Introduction to the Lymphatic System



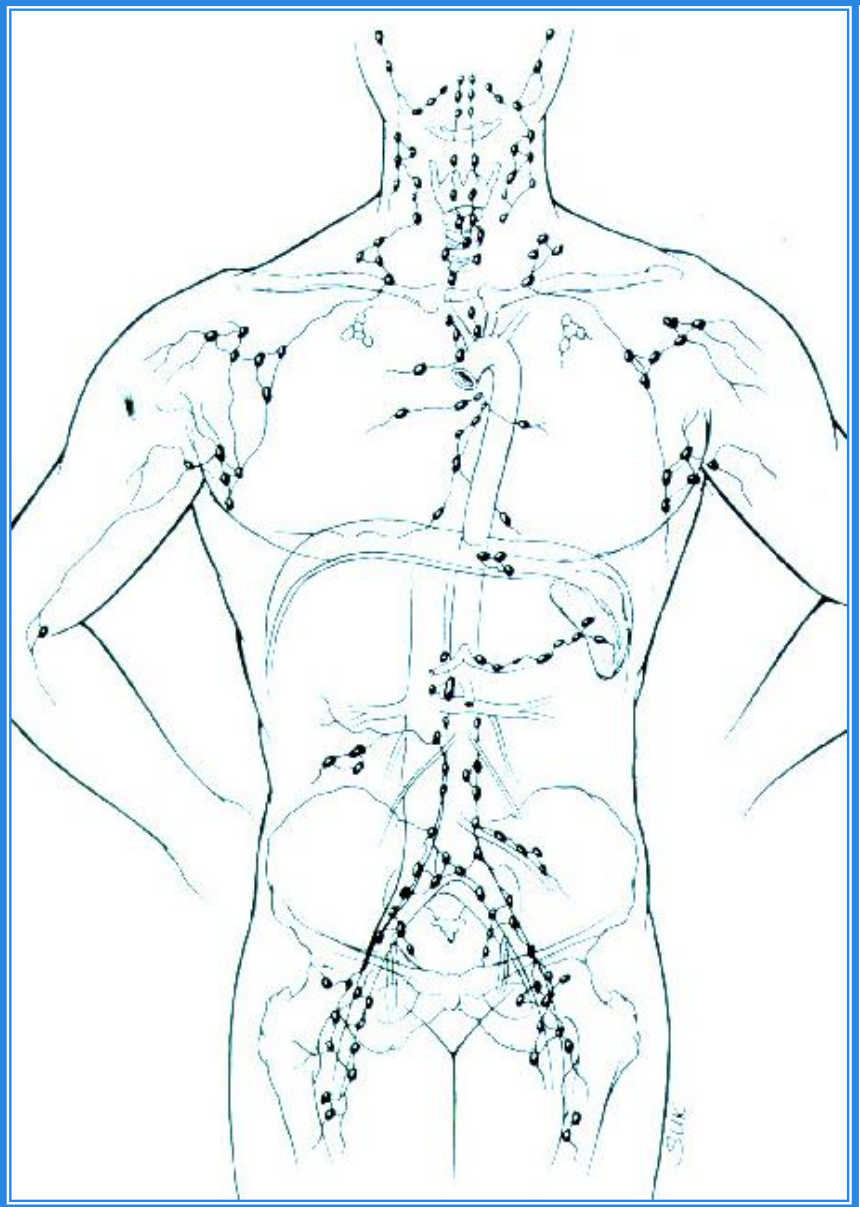
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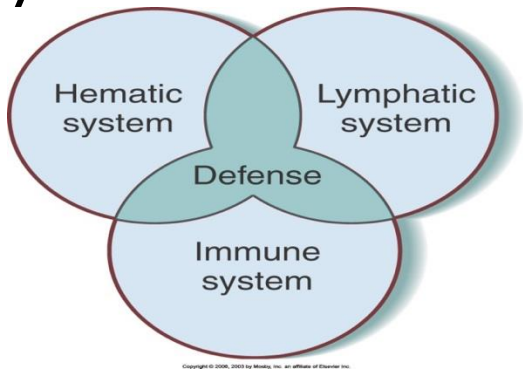
Lymphatic System - Function



- Drains tissue spaces of <u>interstitial fluids</u> back into the bloodstream maintaining fluid levels

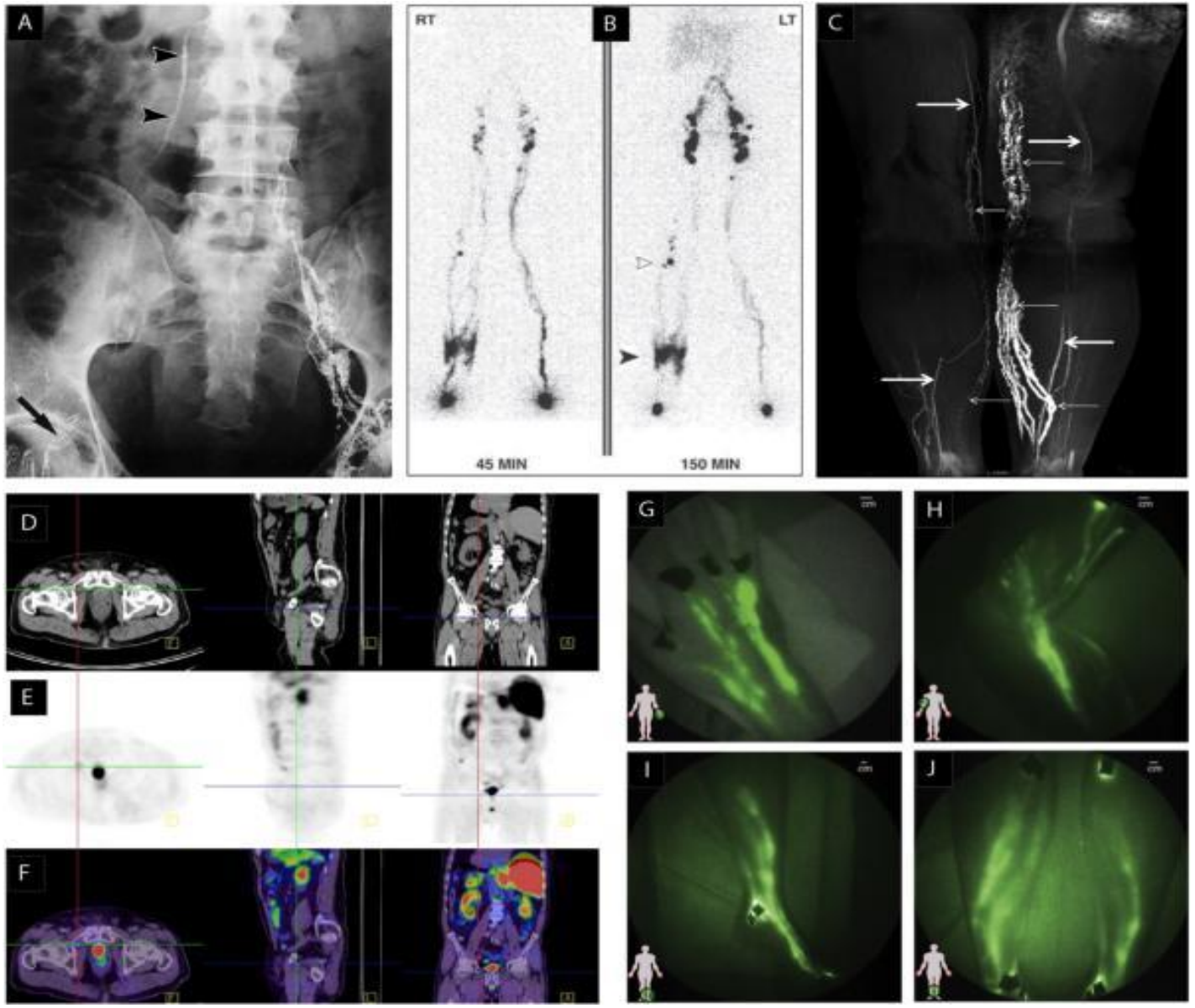
- Absorbs fats and transports it to the bloodstream (lesser function)

- Major role in body defense and immunity



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Lymphatic System - Visualization

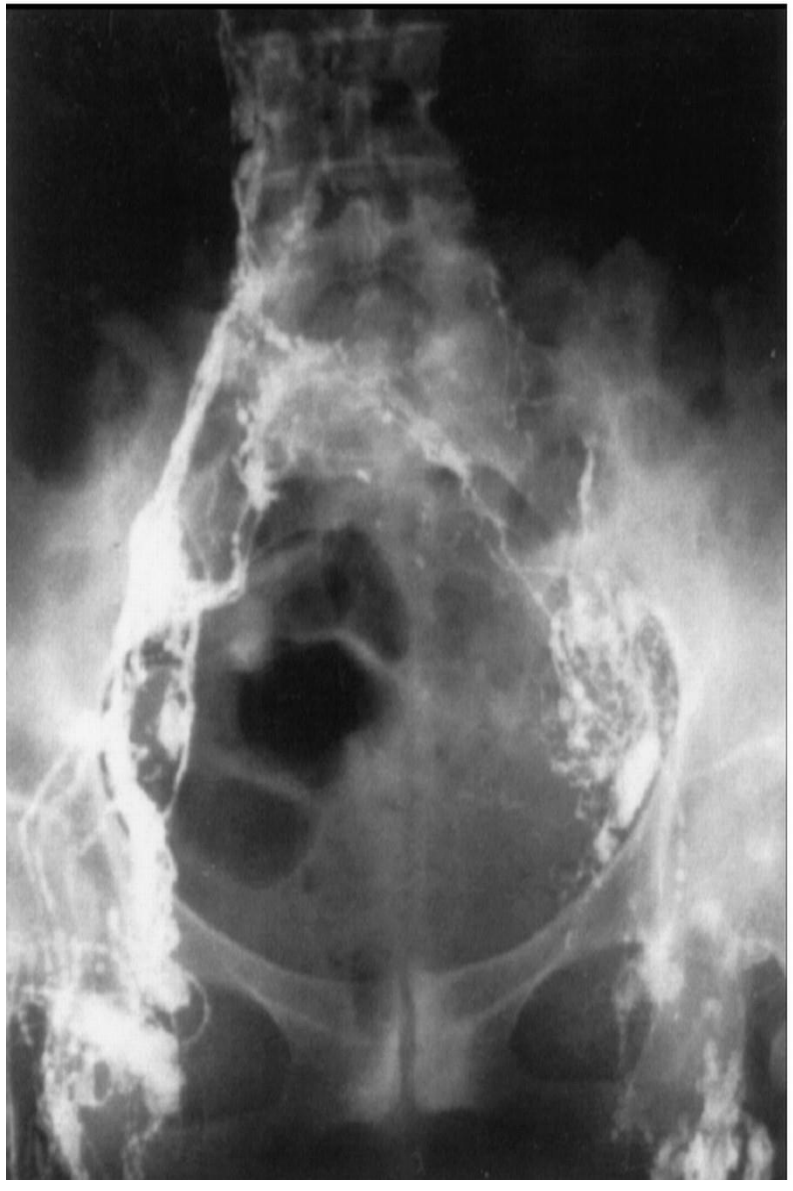


- Lymphography (A)
- Lymphoscintigraphy (B)
- Magnetic Resonance Lymphography (MRL) (C)
- Contrast-enhanced Ultrasound
- PET/CT (D-F)
- Near-infared (NIR) Fluorescence Imaging (G-J)

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4268344/

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Lymphatic System – Filling/Imaging

