The Thorax (Chest)

- This vital part of human body occupies the upper part of the trunk, it is conical in shape being narrower above than below
- Its AP diameter is 3/4 its transverse diameter in adult, though in children it is barrel-shape
- Because of forward projection of the vertebral column inside the thoracic cavity, it took a kidney-shape in cross section
- The superior thoracic aperture (inlet): is bounded by T1 vertebra, the 1st rib on each side & anteriorly by the manubrium sterni, it is higher behind (T1) than in front (T2-T3), & wider in transverse than AP diameter (12X6 cm)

The Thoracic wall:
- This strong but flexible skeleton has many important functions:
  - Protection
  - Muscle attachment
  - RBC production
  - Respiration; as the resilient bones & joints in this wall aided by muscle action renders it capable to expand & reduce its size which will change the intrathoracic pressure & permits air to flow in & out the lungs through the respiratory airways

* The bones of the thoracic wall are:
  - The sternum
  - The thoracic vertebrae & their discs
  - The ribs & their costal cartilages

The Sternum:
- This subcutaneous bone lies anteriorly in the midline & slopes antero-inferiorly
- It is broader above than below & its average length in adult is 17 cm
- It consists of three parts, the manubrium, the body & the xiphoid process

Manubrium: is a quadrilateral piece, wider superiorly than inferiorly, characterized by:
- Depression on the top (jugular notch)
- Two big notches on the superolateral angles for sternoclavicular joints
- A facet on the lateral aspect for the 1st costal cartilage
- A demifacet on the inferolateral aspect for the 2nd costal cartilage
- The manubrio-sternal junction, a synchondrosis, projects forward to produce the important surface landmark (sternal angle) which marks the 2nd costal cartilage

The body: is the longest piece, it is characterized by:
- A demifacet at the superolateral angle for the 2nd c.c
- Four facets on its lateral border for the 3rd, 4th, 5th & 6th c.c
- A demifacet on the inferolateral angle for the 7th c.c

The xiphisternum: is the smallest part of the sternum, it articulates with the inferior aspect of the sternum body & characterized by:
- Carrying a demifacet for the 7th c.c
- Forms synchondrosis with the sternal body
- It marks the lower limit of the thoracic cavity anteriorly
- It may be pointed, or bifid hence its name (sword- shape process)
The ribs:
- These narrow, thin, curved bony plates number 12 on each side (+-)
- All of them articulate posteriorly with the thoracic vertebrae
- The upper 7 articulate anteriorly through their c.c with the sternum so regarded as the true ribs
- The next 3, each articulate with the c.c of the rib above forming the sternal angle, so regarded as the false ribs
- The last 2 have their anterior ends buried in the abdominal muscles so regarded as the floating ribs
- The longest rib is the 7th, the length decreases as we go up & down

Parts of the typical rib:
* The head:
  - Is a triangular structure consists of 2 facets separated by a crest
  - The 2 facets articulate with corresponding demifacets on the bodies of the adjacent vertebrae, the lower costal facet articulates with a demifacet on the upper border of the corresponding vertebra & the upper one with a smaller demifacet on the lower border of the vertebra above
  - The crest is held by a ligament to the intervertebral disc
* The neck:
  - Extends laterally from the head for 2.5 cm
  - It is smooth ventrally & rough dorsally
  - It lies anterior to the transverse process of the corresponding vertebra
  - It is elongated above by a crest
* The tubercle:
  - Is a posterior eminence at the junction of the shaft with the neck
  - It shows 2 facets, the medial is to fit the facet on the tip of the transverse process as the costo-transverse joint, the lateral is for the costo-transverse ligament
* The shaft:
  - Is the main part of the rib
  - It shows the angle just lateral to the tubercle, the angle is the site of abrupt change in rib direction & twist of the bone
  - The superior border of the shaft is thick while the inferior is sharp, a costal groove lies in the inner aspect of the shaft near the lower border for the neurovascular bundle
  - The sternal end of the shaft is cup like to receive the c.c

The first rib:
- Short, acutely curved, has superior & inferior surfaces instead of medial & lateral surfaces
- The head has single facet for T1
- The superior surface is rough & characterized by the scalene tubercle for insertion of Sc. anterior which separates the area of subclavian vein in front from that of subclavian artery behind
- No costal groove
- In upside down position the head will be above the level of the table

The second rib:
- Is midway in position between the 1st & typical ribs

The tenth rib:
- Has only single articular facet on the head

The eleventh rib:
- Single head facet
- No tubercle facet
- Poorly defined angle

The twelfth rib:
- Is a small & thin piece of bone lacking most of the costal features

The costal cartilages:
- They connect the rib with the sternum or with each other & contribute to the elasticity of the chest wall
- The longest is the 7th, from here the straight c.c begin to be angled superiorly to meet the above c.c
- There is no joint between the 1st c.c & the sternum, 2-7 has synovial joints with the sternum & 8,9,10 has synovial joints each with the c.c of the rib above, so the costal margin is formed

The Thoracic vertebrae:
- They possess the parts of any other vertebra (body, pedicles, laminae, articular processes, transverse & spinous processes & vertebral foramen)
- Special features of typical thoracic vertebra:
  • The body is moderate in size & heart shaped
  • They contain 2 costal facets (demifacets) on each side at the junction of the body with the neural arch, one at the upper & the other at the lower border of the body
  • The upper demifacet forms with the lower demifacet of the vertebra above a complete cup-like facet to fit the head of the rib
  • The inferior border of the pedicle is deeply notched to form the intervertebral foramen
  • The laminae are broad & with downward slope covering each other
  • Spines are long & with downward slope & a tubercle at the tip
  • Transverse processes end in a rounded tip carrying on its anterior surface a cup shaped facet for articulation with the tubercle of the corresponding rib at the costo-transverse joint
  • The thin articular processes carry flat surfaces, the superior one faces postero-laterally & slightly upward while the inferior facet faces antero-medially & slightly downward, this direction favors lateral flexion & rotation of the trunk

Atypical thoracic vertebrae:
* The 1st thoracic, T1 vertebra:
  - The upper border of the pedicle is deeply notched as the lower
  - There is a complete upper costal facet for the 1st rib & lower demifacet
  - The spine is nearly horizontal
* The 11th thoracic, T11 vertebra:
  - The spine & transverse processes are very short
  - There is no costal facet on the transverse process
* The 12th thoracic, T12 vertebra:
  - This is a transitional vertebra, its transverse process is rudimentary with 3 tubercles (lumbar in type)
  - Inferior articular facet is elongated & faces laterally like lumbar spines
Articulations of the bony thorax:
* The ribs articulate:
- By their heads, with vertebral bodies & intervening discs (costovertebral joints)
- By their tubercles, with the transverse processes (costotransverse joints)
- By their c.c (except the last 2), with the sternum & costal margin (sternocostal joints & costochondral junctions)

Costo-vertebral articulations:
- The typical rib articulates by the demifacets on its head with demifacets of two adjacent vertebrae, the upper vertebral facet articulates with lower costal facet of corresponding rib
- The intervening crest of the head lies opposite to the intervertebral disc
- Joints are gliding, synovial joints
- Triradiate ligament; lies anterior to these joints, formed of three bands, the upper & lower connect the head with the articulating vertebrae, the middle connects the crest to the disc

Costo-transverse articulations:
- This is a small synovial joint between the costal tubercle & the facet on the anterior surface of the t.p
- The costotransverse ligaments:
  1- Lateral CTL; between the non articular part of the costal tubercle & the tip of t.p
  2- Superior CTL; between the crista colli costae & the lower border of the t.p of the vertebra above
  3- Inferior (posterior) CTL; between the back of the costal neck & the front of t.p of the corresponding vertebra

Sternocostal (chondrosternal) joints:
- The union of the 1st rib with the sternum is synchondrosis (cartilage – bone meeting with no movement)
- Synovial joints present between the c.c 2-7 & the sternal border, they are strengthened anteriorly by the sterno-costal radiate ligaments

