A Practical Guide to Chest Imaging

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Preface

The 'PA chest' is the most frequent examination request in most X-ray departments, and perhaps because of this it does not always get the interest it deserves. One of the pleasures of radiography is that there is always something fresh to learn or discover.

Let me be quite emphatic that a potted radiology is not the aim of this book (nor would I be qualified to write it if it was). Instead its aim is to enable the radiographer to recognise the normal, and from that the abnormal appearances in the chest, and the reasons why certain changes occur or are important. Primarily the book is designed for students preparing for the Diploma or Higher Diploma of the College of Radiographers examinations, and for radiographers in departments where a radiologist is not readily available at all times, for example, at 2 o'clock in the morning!

My main concern is with basic chest radiography and the commoner special procedures. I have included other imaging methods for the benefit of those who have access to them, and this will of course mean most DCR students. I have not attempted to give more than an introductory outline of these, and readers are recommended to the many specialist texts available for detailed information and techniques. A brief survey is made at the end of some techniques which at present are at the research and clinical trial stage of development.

Above all, however, it is my hope that this book may encourage 'student' radiographers, whether of 30 days or 30 years experience, to take a closer look at the chest radiographs they take.

Norwich 1984 P.R.W.

Acknowledgements

My thanks are due to the radiologists, chest physicians and thoracic surgeons who over the years have been willing to share their knowledge and experience with their radiographic staff, and have stimulated in them an interest in chest radiography.

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To Keith Maughan for his careful painstaking work on the line illustrations and Jennie, his wife, courier and on-the-spot technical adviser, and Sue Harrison for typing the Glossary, my gratitude. Finally my thanks to Churchill Livingstone and Dr Wightman for their helpfulness and encouragement.

P.R.W.

Contents

Introductory Note

The diagrams are of the postero-anterior projection of the chest unless otherwise stated. Where only a single lung is shown this is of the right side, but any abnormality shown could equally well be on the left, unless anatomical differences prevent it. The midline of the body is indicated wherever it is of significance. To avoid tedious repetition, the abbreviation PA is generally used throughout, rather than the term postero-anterior. On lateral chest diagrams the heart outline is omitted unless it is relevant to the information.

The terms radiolucent and radio-opaque have been used to avoid the confusion inherent in the word density. Radiolucent refers to the tissue density of a part of the body through which the X-ray beam passes relatively unattenuated, thus producing an area of greater blackening on the radiograph. A radio-opaque part is one which attenuates much of the beam, resulting in a light 'whiter' area on the radiograph. The shading in certain diagrams is a simplified indication of the radiographic blackening in the normal negative image.

SECTION ONE

Review of Anatomy and Radiographic Positioning

1.1 Basic Anatomy of the Adult Chest

The thorax is the upper part of the trunk between the neck and diaphragm. The chest is the collective term for the contents of the thoracic cavity.

Surface markings

See Figures 1.1 to 1.5.

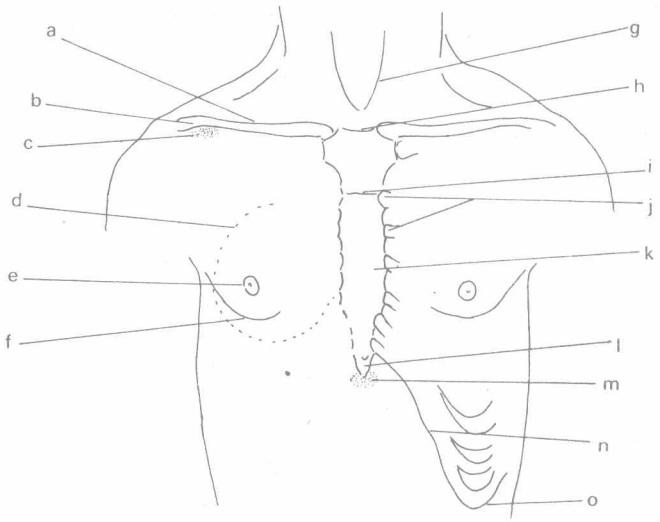


Fig. 1.1
Surface markings.
Anterior aspect, adult chest.

