that?

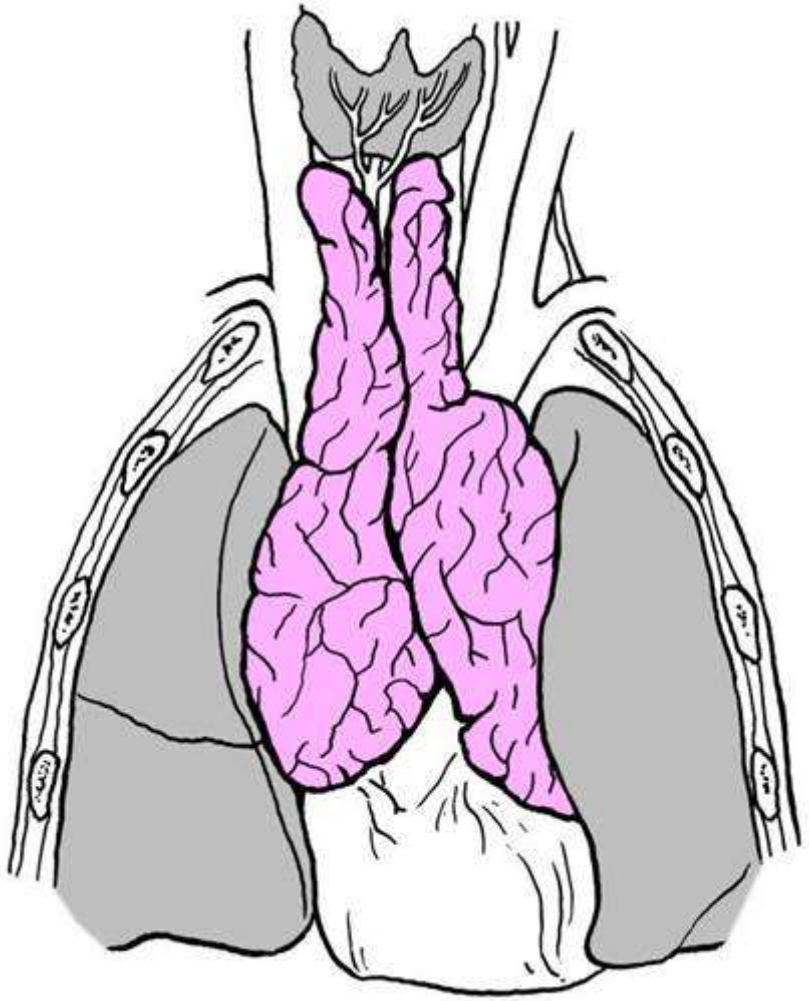


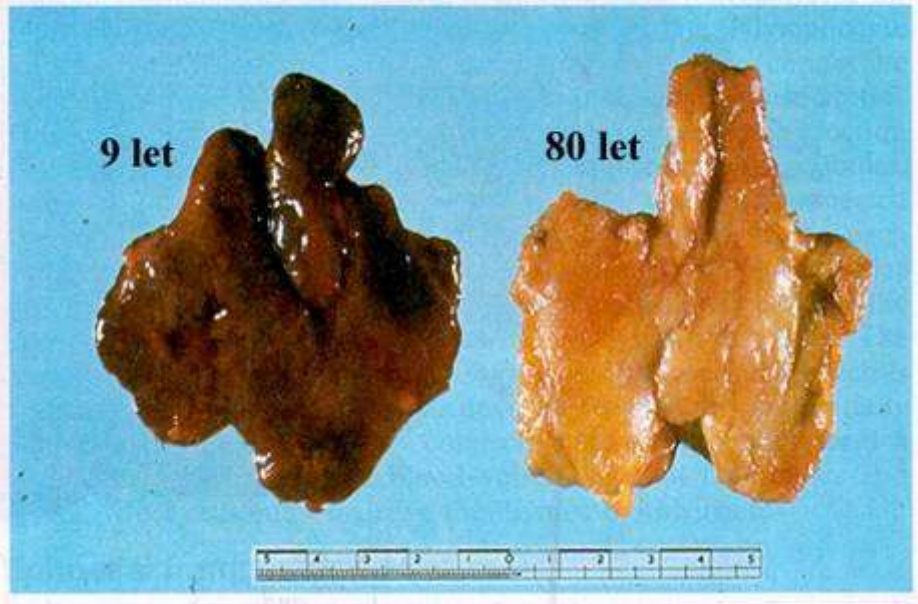
What is that?