Interchondral articulations:
- These are present between the c.c of 7-8, 8-9 & 9-10
- They are small joints strengthened medially & laterally by ligamentous fibers

Movements of the bony thoracic cage:
- Movement of the rib on the CVJ & CTJ is a rotary movement which takes place around an oblique axis passing through the rib neck
- As a result, the rib will be elevated
- The curved shape & oblique position of the rib renders its elevation takes the anterior end more forward & lateral end more outward
- The relative anterior fixation to the sternum makes the rib moves in a bucket-handle movement being fixed on both sides & swings upward & laterally
- As a result both AP & transverse diameters of the thorax will increase
The Thorax, Surface Anatomy:
- The midclavicular line; is the imaginary line passing through the middle of the clavicle
- The midaxillary line; is the imaginary line passing through the middle of the axilla
- The anterior axillary line; passes downward from the anterior axillary fold
- The posterior axillary line; passes downward through the posterior axillary fold
- The suprasternal notch; lies between the 2 clavicles above the sternal manubrium
- The costal margin; is the lower oblique cartilaginous border of the thoracic cage which ascends from the flanks up to the lower end of sternum it consists of the c.c of the 7\textsuperscript{th} – 10\textsuperscript{th} ribs
- The sternal angle (of Louis); is the manubriosternal junction which marks laterally the 2\textsuperscript{nd} c.c

The anterior thoracic wall:

External intercostal muscle:
- They are 11 on each side, occupying the outer most layer of the 11 intercostal spaces
- They extend between the sharp lower border of the rib & the outer margin of the upper border of the rib below
- They extend from the tubercle of the rib behind to the costochondral junction in front, in the interchondras spaces they are replaced by the external intercostal membrane
- The fiber direction is with the rib direction (antero-inferiorly)
- Supplied by the corresponding intercostal nerves
- They elevate the ribs expanding the thoracic cavity volume (inspiratory)
- It never crosses an intercostal space

Internal intercostal muscle:
- They are 11 on each side, occupying the middle layer of the 11 intercostal spaces
- They extend between the inner border of the subcostal groove & the inner margin of the upper border of the rib below
- They extend from the angle of the rib behind to the sternum in front, in the between the angle & neck, they are replaced by the internal intercostal membrane
- The fiber direction is perpendicular to EI (antero-superiorly)
- Supplied by the corresponding intercostal nerves
- They depress the ribs compressing the thoracic cavity & reducing its volume (expiratory)
- It never crosses an intercostal space

Transversus thoracis muscle:
* Subcostalis:
  - Lies on each side of the paravertebral gutter, nearer to the diaphragm
  - They are thin flat sheets of muscle fibers, characteristically cross more than a space
  - Corresponds in direction with the internal intercostal muscle
* Sternocostalis (T. thoracis proper):
  - Arise from the back of the lower 1/2 of the sternum
  - Fibers radiate superolaterally forming many slipd which are inserted into the 2-6 c.c

The neurovascular plane:
- The body wall (thorax & abdomen) is formed of three layers
- EIM represents the outer layer, IIM represents the middle & the TT represents the internal layer
- Vessels & nerves of the body wall pass between the inner 2 layers, i.e.; between the internal intercostal & transversus thoracis muscles

Anatomy of the intercostal space:
- The intercostal space contains a neurovasculaar bundle (Vein, Artery & Nerve –VAN- from above downward) pass in the subcostal groove, the nerve being lowest is sometimes unprotected by the bone
- Each space has an anterior (double) & posterior (single) vessels (V, A) but a single intercostal nerve (N)
- The anterior intercostal vessels arise & terminate in the internal thoracic system on each side of the sternum (anterior)
- The posterior intercostal vessels arise & terminate in the aortic & azygos systems (posterior)
- The intercostal nerve comes from the vertebral column posteriorly & is directed anteriorly in the space

The intercostal nerves:
- The ventral primary rami of the first 11 thoracic spinal nerves pass in the 11 intercostal spaces
- The 12th passes below the 12th rib in the posterior abdominal wall & called the subcostal nerve
- T1 is a small nerve & has no lateral cutaneous branch since most of its fibers are taken by the brachial plexus
- The upper 6 thoracic nerves will be distributed to the thorax while T7-T12 will be distributed to the abdomen

The thoracic intercostal nerves:
- They constitute the upper 6 thoracic neves
- They pass in the intercostal spaces supplying the intercostal muscles (EI, II & TT) & give cutaneous branches

* Branches:
- Collateral branches; each nerve gives a collateral branch which passes below & parallel to the main nerve, these branches contain most of the motor fibers & they are the nerves which supply the intercostal muscles
- Lateral cutaneous branches; arise at the midaxillary line from the remaining part of the nerve, each divides into anterior & posterior branches which meet the lateral branches of the anterior & posterior cutaneous nerves
- Anterior cutaneous branches; are the remaining part of the spinal nerve, pierce the muscles lateral to the sternum & ends into lateral (large) & medial (small) branches

The internal thoracic artery:
- Arises from the inferior aspect of the 1st part of subclavian artery
- Descends on each side of the sternum, 1 cm away, a sort of vascular communication between the 2 arteries is present behind the sternum
- Ends in the 6th intercostal space by dividing into superior epigastric & musculophrenic arteries
- The superior epigastric enters the abdominal wall to the rectus sheath, the musculphrenic passes laterally in the gutter between the chest wall & the dome of the diaphragm supplying it & the pericardium
- The internal thoracic a. gives the upper 6 anterior intercostal arteries, while the lower 5 are given by the musculophrenic branch

Anterior intercostal arteries:
- Are double in each space, given from the internal thoracic & musculophrenic arteries
- Pass laterally in the space to meet the posterior ones
- They are smaller than the posterior intercostal arteries which represent the main intercostal arteries
- Those of the 2nd, 3rd & 4th spaces supply the mammary gland in female
- They give the anterior cutaneous arteries which accompany the anterior cutaneous branches of the intercostal nerve

**Posterior intercostal arteries:**
- The upper 2 arise from the costo-cervical trunk (2nd part of subclavian)
- The lower 9 arise from the sides of the thoracic aorta
- Rt. Arteries are longer than the left & pass behind the oesophagus & azygos system to reach the right intercostal spaces
- At the rib angle each divides into posterior & anterior branch
- The posterior branches go with the dorsal rami of spinal nerves & supply structures in the vertebral canal
- The anterior branches represent the main intercostal arteries & pass with the nerve & vein supplying the intercostal structures & giving collateral & lateral cutaneous branches

**Intercostal veins:**
- They accompany the arteries & have the same course, with some variations:
  • The internal thoracic veins end in the corresponding brachiocephalic veins
  • The highest intercostal vein (1st posterior intercostal) drains on each side to the brachiocephalic or vertebral veins after passing over the pleura of the lung apex
  • The 2nd & 3rd posterior intercostal veins unite to form the superior intercostal vein which drains on the left in the brachiocephalic vein & on the right in the azygos arch
  • The remaining posterior veins drain in the azygos & hemiazygos veins

**Lymphatic drainage of the chest wall:**
* The sternal nodes:
- Lie along the upper part of the internal thoracic artery
- Afferent; medial part of the chest wall, medial side of the breast & upper abdominal wall
- Efferent; drain through the mediastinal lymph trunk or directly to the confluence of IJV & subclavian vein
* The intercostal nodes:
- Lie near the costal heads in each space
- Drain the back of the chest wall medially
- Those of the upper 2 spaces drain to the jugulosubclavian venous confluence, those of the lower 4 spaces drain to cysterna chyli
* The phrenic nodes:
- Anterior group:
  - Lie behind the xiphisternum
  - Receives from lower chest wall, upper abdomen & anterior part of the diaphragm
  - Sends to the sternal nodes
- Middle group:
  - Lie around the phrenic nerve near diaphragm
  - Receive from adjacent areas of chest wall & diaphragm
- Sends to the anterior & posterior groups
- Posterior group:
  - Lie near the diaphragmatic crura
  - Receive from posterior diaphragm & chest wall
  - Sends to the intercostal nodes