- **a.** Supraclavicular fossa
- **b.** Clavicle
- **c.** Infraclavicular fossa
- **d.** Female breast extending from 2nd to 6th ribs approximately
- **e.** Male nipple, commonly in 4th interspace
- **f.** Pectoral muscle over 5th costal cartilage
- **g.** Sterno-mastoid muscle
- **h.** Sternal notch
- **i.** Sternal angle
- **j.** Chondral junctions (2nd and 3rd)
- **k.** Body of sternum
- **l.** Xiphisternum
- **m.** Epigastric fossa
- **n.** Chondral margin
- **o.** Lower costal margin.

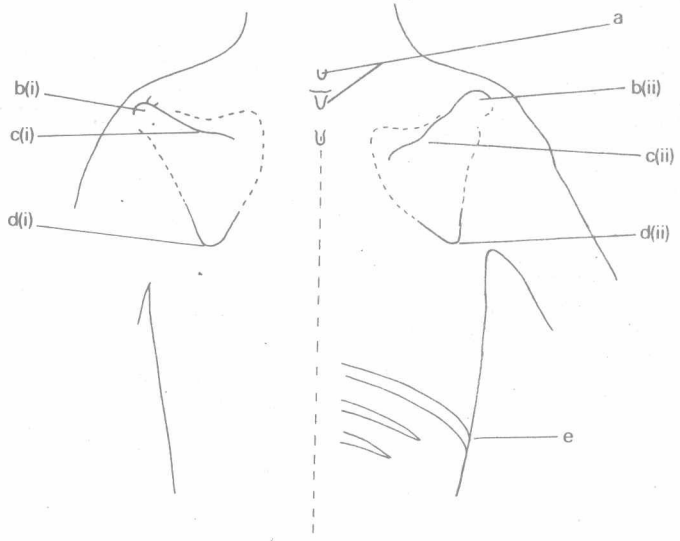
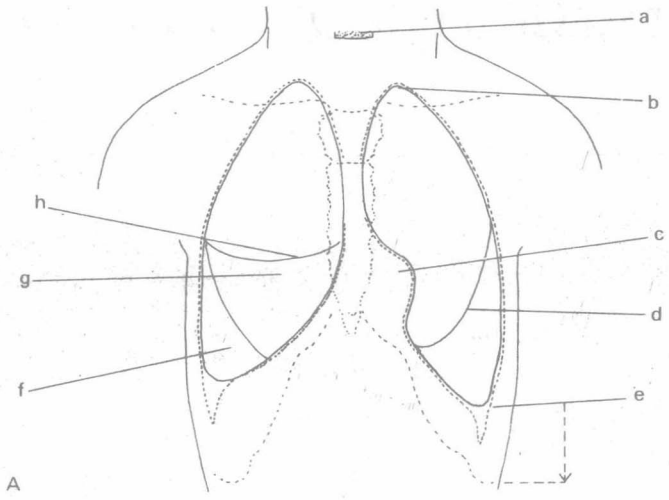


Fig. 1.2
Surface markings.
Posterior aspect, adult chest.

- **a.** Spinous processes of 7th cervical and 1st thoracic vertebrae
- **b.** Acromion process
- **c.** Spine of Scapula
- **d.** Inferior angle of scapula
- **e.** Lower costal margin
  - **(i)** Arm by side
  - **(ii)** Arm in position for postero-anterior chest radiography.

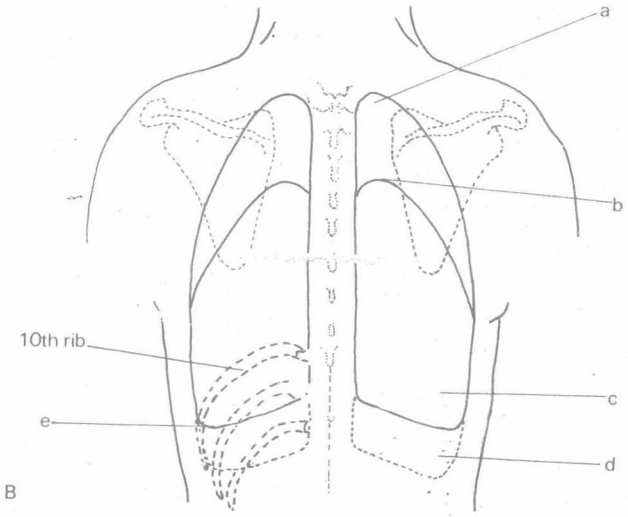
Fig. 1.3
Surface markings.
Lungs.
(**A**) Anterior aspect.