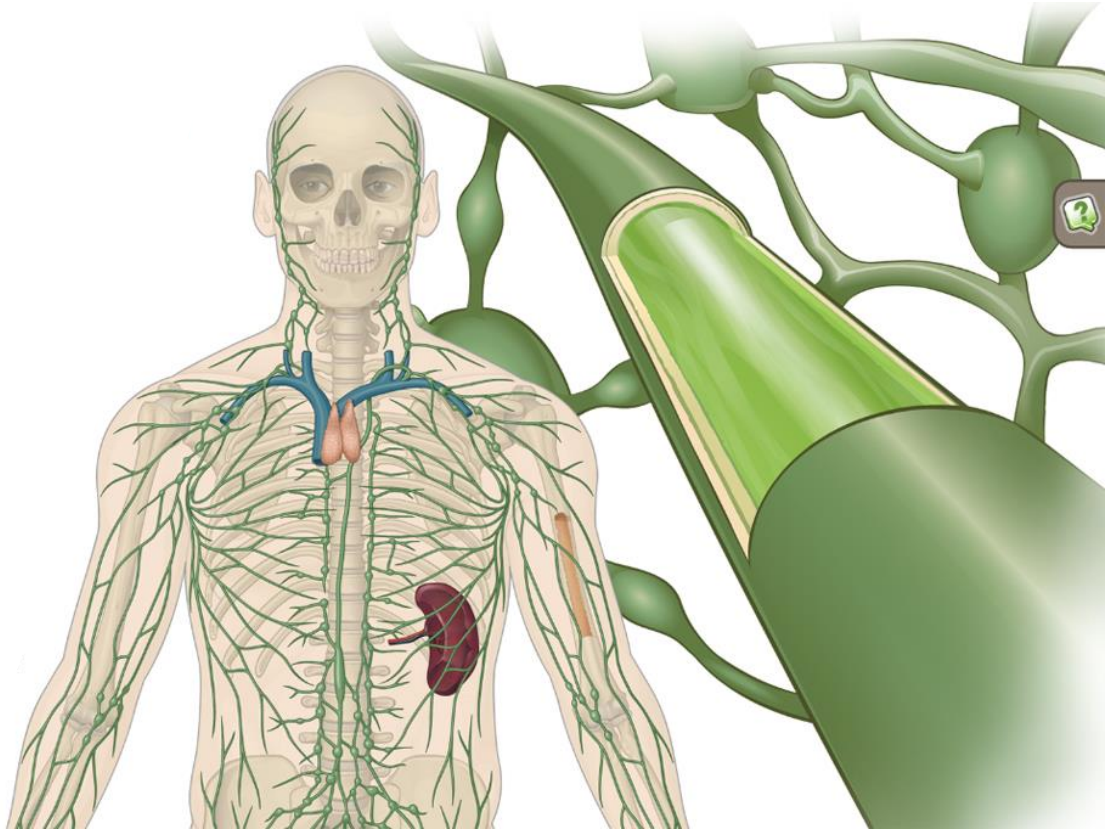




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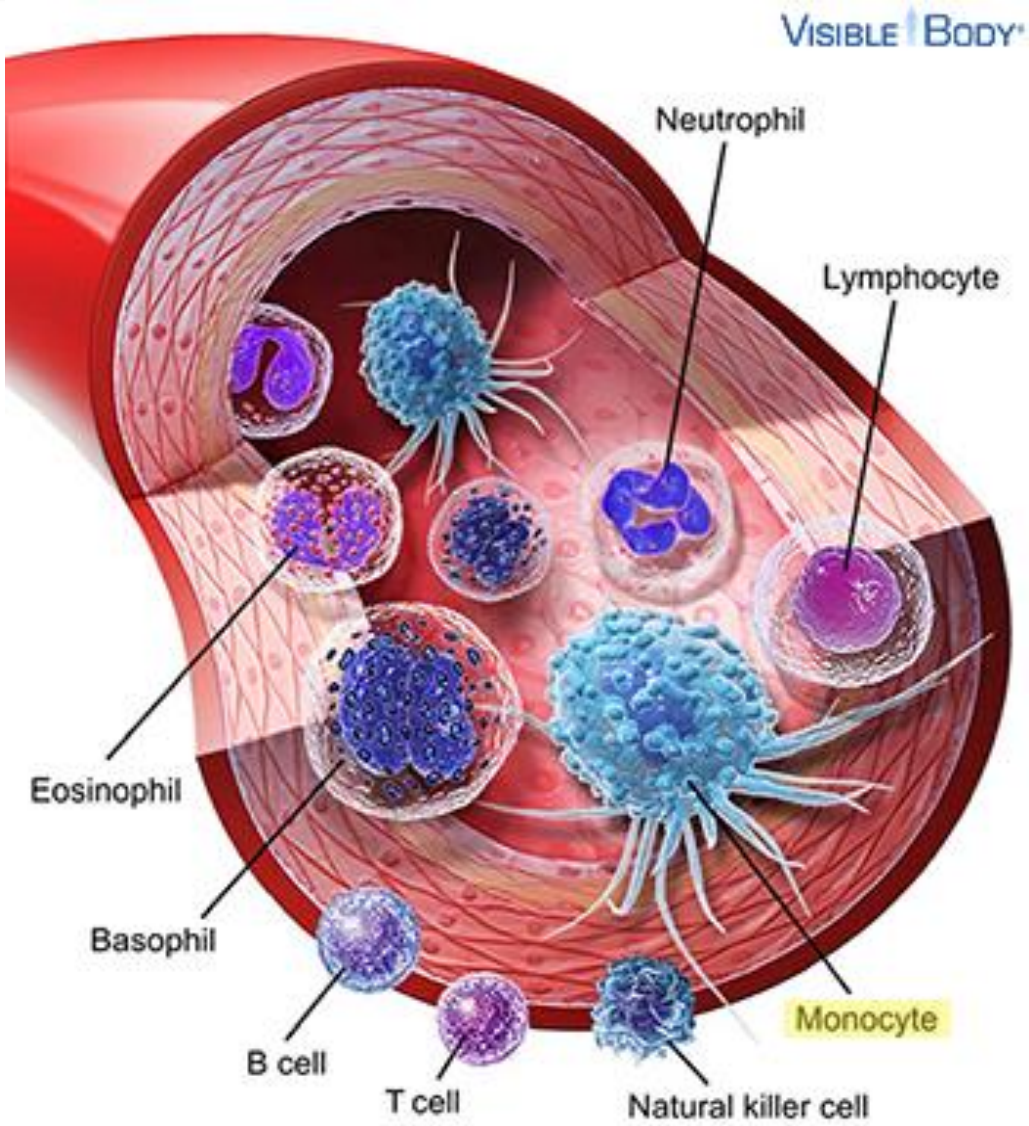
Lymphatic System Components

- Lymph
- Lymph capillaries
- Afferent lymphatic vessels
- Lymph Nodes
- Efferent lymphatic vessels
- Lymphatic trunks/ducts
- Lymphatic organs and tissues



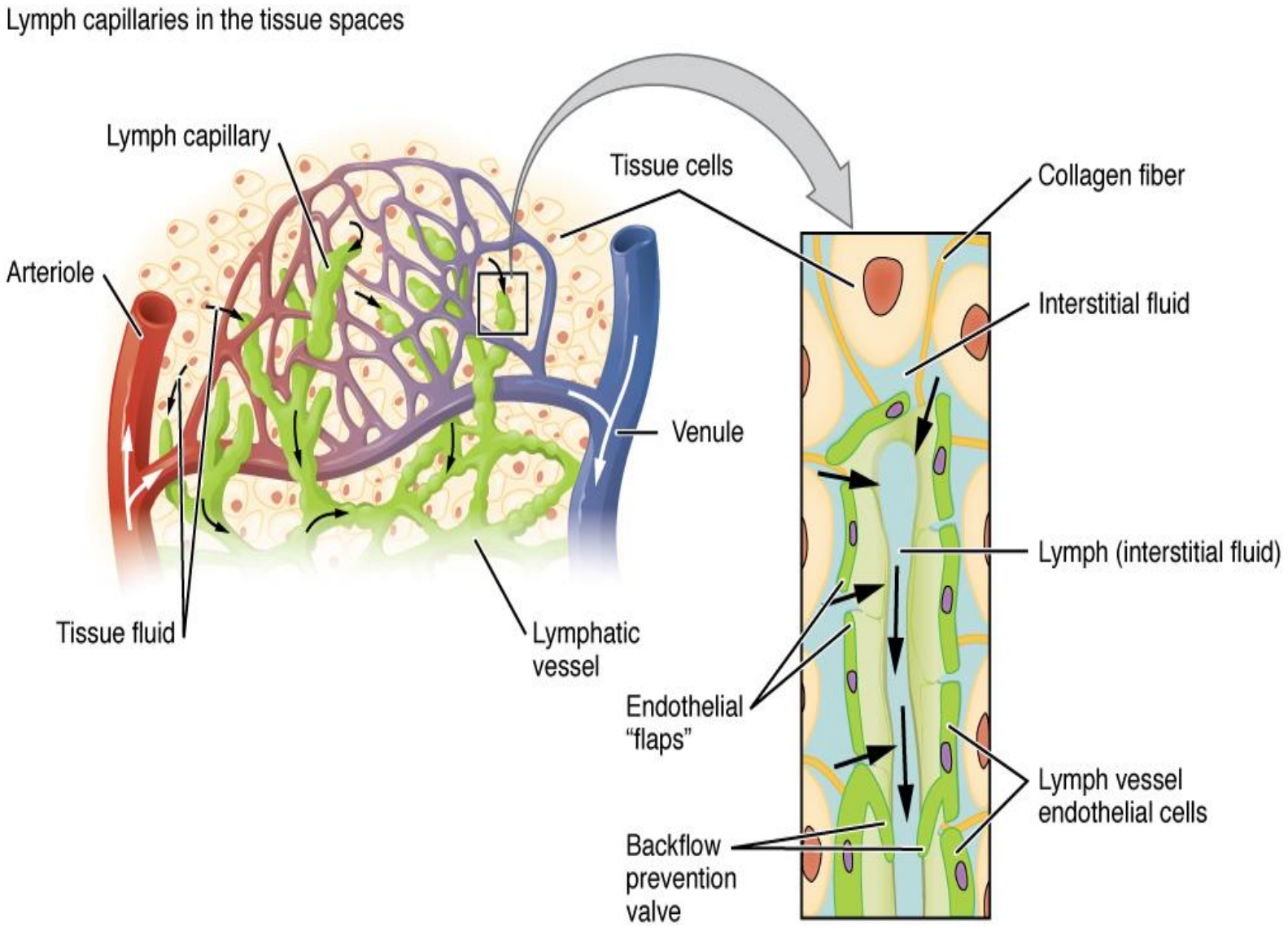
Lymphatic System Cells

- Lymphocytes- (WBC's)
- Lymphocytes are one of the most radiosensitive cells in the body:
  - **T-cells**
    - **fight off infection**
  - **B-cells**
    - **send in anti-bodies**