* The axillary nodes:
  - Anterior group (pectoral); receive from the anterior body wall above the umbilicus superficially
  - Posterior group (scapular); receive from the posterior body wall above the waist superficially

The mammary gland:
- This is a modified sweat gland which functions for lactation in female, therefore they are well develop while in male they are rudimentary
- The base of the breast is almost fixed & extends from the 2\textsuperscript{nd} to the 6\textsuperscript{th} ribs & from the sternal border to just beyond the anterior axillary line
- The shape of the breast is conical in nulliparous females, it takes a semi-spherical shape in lactating multi para
- The stroma of the breast is made of 15-20 flat pyramids of landular tissue whose apices are directed to the center of the breast
- Each of these glandular milk-secreting lobes ends in a lactiferous duct which open on the top of the nipple
- The rest of the breast mass is formed by fascia which is usually fatty
- Ligament of Astley-Cooper: This conical ligament covers the breast underneath the skin & supports its weight, so it is more well defined at the lower than the upper half of the breast
- The areola: is the circular pigmented area which surrounds the nipple, its diameter & color varies depends on many factors, usually it darkens & enlarge during pregnancy & it contains areolar sebaceous glands
- The nipple: is conical or cylindrical, projects from the center of the areola on the most convex part of the breast, it has a fissured top on which opens the lactiferous ducts, it contains smooth muscles under a hormonal control which play part in erecting it by reflex action
- Breast tail; is extension from the supero-lateral part of the breast tissue into the anterior axillary fold

Arterial supply:
1- Perforating branches of the internal thoracic artery, especially of the 2\textsuperscript{nd}, 3\textsuperscript{rd} & 4\textsuperscript{th} spaces
2- Lateral branches of intercostal arteries especially in the above spaces
3- Superior & lateral thoracic branches of the axillary artery

Venous drainage:
Similar to arteries but:
- Veins form a plexus underneath the areola before their distribution
- They communicate with adjacent veins of the neck above & of the anterior abdominal wall below

Lymph drainage:
* Superficial lymphatics:
  - Cutaneous lymphatics of the mammary system is part of the general system of the area so it is connected to the cutaneous lymphatics of the neck above (delto-pectoral & supraclavicular nodes), to the anterior abdominal wall below & to the opposite breast
- This cutaneous lymphatics also has a communication to the subareolar dermal plexus which drains deep lymph of the breast
- Cutaneous lymphatics accompany veins

* Deep lymphatics:
  - Lymph from the gland is collected mainly to the subareolar lymphatic plexus underneath the areola
  - This plexus becomes less defined as we go to the periphery of the breast (circumareolar plexus)
  - From here lymph travel with arteries by two trunks (lateral & medial) to the axillary lymph nodes which are the main nodes draining the breast & affected by its pathology
  - The pectoral, apical & central axillary nodes are the main nodes involved in breast drainage
  - From the medial aspect of the circumareolar plexus, lymph is collected to the parasternal & internal thoracic nodes which have a communication with the contralateral nodes

Applied Anatomy:
- Breast tumors are the commonest cause of death from tumors in female
- Because of the disseminated lymphatic communication of the breast, it is vital to examine the following structures if you suspect a breast pathology:
  1- Axillary & cervical lymph nodes
  2- Other breast
  3- Mediastinum & lungs (X-rays)
  4- Abdomen, especially the liver
- Treatment of breast pathology should take in consideration these facts

The thoracic inlet:
- Inside the concavity of the 1st rib is attached the suprapleural membrane which is a strong shiny membrane acts as the diaphragm between the thorax & the root of the neck
- The membrane slants anteriorly with the 1st rib making the cavity of the thorax taller behind than in front
- An opening in the midline between the two membranes permits connection of the thorax with the neck
- The transverse process of C7 lies just above this membrane, compression of the trunks of brachial plexus or the subclavian artery by an extended T.P causes the thoracic inlet syndrome

The mediastinum:
- The lungs & their pleural coverings occupy the lateral part of the thoracic cavity
- All other structures are contained in a thick partition between the two lungs named the mediastinum
- M is divided into superior & inferior M by a plane passing through the sternal angle anteriorly & the lower border of T4 posteriorly
- The superior M lies behind the manubrium & in front of the upper 4 thoracic vertebrae
- The inferior M lies behind the sternal body & in front of the remaining thoracic vertebrae
- The inferior M is further divided by the pericardial sac into anterior, middle & posterior mediastina, the pericardium & its contents represent the middle M, anything between it & anterior chest wall is anterior M, anything between it & posterior thoracic wall is posterior M
* The superior M will be studied together with the middle M as its main contents are extensions from the middle M & related to it
The anterior mediastinum:
- This is the part of the thoracic cavity which lies between the body of sternum anteriorly & the pericardium posteriorly
- It is continuous above with the anterior triangle of the neck anterior to the pretracheal fascia through the superior M
- It contains only the thymus & some lymph nodes & areolar tissue
- Thymus:
  • Is a gland related to the immune system of the body, well developed in children & rudimentary in adults
  • It may reach above to the superior mediastinum
  • It is supplied by internal thoracic artery

The heart & pericardium (middle M):

The pericardium:
- This conical sac invests the heart & roots of great vessels, being made of an external fibrous & internal serous layers
- The base of the P lies on & fuses with the diaphragm being located at the level of the xiphisternal junction, the apex of the P lies up at the level of the sternal angle where the fibrous layer becomes continuous with the outer layer of the aorta & the serous layer becomes reflected on the roots of blood vessels to the heart

The fibrous pericardium:
- This tough layer surrounds & protects the heart & roots of great vessels
- It is fused inferiorly with the central tendon of the diaphragm
- The anterior borders of the lungs and pleurae separate the upper part of the P from the manubrium, the lower P lies in direct contact with the sternum
- The sides of the P are in direct contact with the mediastinal pleura, only the phrenic nerves & pericardiacophrenic vessels intervene
- The oesophagus & thoracic aorta are in direct contact with the back of the P
- The only penetration of the fibrous P lies inferiorly where the IVC (inferior vena cava) penetrates the P & central diaphragmatic tendon

The serous pericardium:
- This glistening, smooth membrane is made of two layers, a parietal one which is in contact with the fibrous P & visceral one which is the epicardium of the heart & great vessels
- The space between the 2 layers is potential & is lubricated by serous fluid to permit cardiac pulsation
- The reflection around the roots of the aorta & PT (pulmonary trunk) (arterial mesocardium), is separated from the reflection around the veins, SCV (superior vena cava), IVC & the 4 pulmonary veins (venous mesocardium). The slit between the two mesocardia is the transverse sinus.
- The oblique P sinus is a diverticular sac within the irregularities of the venous mesocardium between right & left pulmonary veins

The Heart:
Sterno-costal projection:
- The heart lies to the left of the midline, 2\3 to the left & 1\3 to the right
- The right chambers of the heart lie anterior & the left chambers lie posterior, the interatrial & interventricular septa lie in the coronal plane while the atrioventricular septa lie nearly in the sagittal plane
- It lies oblique in position, its apex being down & to the left
- Its base is the uppermost part giving rise to the aorta, PT & SVC
- The surface projection of the heart can be located by identifying 3 main points:
  - The base; represented by an oblique line extending from the left 3rd c.c 2cm to the left of the sternum to the right 3rd c.c 1 cm to the right of the sternum
  - The cardiac apex; represented by the apex beat at the Lt 5th intercostal space, 8 cm from the midline
  - The right end of the diaphragmatic surface; at the right 6th costochondral junction
- CURVED LINES CONNECTING THESE POINTS REPRESENT THE SURFACE PROJECTION OF THE HEART
* The pericardial projection lies with that of the heart except superiorly where it reaches the 2nd c.c
* Like all other soft organs, the heart projection varies with the built, position & state of health