a. Cricoid cartilage, lies 2 cm above apices in all phases of respiration
b. Apices 2.5 cm above medial third of clavicles in quiet breathing, but on full costal inspiration they may be level
c. Cardiac notch
d. Oblique fissure
e. Base of lungs, about 5 cm above lower costal margin on full inspiration, 10–13 cm on expiration
f. Right lower lobe
g. Right middle lobe
h. Horizontal fissure at level of 4th costal cartilage.



(**B**) Posterior aspect.

a. Right upper lobe
b. Oblique fissure, Upper extent
c. Right lower lobe
d. Pleural cavity, inferior extent
e. Base of lung extends down to 10th rib on quiet breathing, 11th or 12th on full inspiration.



(C) Lateral aspect.

a. Arms raised above head
b. Manubrium
c. Horizontal fissure, at nipple level in male
d. Costo-phrenic recess inferior extent
e. Lower costal margin
f. Mid-axillary line
g. Base of lung extending to 5 cm above lower costal margin in mid-axillary line on full inspiration
h. 10th rib
i. 8th rib
j. Oblique fissure, more or less follows line of medial border of scapula when arms are raised.

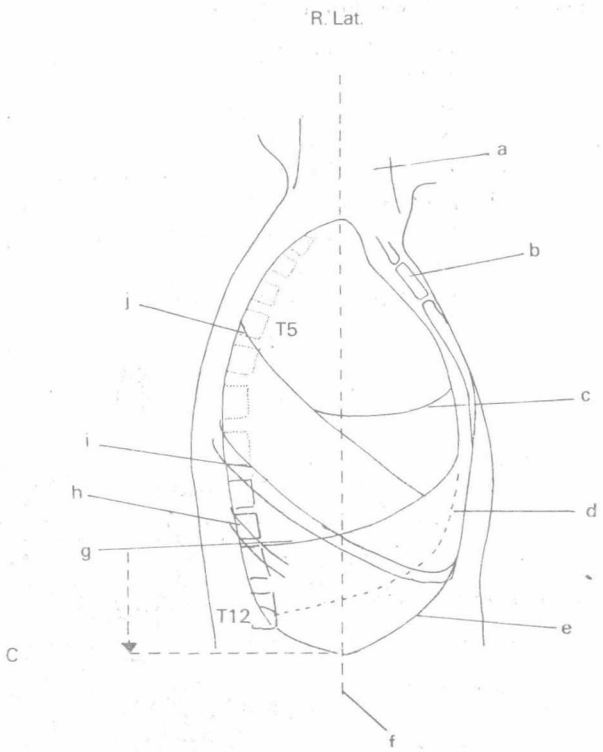
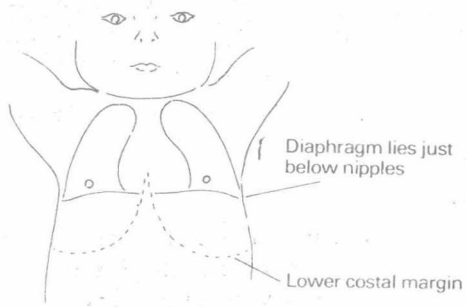


Fig. 1.4
Surface markings. Anterior aspect, infant chest.