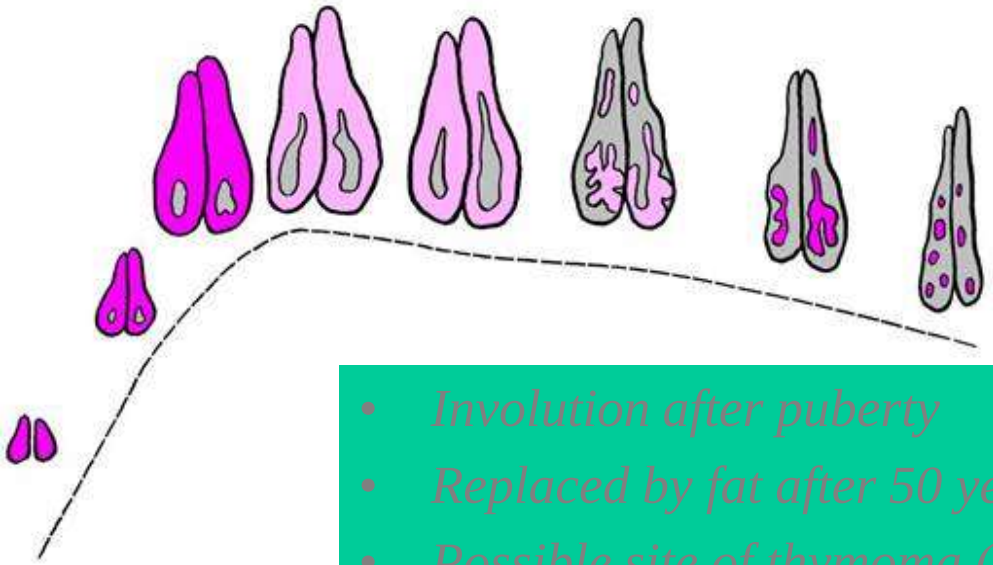
The thymus

- Lympho-epithelial organ
- Primary lymphatic organ
- Left and right lobe
- Lobules, cortex & medulla
- (accessory lobules)
- Fibrous capsule
- Proportionally large at birth (12-14g)
- With ageing undergoes involution and replacement by fatty tissue
- Residues still discernible at the old age (watch out during dissections when opening the chest cavity!)