Cardiac sulci:
1- The coronary (atrio-ventricular) sulcus:
  - Begins in the base line of the heart nearly at the median plane, descends obliquely on the right side (anterior surface) of the heart & ends on the diaphragmatic surface separating the atria from the ventricles
  - The sulcus separates the RA (right atrium) up & to the right from the RV (right ventricle) down & to the left
  - It lodges the right coronary artery & small cardiac veins
  - Posteriorly it lodges the coronary sinus, the terminal part of the great cardiac vein & circumflex coronary artery
2- The anterior interventricular sulcus:
  - Begins at the lower border of the sternocostal surface, to the right of the apex
  - It is almost vertical & ends above to the left of the PT
  - It lodges the anterior interventricular branch of the left coronary & the great cardiac vein
  - It marks the position between the two ventricles (interventricular septum)
  - It is continuous at the cardiac apex with …
3- The posterior interventricular sulcus:
  - This sulcus lies on the diaphragmatic surface of the heart between the two ventricles
  - It lodges the posterior interventricular branch of the right coronary artery

Cardiac chambers:
1- The right atrium:
  - This chamber lies to the right of the coronary sulcus which separates it from the RV
  - It receives the SVC & IVC from above & from below respectively
  - A sulcus on the anterior surface of the RA extends from the SVC to the IVC called sulcus terminalis marks the internal ridge known as crista terminalis
  - Crista terminalis; separates a posterior smooth internal wall (sinus venarum) from an anterior muscular wall marked by bands of muscular tissue (musculi pectinati)
  - Opening of the SVC; lies in the posterosuperior part of the RA & directed antero-inferiorly, it contains no valves
  - The opening of the IVC; occupies most of the floor of this chamber & is directed posterosuperiorly, it contains a posterior valve
- Opening of the coronary sinus; lies between the orifice of the IVC & the atrio-ventricular opening (tricuspid valve)
- Fossa ovalis; lies in the interatrial septum (posterior wall of the RA), it represents the embryological foramen ovale & its upper margin is sharp & called limbus fossa ovalis
- The right auricular appendage; is the part of the RA to the left of the sulcus terminalis, it represents the embryological RA & extends to the left covering the root of the aorta & may touch the left auricular appendage which comes from behind

2- The right ventricle:
- This triangular chamber occupies most of the sternocostal surface of the heart being outlined by the area between the coronary & anterior interventricular sulci & ends above in the PT
- On the diaphragmatic surface it occupies a smaller area than the LV
- As its anterior wall is convex forward as well as the interventricular septum, the RV looks semilunar in cross section
- The wall of the RV is 1/3 the thickness of that of LV
- The endocardial surface of the RV is thrown in criss-crossing muscular ridges known as the trabeculae carneae
- RV is separated from the RA by the AV septum which is nearly totally occupied by the tricuspid valve
- Chordae tendinae; are tendinous strands connecting the margins of the valve cusps through the ventricular cavity to the papillary muscles
- Papillary muscles; are big muscular projections from the wall of the ventricle to which attached the chordae, their contraction with ventricular systole pulls the chordae down preventing evagination of the cusps into the atria, there are 2 muscles in the RV anterior & posterior for chordae of the corresponding cusps, septal cusp has its chordae arise from the interventricular septum directly
- Septomarginal trabecula; is the anterior papillary muscle reaching the septum, it carries the right bundle branch from the conducting system

3- The left atrium:
- This smooth-walled cavity lies behind the RA that the inter-atrial septum forms its anterior wall
- It receives the four pulmonary veins, superior Rt & Lt & inferior Rt & Lt
- The left auricular appendage which has a rough endocardial surface is constricted & projects to the left of the LA to wrap the root of the PT & may reach anteriorly the Rt auricle

4- The left ventricle:
- This chamber is longer & more conical in shape than the RV, its wall is 3 times thicker than it too
- It forms most of the posterior surface of the heart, 2/3 of the inferior surface & the left border of the sternocostal surface
- It endocardial surface also show the trabecular carneae
- Two large papillary muscles with their chordae occupy its lumen, anterior & posterior ones
- The AV (mitral) valve lies in the AV septum behind the tricuspid valve, the aortic (semilunar) valve lies superiorly in the LV
- Aortic vestibule is the smooth part of the LV which leads to the mitral valve

The atrio-ventricular valves:
- Fibrous rings formed of strong fibrous tissue surround the four cardiac valves giving them strength & provide a skeleton for the heart for support & muscle attachment
- The mitral (Lt) & tricuspid (Rt) AV valves are formed of a sheet of fibrous tissue extended from the ring covered on each side by endocardium
- The atrial surface is smooth, ventricular surface is attached by chordae to the papillary muscles
- Each cusp receives chordae from more than one papillary muscle
- Contraction of papillary muscles pulls the non contractile chordae toward the ventricular cavity & prevent bulging of the valves into the atria during ventricular systole
- The Rt AV valve has three cusps (tricuspid), anterior (lies against the anterior wall of the RV), septal (lies against the interventricular septum – posteriorly) & posterior (lies against the posterior wall – inferiorly)
- The Lt Av valve has two cusps (mitral or bicuspid), septal (against the septum – anterior) & posterior (against the posterior wall)

The semilunar valves:
- The structure of these valves is completely different from the AV valves, the contain no chordae tendinae & no papillary muscles
- Each is formed of three pocket-like cusps attached to the roots of the aorta & PT
- Each cusp lies against a saccular dilatation in the great vessel called the sinus
- As the great vessels lies nearly vertical, the valve action depends mainly on the physical rules, when the ventricle is in diastole the blood in the great v. tries to return back to the ventricular cavity by the effect of gravity but the sinuses collect this blood inside the cusps
- When the cusps are filled with blood, they come in contact with each other closing the valve, the defect in the center of each valve after closure, is closed by a nodule in the free end of each cusp, the nodes are formed of fibrous tissue
- In the anatomical position of the heart, the aortic valve has Rt. Lt & anterior cusps while the pulmonary valve is composed of Rt, Lt & posterior cusps

The auscultatory areas:
The areas of auscultation do not coincide with the true projections of the valves;
- Mitral v.; cardiac apex
- Tricuspid v.; lower sternal end 1 cm to the left
- Aortic v.; 2nd right intercostal space
- Pulmonary v.; 2nd left intercostal space

The generator & conducting systems of the heart:
The sinuatrial node:
- This is the area of the RA lying in the angle between the SVC & Rt auricle, it is the site of impulse generation of the heart

The atrioventricular node:
- This lies in the crossing area of the inter-atrial & interventricular septa, at the upper end of the IV septum
- It is the site of impulse regulation before it is distributed to the ventricles

The bundle of His:
- Descends in the IV septum where it divides into Rt & Lt bundle branches
- The Rt one passes in the septomarginal trabecula of the RV
- They are the main ventricular conductive system

Arterial supply of the heart:
1- The right coronary artery:
- Arises from the right aortic sinus (which overlies the right cusp of the aortic valve)
- Descends anteriorly in the right coronary sulcus
- At the lower border of the heart it gives the marginal branch towards the apex, parallel with the diaphragmatic border
- It turns to the diaphragmatic (posterior) surface
- When reaches the posterior interventricular sulcus it continues in that sulcus as the posterior interventricular artery which anastomoses with terminal branches of the anterior IV artery
- It supplies both ventricles (mainly the Rt) & the lower part of their septum