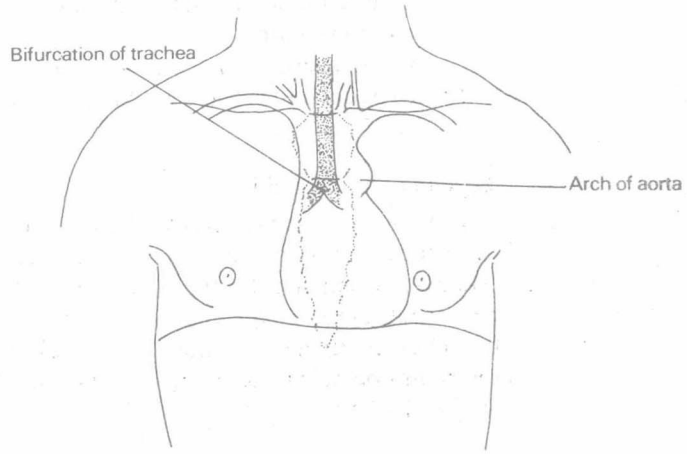


Fig. 1.5
Surface markings. Mediastinal contents, anterior aspect.

Boundaries of the thoracic cavity

a. *the chest wall*
   - thoracic spine
   - shoulder girdle and sternum
   - ribs and costal cartilages
   - vertebral and intercostal muscles.

b. *the thoracic inlet* is the superior boundary lying at the root of the neck. It forms an oval transverse bony ring about the same size and outline as a kidney (Fig. 1.6).

c. *the diaphragm* seals the outlet of the thoracic cavity inferiorly.

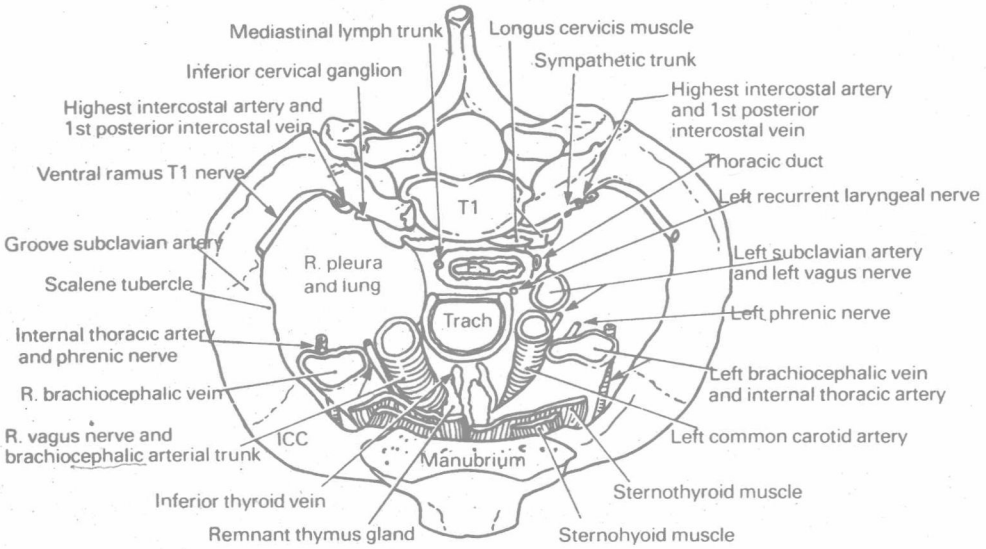


Fig. 1.6 Contents of thoracic inlet (reproduced with permission from *Jamieson's Illustrations of Regional Anatomy* 9th edn. Churchill Livingstone, Edinburgh).

Contents

These lie in one of four self-contained compartments:

1,2 right and left pleural cavities containing the lungs.

3 mediastinum containing the major blood vessels, trachea and main bronchi, oesophagus, lymph nodes and thoracic duct, and the pericardium.

4 pericardium, the heart and the roots of the great vessels.

Their relations to surface markings and vertebral levels are shown in Figures 1.5 to 1.10.

Trachea and bronchi

The trachea, the first part of the lower respiratory tract, starts at the level of the 6th cervical vertebra, as a continuation downwards of the larynx. The trachea is a semicircular tube, flattened behind where it is in contact with the oesophagus. Immediately anterior to the trachea is the aortic arch and its branches. At the level of the sternal angle it bifurcates into the main bronchi, the right one being wider, shorter and more vertical than the left (Figs 1.7–1.8).

