

Surface Anatomy and Ultrasound Scanning

Surface Anatomy

Anatomical Boundaries

Instructions: On an articulated skeleton, identify or trace the following anatomical landmarks as indicated using the notes and diagrams as a guide.

- On an articulated skeleton, trace bilaterally the **costal margin** and identify the **xiphoid process**.
- Note that the **diaphragm** physically separates the thoracic cavity from the abdominal cavity.
- On an articulated skeleton, identify the following anatomical landmarks:
 - **Anterior superior iliac spine**
 - **Posterior superior iliac spine**
 - **Iliac crest** (trace the entire length of the iliac crest)
 - **Iliac tubercle**
 - **Pubic tubercle**
 - **Pubic symphysis**
 - **Pubic crest**

Notes

The iliac crest starts at the anterior superior iliac spine and terminates at the posterior superior iliac spine. The iliac tubercle and anterior superior iliac spine are part of the iliac crest. In the anatomical position, the most lateral bony projection of the iliac crest corresponds to the iliac tubercle. The pubic crest lies between the pubic tubercle and the symphysis pubis.

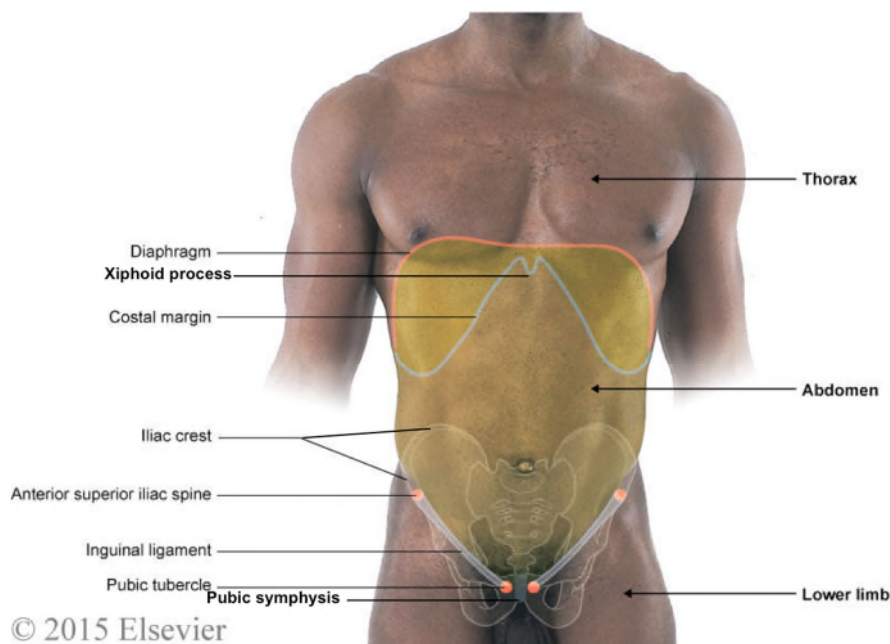


Fig. 4-163. Anterior view of the abdominal region of a man. Palpable bony landmarks, the inguinal ligament, and the position of the diaphragm are indicated.

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- On an articulated skeleton, trace the **inguinal ligament** from the **anterior superior iliac spine** to the **pubic tubercle** as shown on the diagram above.

- Differentiate between the **mid-inguinal point**, which is the surface marking of the femoral artery, and the **midpoint of the inguinal ligament**.

Notes

The mid-inguinal point lies midway along a line between the anterior superior iliac spine and the pubic symphysis. This is the surface landmark of the femoral artery inferior to the inguinal ligament. The midpoint of the inguinal ligament lies midway along a line between the anterior superior iliac spine and the pubic tubercle. This has classically been described as the approximate surface landmark of the deep inguinal ring superior to the inguinal ligament. The surface marking of the deep inguinal ring is a matter of on-going debate with some textbooks stating that this is superior to the mid-inguinal point. Recent literature has also suggested that the deep inguinal ring is located in the mid-inguinal region between the mid-inguinal point and the midpoint of the inguinal ligament. Please note that there is no consensus regarding the exact surface marking of the deep inguinal ring.

Four Quadrant Topographical Pattern

Instructions: Complete the first task from this section before the workshop and bring the drawings with you for the demonstrator to check them.

- On an A4 paper, draw the **four quadrant topographical pattern** of the anterior abdominal wall and label this diagram with the following landmarks:
 - **Transumbilical and median planes.**
 - **Right upper and lower quadrants.**
 - **Left upper and lower quadrants.**

Notes

The transumbilical plane lies at the level of the umbilicus corresponding to the L3/4 intervertebral disc. The median plane passes through the xiphoid process and pubic symphysis.