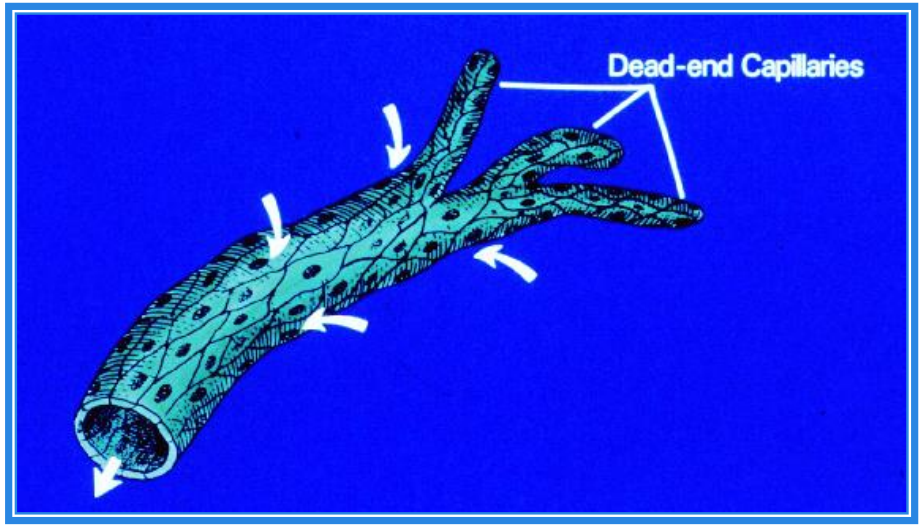


https://www.visiblebody.com/learn/lymphatic/glossary

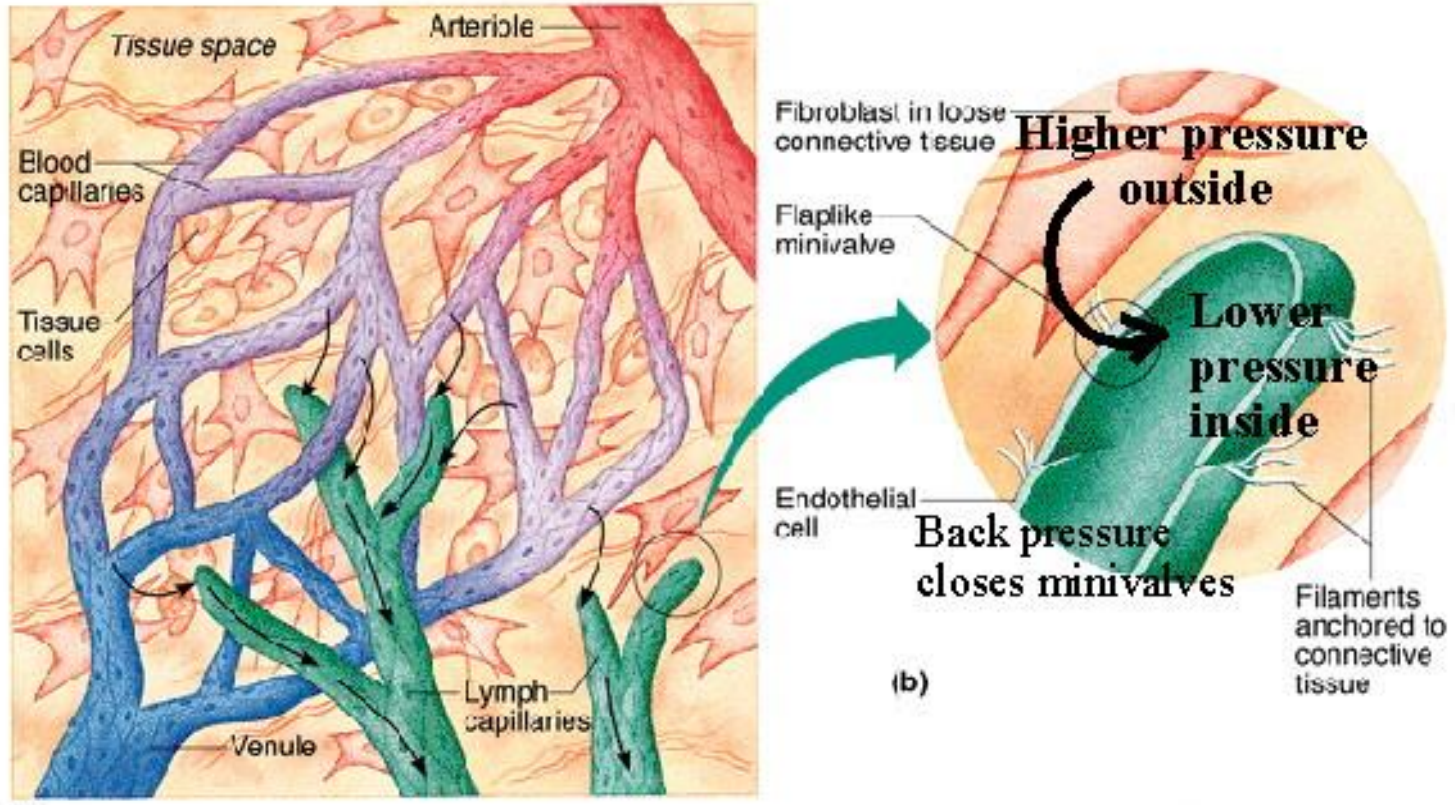
Lymphatic Capillaries



- Start blindly in interstitial spaces
- More permeable than blood capillaries
- Flows in one direction



Lymphatic One-way Flow



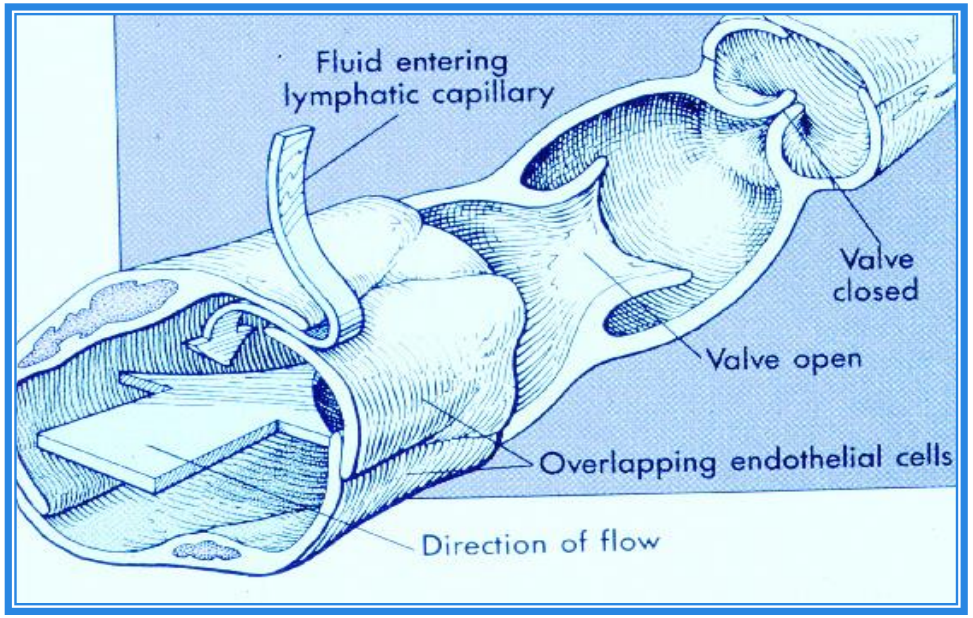
Lymphokinetic Motion and Pressure Gradient

Blood capillaries → Interstitial Fluid → Lymph capillaries → Lymph veins → Lymph ducts → Large circ. Veins

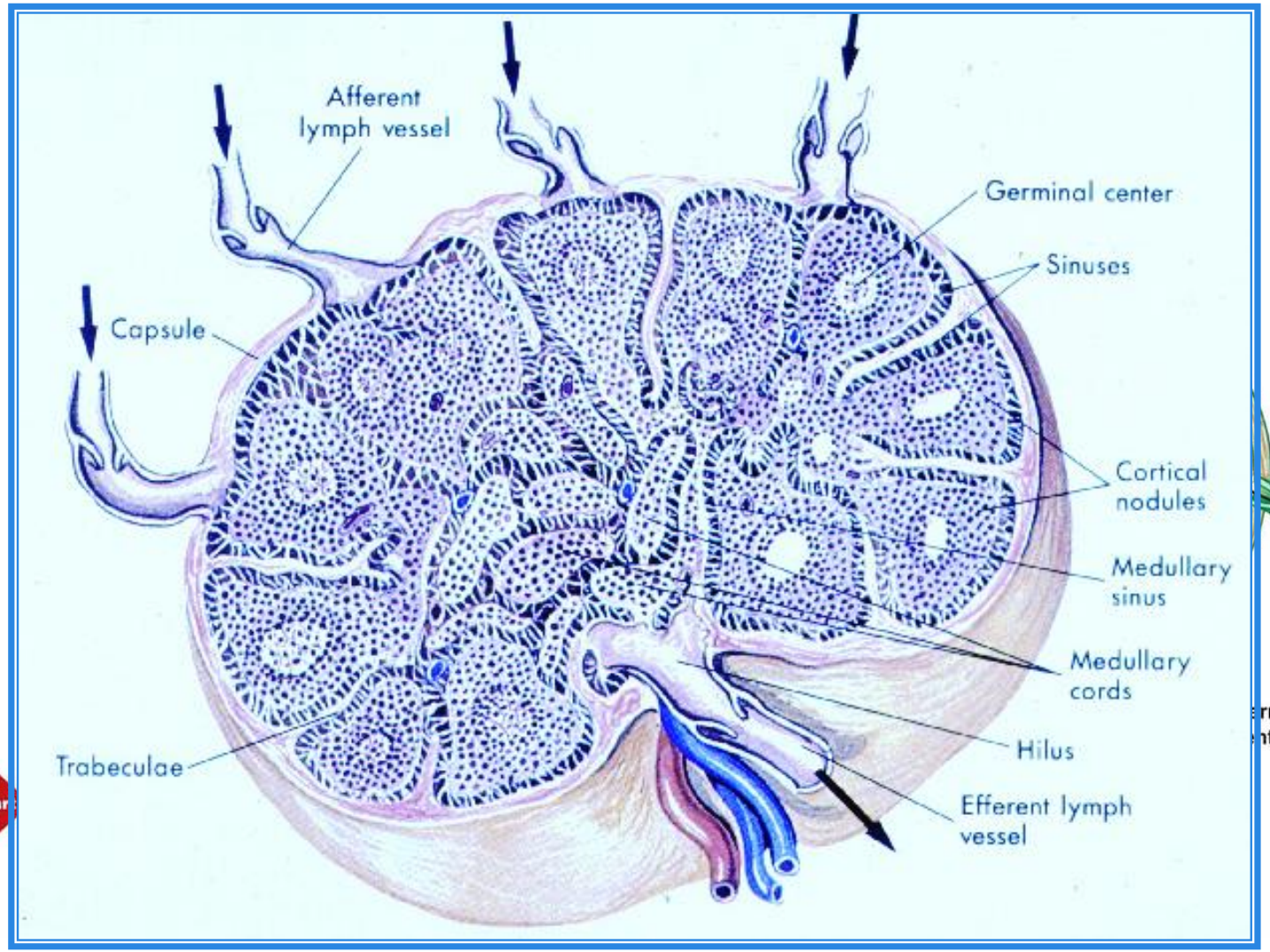
Highest pressure

Lowest pressure

- Movement of lymph depends on hydrostatic and osmotic pressures
  - facilitated by muscular contractions and gravity
- One-way flow due to valves located within the vessels