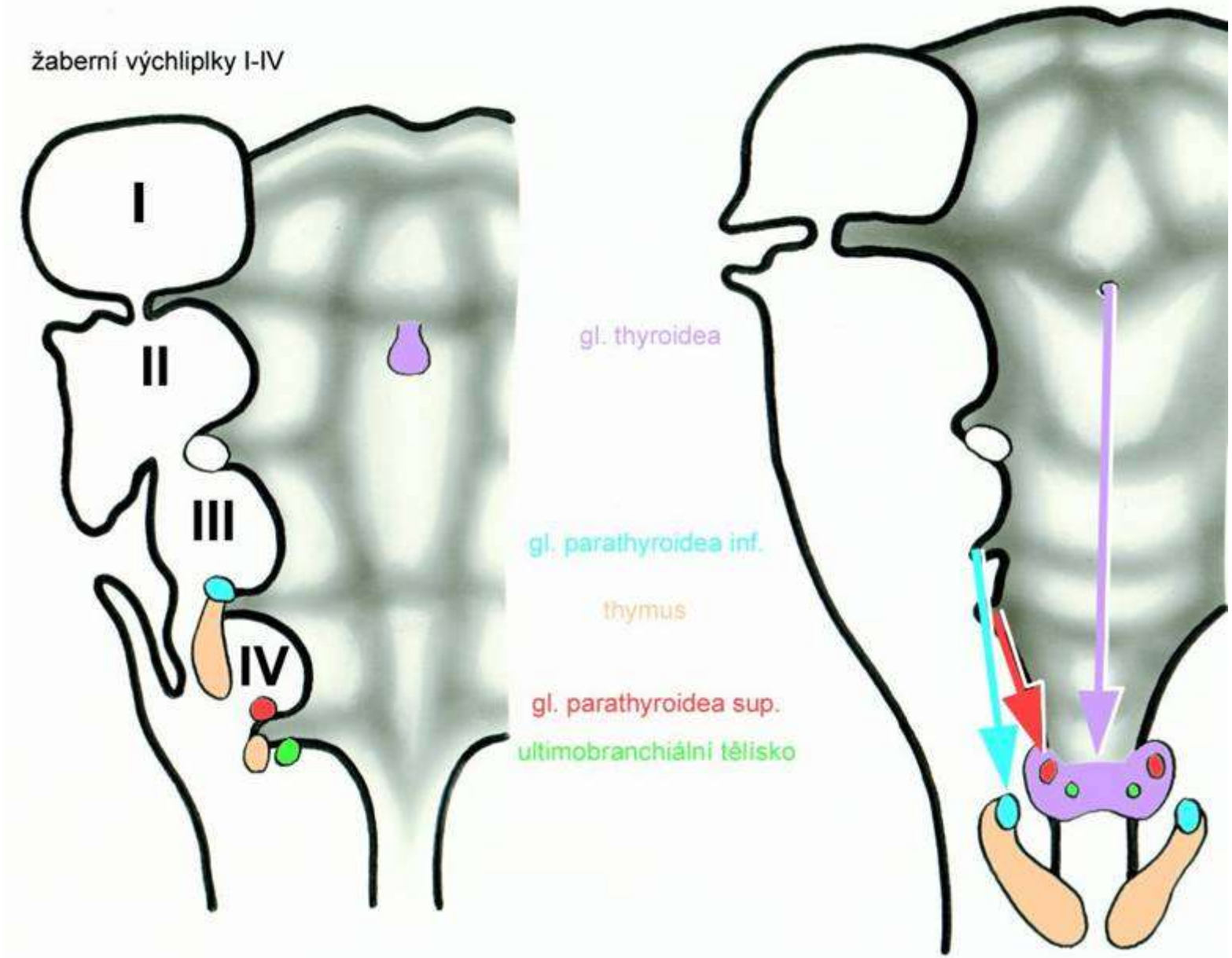


Located in the superior mediastinum behind the sternum
30-40 g



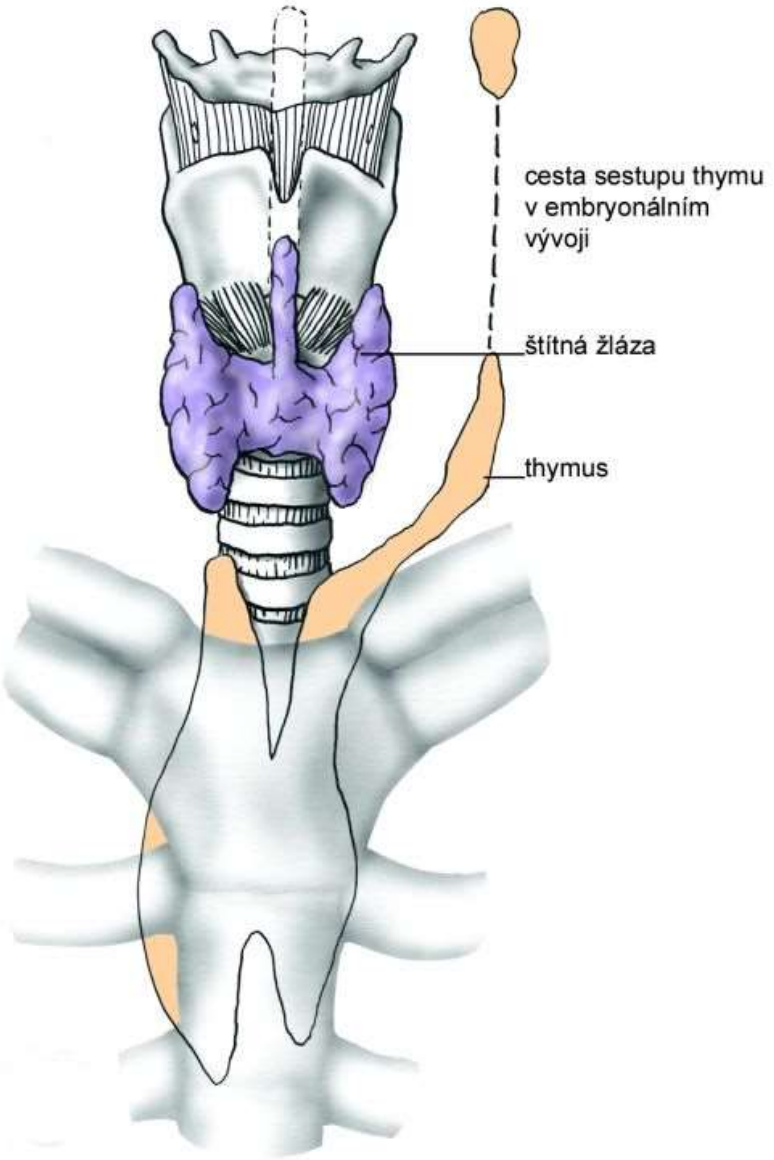
- *Involution after puberty*
- *Replaced by fat after 50 years*
- *Possible site of thymoma (cancer from white blood cells)*