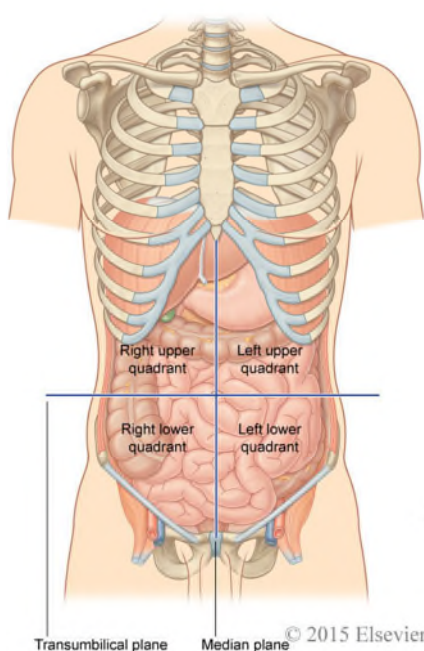


Fig. 4-22. Four-quadrant topographical pattern.
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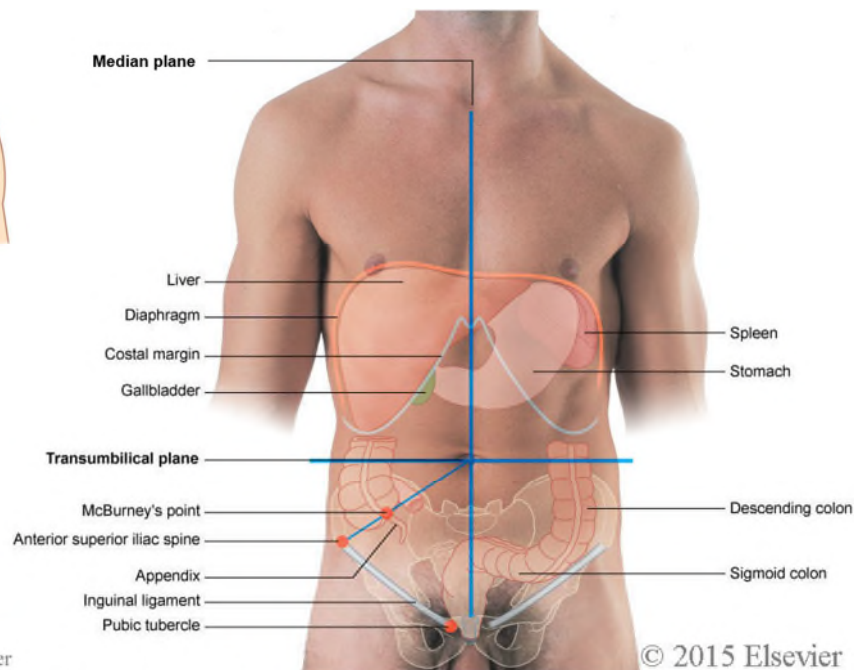


Fig. 4-168. Abdominal quadrants and the positions of major viscera. Anterior view of a man.
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- On an articulate skeleton, indicate the position of **McBurney's point**, which typically overlies the base of the vermiform appendix as it attached to the caecum, and is a **third of the distance from the right anterior superior iliac spine to the umbilicus**.

Notes

Tenderness at McBurney's point during deep palpation is known as McBurney's sign, which can signify acute appendicitis. Pain localisation at McBurney's point indicates irritation of the peritoneum that is in contact with the vermiform appendix.

- Note the major organs in each quadrant as illustrated in the diagram above (e.g. liver, gallbladder, stomach, spleen, vermiform appendix, descending colon, and sigmoid colon).

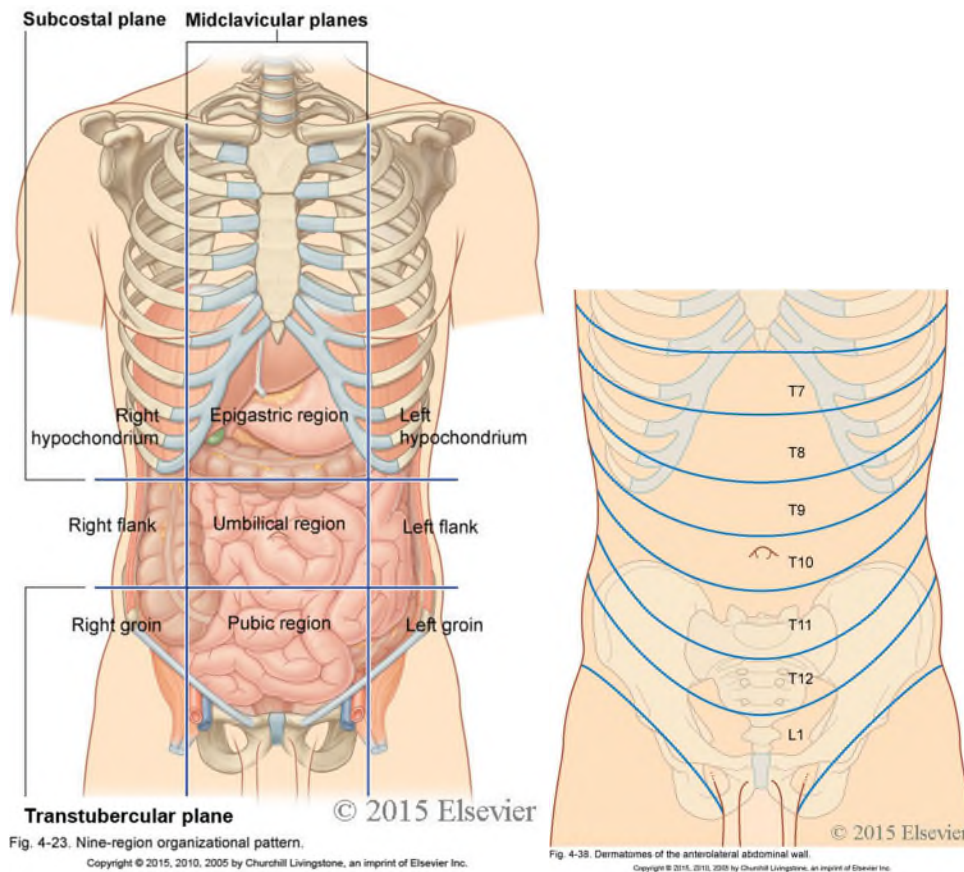
Nine Region Topographical Pattern

Instructions: Complete the first task from this section before the workshop and bring the drawings with you for the demonstrator to check them. Please note that different terms are used interchangeably to describe the same plane/region and it would be advisable to be familiar with all of these terms as they are described below.