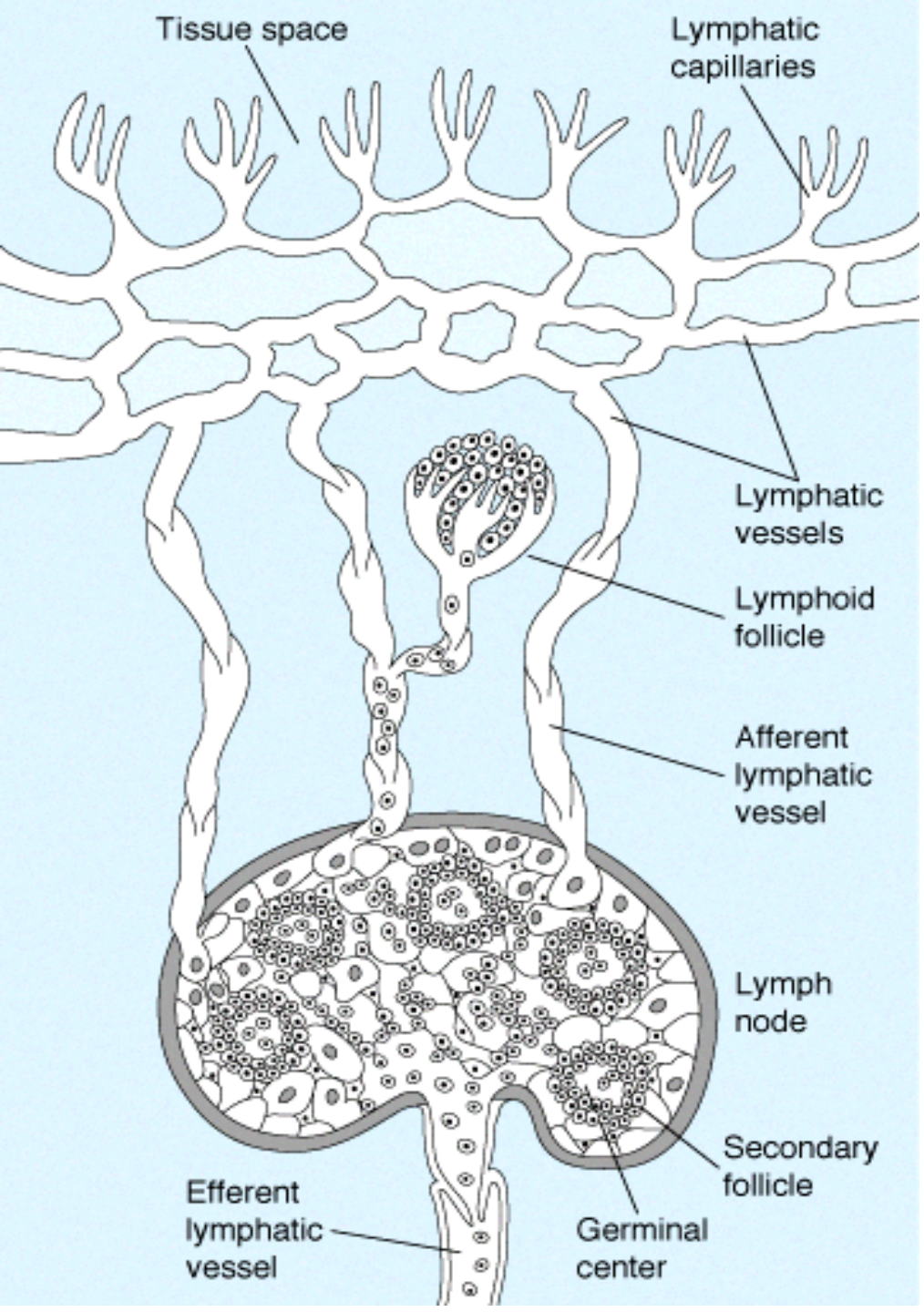
Lymph Nodes



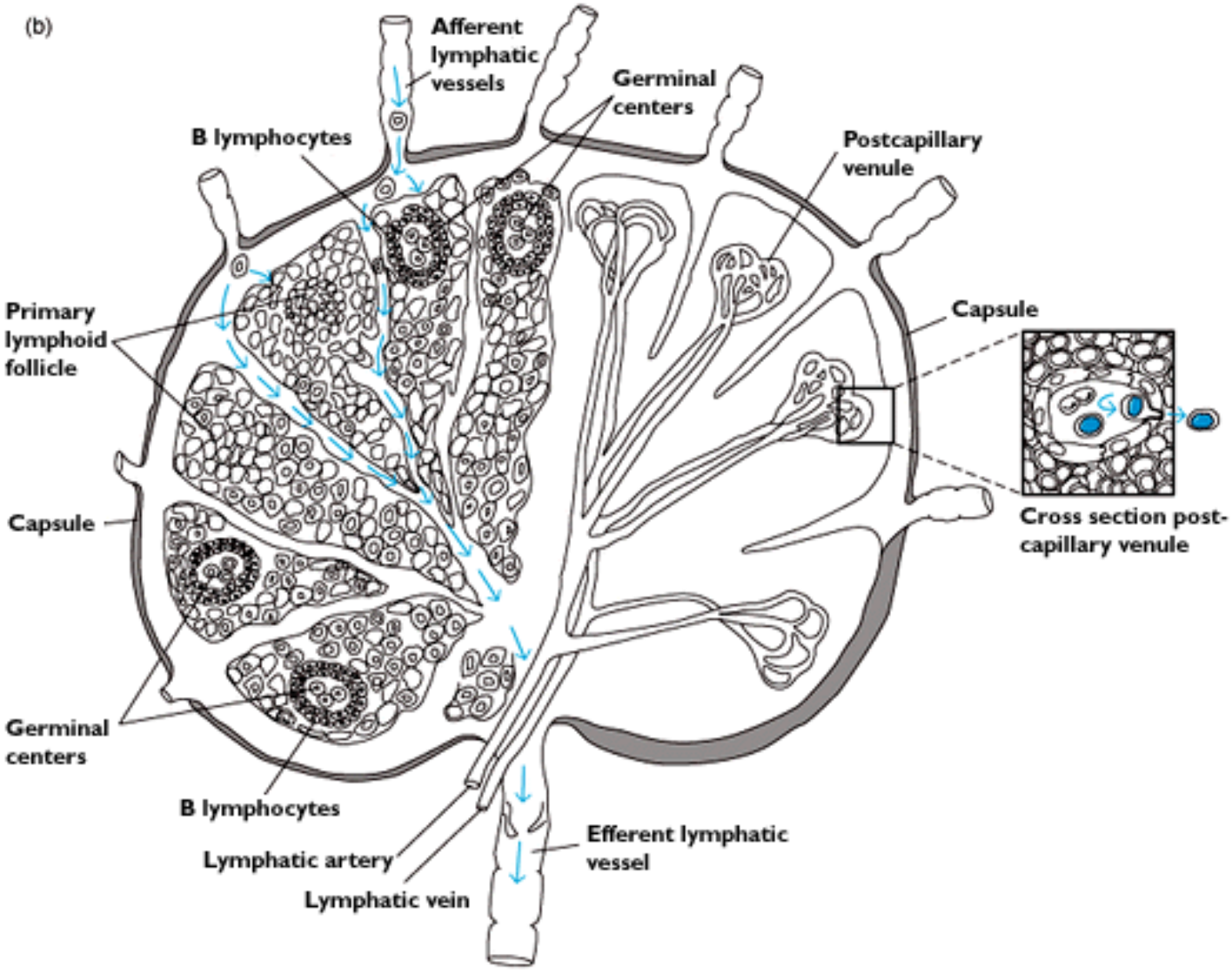
https://nurseslabs.com/lymphatic-system-anatomy-physiology/

- More afferent than efferent vessels
- Fluid slows down in the node
- Lymphocytes can breakdown items in lymph
- As fluid exits, it flows to another node for further filtration

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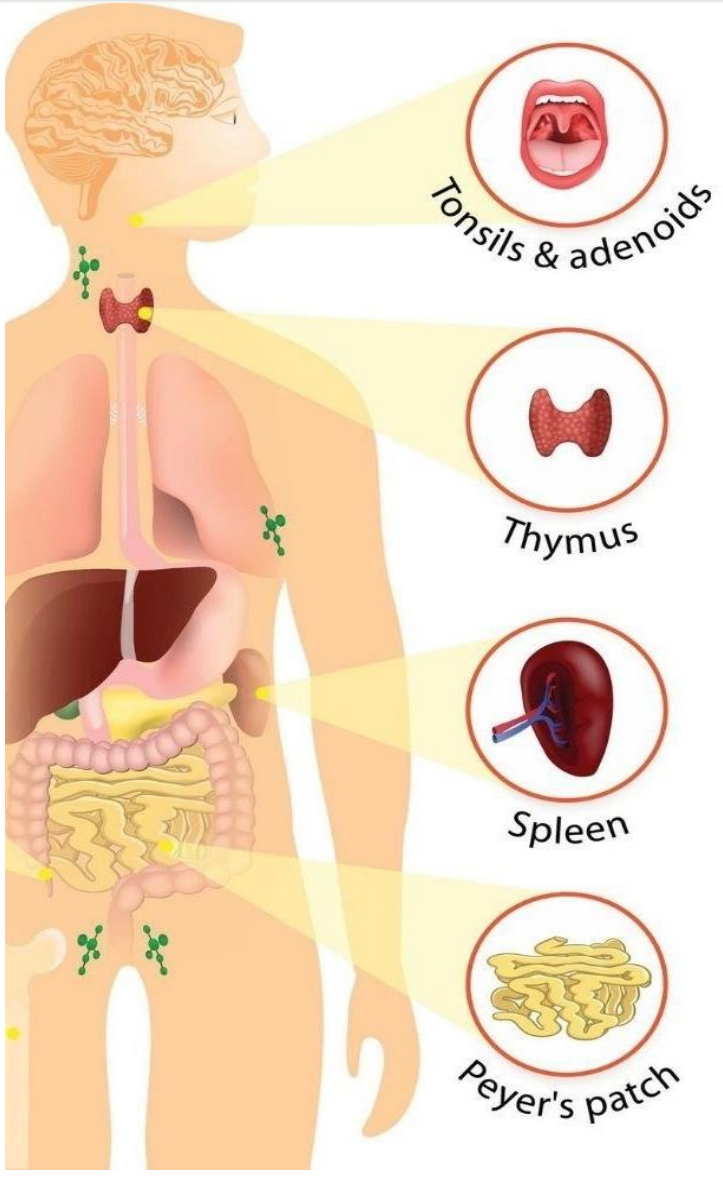


Lymph Node Architecture



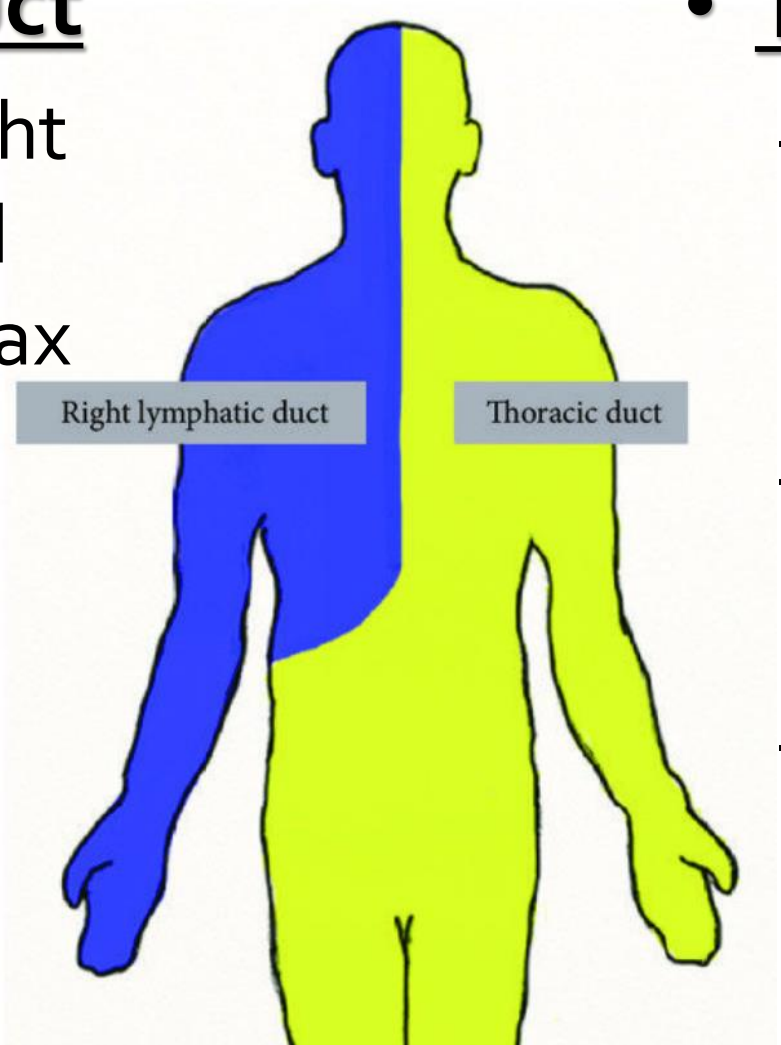
Lymphatic Organs

- Spleen
  - filters blood and manufactures B-lymphocytes that are active in antibody production
- Thymus
  - a gland located in front of the heart; it produces immature T-cells that, when mature, are involved in immune system responses
  - pediatric immunity
- Tonsils
  - palatinine in the lateral oropharynx
  - pharyngeal (adenoids) in the nasopharynx
  - lingual at the base of the tongue in the oropharynx



Lymphatic Ducts

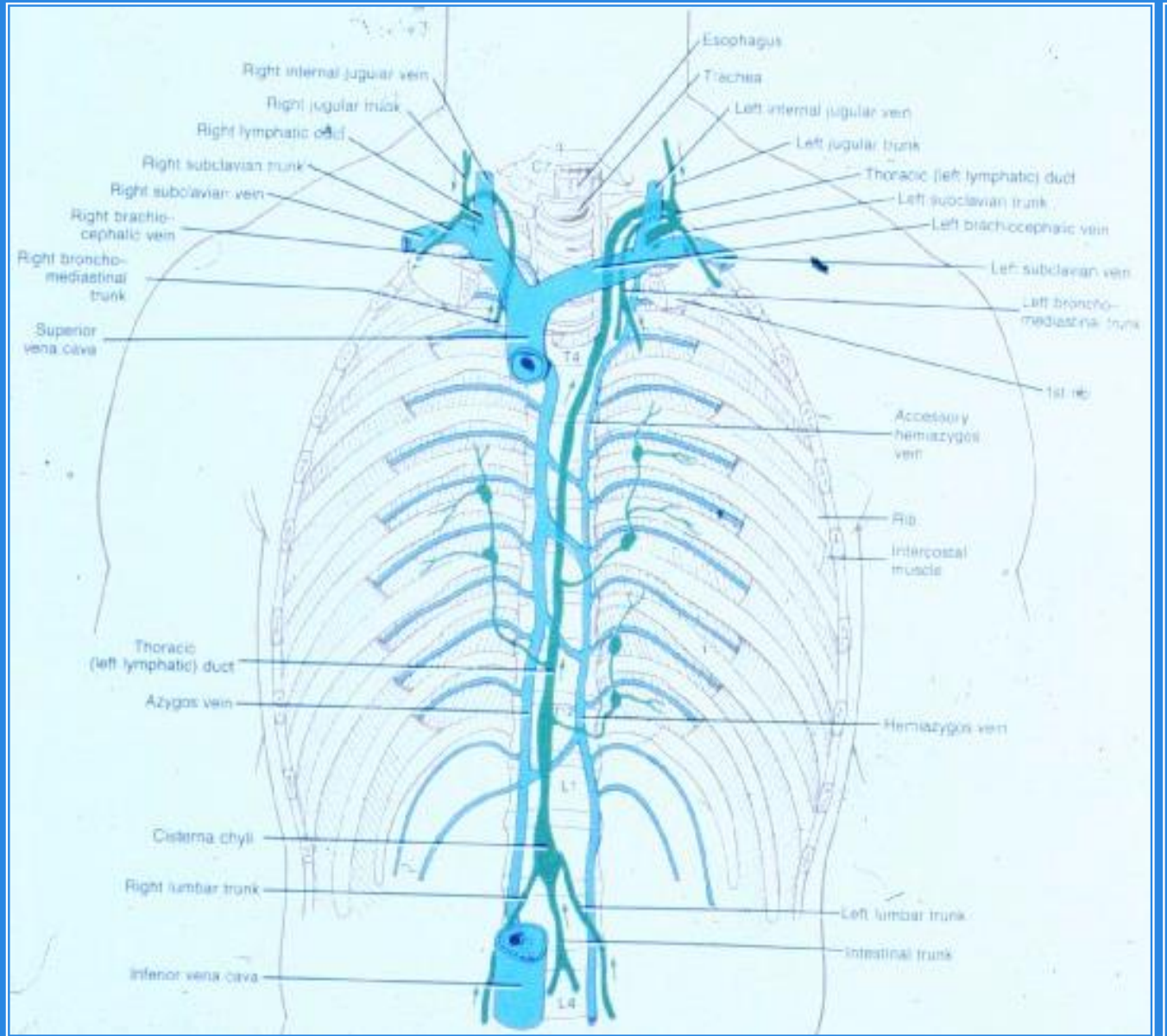
- **Right lymphatic duct**
  - drains right arm, right side of the head and neck, and right thorax
  - drains into the right subclavian vein