2- The left coronary artery:
- Arises from the left aortic sinus (which overlies the left cusp of the aortic valve)
- Directed anteriorly & to the left, it divides after a very short course into the anterior IV & circumflex branches
- The anterior IV artery passes in the anterior IV sulcus supplying both ventricles (especially the left) the upper part of their septum, at the apex it anastomoses with terminal branches of the posterior IV artery
- The circumflex artery descends on the back of the heart in the coronary sulcus, at the lower border it also gives a marginal branch, then on the posterior surface it ends near the posterior IV sulcus anastomosing with branches from the right coronary artery
- Other branches of the coronary arteries:
  - 1- Diagonal branches; across the walls of the ventricles
  - 2- Septal branches; into the IV septum
  - 3- Sinuatrial branch; from the Rt coronary in (60%) of cases, it is given at the root of the SVC & supplies SA-node & wall of RA
  - 4- Atrioventricular branch; from the Rt coronary in (85%) of individuals, given at the beginning of the posterior IV artery & ascends to the AV node
  - 5- Rt intermediate atrial branch; given from the Rt coronary near the marginal branch, supplies mainly he RA
  - 6- Lt intermediate atrial branch; given from the Lt coronary above the coronary sinus, it supplies the LA

Dominance of the coronary arteries:
- This clinical term reflects which artery predominates in supplying the posterior wall of the heart
- In 70% the post. Wall is supplies by branches from both coronaries (co-dominant)
- In 20% it is mainly supplied by the left coronary (left dominant)
- In 10% it is mainly supplied by the right coronary (right dominant)

Veins of the heart:
- RA veins drain directly to the RA
- Other parts of the heart drain to the coronary sinus

The coronary sinus:
- It receives more than 70% of venous blood of the heart
- It lies in the posterior part of the coronary sulcus between the 2 left chambers
- It enters the RA between the orifices of SVC & tricuspid valve
- A valve is present at its opening
- It receives venous blood via 5 main tributaries:
  - 1- Great cardiac v.; accompanies the anterior IV artery, drains most of the blood of the other 3 chambers
  - 2- Middle cardiac v.; accompanies the posterior IV artery
  - 3- Small cardiac v.; accompanies the marginal artery & drains mainly the RV
  - 4- Posterior v. of the LV

Anatomy of the Thorax
- 5- Oblique v. of the LA

Lymphatics of the heart:
- Sub-epicardial plexus receives lymph from the heart
- Efferents accompany the LT & Rt coronary arteries
- Those with the Rt coronary end in the left anterior mediastinal nodes
- Those with the left coronary end in the right tracheo-bronchial nodes

Cardiac plexuses:
- Impulse generation of the heart is a spontaneous action of cardiac muscles
- Nerves of the heart are arranged in 2 cardiac plexuses, superficial & deep which lie around ligamentum arteriosum
- Sympathetic fibers come from the upper 5 thoracic sympathetic ganglia
- Parasympathetic branches are the 6 cervical cardiac vagal branches
- Their main action is for sensation & regulation of cardiac action
- Sensation, acceleration & dilatation of coronaries is the main sympathetic action
- Deceleration & coronary constriction is the main parasympathetic action

Applied anatomy:
- In ischaemic heart disease (IHD) the picture varies in their signs, symptoms, ECG & other changes & even in the treatment on the artery affected
- Electrocardiography (ECG); is recording the cardiac electricity by leads placed on the chest wall reflecting the heart beat in a special picture on a paper
- Echocardiography; is visualizing the heart & recording certain data using ultrasound technique
- Cardiac catheterization; is an invasive technique by which adequate data are recorded about the state of heart function & visualization of the coronary arteries & even therapeutic techniques could be done to an acceptable degree

The great vessels:
- At the base of the heart, the aorta, PT & SVC communicate with the heart, their roots are enclosed by the pericardial sac
- The IVC leaves the heart at the floor of the RA directly piercing the diaphragm
- The four pulmonary veins enter the back of the heart, the LA

The ascending aorta:
- Arises from the upper part of the LV level with the 3rd left chondro-sternal junction
- Ascends upward, anteriorly & to the right to touch the back of the 2nd right c.c
- From this point the aortic arch begins & is directed backward & to the left
- It is 5 cm long, 3 cm in diameter
- At its root, the three aortic sinuses overlie the three semilunar cusps, 2 of them give the 2 coronaries
- The beginning of this vessel is covered by the PT & the Rt auricle
- The Rt PA passes behind it

The aortic arch:
- Begins from the back of the 2nd Rt c.c
  - Ascends upward, backward & to the left to end at the left border of the body of T4 vertebra
  - In the concavity of the arch, the PT bifurcates so that the Rt PA passes behind the ascending aorta

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To the Rt side of the arch, the trachea bifurcates so that the Lt main bronchus passes underneath the arch.

The arch of aorta measures 5 X 3 cm, its diameter is reduced to 2 cm just distal to the origin of the Lt subclavian a., the area is called the aortic isthmus which is the site of aortic coarctation.

Ligamentum arteriosum; this fibrous band, 1.5 X 0.5 cm, extends between the underside of the aortic arch, opposite to the origin of the left subclavian artery, & the very beginning of the Lt PA. It represents the foetal ductus arteriosus, the cardiac plexuses lie anterior to it & the Lt recurrent laryngeal nerve hooks below it.

Branches of the aortic arch:

1. The brachiocephalic trunk:
   - The 1st branch of the aortic arch, arises from its beginning behind the middle of the sternal manubrium
     - It ascends up & to the left in the direction of the Lt sterno-clavicular joint behind which it divides into the Rt. Suclavian a. & Rt CCA
     - It is 4-5 cm long & with the Lt CCA it forms a V-shape arterial trunk inside which the trachea is seen
     - No branches given from this trunk except the rare thyroidea ima arteries

2. The Lt. CCA:
   - Springs from the top of the aortic arch
   - Ascends (with the Lt SCA posterolateral to it) in the direction of the Lt sternoclavicular joint where the 2 arteries diverge from each other
   - To its Rt lie the trachea
   - Behind it lie the oesophagus, Lt recurrent laryngeal n. & thoracic duct
   - To its Lt side lie the left phrenic & Lt vagus nerves

3. The Lt.SCA:
   - Arises from the aortic arch 1 cm distal to the origin of the LT CCA
   - It ascends posterolateral to the Lt CCA to reach the back of Lt sternoclavicular joint where it curves to the left over the first rib behind scalenus anterior
   - As it ascends, it grooves the medial side of the apex of Lt lung
   - The left phrenic & Lt X nerves lie to the left of the artery
   - The trachea, oesophagus & Lt recurrent laryngeal nerve lie medial to it

Brachiocephalic veins:
These big veins are formed behind the corresponding sternal ends of the 2 clavicles by union of the IJV & SCV

The Rt. BCV:
   - Is 2.5 cm in length, descends vertically to joint the Lt fellow behind the Rt 1st c.c forming the SVC
   - It lies to the Rt of the brachiocephalic trunk, the Rt vagus is in between
   - To its right side, the Rt phrenic nerve & Rt pleura lie
   - It receives the Rt vertebral v., Rt inferior thyroid v., the Rt internal thoracic v. & the Rt highest intercostal v.