- On an A4 paper, draw the **nine region topographical pattern** of the anterior abdominal wall and label this diagram with the following landmarks:
 - **Midclavicular lines/planes**
 - **Subcostal plane**
 - **Transtubercular/intertubercular plane**
 - **Right and left hypochondrium**
 - **Right and left flank/lumbar regions**
 - **Right and left groin/inguinal regions/iliac fossae**
 - **Epigastric, umbilical and pubic/suprapubic/hypogastric regions**
- Note that the **T10 dermatome** lies at the level of the umbilicus.

Notes

The midclavicular plane/line passes through the midpoint of the clavicle. The subcostal plane lies at the level of the L3 vertebra uniting the lowest point of the costal margins that are typically at the level of the 10th costal cartilages. The origin of the inferior mesenteric artery and the 3rd part of the duodenum lie on the subcostal plane. The transtubercular/intertubercular plane lies at the level of the L5 vertebra uniting the two iliac tubercles. This is the plane where the common iliac veins join to form the inferior vena cava (origin of inferior vena cava).



Anatomical Planes

Instructions: On an articulated skeleton, trace the following anatomical planes using the notes and diagrams as a guide.

- Trace the **transpyloric plane**.

Notes

The transpyloric plane lies midway between the suprasternal/jugular notch and the superior border of the pubic symphysis. This roughly corresponds to a plane that is midway between the xiphisternal joint and the umbilicus. Posteriorly, the transpyloric plane intersects the L1 vertebra. Anteriorly, it intersects the costal margin of the 9th costal cartilage. The following structures are traditionally described as lying on this plane: pylorus of stomach; neck of pancreas; fundus of gallbladder; first part of duodenum; duodenojejunal flexure; origin of superior mesenteric artery; and termination of spinal cord.

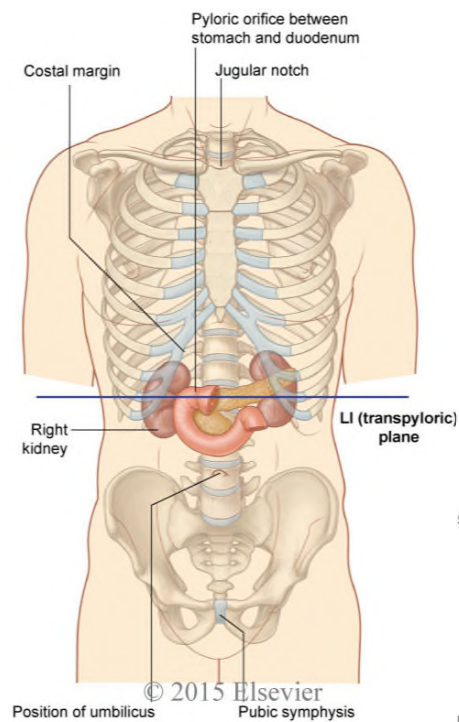


Fig. 4-16. Vertebral level L1.
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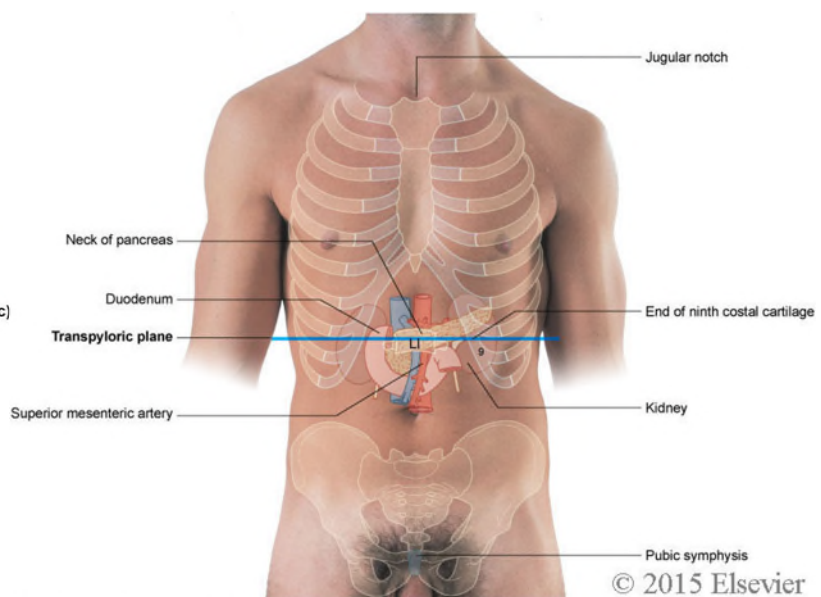


Fig. 4-166. L1 vertebral level and the important viscera associated with this level. Anterior view of the abdominal region of a man.

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- Trace the **subcostal plane**.
- Trace the **supracristal plane**.

Notes

The supracristal plane lies at the level of the L4 spinous process or the L4/5 intervertebral disc uniting the most superior points of the iliac crests. It is a useful landmark for lumbar puncture and the bifurcation of the aorta also lies on this plane.