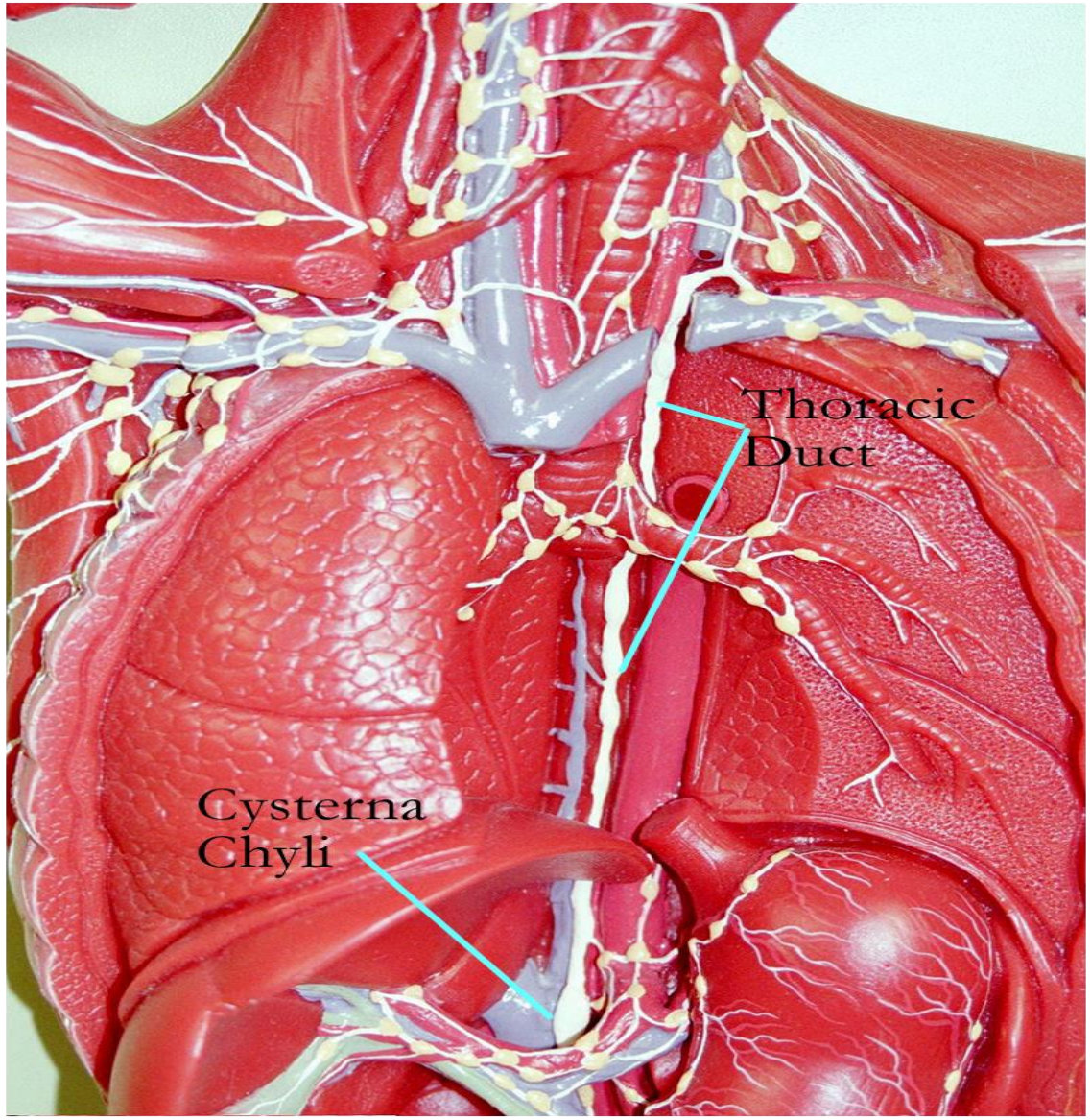


- **Thoracic duct**
  - drains the lower extremities, pelvis, and abdomen via the cysterna chyli
  - drains the left arm, left thorax, and left side of the head and neck
  - drains into the left subclavian vein

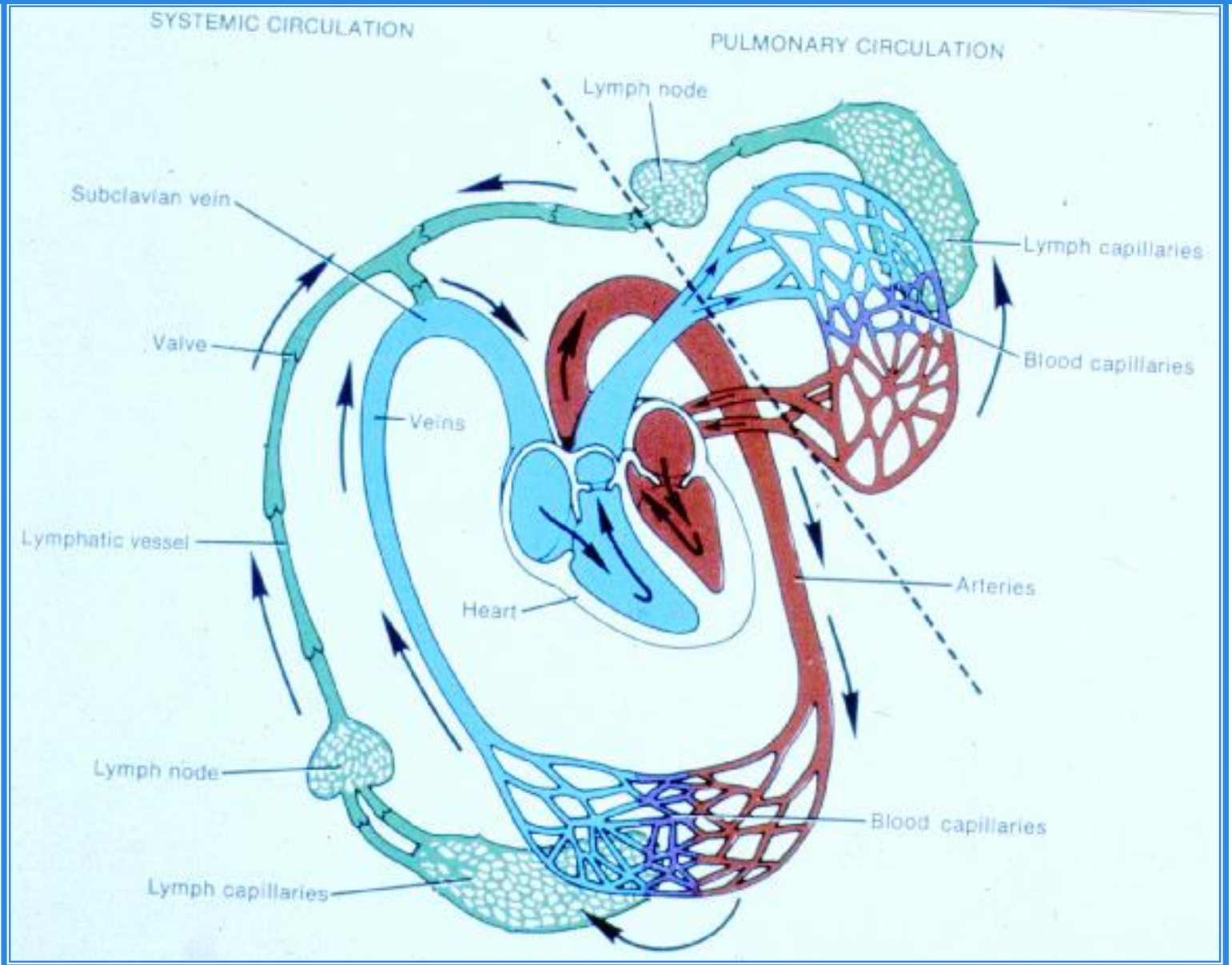
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Thoracic Duct





Lymphatic Circulation



LYMPHATIC CAPPILLARY

↓

LYMPHATIC VESSEL

↓

LYMPHATIC NODE

↓

LYMPHATIC VESSEL

↓

LYMPHATIC TRUNK

↓

SUBCLAVIAN VEIN

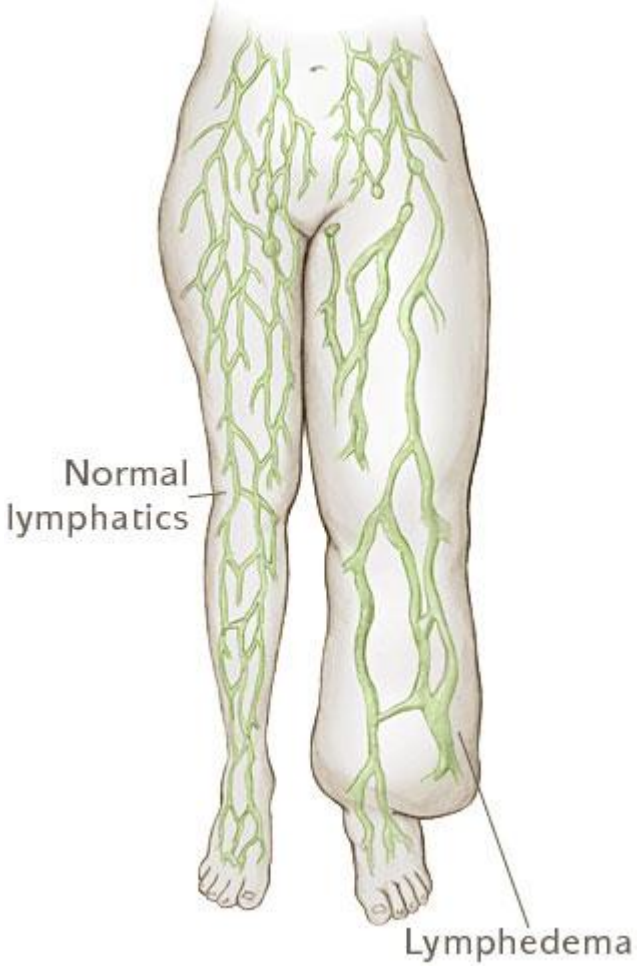
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Lymphatic Flow vs. Circulatory Flow

Topic	Circulatory System	Lymphatic System
How does the fluid flow around the system?	Flows in a **closed continuous loop** through arteries, capillaries & veins. Blood is pumped by the **heart**. **Muscles in veins** assist in movement. **Valves** prevent backflow in veins	Flows in an **open circuit** from tissues into **lymphatic vessels** to be deposited into **vena cava**. Lymph is **not pumped**. **Muscles in vessels** assist movement. **Valves** prevent backflow in larger lymphatic vessels.

- **Blood vessels**
  - Thicker walls
  - Valves
  - Closed system
  - No lymph nodes
  - Heart facilitates the flow
- **Lymph vessels**
  - Thin walled
  - More valves
  - Begin blindly
  - Lymph nodes
  - No pump; muscles facilitate flow

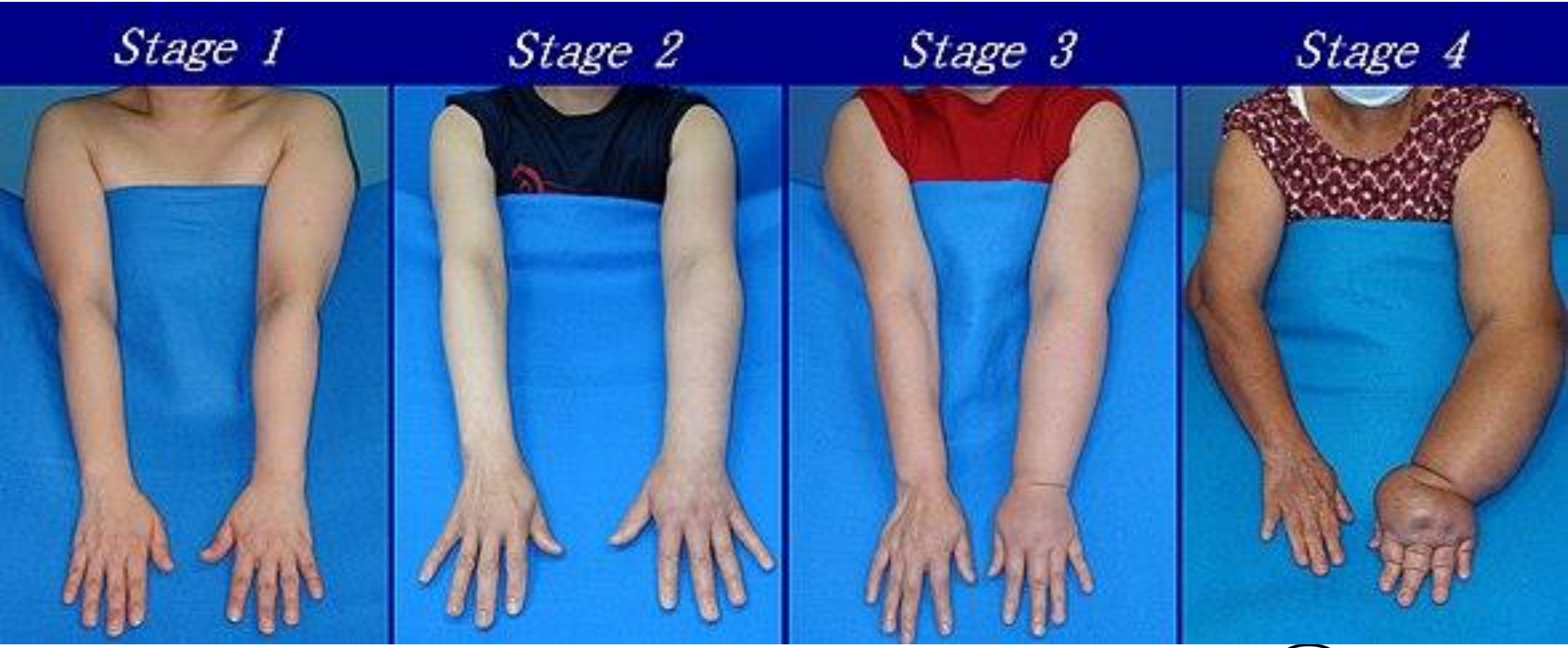
Lymphedema





- Excessive accumulation of fluid in tissue
- Due to blockage of protein and lymph fluid return
- Tumor
- Surgery
  - Removal of axillary lymph nodes in breast patients
- Radiation