The Lt. BCV:
   - Courses down & to the left in nearly a horizontal course behind the upper half of the manubrium sterni
   - It is 6 cm long, in its course it crosses in front of the branches of the aortic arch & both vagi & phrenic nerves

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- It drains the followings:
  - Lt vertebral v.
  - Lt inferior thyroid v.
  - Lt internal thoracic v.
  - Lt superior intercostal v.
  - Lt highest intercostal v.
  - Pericardial, thymic & mediastinal veins

The superior vena cava (SVC):
- This vertical venous channel, 7.5 cm long receives the venous blood of the upper limbs, head & neck & the thoracic wall
- It starts behind the Rt 1st c.c by union of the 2 BCVs
- To its left lies the ascending aorta, to its right side lie the anterior border of the Rt lung, pleura & the Rt phrenic n.
- Posteriorly it lies against structures of the root of the Rt lung
- Azygos v. enters the SVC level with the Rt 2nd c.c
- It ends in the RA at the level of the Rt 3rd c.c
- SVC may be involved in stab wounds in the Rt 1st or 2nd intercostal spaces just lateral to the sternal border

The pulmonary trunk:
- This short (5 X 3 cm) arterial trunk emerges from the apex (infundibulum) of the RV postero-superiorly across the origin of the ascending aorta
- It divides in the concavity of the aortic arch at the level of the sternal angle
- It is nearly completely enclosed within the pericardial sac
- It is embraced by the two auricles of the heart

The Rt PA:
- Passes to the Rt in front of the Rt main bronchus behind the ascending aorta & SVC
- At the hilum of the Rt lung it divides into a smaller upper branch to the upper lobe of the lung & larger lower branch for the rest of the lung

The Lt PA:
- Shorter than the Rt, this artery passes to the root of the Lt lung anterior to the Lt main bronchus, both in front of the descending thoracic aorta
- It is connected to the underside of the aortic arch by ligamentum arteriosum

Nerves of the superior mediastinum:

Vagus nerves:
- In the root of the neck, the nerve crosses the 1st part of the subclavian a., where (on the Rt side) it gives the Rt recurrent laryngeal nerve
- Entering the thorax between the Rt BCV & brachiocephalic trunk it descends on the Rt side of the trachea to reach the lung root
- In the root of the Rt lung it shares in the formation of the pulmonary plexus
- The left vagus enters the thorax behind the Lt BCV between the Lt CCA & Lt SCA
- Being at the side of the aortic arch it gives the Lt RLN underneath ligamentum arteriosum
- Then it goes behind the root of the Lt lung to the pulmonary plexus

Phrenic nerves:
- Enter the thorax between the two subclavian vessels
- Descend with the pericardiaco-phrenic vessels (branches of internal thoracic vessels) anterior to the lung roots
- The Rt nerve descends directly to the Rt dome of the diaphragm to the Rt side of the venous channel (Rt BCV & SVC)
- The Lt nerve is directed to the cardiac apex
- Phrenic nerves are motor to the diaphragm & sensory to the mediastinal pleura & central area of the diaphragm & the pericardium

Respiration:
- Inspiration is an active process by which the dimensions of the thoracic cavity is increased by muscle action
- As a result, negative pressure is produced inside which is less than the atmospheric pressure
- Air will flow inside the respiratory passages to reach the linings of the lungs
- Expiration will occur passively as a result of muscle relaxation & elastic recoil of the chest wall
- The surface area available for respiration is about 70 square meters

The trachea:
- The thoracic part of the trachea lies posteriorly in the superior mediastinum
- T is a midline structure which in resting (expiration) phase, the T bifurcates at the level of the sternal angle (T4), inspiration pulls it down to the level of T6
- Aortic arch lies first in front then to the left of the T
- The BCT & Lt CCA arise anterior to it then diverge on each side as they ascend up, the BCVs lie in front of them
- The T lie between the Rt vagus & Lt RLN
- The T wall is reinforced by C-shaped cartilagenous rings which open posteriorly, the gap being closed by a muscle strip (trachealis), the T is always patent with an average diameter of 1.7 cm
- At the bifurcation (carina), the T divides into Rt & Lt main bronchi, the Rt is more vertical & represents the direct continuation of the T lumen
- The bronchi:
- Like the T, the Rt & Lt main bronchi are maintained patent by the C-shape cartilagenous rings, the Rt is more vertical, shorter & wider than the Lt hence the tendency of foreign bodies to lodge in it
- Right main bronchus:
- - 2.5 X 1.3 cm in dimensions, enters the Rt lung root at T5 level
- - At the lung root the bronchus is most posterior, lying below the PA, but the upper lobe bronchus leaves the Rt main bronchus outside the lung & enters the lung root above the PA so called the eparterial bronchus
- - The remaining bronchus divides inside the lung into Middle & lower lobe bronchi
- Left main bronchus:
- - 5 X 1.2 cm in dimensions
- - Passes to the Lt under the aortic arch, anterior to the descending aorta & oesophagus to the root of the Lt lung
- - Its terminal division takes place inside the lung substance into upper lobe, lingular lobe & lower lobe bronchi
- Blood supply of the bronchial tree:
- - Bronchial arteries are small branches that accompany the bronchi posteriorly supplying them distally until the respiratory bronchioles
Two left bronchial arteries arise from the descending thoracic aorta, while there is only one Rt bronchial a. arising from the upper left bronchial a. or from intercostal arteries

- Venous blood drains on the Rt side to the azygos & on the Lt to the accessory hemiazygos veins

Lymphatics of the bronchial tree:
- *Around 50 node form 5 main groups along the bronchial tree:
  - 1- Paratracheal; on each side of the T
  - 2- Superior tracheo-bronchial; in the angle between T & bronchi
  - 3- Inferior tracheo-bronchial; below the carina
  - 4- Broncho-pulmonary; at the lung hilum
  - 5- Pulmonary; along large bronchi inside the lung
- * Lymph drains in the direction of the T where Rt & Lt bronchial lymph trunks joint the Rt & Lt mediastinal & sternal trunks to form the Rt & Lt broncho-mediastinal lymph trunks
- * Bronchomediastinal lymph trunks drain on the Rt to the Rt lymph duct & on the Lt to the thoracic duct

The pleura:
- This is a closed serous sac, invaginated from the mediastinal side by the lung as if a balloon is invaginated by a fist
- The lung (fist) carries the invaginated layer inside the sac until it comes in contact with the outer layer
- The 2 layers will be continuous with each other around the lung hilum (the wrist)
- The layer in direct contact with the lung is the pulmonary pleura which is inseparable from the lung tissue, it enters lung fissures
- The outer layer (parietal pleura) lines the thoracic wall so it is divided according to its position into: costal, diaphragmatic, mediastinal & cervical
- The 2 layers are lined with endothelium which secretes lubricating fluid
- The pleural cavity is larger than the lung size in order that it can accommodate for the change in the lung size during respiration, this excessive space is most evident inferiorly where the costal & diaphragmatic pleurae meet, so called the costo-diaphragmatic recess
- This recess will be empty during expiration & filled by the lower border of the lung during inspiration
- The pleural space, which is a slit like space, is filled by serous fluid
- When the chest wall expand, the 2 layers will separate from each other, the closed space between them increase in size & since it is closed a negative pressure will be established inside it permitting atmospheric air to push the lungs & expand them by the process of inspiration
- The pulmonary ligament; as the structures of the lung root pushes inside & upward, the lower part of the line of reflection will be loose & will lag down a little, this is the pulmonary ligament which usually surrounds pulmonary veins which enter the lung root antero-inferiorly

Vessels:
- Parietal pleura is supplied by regional vessels of the chest wall (intercostals & pericardiaco-phrenic vessels)
- Visceral pleura is supplied by bronchial & pulmonary vessels

Nerves:
- Parietal P is supplied; costal surface by intercostal nerves, mediastinal & phrenic surface by the phrenic nerves
- Visceral pleura is supplied by pulmonary plexus (autonomic) so it is insensitive
Lymphatics:
Follows the superficial surface of the lung
Lines of reflection:
- The costal P is reflected anteriorly & posteriorly into the mediastinal P & is reflected inferiorly into the diaphragmatic P
- Cervical pleura covers the apex of the lung which projects behind the oblique suprapleural membrane, the pleural apex on the surface is marked 2 cm above the sternal end of the clavicle
- From this point, follow the line down to the sterno-clavicular joint
- The 2 lines meet each other behind the sternum at the level of sternal angle
- The 2 pleurae remain in contact at the midline down of the level of the 4th c.c
- From here the Rt P descends vertically to leave the sternum at the 6th c.c, where it could be traced down & to the Rt to meet the midclavicular line at the 8th rib, the axillary line at the 10th rib & the back on the side of the vertebral column at the 12th rib
- From here the line of reflection ascends up to meet the line of cervical pleura
- The Lt P differs little from the Rt, from the 4th c.c the reflection line passes to the left as it descends to lie 2 cm from the sternal border at the 6th c.c, then at the 8th rib it meets the MCL then the same thing of the Rt happen to the Lt reflection line
- Left pleura has no cardiac notch like the lung
- The area of the heart so exposed by this pleural & lung reflection is called the precordium
- Lower pleural reflection drops little below the 12th rib, an important point to be noticed in incisions for renal operations!
- A stab wound in the lower 2 intercostal spaces also endanger the pleura & may cause pneumo- or haemothorax