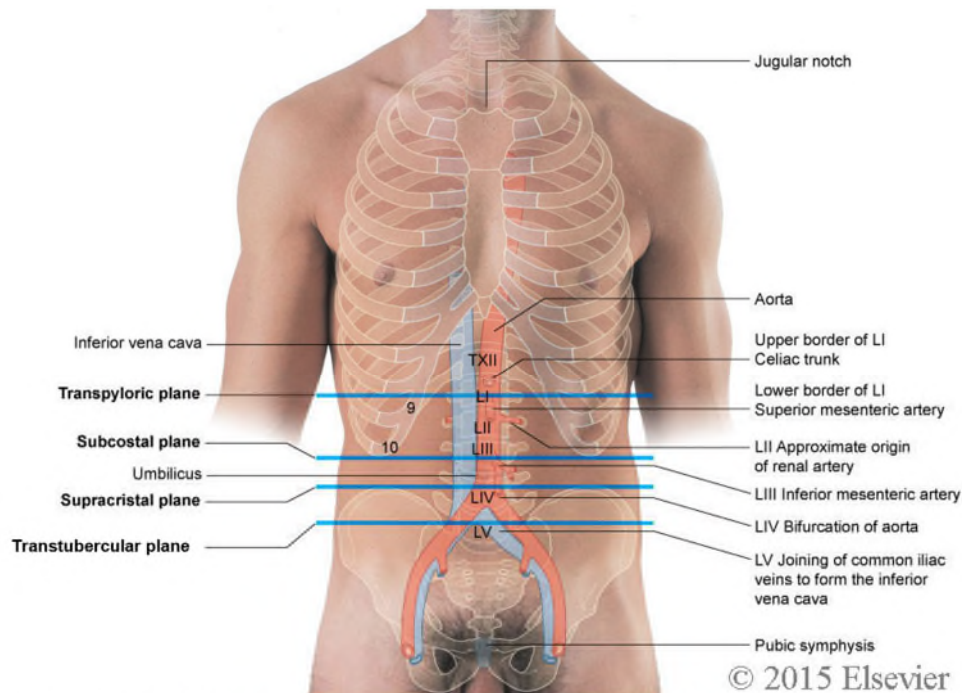


Fig. 4-167. Major vessels projected onto the body's surface. Anterior view of the abdominal region of a man.

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- Trace the **transtubercular/intertubercular plane**.

Abdominal Viscera

Instructions: On an articulated skeleton, indicate the position of the following abdominal organs using the notes and diagrams as a guide.

- Indicate the position of the **right and left kidneys**.

Notes

The right kidney typically lies, on average, 2cm lower than the left kidney. The vertebral limits of the left kidney are T12 to L3 and of the right kidney are L1 to L4.

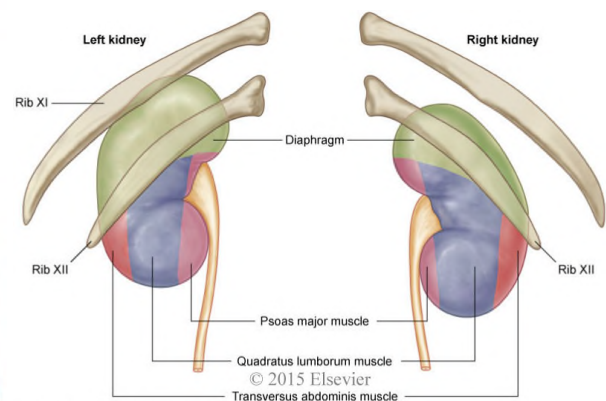
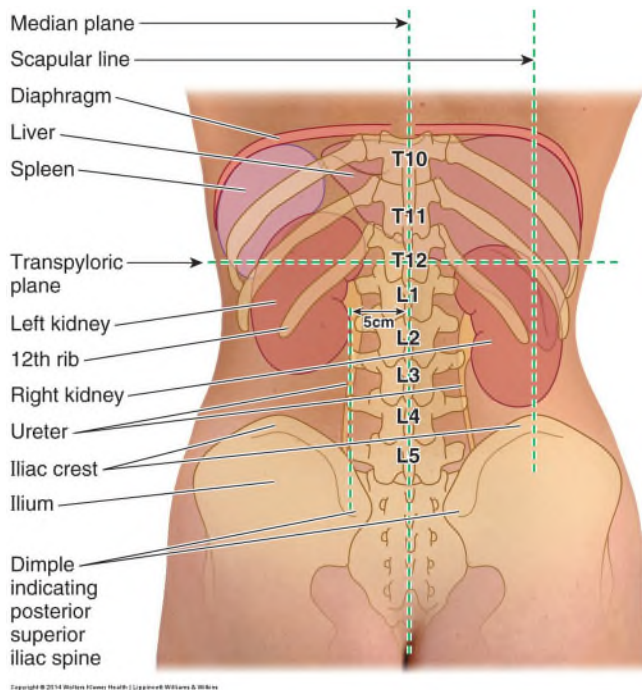


Fig. 4-139. Structures related to the posterior surface of each kidney.
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- Indicate the position of the **spleen**.

Notes

The spleen is traditionally described as lying on the left posterolateral abdominal wall deep to ribs 9, 10, and 11.

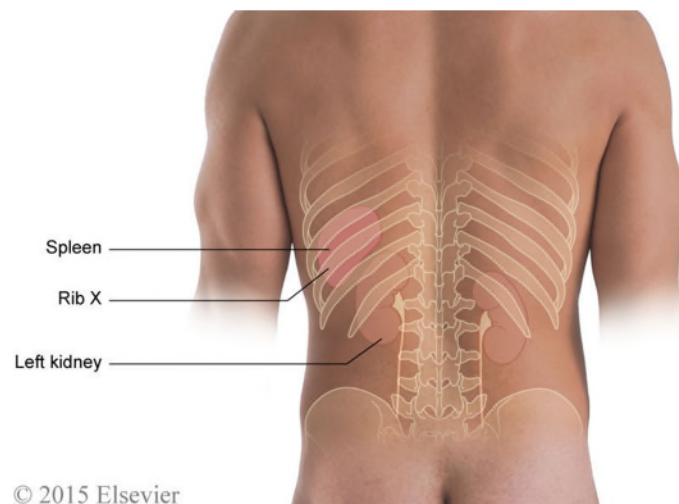


Fig. 4-171. Surface projection of the spleen. Posterior view of a man.
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Ultrasound Scanning

