Thoracic wall
- The main function of the thoracic wall is to protect the viscera within
- Mechanical basis of breathing
- Thoracic wall includes thoracic cage (ribs, sternum and vertebra) and covering (skin and muscle)

Thoracic cage
Ribs
- There are 12 ribs and each of these ribs are associated with a costal cartilage (anteriorly). And these costal cartilages attach the each of the ribs to the sternum anteriorly.
- The costal cartilage is movable so they are very important for mobility of the thoracic cage (allows it to expand in breathing)
- The ribs can be classified via various systems
  - True, false, floating
    - Ribs 1-7 = true ribs
      - Each of them attach directly to the sternum via there own costal cartilage
    - Ribs 8-10 = false ribs
      - Each of them attach to the costal cartilage of the rib above it (no direct attachment to the sternum)
    - Ribs 11-12 = floating ribs
      - They have no anterior attachment at all
  - Typical or atypical
    - Ribs 3-9 = typical ribs
      - They have all the sorts of features that most of the ribs have
      - Curved and flat
      - There are some lumps particularly in the posterior end that are relevant for articulation with the vertebra and for both the body of the vertebra and the transverse processes
    - There is a groove around most of the shaft of the rib and this is called the costal groove. This groove shelters and protects the intercostal vein, artery and nerves in the intercostal space.
    - Posterior end
      - There are 2 articular processes called facets. These facets articulate with the body of the vertebra.
        - Superior facet articulates with inferior demifacet of the body of vertebra and the inferior facet articulates with the superior demifacet of the body of the vertebra below
      - There is an articular facet and tubercle just lateral to the neck.
        - The articular facet is used for the articulation with the transverse process of the vertebra. So, the head of each rib articulates with the
body of the vertebra and the transverse process articulates with the transverse process

- The tubercle is made by mainly the ligaments associated with the joints between the ribs and the vertebra

- Ribs 1-2, 10-12 = Atypical ribs
  - They look different to a typical rib due to different markings
  - i.e. rib 1 (picture) – it is flat in the coronal plane unlike other ribs that are flat vertically. There are some grooves for the subclavian vessels over the top of the first rib. There is a scalene tubercle and this is relevant for the attachment of some of the scalene muscles in the neck.
  - [we don’t need to know the features of all the atypical ribs – just know the relationship of the structures around these ribs based on the lumps etc.]

**Sternum**

- This is commonly known as the breast plate [check] and it closes the anterior aspect of our ribcage.
- It is made of 3 different processes:
  - Manubrium
    - It has a jugular notch which has some highly innervated periosteum and skin
    - Clavicular notch – for the articulation of the clavicles
    - Directly below the clavicular notch is the point of articulation for rib-1
      - Rib 2 articulates at the junction between the manubrium and the sternum = manubriosternal joint
        - In a lateral view, we can see a bump that is formed by the angle of the manubrium and the sternum at this joint
        - This is known as the angle of Louis or the sternal angle
        - If we were to put a horizontal line all the way through the thorax we will get this transverse plane through the sternal angle and this is called the plane of Louis
  - Body of sternum
  - Xiphoid process – this is largely cartilaginous until much later in life when it starts to ossify and become less cartilaginous

**Thoracic vertebra**

- Thoracic vertebra has many features similar to other vertebra but they have some unique features

**Articulations for ribs**

- There is a superior demifacet for the articulation with the rib of the same number as the vertebra
- The inferior demifacet articulates with the rib below
- [note: Vertebra one has a superior facet not a demifacet and the full rib sits here]
- Costovertebral joint – the joint where the rib and the vertebra joins
- Costotransverse joint – the joint between the transverse process of the vertebra and the rib
  - There are some ligaments reinforcing this and this occurs at the Costal facet of the transverse process
Intercostal space
- Intercostal space – space between each of the ribs
- Intercostal muscles – muscles that fill up these spaces.

Intercostal muscles
- There are 3 layers of intercostal muscles – they all run in the same sort of orientation
- The most superficial layer of the muscles is called the external intercostal muscles and they run antero-inferiorly
  - They project all the way through the space posteriorly and anteriorly they form a membrane so there are no muscle fibres anteriorly
  - The external intercostal muscles elevate the ribs
  - They stop somewhere at the costochondral junction
- The second layer of muscles is called the internal intercostal muscles and they run perpendicular to the external intercostal muscles – postero-inferiorly
  - Posteriorly, these muscles break down and form a membrane but anteriorly we can see all the muscles through to the sternum
  - There are 2 types of movements here depending on where in the intercostal space
    - If it is lateral to the costochondral junction – because they have the opposite fibre direction to external intercostal muscles, the internal intercostal muscles will depress the ribs (not elevate)
    - If they are medial to the costochondral junction – then they will elevate the ribs. This is due to the shape of the ribs (3D structure of the ribs)
- Innermost intercostal muscles – they tend to be broken down and be patchy
  - Posteriorly they are very deficient – there is no membrane either
  - The direction of these muscle fibres are the same as those of the internal intercostal muscles so they both must have the same functions

Intercostal space
- Intercostal veins, arteries and nerves are in between the innermost intercostal layer and the internal intercostal muscle layer. They are sheltered high in the intercostal space under the costal groove of the rib above.
  - So, if we want to aspirate some fluid in the pleura we want to make sure that we penetrate above the rib below to avoid going close to and damaging this neurovascular bundle
Intercostal nerves
- The figure is a coronal section
- Intercostal nerves are extensions of the spinal segmental nerves which comes out of the intervertebral foramina of the vertebral column
- As the spinal nerve leaves the intervertebral foramina it also gives off a dorsal ramus to supply the skin and muscles over the vertebral column = erector spinae muscles
- As it comes out laterally, these intercostal nerves give off muscular branches to all the intercostal muscles (in the same segment) and this is important as they produce movements of the ribs that contribute to breathing
- As it goes through and runs forward, it ends up terminating at some cutaneous branches on the anterior thoracic wall and also some lateral cutaneous branches which innervates the skin over the lateral thoracic wall.
  - Each of these branches supply a strip of skin over the thoracic wall which is related to that spinal segmental wall. This makes it easy for us to define the dermatomes in relative to the intercostal spaces. (it is a single nerve here – there are no plexuses and there is no mixing etc.)
- There are 12 thoracic segments. T4 = strip over nipples and T10 = strip over belly button

Intercostal vessels
- There are 2 intercostal arteries – 1 posterior which enters the space from behind and 1 anterior one that enters the space from the front.
- Posterior intercostal arteries are just segmental branches of the thoracic aorta
- Anterior intercostal arteries are branches of the internal thoracic arteries. The internal thoracic arteries are branches of the subclavian artery and they descend posterior and lateral to the sternum all the way down the segments giving anterior intercostal arteries into the anterior aspect of the intercostal space.
- Anterior and posterior intercostal nerves anastomose with each other somewhere on the anterior thoracic wall. This is important clinically as it provides an alternate route for blood to some of the skin and muscle in this intercostal space
  - The internal intercostal arteries are often used for bypasses of coronary artery blockages.
- The transversus thoracis muscle is on the inside of the anterior thoracic wall. It attaches partly to the sternum so it has its own name. But it has the same sort of functions as the innermost intercostal muscles.