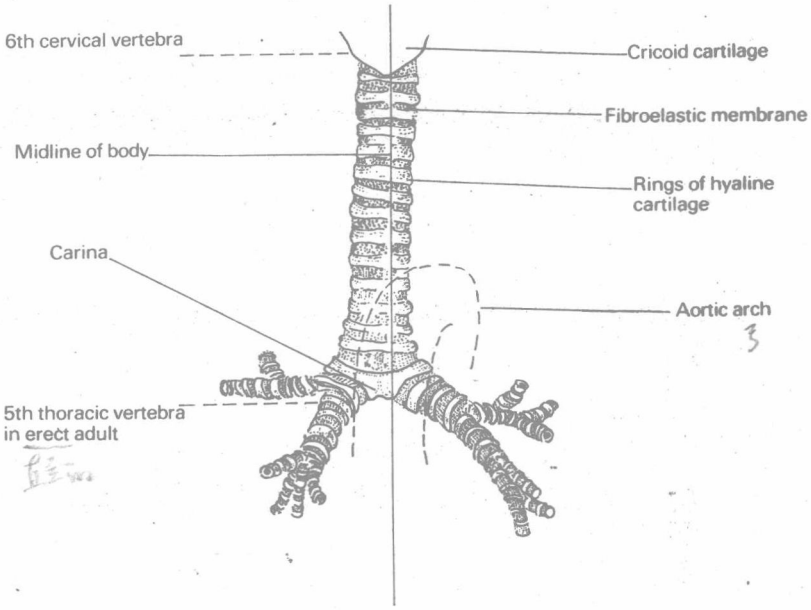


Fig. 1.7
Trachea and main bronchi, anterior aspect.

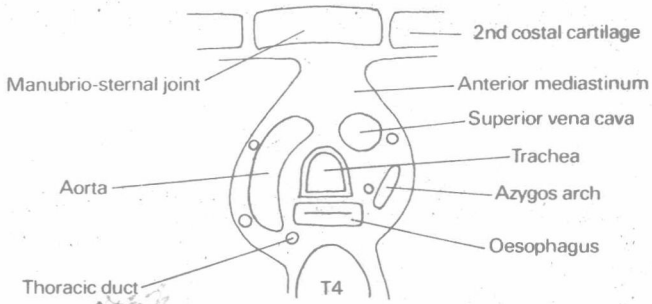


Fig. 1.8
Trachea, relations at level of 4th thoracic vertebra.
Transverse section.

The bronchi subdivide several times within the lungs (see Fig. 6.2). Throughout their length the trachea and bronchi are reinforced with rings of cartilage around their walls, preventing over-expansion or collapse of the airways, but at the same time possessing some elasticity. Extra support is given at the bifurcation by the union of the first ring of each bronchus in the midline. This piece of cartilage is called the carina.

Pleural cavities

Together they three-quarters fill the thorax, the remaining central space being the mediastinum. Each pleural cavity is lined with a smooth serous membrane, the parietal pleura. At the hilum it is reflected back and is continuous with the inner, visceral pleura which completely covers each lobe of the lung. A small area lies bare of pleura at each hilum. In the healthy chest the two layers of pleura are in contact with each other throughout, except at the bottom of the costophrenic recesses where the pleural cavity extends inferiorly a few centimetres beyond the lungs. The 'cavity' is therefore only a potential one.

Lungs

The right lung has three lobes: upper, middle and lower. The left lung is a little smaller because the heart lies more on that side (Fig. 1.9) It has two lobes, upper and lower, although sometimes the lingular segment of the upper lobe is covered in pleura and becomes a true left middle lobe. Each lobe is further subdivided into a number of self-contained segments, each with its own segmental bronchus and blood supply.