Development of the thymus



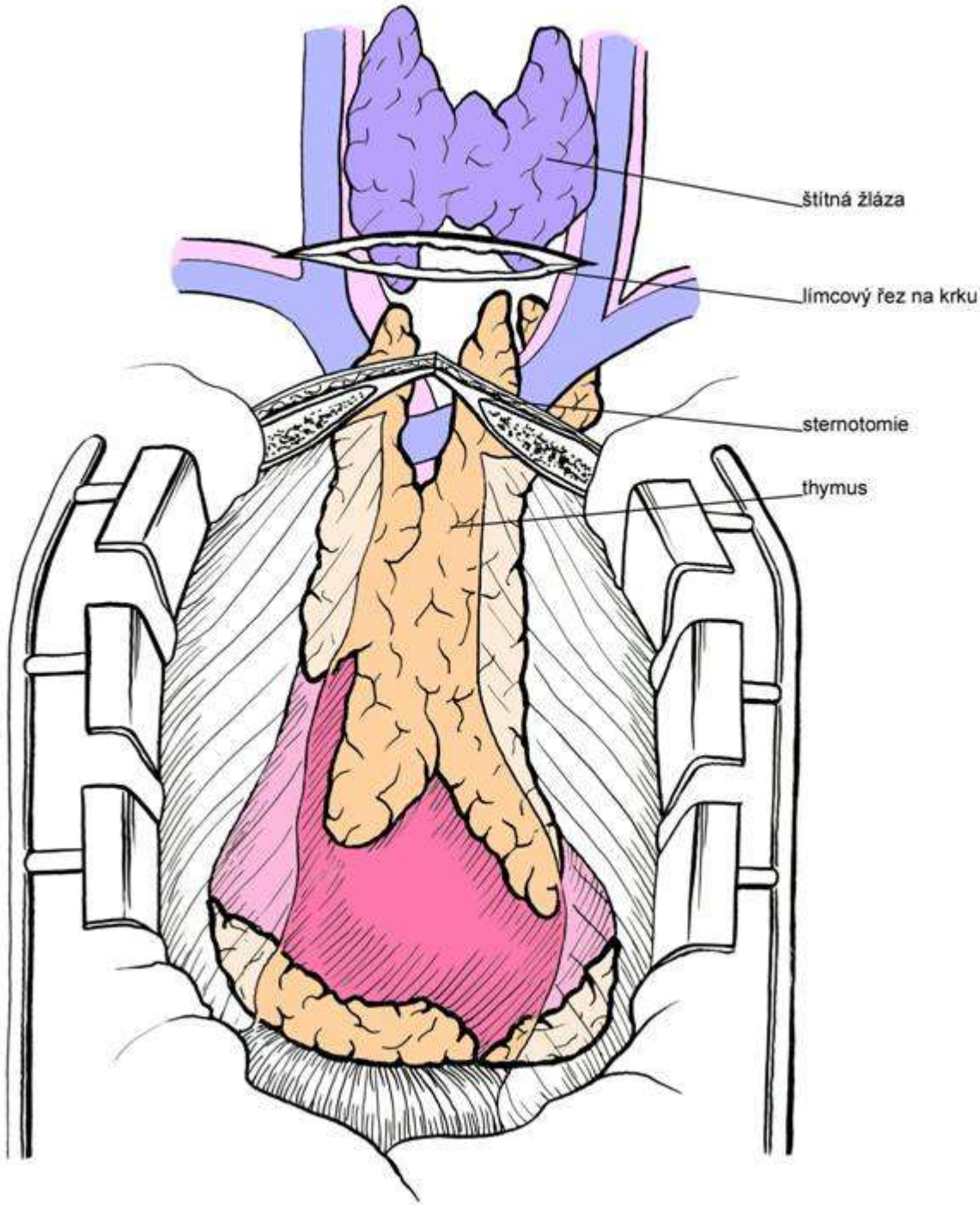
Development of thymus

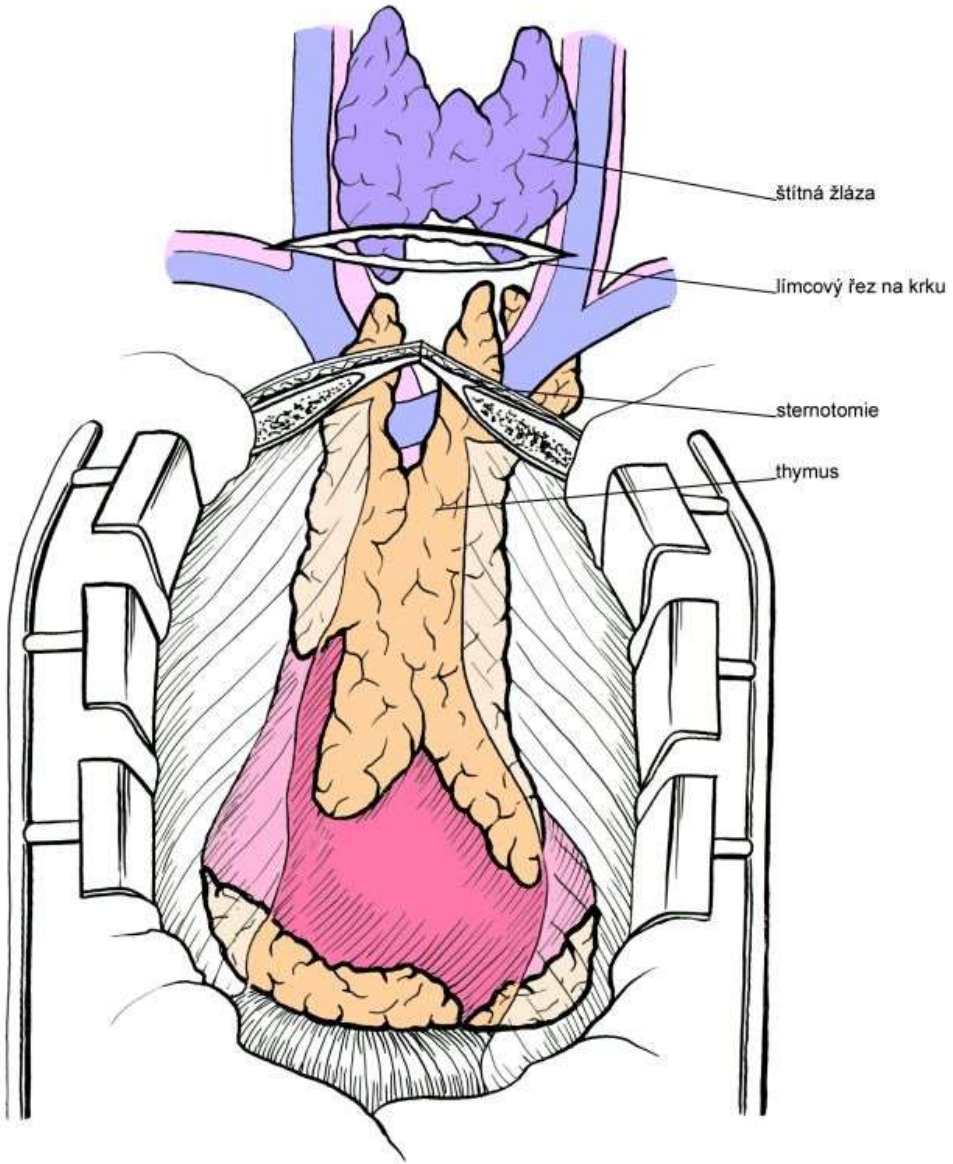
- ventral process of the 3rd branchial pouch
- mediocaudal descensus
- endodermal proliferation
- stem cell colonization in the 10th week /lymphocytes derived from blood island, liver, bone marow
- ingrowth of the mesenchymal septa (fibrous tissue)

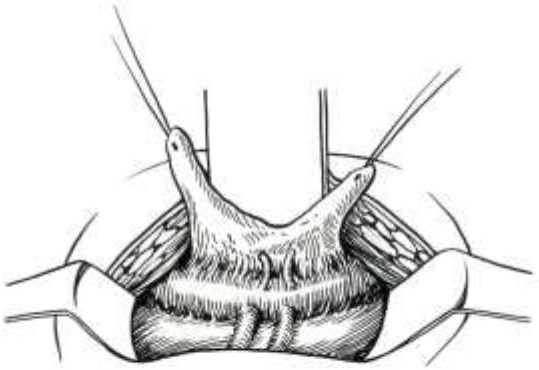


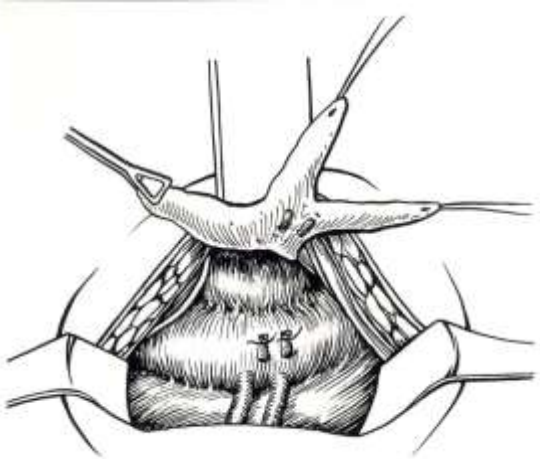
Parathyroid tissue in the mediastinum can be everywhere thymus could be including mediastinal fat