Lymphedema



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Lymphedema Prevention

- In radiation therapy
  - When treating extremities always leave a strip of untreated tissue to prevent lymphedema
  - Massage therapy can be used to alleviate pain and prevent lymphedema

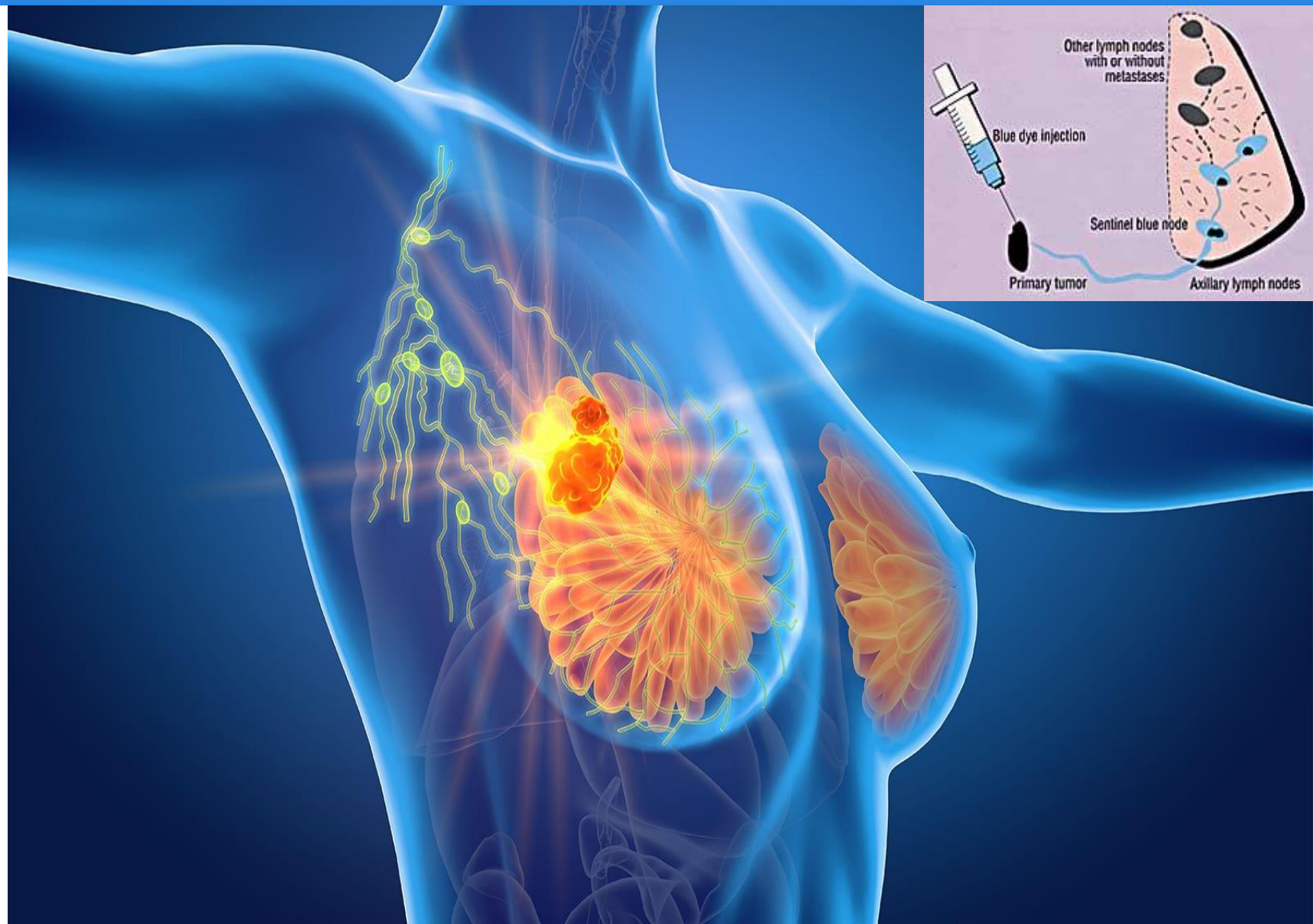




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Sentinel Lymph Node Mapping

- Determines precisely the site of lymphatic drainage in the axilla
- Surgeons can remove only infected nodes



Lymphomas

- Hodgkins disease
  - Two peak periods of presentation
    - Young adults 15-40
    - Older adults 55+
  - Spreads predictably
  - Does not frequently present in the extranodal site
  - Reed-Sternberg cells

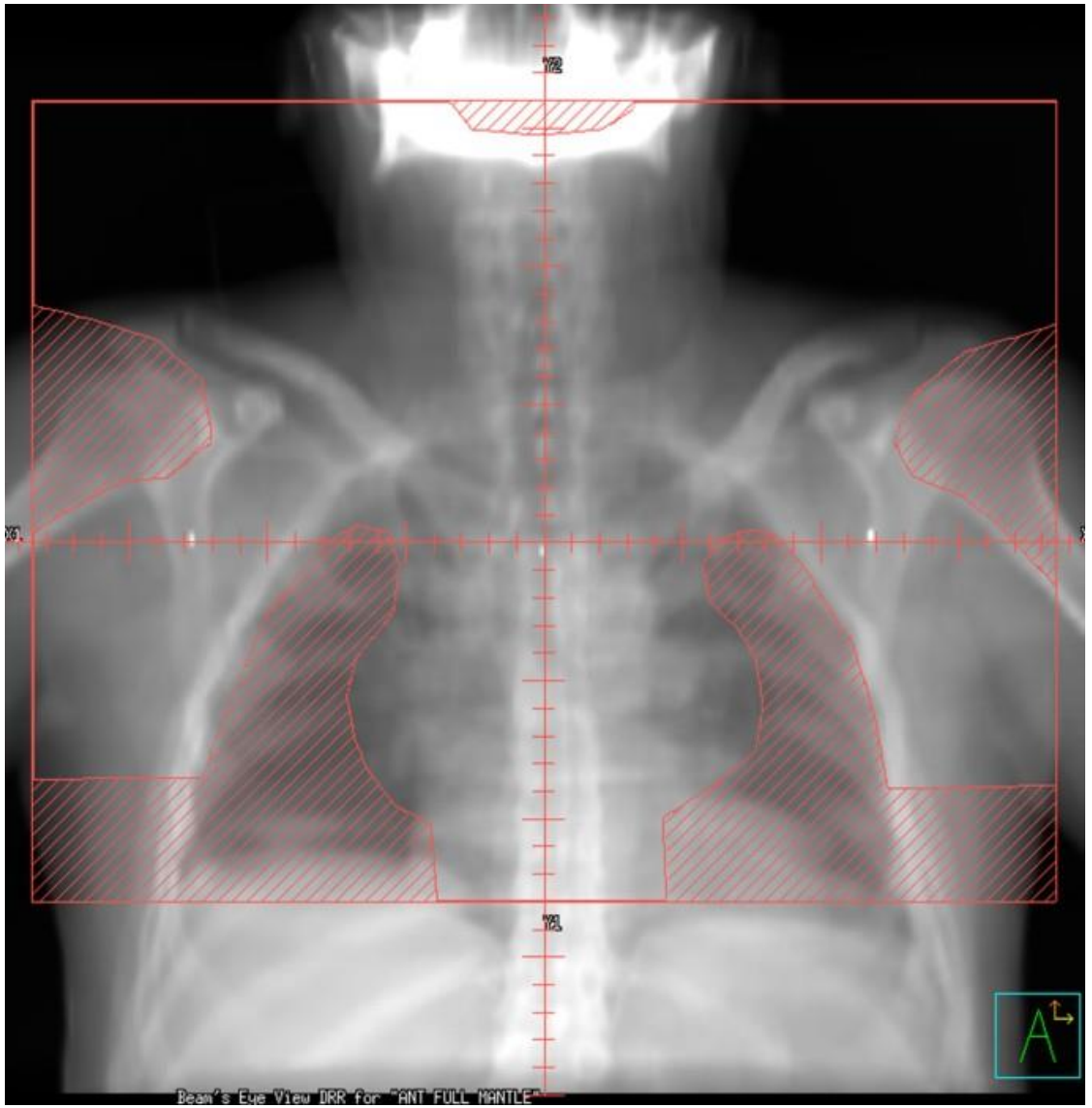


- Non-Hodgkins Lymphoma
  - Pts usually older
  - 95% 40-70 yrs of age
  - Can arise anywhere
  - Unpredictable spread
  - More men than women



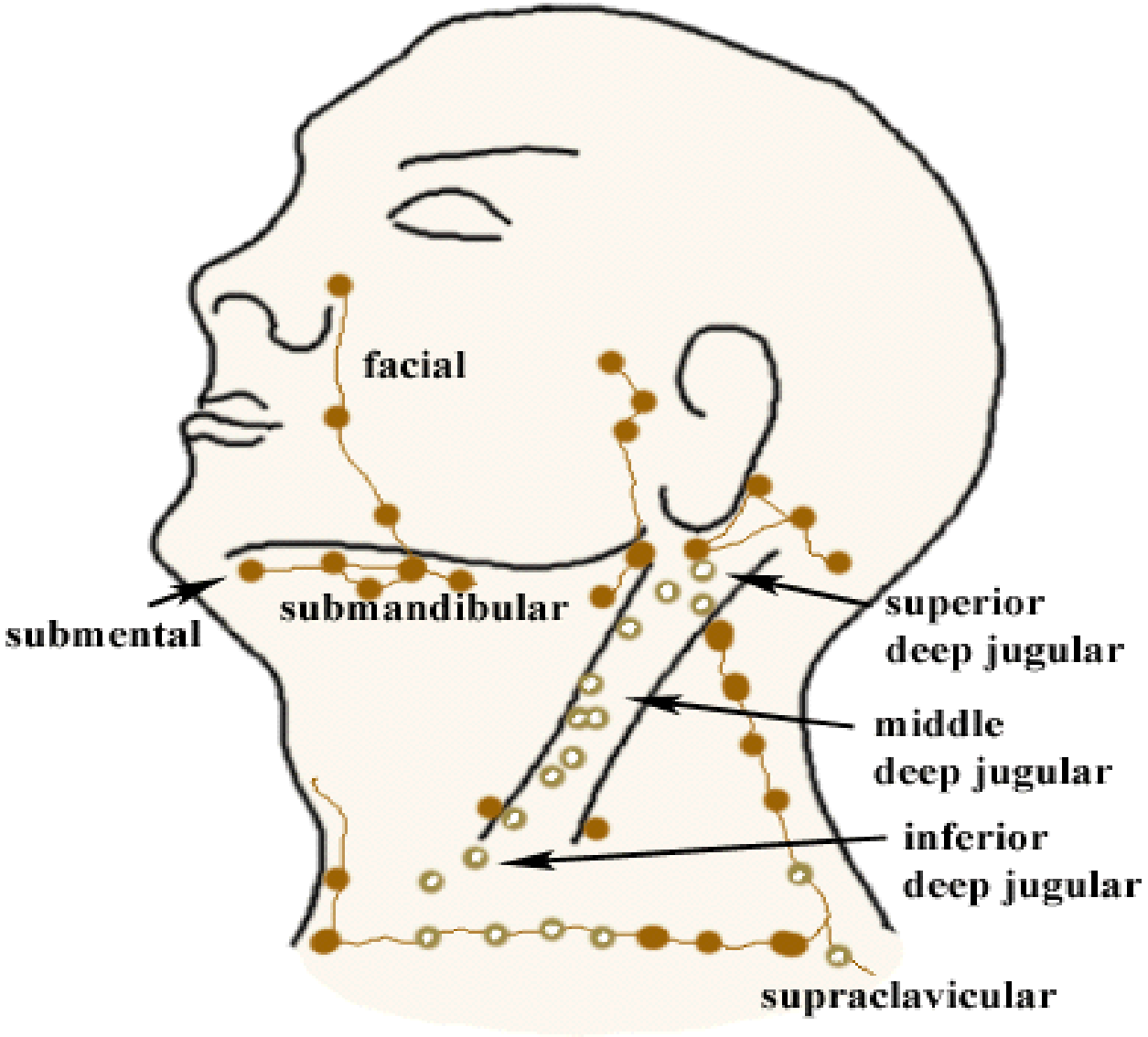
Mantle Field

- Axillary nodes
- Cervical
- Submandibular
- Supraclavicular
- Infraclavicular
- Mediastinal
- Hilar