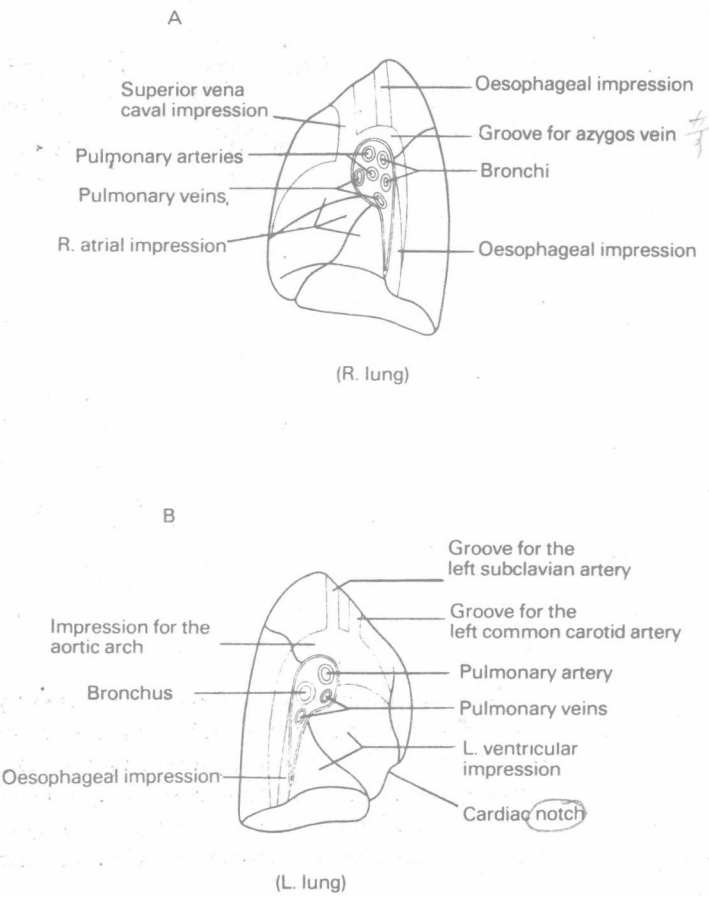


Fig. 1.9
Medial aspect of
(**A**) right and
(**B**) left lung
(reproduced with permission from Lumley Craven & Aitken *Essential Anatomy*. Churchill Livingstone, Edinburgh).

Deep in the lungs the smallest bronchi divide into microscopic airways unsupported by cartilage and these are called bronchioles. These divide several times in turn and eventually end in the alveoli (or acini) where gaseous exchange takes place (Fig. 1.10). Throughout the whole of the bronchial tree, apart from the alveoli and their ducts, the walls are lined with cilia and mucus producing cells. These are constantly active in propelling upwards dust and other debris from the lungs.

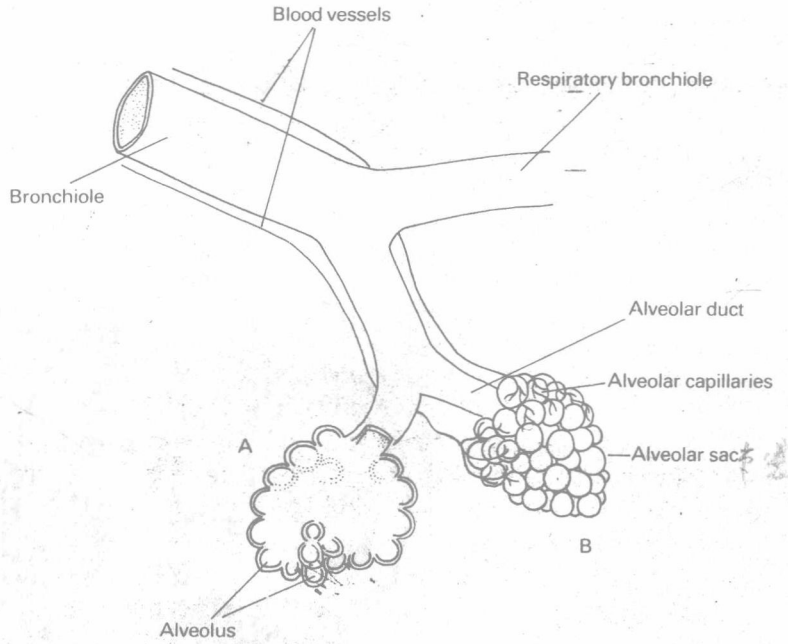


Fig. 1.10
Lung alveoli.