Instructions: Identify the following anatomical landmarks while scanning the **upper abdomen**. For this part of the session, stand on the volunteer's right side and use ample ultrasound gel (known as coupling medium) to allow for maximal visualisation of relevant structures. Please handle the transducer with care, as it is sensitive even to minor impact. Always place the transducer on the probe rack of the ultrasound trolley when it is not used. Always press **Freeze** when not actively scanning. The **Freeze** function is also automatically activated after a period of inactivity; please remember to inactive this function when wishing to commence scanning. **This is a challenging region to scan and as such it may not be possible to clearly visualise all the named structures. In this case, please consult the diagrams of this guide to consolidate your learning.**

Settings

Instructions: Use the roller and **Set/B Pause** button as a mouse to change settings. To adjust image 'brightness', use the overall **Gain** button (left side). To change the 'screen size' of the area of interest, use the **Depth** button (right side). If the cursor disappears from your screen, press the **Cursor** button. To return to normal grey scale imaging, press the **B** button.

- Switch on the ultrasound machine.
- Press **Preset** and under **4C**, select **ABD** and then **Abd**.
- If any parameters change, to restore factory/default settings, follow the process above.

ScanCoach

The ultrasound machines have an in-built teaching and reference image facility called **ScanCoach** that can assist you while scanning. To open this function, first press the **R** button of **ScanCoach** and then select the imaging that you wish to perform. On-screen information includes the optimal position for the transducer, an anatomical image, and a reference image. To open the reference image, press the **Ref** button of **ScanCoach**. To close the reference image, press again the **Ref** button of **ScanCoach**. To exit **ScanCoach**, press the square box at the bottom of this function.

Transducer (Probe)

- First identify and then practise holding the **curvilinear array transducer**. It is best to hold the transducer like a pen or like chopsticks predominantly with the first three fingers and stabilised with the remaining two fingers that can be rested on the volunteer's body.

Notes

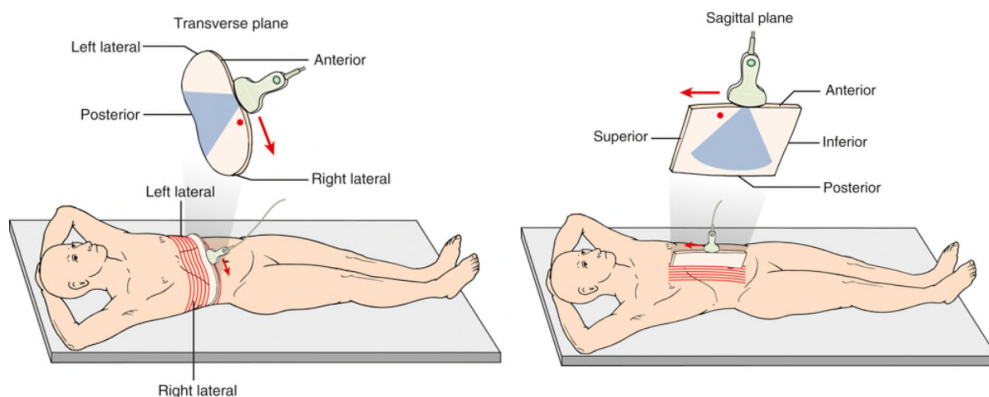
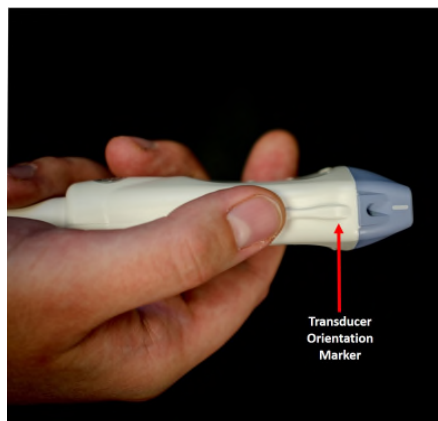
Curvilinear array transducers utilise lower frequencies to produce a fan-like image that is characterised by greater imaging depth but not as good resolution when compared to linear array transducers. The curvilinear array transducers are ideal for visualising deep structures (>5cm) in the abdomen and pelvis.

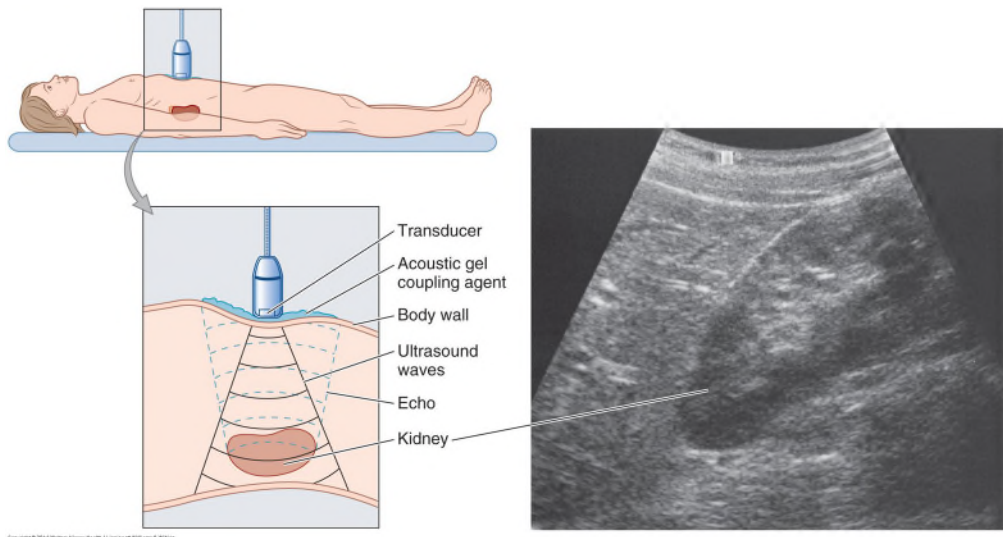


- Identify the **transducer orientation marker** (notch/probe marker) on the side. The transducer marker should be facing towards the volunteer's right side (your left side) when scanning in the transverse plane or towards the volunteer's head when scanning in the longitudinal/sagittal plane.