The lungs:
- In health, each lung lies free in its pleural coverings attached only by its roots & the pulmonary ligament
- The Rt lung is larger, though shorter & wider than the Lt as the liver pushes it upward across the Rt dome of the diaphragm
- The heart occupies more from the Lt than the Rt side of the thorax, hence the smaller size of the Lt lung
- A healthy lung looks shiny pink-gray with polygonal lobules, impregnation in the fixative darkens its colour
- Parts:
  * Apex; is the part of the lung which lies in the root of the neck, above the 1st rib
  * Base; is concave in conformity with the dome of the diaphragm, the concavity of the Rt lung is deeper than the Lt
- The lung root:
  - Surrounded by the pleural reflection where the 2 layers are continuous with each other
  - It is occupied by the PA, 2 PV & the main bronchi
  - The PV lies highest, the bronchus most posterior & the 2 PV one anterior & one inferior
  - On the Rt side, the eparterial bronchus may be seen above the PA, a picture not available in the Lt lung
  - Pulmonary ligament; is a loose layer of the pleura dropped behind the structures of the lung root
  - Bronchial vessels, pulmonary plexuses & lymph nodes are also seen at the lung root
- Surface projections:
- Lung projections are similar to the pleural projections with the following notes:
  - Apex & Rt anterior border are identical, though as the 2 pleurae meet each other in the midline retro-sternally, the anterior borders of the lungs lie behind the sternal borders
  - Regarding the lower border, lungs are 2 ribs short of the pleural reflections, i.e; if pleural reflection at the axillary line is at the 10th rib the lung at this line is reflected at the level of the 8th rib & so on
  - The anterior border of the Lt lung leaves the 4th c.c & goes horizontally to the point midway between the midline & MCL, then descends down & medially to the back of the 6th c.c at the side of the sternum, producing the cardiac notch
- Lobes & fissures:
  - * Oblique fissure;
  - Present in both lungs, starts level with the spine of T3 posteriorly, it cuts the 5th rib in the MAXL, then ends at the 6th chondrosternal junction anteriorly
  - It extends from the costal surface to the lung root completely dividing the lung into 2 lobes, an anterosuperior (upper lobe) & a posteroinferior (lower lobe)
  - * Horizontal fissure;
  - Only seen in the Rt lung, starting under the 5th rib in the posterior axillary line & passes anteriorly to end behind the 4th c.c
  - It divides the Rt upper lobe into upper & middle lobes
  - The lingula of the left lung is homologous with the middle lobe of the Rt lung in broncho-pulmonary architecture
- The broncho-pulmonary segments:
  - Each lobe is further divided into smaller lobes which receive separate bronchi from the main lobar bronchus
  - The segments are 3 for the upper, 2 for the middle (or lingula) & 5 for the lower lobe
- Bronchial divisions:
  - About 20-25 generations arise from the main bronchi
  - The 1st ten generations are the secondary bronchi which contain cartilage in their walls & are more packed
  - The next 15-20 generations are the bronchioles, which contain a good amount of muscle in their walls
  - Terminal bronchioles have complete muscle wall, they are 0.7 mm in diameter
  - Respiratory bronchioles, each one gives 2-11 alveolar ducts, each duct gives rise to 5-6 alveoli resulting in 300-400 million alveolus in each lung

The pulmonary arterial system:
  - Each PA enters the root of the corresponding lung being the highest structure, in the Rt lung the eparterial bronchus overlies the Rt PA
  - The artery ramifies & subdivide following the bronchial tree & pulmonary segments

The pulmonary veins:
  - Small veins are superficially arranged in the lobules & segments
  - 2 PV leave each lung, a superior & inferior, each comes from the corresponding main lobe
  - The superior PV is the most anterior & the inferior PV is the most inferior structures in the lung root

The pulmonary lymphatics:
  - Superficial L follow the lung surface & borders to drain into the broncho-pulmonary nodes at the lung root
  - Deep L follow the bronchial & venous system & also end in the same nodes

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- There are no lymphatics in the alveolar wall

The pulmonary nerve plexus:
- Anterior & posterior pulmonary plexuses are formed by vagal & sympathetic fibers
- They lie anterior & posterior to lung root
- Ant. one communicates with the posterior
- The posterior communicates with aortic & oesophageal plexuses
- Vagal stimulation produces bronchospasm & increases mucous secretion
- Sympathetic stimulation produces bronchodilatation & reduces glandular activity

The posterior mediastinum:
- This is the area of the inferior M which lies behind the pericardium
- It contains all the remaining structures of the thorax
- It is continuous above with most of tissue spaces of the neck
- Contents;
  - Oesophagus
  - Descending aorta
  - Azygos & hemiazygos systems
  - Thoracic duct
  - Autonomic nerves & plexuses (sympathetic trunk & vagal system)
  - Lymph nodes

The oesophagus:
- This muscular tube, 25 cm long, lies in the midline with tendency to incline to the left side as it descends, that it pierces the diaphragm distinctly to the left of the midline
- It starts at C6 level, descends in the superior M like in the neck behind the trachea anterior to the vertebral column
- It has 3 main constrictions, at C6, where the left main bronchus passes in front of it compressing it & at the diaphragmatic orifice
- The O lies on the Rt of the aortic arch & descending thoracic aorta, as the O tends to attain Lt position & the aorta tends to take midline position, the O will pass anterior to the thoracic aorta crossing it at the level of T8 vertebra
- The azygos vein lies to its Rt side, the thoracic duct intervenes between the two
- As it descends, the O lies anterior to the Rt posterior intercostal arteries
- Behind the pericardium, the O is in very close contact with the LA who it indents in contrast radiography
- It pierces the diaphragm to the left of the central tendon at the level of T10 vertebra
- Phrenico-oesophageal lig.; an extension from the inferior diaphragmatic fascia through the O hiatus for many centimeters inside the thorax to enclose the lower O, it permits independent movements of O & diaphragm & prevents hiatus hernia
- Abdominal O is funnel shape, 1.2 cm long, grooves the back of the Lt lobe of the liver to enter the gastro-oesophageal junction at the level of the body of T11

Arteries:
- Cervical O; inferior thyroid a.
- Thoracic O; oesophageal branches from the bronchial arteries & thoracic aorta
- Abdominal O; left gastric a.

Veins:
- Cervical O; inferior thyroid v.
- Thoracic O; azygos system
- Abdominal O; left gastric v.