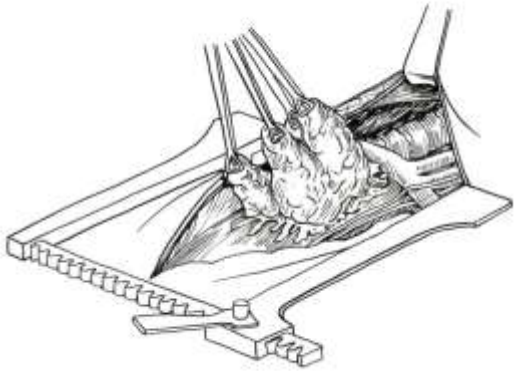
Residual thymus tissue after standard thymectomy, based upon 50 clinico-anatomical studies

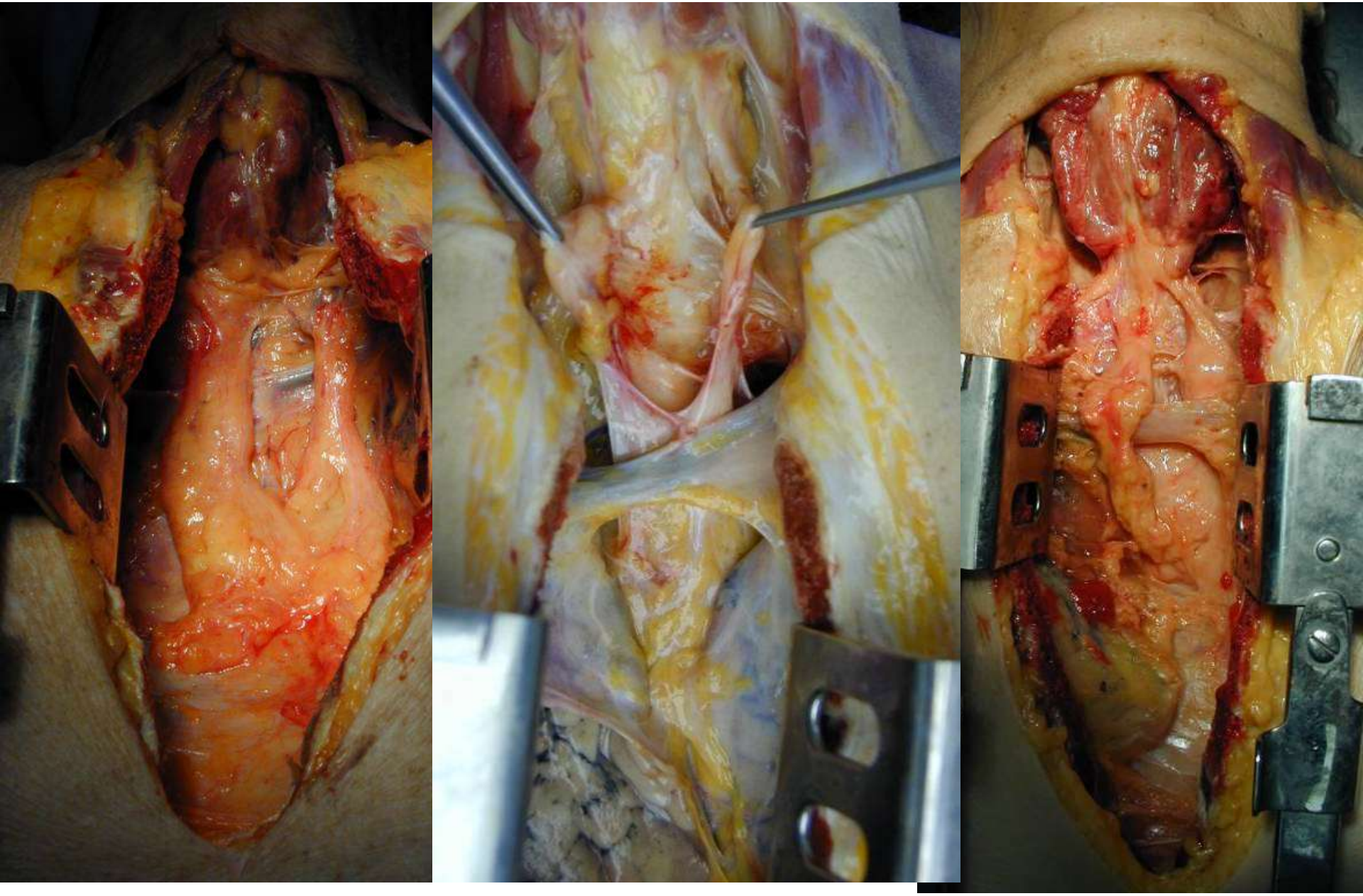



štítná žláza
límcový řez na krku
sternotomie
thymus