Notes

The transducer orientation marker corresponds to the left side of the screen. Holding the transducer in the transverse plane will produce cross-sectional images as if we are viewing from the foot of the bed. Superficial structures are viewed at the top of the image (next to the transducer) with deeper structures following further down.





- Touch the end of the transducer with the marker and look for faint movement on the left side of your screen to confirm correct orientation.

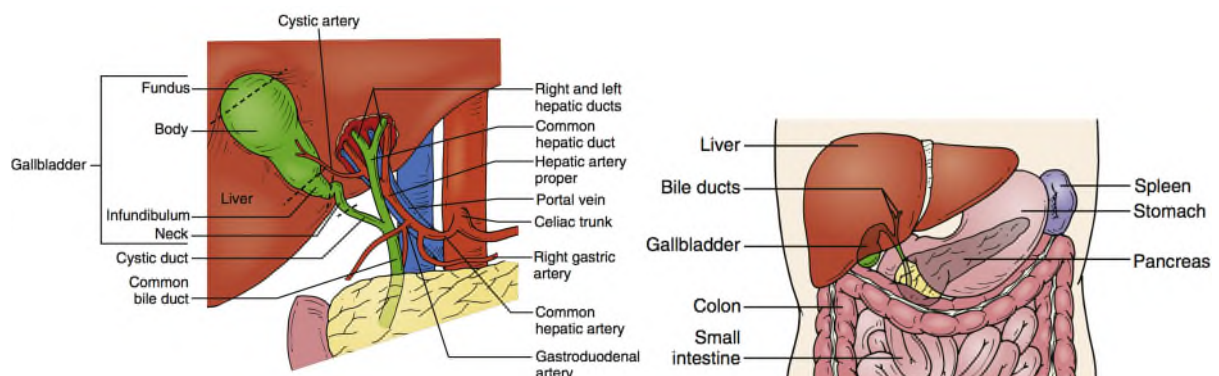
Notes

Maintain the structure(s) of interest in the centre of your screen.

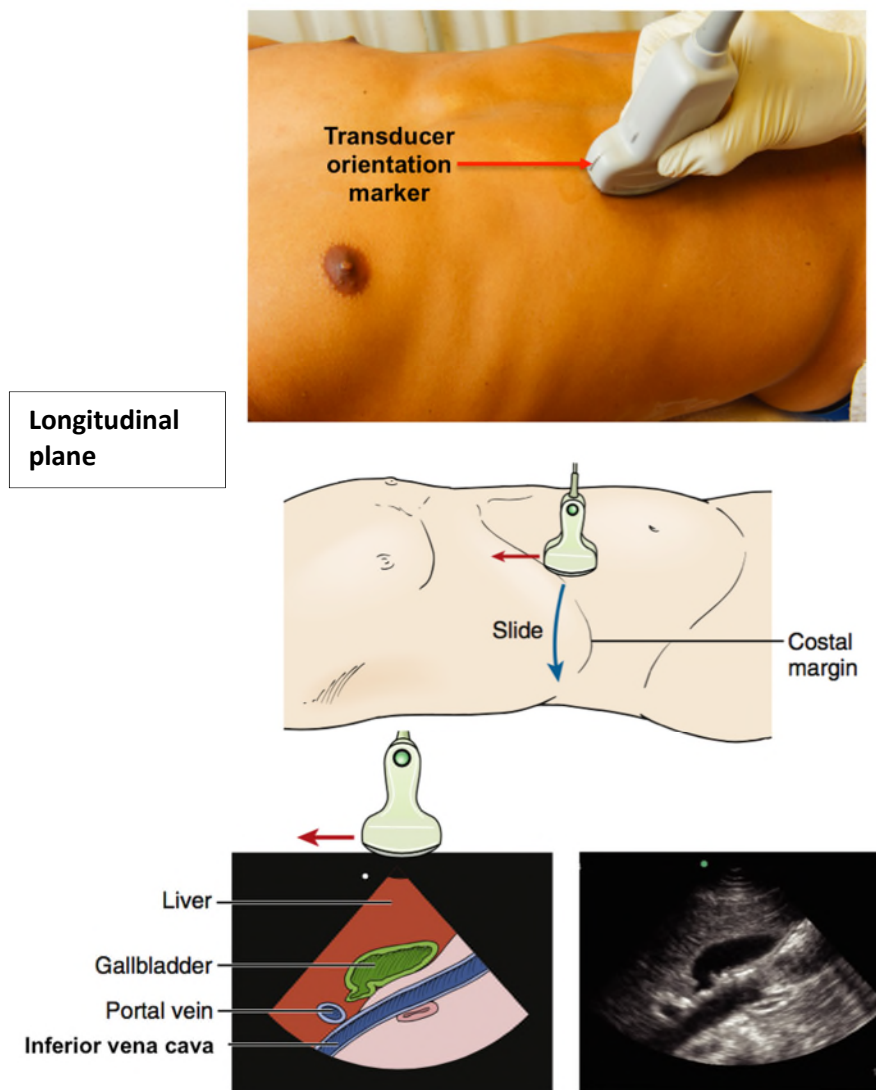
Upper Abdomen

Instructions: For this part of the session, follow the instructions below with or without **ScanCoach** to identify the relevant anatomical structures. Please keep in mind that visualisation of the abdominal viscera may be challenging.