*Porto-systemic anastomosis in the lower O:
- Veins in the submucosa of the O anastomose with each other
- Those of the thoracic O drain to the systemic veins
- Those of the lower O drain to portal veins
- Communication between systemic & portal systems will be established in the lower O
- As these veins are not well supported they will engorge in case of liver diseases (portal hypertension)
- The engorged veins will bleed easily resulting in vomiting of blood, a sign of liver disease clinically known as haematemesis

Lymphatics:
O drains to:
- Posteroinferior deep cervical nodes
- Paratracheal nodes
- Posterior mediastinal nodes
- Upper gastric nodes

Nerve supply (oesophageal plexus):
- After leaving the pulmonary plexus, the vagi faltten & become arranged behind (the Rt) & in front of (the left) the O
- In this new position, vagi do not loose communication with each other
- Then they re-divide to form a plexus which surrounds & infiltrate the O wall, O plexus
- Sympathetic fibers share in the formation of this plexus, they come from the greater splanchnic n. & ganglia T 6-10
- Just above the diaphragm, the plexus gives rise to 2 vagal trunk, anterior & posterior, each contains fibers from the original 2 vagus nerves
- This plexus supplies the smooth muscles & glands of the lower 2/3 of the O, the upper 1/3 (striated muscles) with its glandsis supplied by the RLN

The descending thoracic aorta:
- This is the continuation of the aortic arch at the lower border of T4 vertebra
- Here it lies on the left of the midline, as it descends it attains a midline position to leave the thorax in the midline between the 2 diaphragmatic crura opposite to T12 vertebra
- The following structures lie anterior to it as it descends: root of Lt lung, pericardium, oesophagus & diaphragm.
- The azygos, hemiazygos & accessory H systems with the posterior intercostal veins lie behind it
- O crosses it from Rt to Lt at T8 level
- Apart from the lower 9 posterior intercostal arteries, the thoracic aorta gives small branches: Pericardial, bronchial, oesophageal, posterior mediastinal & superior phrenic arteries

The azygos venous system:
The azygos vein:
- This venous channel is formed in the upper part of the posterior abdominal wall by union of the ascending lumbar & Rt subcostal veins (inferior phrenic may replace the subcostal v.)
- It ascends to the thorax piercing the Rt crus of the diaphragm
- In the thorax it ascends on the Rt side of the vertebral column anterior to the intercostal a.
- Thoracic duct intervenes between it & the aorta

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- At the level of 2nd c.c (T4) the vein arches forward over the root of the Rt lung (grooving it) to empty in the SVC before the latter pierces the pericardium
- Tributaries:
  1-Rt post. intercostal v. 4-11 directly.
  2- Rt. post. intercostal v. 2&3 through the Rt superior intercostal vein.
  3- Hemiazygos & accessory hemiazygos veins.
  4- Veins corresponding to branches of thoracic aorta (oesophageal, bronchial …).
  5- In cases of absent left venous channels it receives the left posterior intercostal v. too.

The hemiazygos vein:
- Formed like the azygos v.
- Ascends to the left of vertebral bodies behind the aorta as high up as T9
- At T9 it passes to the Rt side behind aorta, oesophagus & thoracic duct to end in the azygos v.
- Tributaries;
- • Lower 4-5 intercostal v.
- • Lower oesoph. v.
- • Some mediastinal v.
- • Sometimes, the accessory hemiazygos v.

The accessory hemiazygos vein:
- This v. occurs occasionally in the upper left part of the posterior M.
- Interposed between the hemiazygos & left superior intercostal vein, being connected to both
- Receives:
- • The posterior intercostal veins 4-7-8
- • Bronchial v.
- • Upper oesophageal v.
- • Mediastinal v.
- Ends at T8 in the azygos v.

The thoracic duct:
- This is the largest lymphatic channel in the body bringing chyle from all the body except the Rt half above the diaphragm
- It is the continuation upward of cysterna chyli which is formed in the posterior abdominal wall at L2 level by union of the lumbar & intestinal lymph trunks
- It enters the thorax through the aortic opening of diaphragm between the aorta & azygos v.
- Ascends behind the aorta on the veins of post. M
- At T4 (sternal angle), TD inclines to the left to lie behind the aortic arch in the superior M
- At the root of the neck, TD arches anteriorly to end in the junction of the Lt SCV & IJV
- It receives; post. intercostal LT, pos. mediastinal LT, bronchomediastinal LT, Lt subclavian & Lt jugular LT
- TD conveys 100-200 cc of lymph per hour, its traumatic or iatrogenic injury leads to accumulation of lymph in the thorax, a condition called chylothorax
- Lymphatics of the chest:
- * Parietal L.; discussed
- * Visceral L.;
- 1- Tracheobronchial nodes; discussed
- 2- Anterior mediastinal nodes; lie along the brachiocephalic veins, receive from structures in the anterior M & anterior part of the superior M, joins with (1) to form the bronchomediastinal LT
3- Posterior mediastinal nodes; lie in the region of the O & thoracic aorta behind the pericardium, receives from the post. M & post. part of superior M, their efferent goes to the TD, or sometimed join the bronchomediastinal trunk.

The thoracic sympathetic trunk:
- It is the largest autonomic chain in the body
- Its formed of 12 ganglia, in 80% of cases T1 fuses with the lower cervical ganglion forming the stellate G. at the neck of the 1st rib
- The trunk lies on each side of the vertebral column in the region of the rib necks
- Preganglionic fibers of the thoracic G comes from the lateral gray column of the spinal cord which extends from T1-L2 segments
- A communication of each segment with 1-2 segments above & below for better function
- Postganglionic fibers are somatic & visceral branches
- Somatic postganglionic Fibers accompany the corresponding spinal nerves & distribute with them
- Visceral postganglionic branches are:
  - To thoracic viscera:
    - These branches mainly furnished by T1-T4 ganglia & distributed to:
      - 1- Branches to the pulmonary plexus.
      - 2- Branches to the oedophageal plexus.
      - 3- Branches to the aortic plexus.
    - To abdominal viscera:
      - These are preganglionic nerves which synapse in abdominal ganglia where postganglionic branches supply abdominal viscra, they are mainly given by lower thoracic ganglia:
        - 1- Greater splanchnic nerve; arises from T5-9 ganglia, descends lateral to the ST to pierce the crus of the diaphragm & end in the coeliac ganglion.
        - 2- Lesser splanchnic n.; arises from T10-11 ganglia, also pierce the diaphragmatic crus & end in the aortorenal plexus.
        - 3- Least splanchnic n.; arises from T12 g.; pierce the crus & end in the renal plexus

The diaphragm:
- A thin sheet of muscle essentially work for respiration separating the abdominal from the thoracic cavities
- Viewed from the ventral side, the D possesses right & left domes , both ascend during full expiration to their highest levels where the right dome reaches the 4th space on the right & the left reaches the 5th rib on the left
- In between these 2 domes the D has a central tendon lying at the level of the lower sternum (6th costal c.)
- Viewed from lateral profile, the D is seen in an inverted J shape with the long limb ascending from the upper lumber region (PAW) & the short limb descends to the xiphisternum
- Viewed from above, the D is kidney shaped
- Origin:
  - Trace the ring shaped origin of the d from behind forward:
    - 1-crura:
      - Right crus lies on the right side of the upper 3 lumbar vertebrae & the intervening discs
      - Left crus lies on the left side of the upper 2 lumbar vertebrae & the intervening disc
    - Muscles radiate from each crus overlap & then pass to the central tendon

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- * Right crus supports the gastro-oesophageal & duodeno-jejunal flexures
- 2- Arcuate ligaments:
- - Medial arcuate ligament is a thickening in psoas fascia between the body of L2 & transverse process of L1
- - Lateral arcuate ligament is a thickening in the anterior lamella of lumbar fascia between the transverse process of L1 & the tip of the 12th rib
- 3- The tip of twelfth rib
- 4- The inside inside of the costal margin
- 5- The xiphisternum
- Insertion:
- From this ring shaped origin, fibers ascend & then descend in the direction of the central tendon which looks like tripple-headed leaf nearer to the posterior than the anterior aspect to complete the seal of the two cavities.
- Openings:
- * Caval: T8 , on the Rt of the central tendon
- * Oesophageal: T10, in the fibers of the Lt crus
- * Aortic: T12, in between the 2 crura
- Other structures like the azygos veins, thoracic duct, splanchnic nerves … pass with these main structures
- Blood supply:
- 1- Pericardiacophrenic a.
- 2- Superior phrenic branches of thoracic aorta
- 3- Inferior phrenic branches of abdominal aorta
- Nerve supply:
- Phrenic nerves