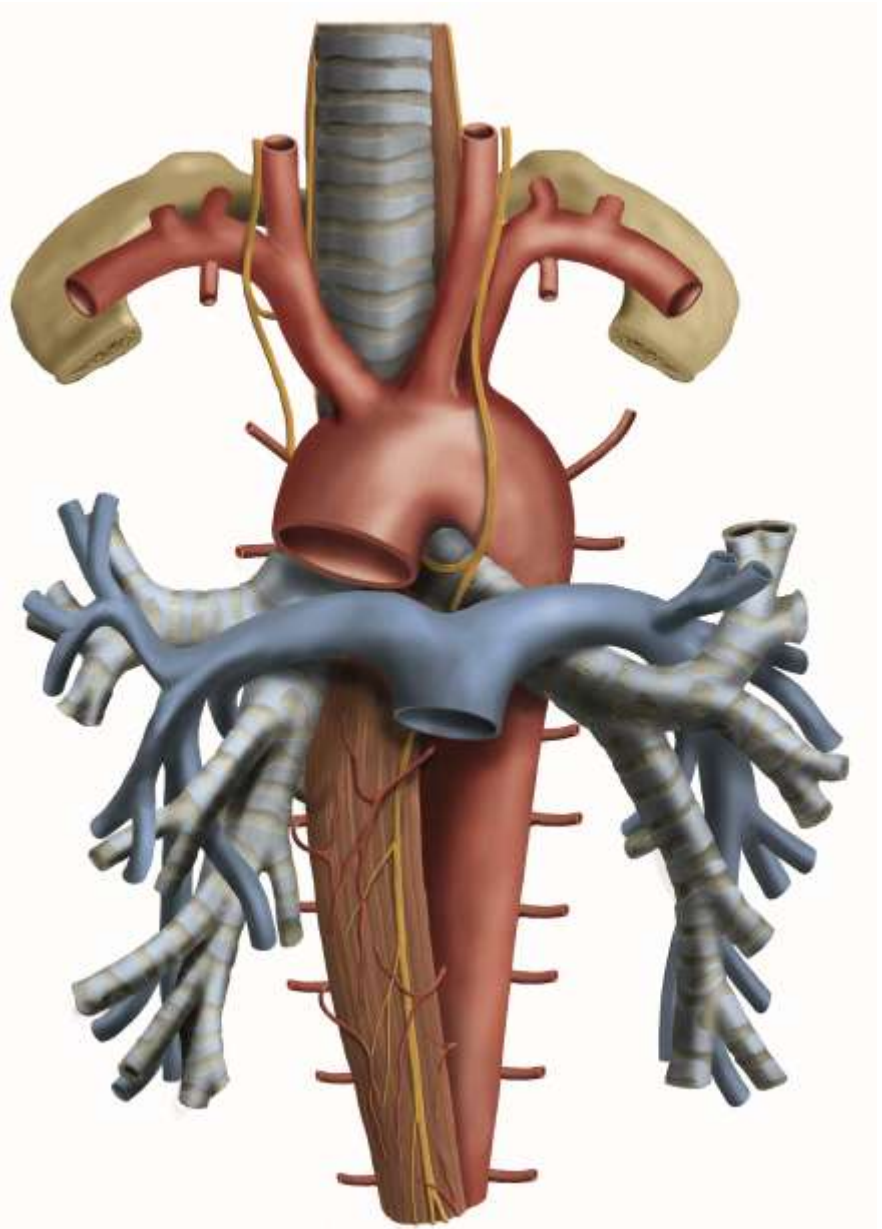


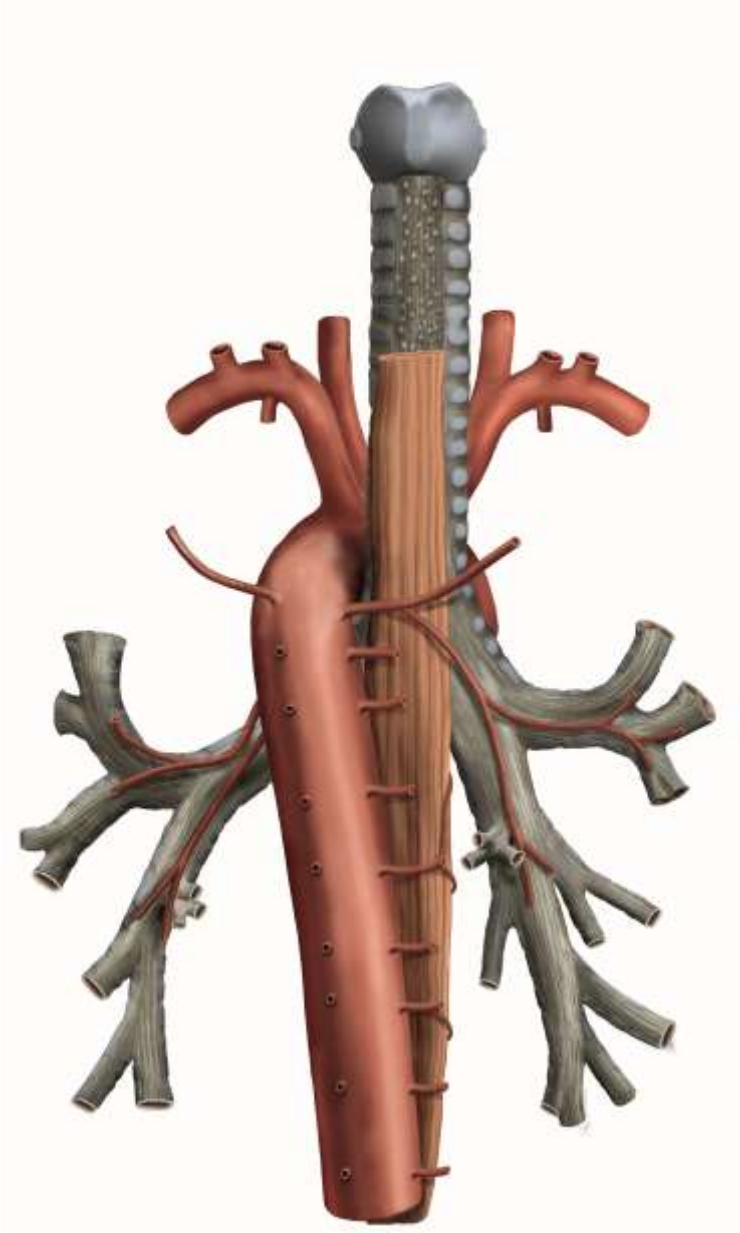






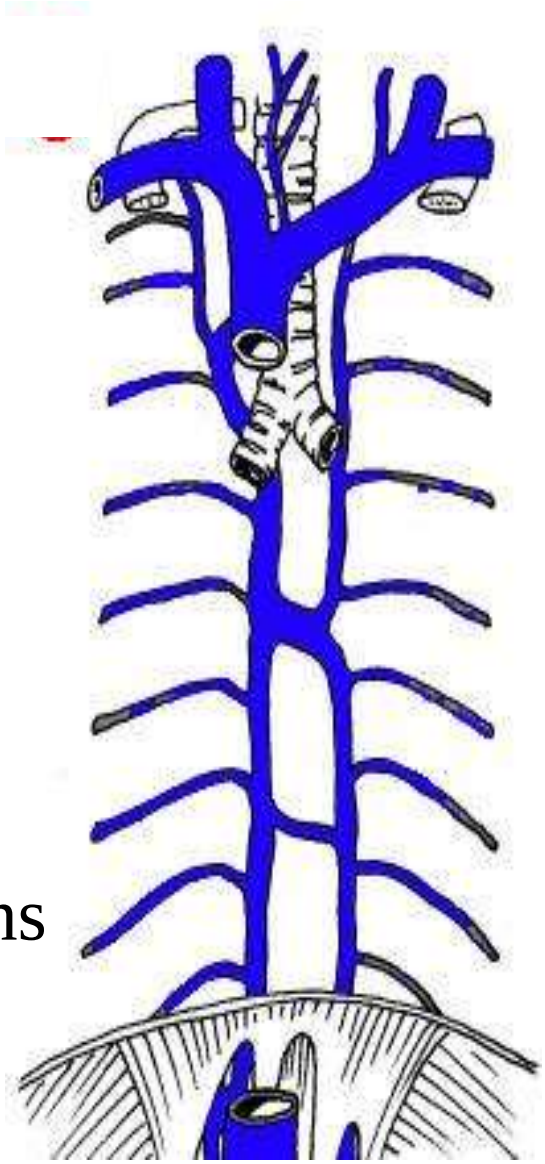
THORACIC AORTA

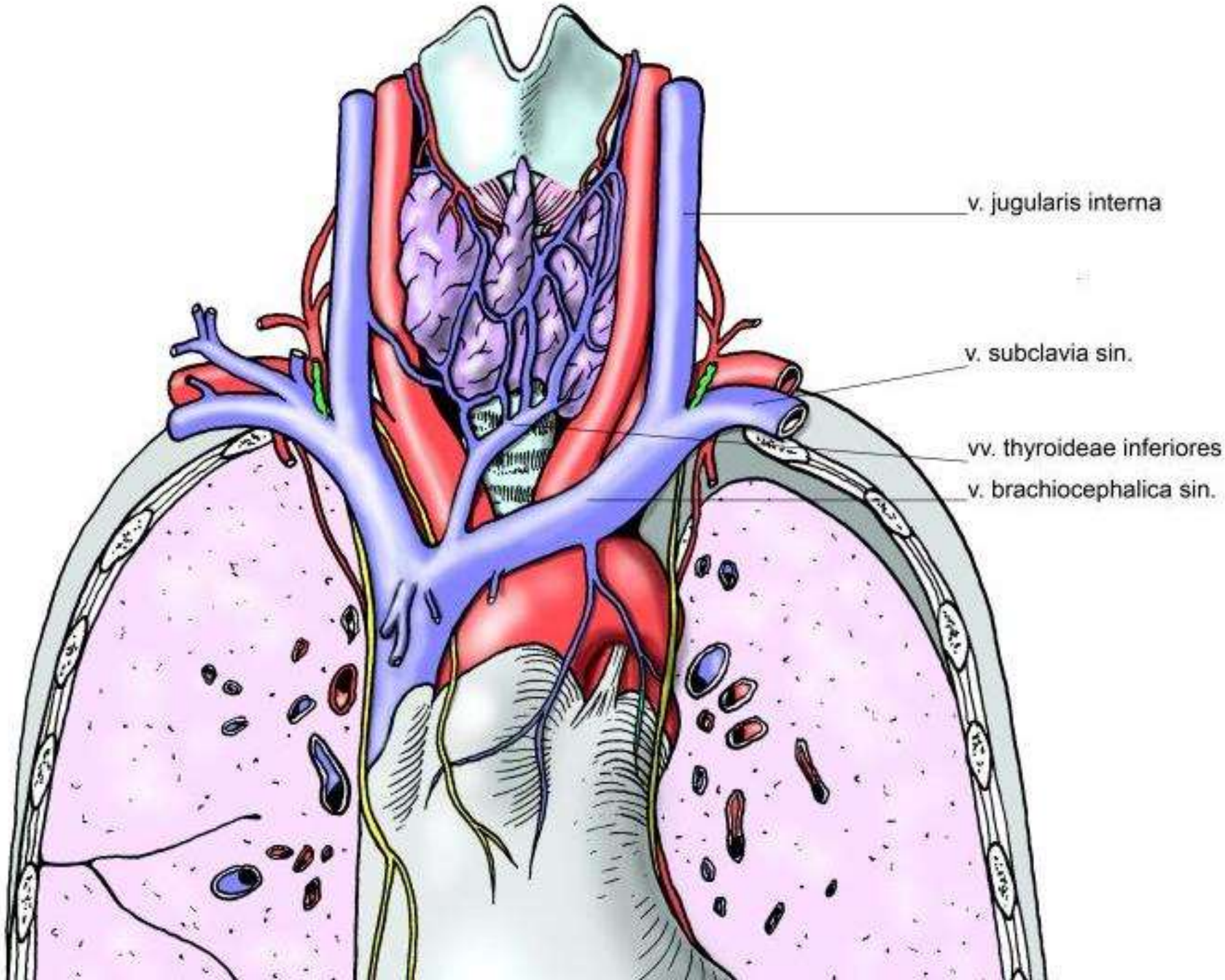


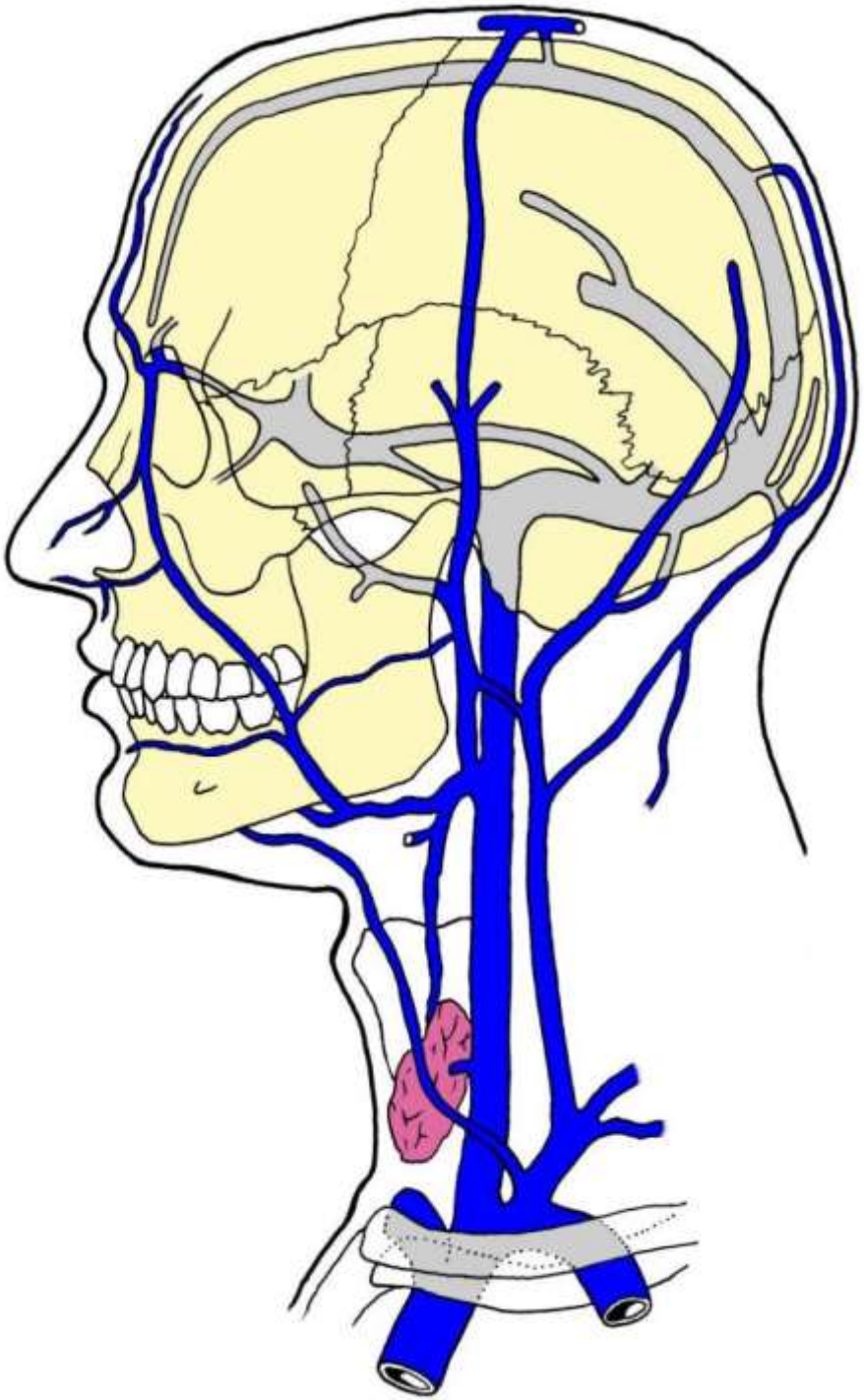


SUPERIOR VENA CAVA

- Formed by the confluence of the brachiocephalic veins
- tributaries:
  - v. thyroidea inf.
  - v. vertebralis
  - v. intercostalis suprema, intercosalis sup. sin.
- v. azygos
- v. thoracica interna
- Visceral branches of the mediastinal organs




v. jugularis interna
v. subclavia sin.
vv. thyroideae inferiores
v. brachiocephalica sin.



Cranial tributaries of the superior vena cava

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