Gallbladder and Liver

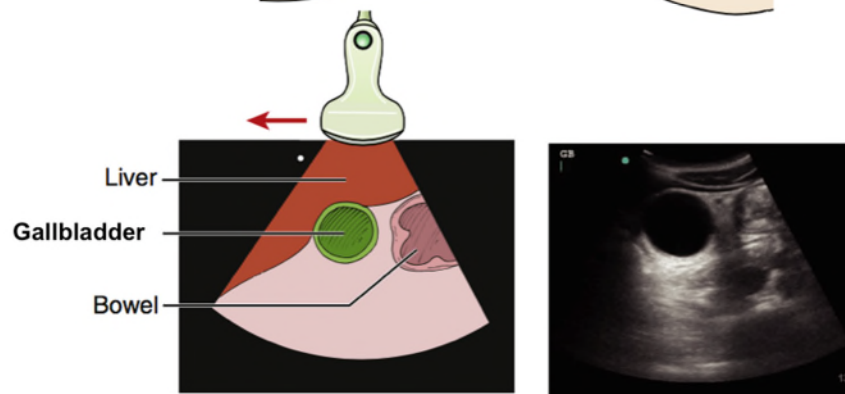
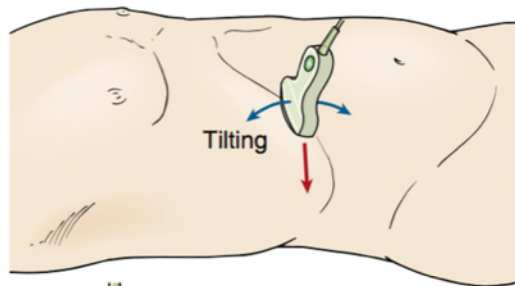


- Ask the volunteer to lie in the supine position.
- Place the transducer at the **right costal margin** starting medially at the xiphoid process.
- Slide the transducer laterally and inferiorly along the **costal margin** until the **gallbladder** is visualised in the longitudinal plane as per the diagram below.



- Identify, the following anatomical structures:
 - **Liver**
 - **Gallbladder**
 - **Portal vein**
 - **Inferior vena cava**
- Optional step: If visualisation is challenging, ask the volunteer to take a deep breath and hold this for a few seconds that will transiently descends the gallbladder inferiorly.
- Rotate the transducer orientation marker 90° counterclockwise to visualise the **gallbladder** in the transverse plane as per the diagram below.

Transverse
plane



- Optional step: If visualisation is challenging, ask the volunteer to take a deep breath and hold this for a few seconds that will transiently descend the gallbladder inferiorly.
- Identify, the following anatomical structures:
 - **Liver**
 - **Gallbladder**

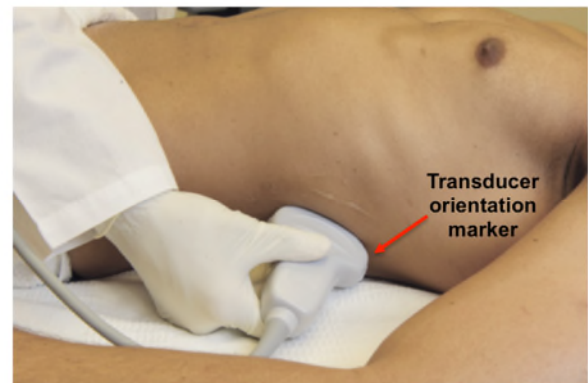
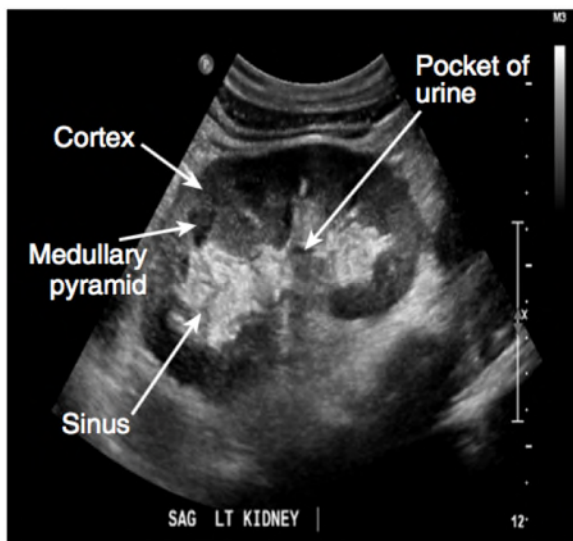
Kidneys

Notes

As the kidneys lie in an oblique longitudinal plane, with the inferior pole more anterior and lateral when compared to the superior pole, the conventional approach to producing ultrasound images as described above is not recommended.