A sections through alveolar sac
B external appearance

Heart and great vessels

This conical organ lies obliquely in the middle mediastinum with its apex pointing downwards to the 5th left interspace in the mid-clavicular line. It is entirely enclosed within the pericardial cavity. The tough outer layer of the pericardium (the fibrous pericardium) is attached to adjacent viscera, diaphragm and thoracic cage, anchoring the heart firmly but not rigidly. At the base of the heart the pericardium merges with the outer coats of the great vessels. The right and left sides of the heart are similar in structure and are separated by a septum through which there is no communication once development is complete. Blood enters the heart at the atria and leaves from the ventricles, from the right side to the pulmonary circulation and from the left to the systemic circulation (Fig. 1.11).

From Figure 1.11 it can be seen that the entrance and exit of each ventricle are close to each other. The blood however flows along a V-shaped track through the ventricle, referred to as the inflow and outflow tracts. On atrial systole the jet of blood follows the inflow tract to the apex and on ventricular systole the ventricular muscle wall contracts towards the septum 'bouncing' the blood up the outflow tract. This feature is important in angiocardiography. For anatomy of the oesophagus see Figure 6.19 and section 6.4 (p. 207). For anatomy of the thoracic duct see Figure 6.17 and section 6.3 (p. 204).

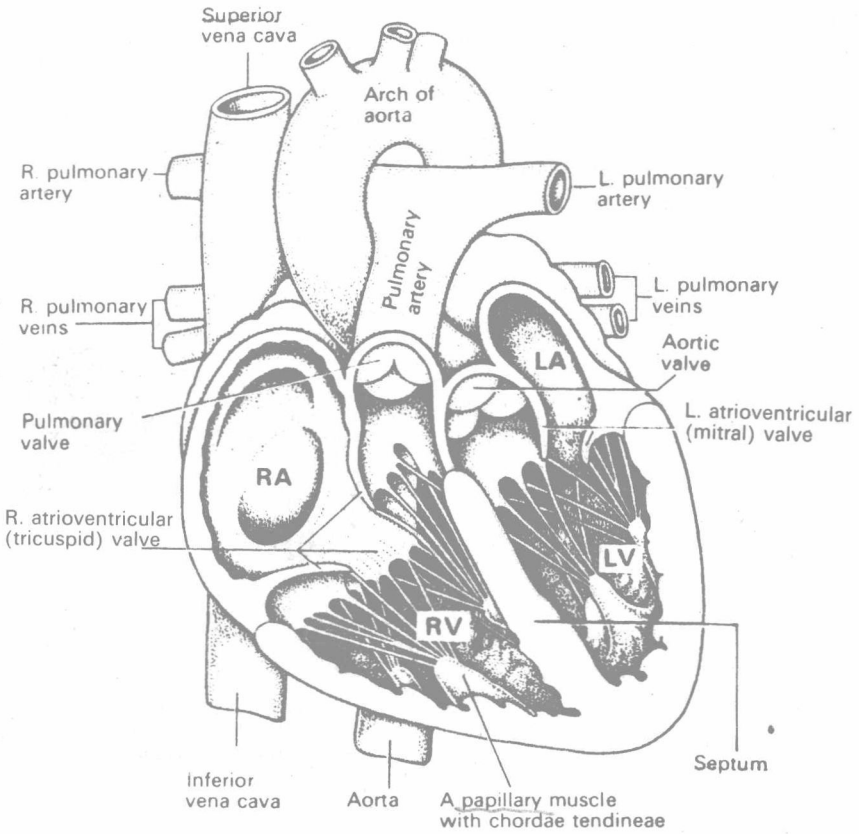


Fig. 1.11
Heart, showing relationships between chambers, valves and great vessels (reproduced with permission from Ross & Wilson *Foundations of Anatomy and Physiology* 5th edn. Churchill Livingstone, Edinburgh).