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Nodes of the Head and Neck



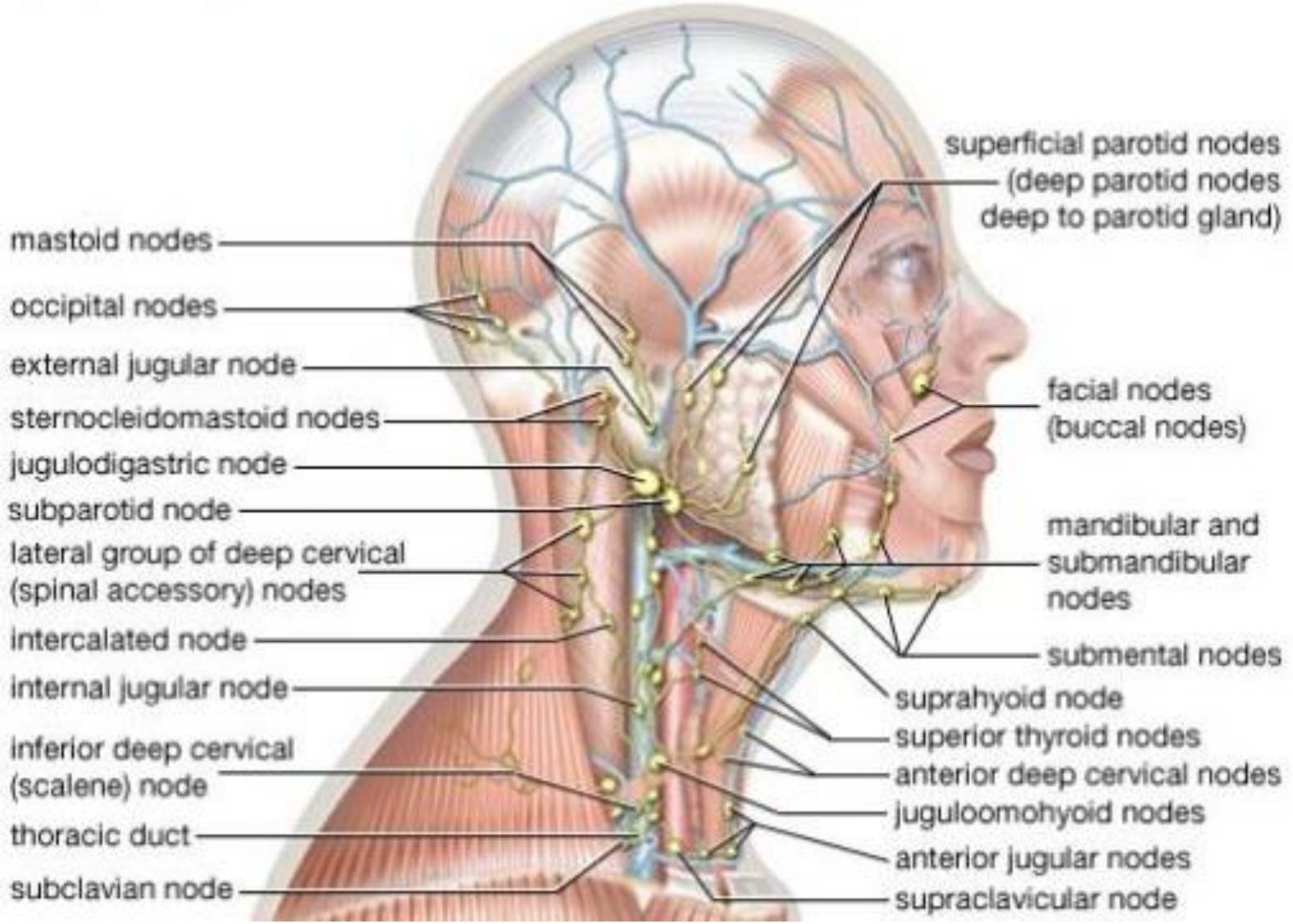
- Submental
- Submandibular
- Jugular chain
  - Anterior part of the neck
- Facial

Tip for therapist

The most common lymph node involved in head and neck cancer is the jugulodigastric node found at the angle of the mandible.

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Nodes of the Head and Neck

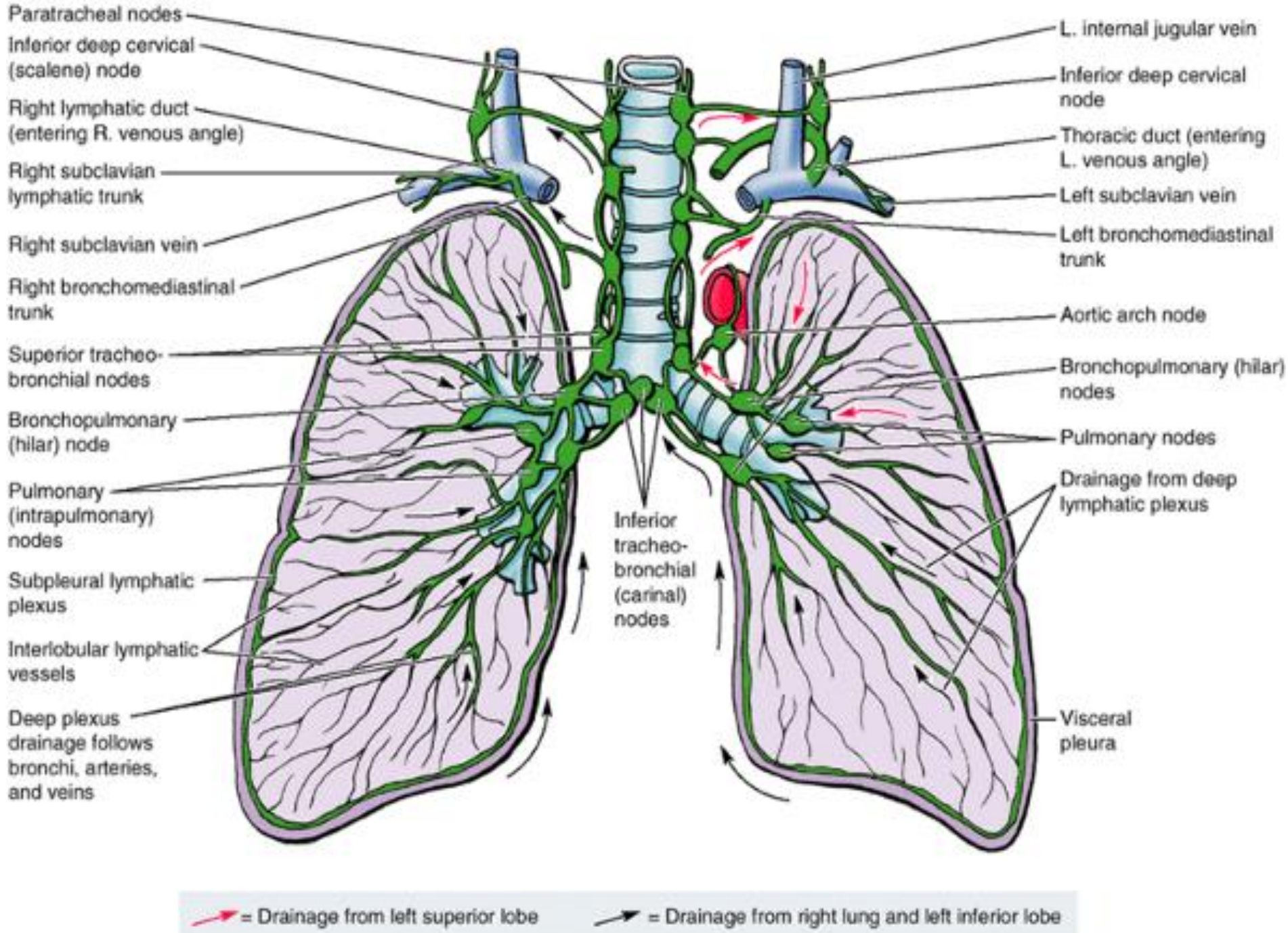


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Lymphatic of the Lung

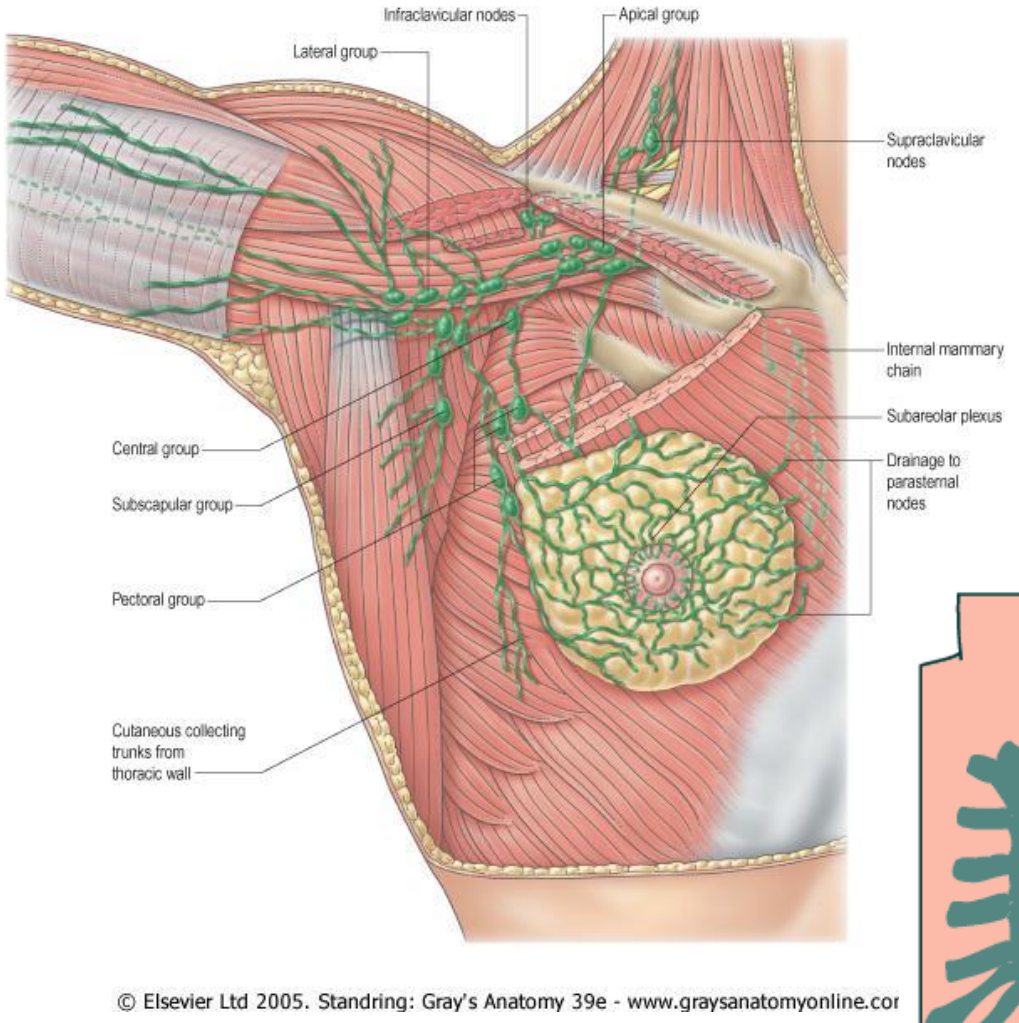
- Drainage to lymph nodes is dependent on each lobe:
- Hilar involvement= **60% in rt upper and middle lobe ca. 75% in lower lobe ca.**
- Mediastinal= 40-50% of all cancers
- Supraclav= 2-37% Superior mediastinal metastasis

- *Small cell lung cancer tends to metastasize quickly
  - Usually most aggressive- manifests and spreads rapidly