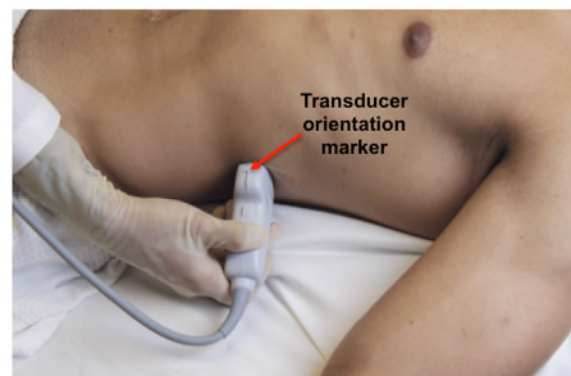
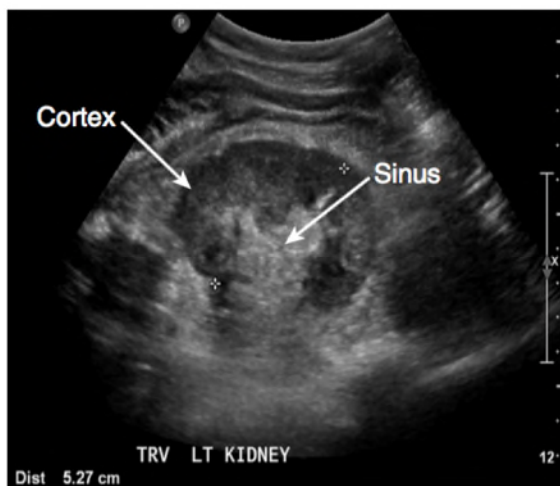
- Ask the volunteer to lie in the supine position. It may be easier to visualise the right kidney due to its position when compared to the left kidney.
- Place the transducer in the coronal plane, between the mid-axillary and anterior axillary lines, at the level of the xiphoid process. Rotate the top of the transducer and hence the transducer

orientation marker, 15-30° posteriorly, to capture the long axis of the kidney as per the diagram below.



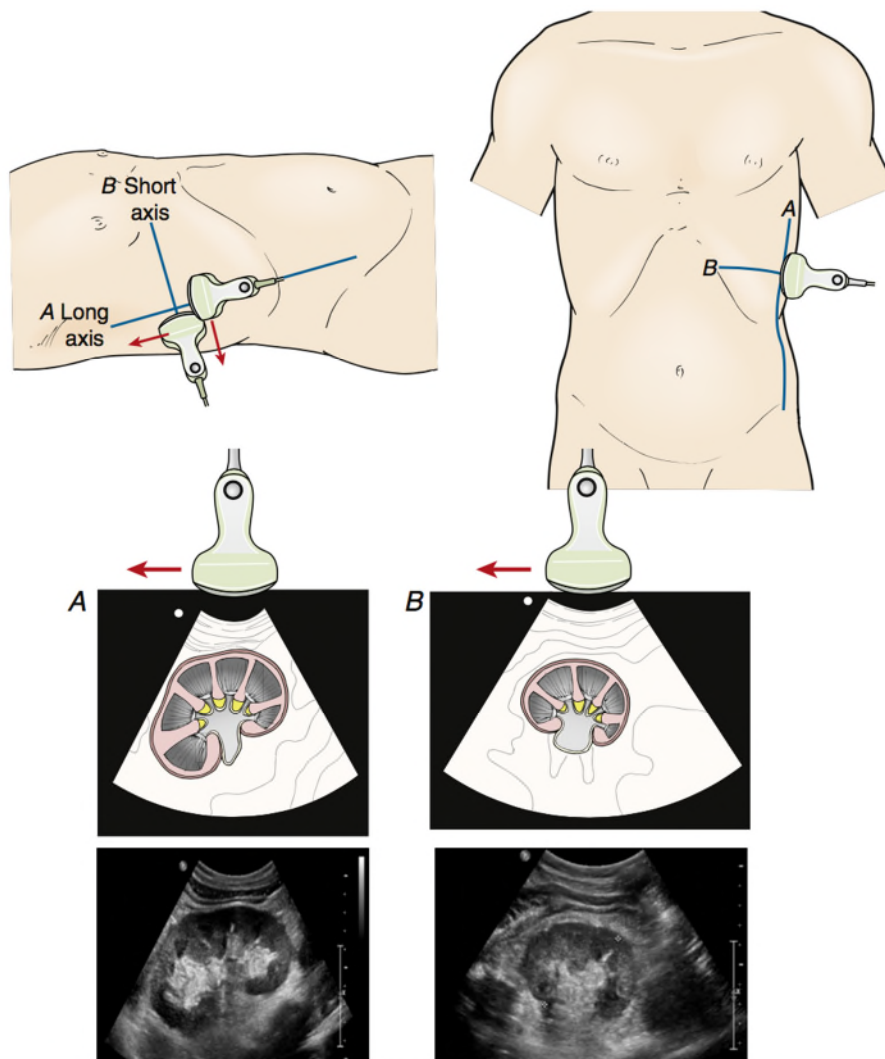
Long axis

- While holding the top of the transducer in place, slowly slide the inferior part of the transducer from anterior to posterior with the aim of visualising the entire kidney.
- Identify, the following anatomical structures:
 - **Renal cortex**
 - **Renal medulla and pyramid**
- Rotate the transducer orientation marker 90° counterclockwise to visualise the kidney in the transverse plane (short axis) as per the diagram below.



Short axis/transverse plane

- Slowly slide the transducer superiorly and then inferiorly with the aim of visualising the entire kidney.
- Identify, the following anatomical structures:
 - **Renal cortex**
 - **Renal medulla and pyramid**



- Optional step: If visualisation is challenging, ask the volunteer to take a deep breath and hold this for a few seconds that will reduce interference from the ribs. Asking the volunteer to lie in the lateral decubitus position, opposite from the side that is being scanned, may also help especially for the left kidney.

References

- Drake et al, Gray's Anatomy for Students.
- Moore et al, Clinically Oriented Anatomy.
- Soni et al, Point of Care Ultrasound.