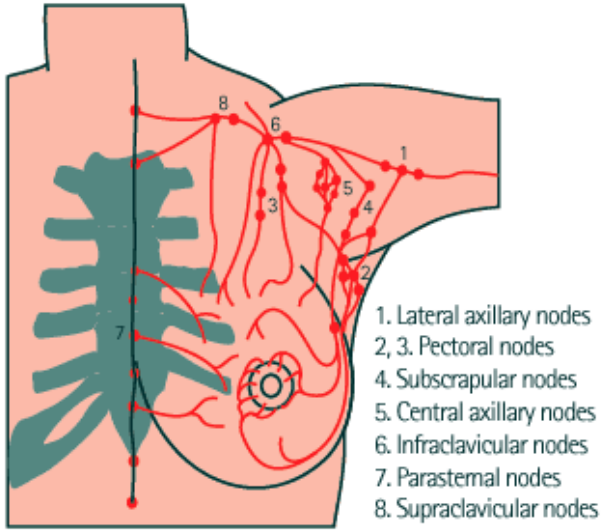

Paratracheal nodes
Inferior deep cervical (scalene) node
Right lymphatic duct (entering R. venous angle)
Right subclavian lymphatic trunk
Right subclavian vein
Right bronchomediastinal trunk
Superior tracheo-bronchial nodes
Bronchopulmonary (hilar) node
Pulmonary (intrapulmonary) nodes
Subpleural lymphatic plexus
Interlobular lymphatic vessels
Deep plexus drainage follows bronchi, arteries, and veins
L. internal jugular vein
Inferior deep cervical node
Thoracic duct (entering L. venous angle)
Left subclavian vein
Left bronchomediastinal trunk
Aortic arch node
Bronchopulmonary (hilar) nodes
Pulmonary nodes
Drainage from deep lymphatic plexus
Visceral pleura
Inferior tracheo-bronchial (carinal) nodes
= Drainage from left superior lobe
= Drainage from right lung and left inferior lobe

Lymphatics of the Breast

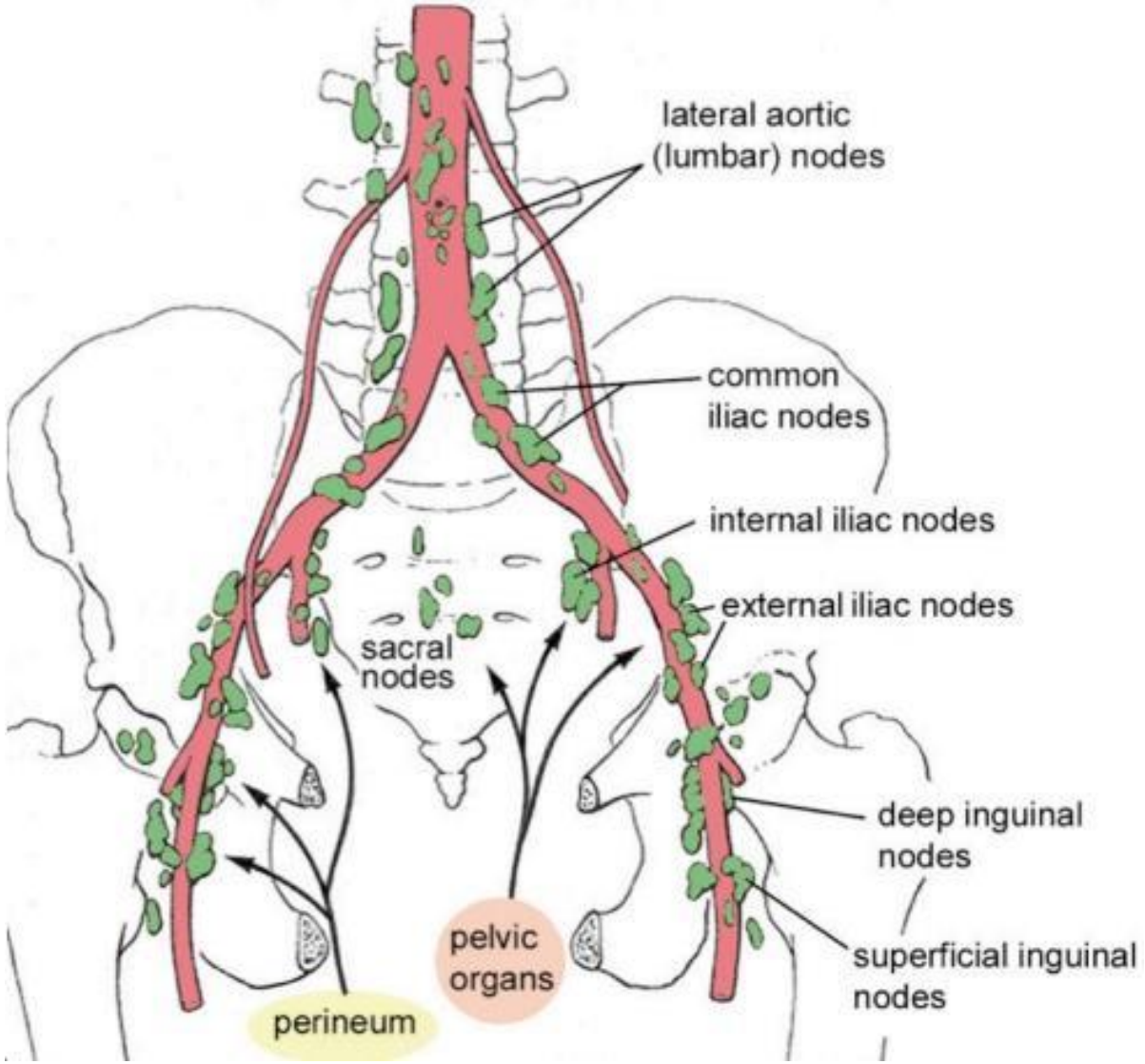
- Primary lymphatic drainage to the axilla (75%)
- Second drainage pathway is infraclavicular and supraclavicular nodes
- **Internal mammary chain (IMC)**
  - Most common in inner quadrant breast cancer

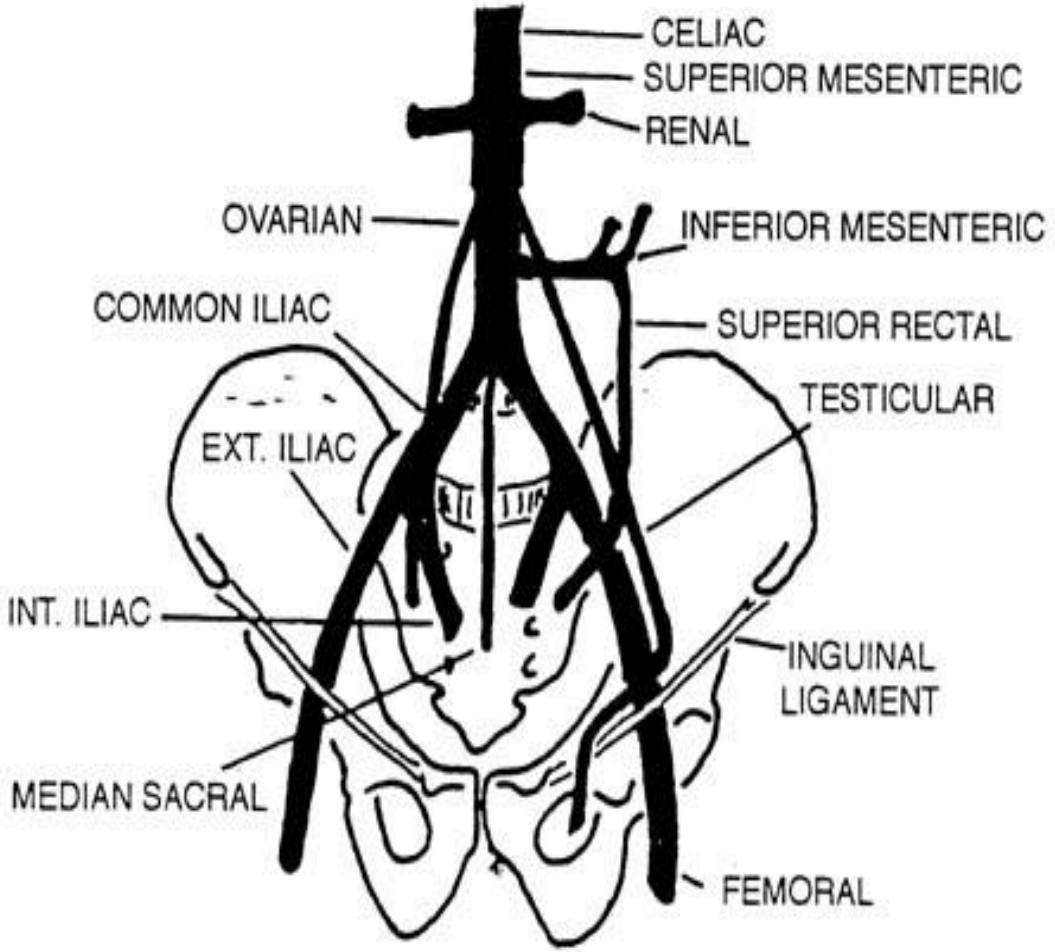




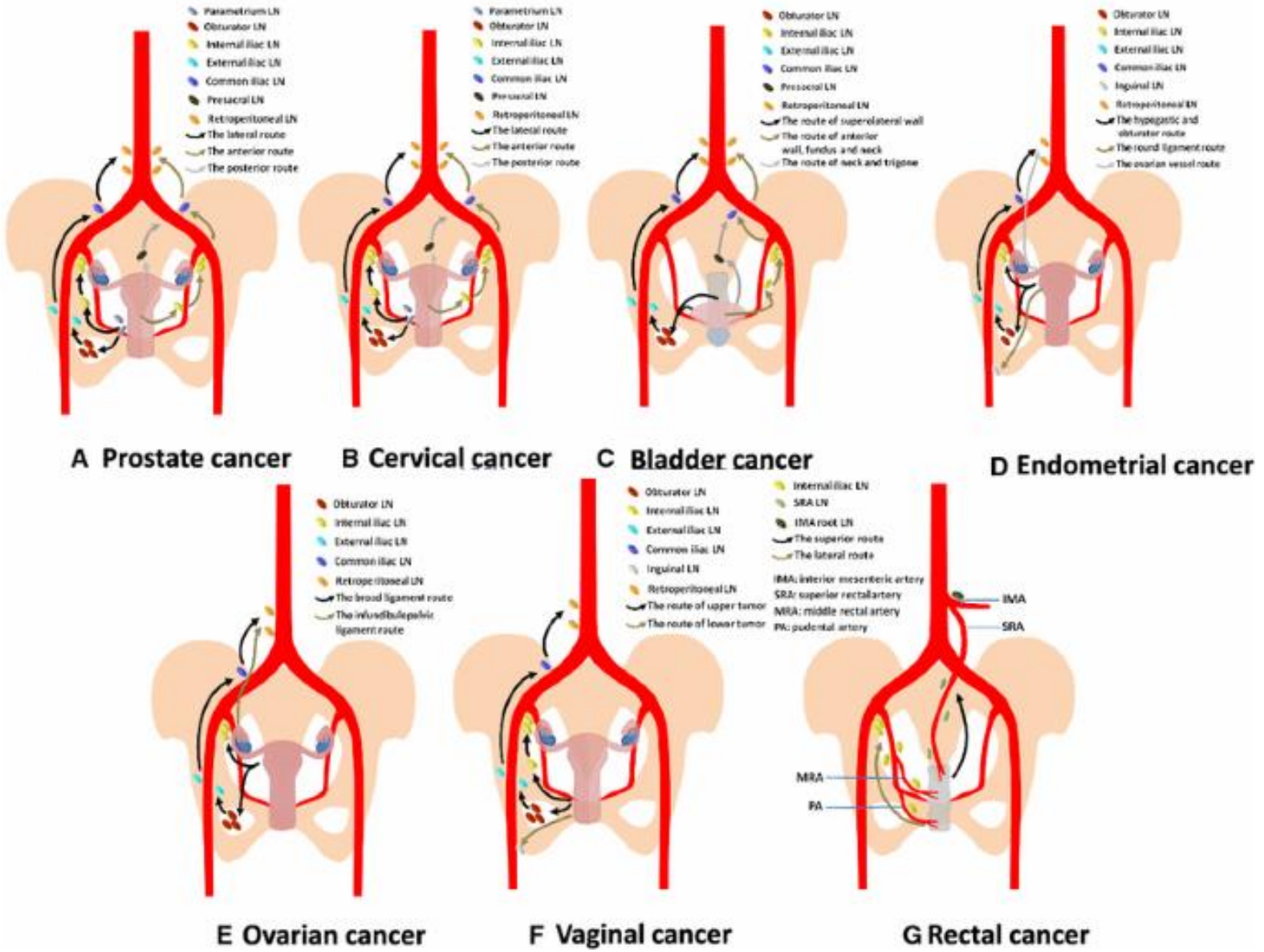


Lymphatics of the Pelvis





Lymphatic Drainage of Pelvic Tumors



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